



# THE STATE OF BERMUDA'S WATERS:

A Snapshot of Bermuda's Exclusive  
Economic Zone (EEZ) From the  
Coastline to 200 Nautical Miles (nm)



February 01, 2022

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## Aerial View of North Rock Reef

Photo Credit // © J-P Rouja



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This report was produced by the Government of Bermuda and looks at the physical status, economic context, and social influences on Bermuda's Exclusive Economic Zone (EEZ). Many contributors added their knowledge, expertise, and perspectives to its creation.

This is a public document and its contents will be used to inform Bermuda's decision makers on appropriate management decisions for Bermuda's EEZ.

### Contributors

Substantial drafting and editorial contributions were made by Alexander Abbott, Dr. Nick Bates, Sarah Brooks, Chris Bulley, Jennie Dean, Vanessa Dick, Lauren Gode, Ali Hochberg, Dr. Sarah Manuel, Julie Marshall, Aran McKittrick, Bruce Myers, Captain Jeffrey Patterson, Victoria Pereira, Amos Peters, Dr. Andrew Pettit, Dr. Joanna Pitt, Canon Purdy, Philippe Rouja, David Simmons, Scott Simmons, Dr. Geoff Smith, Dr. Struan Robbie Smith, and Dr. Tammy Warren. Katherine Gustafson, freelance writer and editor, collated and edited the report.

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### About Bermuda Ocean Prosperity Program

The Bermuda Ocean Prosperity Programme (BOPP) is an inclusive initiative to support sustainable growth of ocean economies while maintaining the health of the ocean from now into the future. Led by the Government of Bermuda, in collaboration with the Bermuda Institute of Ocean Sciences (BIOS) and the Waitt Institute, BOPP aims to foster the sustainable, profitable, and enjoyable use of ocean resources for present and future generations.



**BERMUDA OCEAN**  
PROSPERITY PROGRAMME

# INTRODUCTION

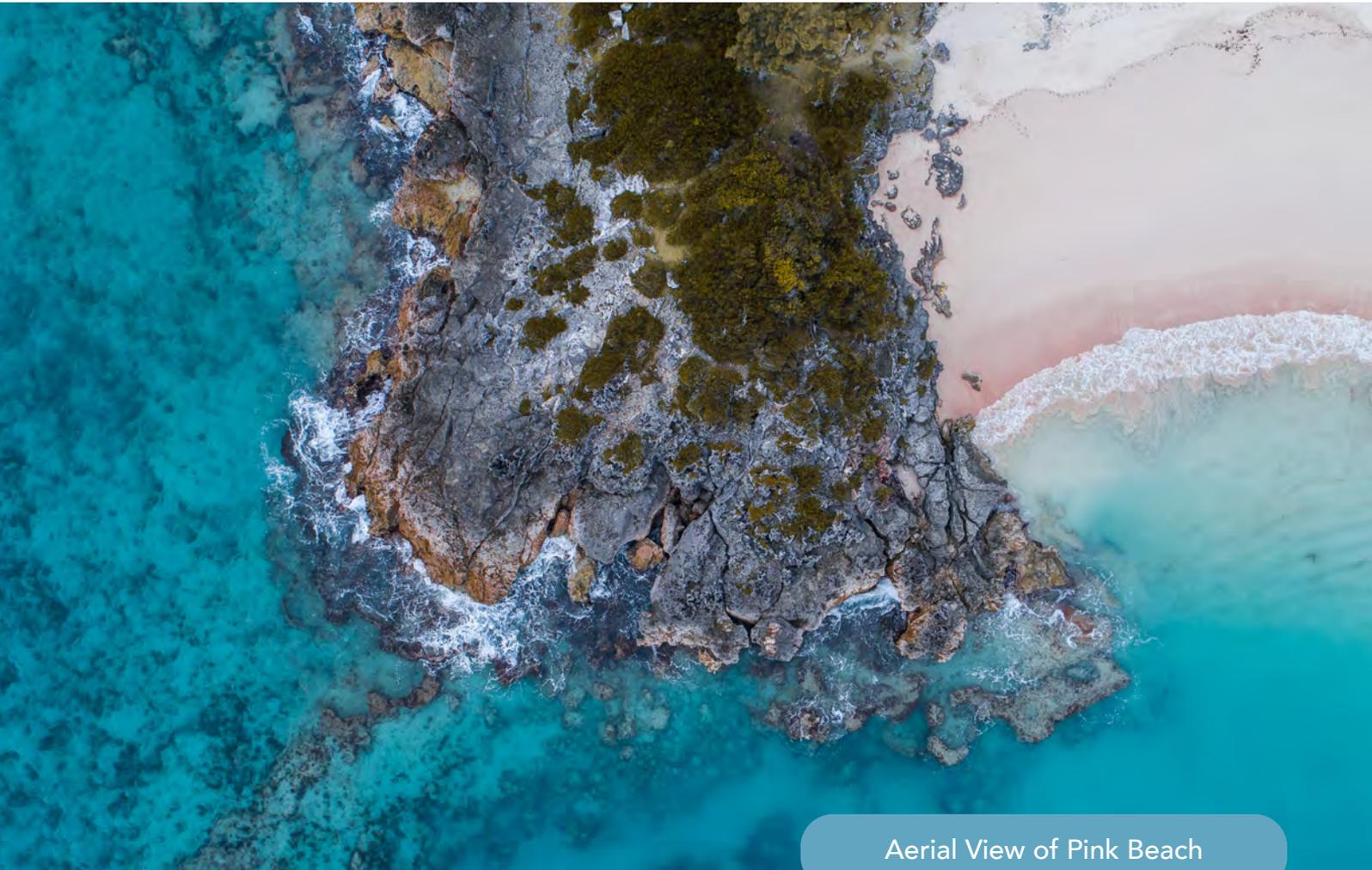
This report looks at the physical status, economic context, and social influences on Bermuda's Exclusive Economic Zone (EEZ). This report does not provide a comprehensive breakdown of all aspects of the EEZ, but instead establishes a baseline for further research and development into how to sustainably manage Bermuda's marine space and resources. It builds upon the Government of Bermuda's 2005 State of the Environment report.

Specifically, the report outlines the status, uses, threats, and governance of the EEZ's marine environment and underwater cultural resources. This information can help identify priorities for the island's future development and use of environmental resources and practices.

In 2010, the Government of Bermuda articulated a vision for Bermuda's marine environment in the report *A Strategy for the Sustainable Use of Bermuda's Living Resources*. It included a commitment to integrated planning for Bermuda's marine waters. This new report aims to provide context for current and future comprehensive marine planning processes, a topic discussed further in the report's final section. Marine spatial planning is a public participatory process that uses the best available information about the natural environment and human activities to direct how to plan for future use and conservation of ocean space.

**How this report is organized:** The document is arranged in sections that follow the same sequence as the topics in this introduction. As such, this introduction serves as a summary, and the sections that follow will provide more context and detail on the topics summarized here.

The report was completed through the combined effort of several Bermudian industry experts along with support from the Bermuda Ocean Prosperity Programme (BOPP).



Aerial View of Pink Beach

## What Is Bermuda's EEZ?

Established in 1996, Bermuda's Exclusive Economic Zone (EEZ) stretches 200 nautical miles (nm) from its coast. Bermuda has special rights over its EEZ, including the rights to:

1. explore, exploit, conserve, and manage natural resources of the water, seabed, and subsoil;
2. explore and exploit the zone for energy production; and
3. exercise jurisdiction regarding installations, marine scientific research, and the protection of the marine environment.

Although the island is only 54 square kilometers (km<sup>2</sup>), Bermuda's EEZ is a total of 464,389 km<sup>2</sup>, just over the size of California. The EEZ encompasses the Bermuda Rise, a vast raised portion of the Atlantic seafloor that is home to seven seamounts, including the Bermuda Seamount, the shallow top of which is known as the Bermuda Platform. The Bermuda islands are the emergent portion of the Bermuda Seamount, the only portion of the seven seamounts that rise above sea level. The islands' coastal environments, coral reefs, and surrounding ocean are biologically rich, contain priceless marine cultural heritage, provide food and economic opportunities for Bermudians, and support diverse local and touristic recreational activities.

## The State of the EEZ's Marine Environments, Species, and Cultural Resources

Bermuda's natural habitats provide critically important ecosystem services, from serving as storm buffers, to supporting fisheries, to hosting spawning grounds for diverse sea creatures. Bermuda's underwater cultural

resources, primarily shipwrecks, are world-renowned and attract tourists that are a mainstay of Bermuda's economy. Yet, despite their importance, most of these resources are facing threats of various kinds, including sea level rise, coastal development, climate change, and overfishing. The following is an overview of the status of Bermuda's main ecosystems and cultural treasures.

**Coral reefs:** Bermuda's coral reefs provide critically important ecosystem services, including acting as a natural storm wave buffer that protects Bermuda's shorelines, beaches, and maritime infrastructure. Reefs support diverse fisheries, as well as SCUBA diving and snorkeling businesses that use the historic wrecks. Bermuda's coral reefs are in good shape, though they face a number of challenges, particularly overfishing, climate change, and sea level rise.

**Seagrass:** Seagrass beds are critical habitats in Bermuda's extensive North Lagoon and protected inshore waters, providing essential ecosystem services. Numerous animals move between seagrass beds and coral reefs, including many of the fish that serve as food for the islands' human inhabitants. Evidence suggests that many seagrass beds throughout Bermuda have collapsed in the past 20 years. Restoration and protection measures are currently being developed.

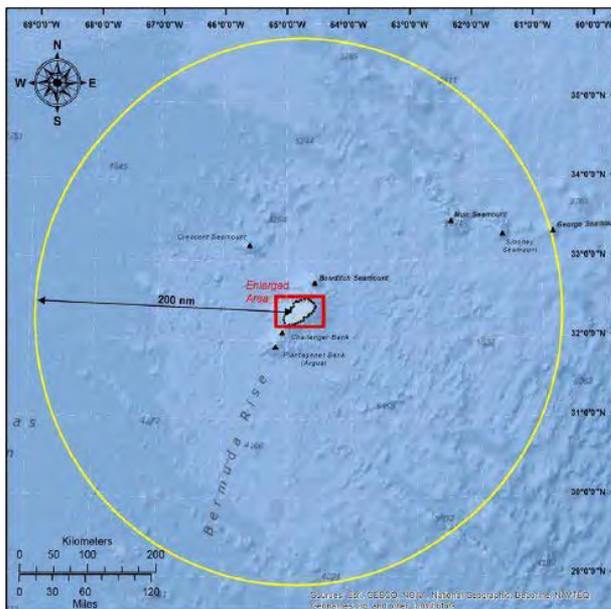
**Mangroves:** Bermuda's mangroves develop in the intertidal zone of protected bays and provide similar ecosystem services to seagrass beds, as well as serve as a natural storm buffer that protect shorelines and maritime infrastructure. Mangroves have been devastated by centuries of coastal development and simultaneously impacted by hurricanes and sea level rise. The magnitude of mangrove loss and their diverse ecosystem services cannot be overstated.

**Inshore waters:** Bermuda's inshore waters include protected bays, sounds, smaller islands, and islets. These sheltered areas support rich plankton communities, which benefit filter-feeders (e.g., clams and oysters) and baitfishes. Water quality is improving due to new regulations. However, the decline of inshore seagrass beds and coastal mangroves has eliminated important habitats for many species.

**Offshore banks:** Challenger, Plantagenet (Argus), and Bowditch are local offshore banks that are important locations for several species of pelagic fishes, baitfishes, top predators, and marine mammals. The deep slopes of the banks and the Bermuda Platform support distinct coral, sponge, and fish communities. Extensive fishing occurs on the banks and along the perimeter of the Bermuda Seamount.

**Open ocean:** Open ocean comprises the largest part of Bermuda's EEZ. The broader Sargasso Sea is essential to sustain pelagic fishes since it serves as a spawning ground and developmental habitat for juvenile fishes and sea turtles. In addition, pelagic Sargassum mats are critical habitat for many species. Local seabirds and diverse migratory seabirds forage in surface waters. The warming and acidification of the ocean and persistent

FIGURE 1: Map of Bermuda's Exclusive Economic Zone (EEZ)



plastic pollution are threats to numerous fishes, turtles, seabirds, and marine mammals.

**Protected and endemic species:** Bermuda's protected marine species are either those that provide structural integrity for ecosystems and habitats (such as coral and mangroves) or those that have been damaged by over-exploitation or habitat loss. Identification of these species is important to reverse their decline by promoting protection and restoration. However, there is insufficient information to mount effective conservation work for most of these species.

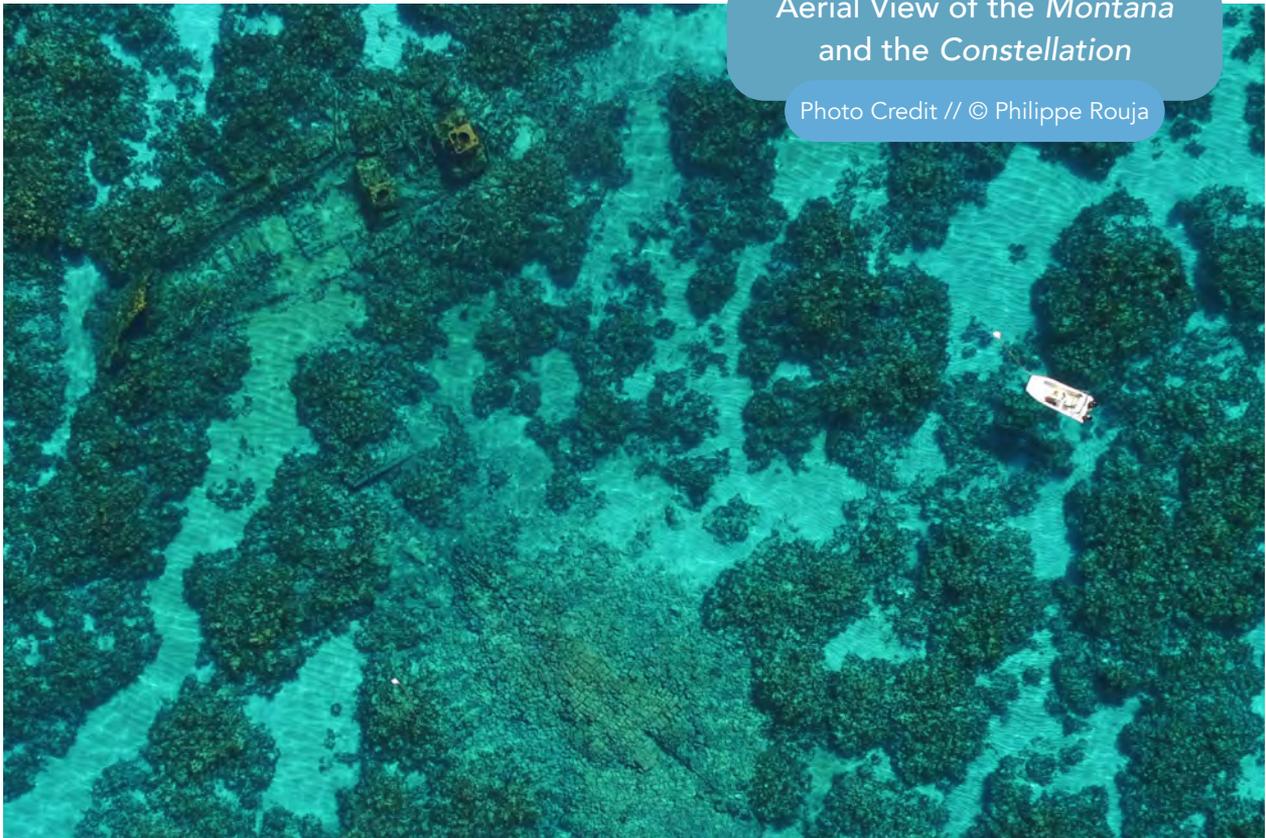
**Underwater cultural heritage:** Shipwrecks and maritime history are Bermuda's origin story. There are currently 215 historic shipwrecks in the official Register of Wrecks. Of these, 38 have been classified as *Open* and 13 have been classified as *Closed*. Wrecks listed as *Open* under the Historic Wrecks Act (HWA) comprise the major portion of Bermuda's most extensive no-fishing protected area network. The Register of Wrecks also contains 164 wrecks that have not been classified as either *Open* or *Closed*, and information on these is not shared with the public. Wrecks are well-regulated, but face a number of threats, from the effects of climate change to illegal treasure-hunting to destruction due to storm events.

## Current Uses of the Marine Environment in the EEZ

Bermuda's EEZ is put to a wide array of uses, all of which are managed and regulated to varying extents and in a variety of ways.

**Fisheries:** Fishing, whether for subsistence, at a commercial scale, or for leisure, is the longest continuous human activity affecting Bermuda's marine environment, and it has both economic and socio-cultural significance. Although the commercial fishery employs fewer people (~300) and contributes far less to GDP (~0.25%) than other maritime sectors such as tourism, it makes an important contribution to food security, supplying ~33% of marine fish, and ~15% of all fish and shellfish consumed locally. Fishing in Bermuda has a correspondingly long history of management and regulation, with a recurrent theme of regulating the use of fish pots/traps until they were banned in 1990. Since then, approximately half of commercial fisheries landings have been comprised of pelagic species such as tuna and wahoo, while reef fishes such as snapper and groupers make up the remainder. The central fisheries legislation remains the Fisheries Act 1972, which makes provisions for an advisory Marine Resource Board (MRB) and a Commercial Fisheries Council (CFC).

Recreational fishing is extremely popular in Bermuda. Sport fishing tournaments are a big economic contributor. It is estimated that 30% of all households in Bermuda have at least one member of the family who fishes recreationally. Recreational fishing is largely unregulated and is likely to have significant catch volume. There are no estimates of total recreational catch on an annual basis. The difficulty of monitoring recreational fishing combined with the lack of oversight of commercial sales creates challenges for enforcement and stock assessments.



Aerial View of the *Montana* and the *Constellation*

Photo Credit // © Philippe Rouja

**Tourism:** The tourism industry represents a significant portion of the island's economy and employment opportunities. The industry accounted for approximately 5.3% of Bermuda's GDP in 2018 and is responsible for approximately 3,800 jobs (10.2% of employment). The 2019-2025 Bermuda National Tourism Plan, authored by the Bermuda Tourism Authority, contains robust analysis and makes several strong recommendations, including identifying the "must-win" U.S. segments: experience enthusiasts and adventure seekers. While COVID-19 decimated the tourist economy throughout 2020, there is a hopeful outlook for tourism industry recovery in the near future, with a focus on sports and social group travel in the short-term, and corporate business travel resuming.

Cruise travel has been a particularly prominent segment of Bermuda's tourism sector. Prior to COVID-19, cruise travel outpaced overall tourism, with passenger counts rising by 6.6% (vs. 4.5% for all travel spending) in 2018. The cruise industry is among the hardest hit of the travel sectors due to COVID-19. Many travelers are unsure if cruise travel can be conducted safely and, consequently, the cruise industry is unlikely to see significant growth for the next few years.

**Cultural exploration and SCUBA diving:** Shipwrecks are one of Bermuda's most distinctive identifying maritime features and one of the island's most popular paid visitor attractions. This underwater cultural heritage also has inherent scientific, historical, and archaeological significance. Recreational diving is an important economic activity, and shipwrecks are the cornerstone of the recreational dive industry in Bermuda. Recreational diving enhances heritage awareness but can also threaten preservation if not appropriately managed.

**Development of the coastline and inshore waters:** Since 2016, the Department of Planning has received an average of 1,000 planning applications and issued 1,000 building permits each year for various development proposals. Of these 1,000 applications, 132 involved coastal development, such as docks, floating docks, boat maintenance and storage, boat houses, seawalls, revetments, and marinas. Other coastal development proposals included a bridge, subsea water and wastewater piping, and works related to America's Cup. While the current planning framework of conservation zones and coastal development policies appear to be effective in terms of limiting coastal development to that which is necessary and appropriate, there are practices that could be improved. In addition, there is little guidance regarding marine development in places outside coastal areas.

**Energy provision and telecommunications in the marine environment:** The space, satellite, telecommunications, and energy industries in Bermuda are thriving through the continued development of robust policy and legislation by the Department of Energy. As an island nation, most major industries, including the telecommunications and energy industries, rely directly on infrastructure located in the marine environment, such as fibre-optic cables. As such, Bermuda is dependent

on the continued maintenance and security of this environment to maintain its economic stability. Currently, Bermuda's Ministry of Home Affairs is looking to diversify the island's energy production through the establishment of a Regulatory Sandbox, a legislative framework aimed towards companies interested in testing innovative and large-scale renewable technologies. The first company to utilize the Regulatory Sandbox is Seabased, who will, with the help of the Government and the people of Bermuda, implement a wave energy pilot program in an approved area of Bermuda's waters.

**Transportation in the marine environment:** Managed by the Department of Marine and Ports Services, the SeaExpress Ferry Service is part of Bermuda's public transportation system and, as such, it plays an important role in the community, both for locals and visitors alike.

**Shipping:** The Mandate of the Bermuda Shipping and Maritime Authority (BSMA) is to administer the statutory functions related to the international registration, survey, certification, and enforcement of Bermuda Laws on ships flying the Bermuda flag. The BSMA also has oversight of Bermuda's Marine Pollution Response readiness to ensure an effective response following an accident or pollution incident on a ship in the territorial waters or the Exclusive Economic Zone of Bermuda.

## Threats to Marine Natural Resources and Cultural Heritage in the EEZ

Bermuda's EEZ faces a number of ongoing and growing threats, some specific to certain environments and others affecting an array of ecosystems. The following outlines the main threats to the health of Bermuda's EEZ.

**Climate change and sea level rise:** Bermuda's waters have become warmer, saltier, more acidic, and less oxygenated due to impacts from the Climate Crisis. In the last ten years, the oceans around Bermuda warmed by nearly 1°C. Water temperature that peaks above 29°C in the summer can result in several consequences for coral reefs, including coral bleaching and alteration of the corals' microbial community. Bermuda has also witnessed several fish "die-offs" in the past 20 years, including a mass die-off in the summer of 2017 during a spate of higher-than-normal surface seawater temperatures. Along with direct impact from warmer waters, sea level rise threatens Bermuda in several ways. For example, it inhibits the ability of mangroves to create peat, disrupting their natural ability to trap leaves and other organic material among their roots. Ocean acidification and deoxygenation also compromises the ability of coral to grow in pace with predicted sea level rise. And longer periods of warmer waters increase the risk to Bermuda from hurricanes. These combined impacts alter the delicate balance of biodiversity and ecosystem function, leaving Bermuda more vulnerable to storm surge, fish stock collapse, and other consequences of a disrupted marine system.

**Shoreline development:** Development of Bermuda's inshore waters with docks, marinas, dredging, land reclamation, and dense swinging moorings is decimating mangroves and seagrass beds. Mooring systems with chains that drag across the seabed are particularly destructive to seagrass. Mangroves often suffer from the construction of commercial properties and infrastructure. Additionally, infrastructure projects in coastal areas such as cruise ship dock creation, dredging of channels and bridge construction, sand extraction, pipeline and cable laying, and land reclamation have had major impacts on the areas that contain known and potential underwater cultural heritage sites.

**Overfishing:** The consequences of historical overfishing of coral reef fish has been exacerbated by a limited understanding of the balance between conservation and extraction in some cases. Insufficient data on Bermuda's fish populations and on the number of Recreational fishers and their harvest greatly limits an understanding of how much fishing occurs on Bermuda's reefs and places the burden of regulation on Commercial fishers.

**Overgrazing:** In recent years, green turtle grazing put unprecedented pressure on seagrass habitat, resulting in the collapse of local beds and creating a conservation dilemma where one protected species, the green turtle, is causing the decline of other protected species, the seagrasses. In a healthy marine ecosystem, seagrasses and green turtles co-exist but, in this case, the overfishing of sharks, a key turtle predator, may have led to an imbalance in the ecosystem on the Bermuda Platform.

**Invasive species:** Various invasive species are threatening Bermuda's ecosystems. Lionfish are pervasive across reefs and have been seen congregating on reefs up to 60 m deep, though there is evidence they are currently kept in check by intensive collection by licensed cullers. Additionally, cow nose rays recently appeared in Bermuda and are growing in number.

**Wastewater, pollution, and durable waste:** Pollution in Bermuda's waters can originate from both overseas and local sources of pollutants, including cruise ships, merchant ships, and oil tankers; oil pipelines; municipal sewage discharge; stormwater, road, and

landfill run-off; contaminants leached from groundwater; antifoulant paints; and in sewage from local boats. Pollution in Bermuda's near-shore waters is generally well-understood and has been partly mitigated in many instances. Recent decades saw a significant increase in the amount of plastic marine debris in the Sargasso Sea, and disposal of metal waste and other inert materials into a marine landfill remains a less-environmentally desirable disposal option.

**Storm events:** The impact and reach of extreme storm events have also increased with the rising sea levels, allowing more water to reach farther onto the reef platform and higher up the coasts, causing significant erosion and destruction of coastal properties, as well as loss of local vessels. Several historic shipwrecks in Bermuda suffered damage because of the increased frequency and intensity of storm events, winter gales, and hurricanes. Furthermore, a number of moored boats break loose and run aground annually during storms and are abandoned by their owners to become ecological and safety hazards.

**Tourism and treasure-hunting:** The tourism industry has the potential to cause negative impacts on Bermuda's natural environment and underwater cultural heritage. Cruise ships have issues with waste management despite waste discharge currently being regulated by domestic and international pollution prevention laws. At the same time, even the cleanest cruise ships emit over three times as much carbon dioxide per passenger mile as jets. Once cruise ships arrive on the coasts, they need to be harbored, and the environmental damage caused by dredging and anchoring to accommodate massive ships can be significant. In addition, there are concerns about possible fuel leaks.

In regards to tourism at cultural heritage sites, key dive sites can become congested with dive boats, and poor anchoring practices can damage shipwrecks. Additionally, while it is illegal to remove any historic artifacts from a historic shipwreck or marine heritage site in Bermuda without authorization, the removal and damage of historic shipwreck and marine heritage sites remains a problem.



## Governance of Marine Resources and Underwater Cultural Heritage in the EEZ

Bermuda is a United Kingdom Overseas Territory with independent authority to develop laws and policies to manage its own resources, subject to limited United Kingdom oversight and reciprocal responsibilities. In practice, Bermuda is self-governing with respect to all services, and exercises authority within its Territorial Sea limit of 12 nautical miles, including the resources within the water column. One of the few exceptions to this authority is Bermuda's seabed, which resides under the sovereignty of the Crown. However, Bermuda's authority over fisheries resources extends to the entire Exclusive Economic Zone.

The agencies responsible for the protection of Bermuda's marine environment and natural resources tend to work independently, focused on each of their specific areas of interest, cooperating when a common interest is identified. Other government and non-governmental departments, quangos, and organizations are consulted and/or advised as necessary.

A full list of the central regulatory framework or legislation governing the variety of activities that takes place in Bermuda's marine environment is provided in [Appendix A](#).

## The Importance of Marine Spatial Planning

Currently, Bermuda has no comprehensive planning system operating below the mean high-water mark. Only developments that are connected to land, such as docks and marinas, are regulated. Thus, there is no system for producing an integrated forward-looking plan for marine spaces, and no marine planning strategy to guide such plans.

The current governance system of local marine management can be described as a patchwork of dozens of ocean-relevant laws in which authorities—often independently—make decisions about how to utilize ocean resources. Notably, Bermuda has not enacted laws to comprehensively govern certain new and emerging activities, including offshore mining, energy development (e.g., wind, tidal, wave, current, thermal, and petroleum facilities), and aquaculture.

Various types of marine protected areas (MPAs) have been established in the shallow waters of the Bermuda Platform to protect important coral reef areas, prohibit fishing at seasonal fish spawning grounds, restrict certain types of fishing gear, and ease conflict between divers and fishermen at particular sites. However, Bermuda lacks a coherent strategy for the design and objectives of MPAs, or a MPA network, that would inform an overall marine use and marine resource conservation plan.

With increases in marine activity and development, there are corresponding increasing demands on natural marine resources and potential for user conflict. While many

existing laws do provide adequate authority for effective implementation, some areas present opportunities for improvement. And because regulatory management is fragmented, marine enforcement is often focused on specific sectoral activities, thus reducing their broader effectiveness.

Marine spatial planning (MSP) is an important tool to sustainably optimize Bermuda's marine environment. Globally, nations are developing MSPs as recognition spreads that ocean spaces need a planning framework similar to that which has existed for land resources for decades.

While Bermuda's existing planning structure has many of the elements needed to develop a comprehensive MSP, there is a need for a new overarching policy and legal framework that ties these pieces together and fills gaps, as the most effective and efficient way forward.

In 2010, the Government of Bermuda articulated a vision for Bermuda's marine environment in the report *A Strategy for the Sustainable Use of Bermuda's Living Resources*. This included a commitment to integrated planning for Bermuda's marine waters that involved all of Government and stakeholders in its development and implementation. In 2019, to achieve this commitment, the Government of Bermuda partnered with the Waitt Institute and the Bermuda Institute of Ocean Sciences (BIOS), forming the Bermuda Ocean Prosperity Programme (BOPP). The original commitment expanded to include a Blue Prosperity Plan that includes a Marine Spatial Plan to preserve 90,000 square kilometers (50,000 square miles) of Bermuda's waters in fully protected, no-take fisheries replenishment zones, and a Blue Economy Strategy to sustainably develop, manage, and improve ocean industries. BOPP officially launched in June, 2019.

The goal of BOPP is to foster the sustainable, profitable, and enjoyable use of ocean resources for present and future generations. The program goals of BOPP include:

- **Thriving Blue Economy:** Assist Bermuda with the diversification of its national revenue and strengthen the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and continued ecosystem health.
- **Marine Spatial Planning:** Develop and legally adopt an enforceable, comprehensive, EEZ-wide Marine Spatial Plan designed to sustainably manage resources and protect 20% of Bermuda's waters as no-take fisheries replenishment zone.
- **Sustainable Fisheries:** Improve fisheries management, where appropriate, and partner with stakeholders to support Bermuda's fisheries goals through consultations, scientific research, and economic analyses.

Marine spatial planning relies heavily on scientific data and knowledge. This works well for this island nation because Bermuda has been home to a prolific marine science community for many decades, and aspects of Bermuda's marine environment have been well-studied. A marine spatial planning process will help generate a central system where this scientific information can be

stored, shared, and cross-referenced, thereby informing the basis for marine planning.

For this to be successful, more frequent and effective interdepartmental collaboration and consultation is needed. Such collaboration and consultation can be achieved informally between government technical officers or formally as a result of legal requirements. Increasing the frequency and quality of collaboration within the government on marine issues may be among the most promising first steps Bermuda can take on the path to an MSP. This could include the creation of a Marine Spatial Planning Task Force, Committee, or Working Group.

Enacting new legislation will help to recognize and incorporate existing processes such as:

1. Continued oversight of marine resources, fisheries, and marine heritage by the Department of Environment and Natural Resources (DENR);
2. Continued oversight of the development process by the Department of Planning;
3. Continued oversight by the Department of Marine and Ports for operations and management of channels and navigation routes; and
4. Continued oversight of telecommunications and energy sectors by the Regulatory Authority.

The MSP will provide policymakers a framework for balancing development with sustainability while delivering social and economic outcomes in a planned and predictable way. It will outline guidance for managing ocean uses across the entire EEZ and direct marine development proposals in a planning process that draws on local expertise and utilises an environmental impact assessment procedure. Current legislation does not provide for the comprehensive, integrated management of Bermuda's marine environment and many Ministries and Departments have jurisdiction over some aspect of Bermuda's waters. Therefore, in order to ensure environmental health and continued economic growth, the management of Bermuda's waters needs to be conducted in a coordinated manner, hence an MSP. New legislation will complement existing marine legislation, and provide an overarching framework for the principles, scope, governance, implementation, and enforcement of the MSP. It will also draw from existing terrestrial planning mechanisms and expertise to apply the environmental impact assessment process to development proposals in marine waters.

## Fisherman Mural by Graham Foster

Photo Credit // © Shayna Brody



# 1 THE STATE OF THE EEZ'S MARINE ENVIRONMENTS, SPECIES, AND UNDERWATER CULTURAL RESOURCES



North Rock Reef // © Shayna Brody

Sections 1-5 provide more detail on the themes outlined in the introduction. Sections 1 and 2 discuss the state of critical habitats, species, and historical wreck sites within Bermuda’s marine environment, as well as how they are utilized by ocean-reliant sectors in Bermuda. Sections 3 and 4 expand on different human and environmental factors that threaten the natural and cultural resources within the EEZ, and the importance of comprehensive marine management and spatial planning. Section 5 provides an explanation on the Government of Bermuda’s decision to implement a marine spatial plan that will address and diminish current risks to Bermuda’s valuable marine environment. Lastly, Section 6 concludes the report and Section 7 provides an inclusive summary of all preceding sections.

## 1.1 Coral Reefs

Bermuda’s coral reefs provide critical ecosystem services to Bermuda, such as storm wave buffering to protect coastal environments, and serving as home to diverse commercial species, such as rockfish, snappers, hinds, and lobsters. The coral reefs also harbor renowned underwater cultural heritage in the form of historic wrecks, which support a variety of SCUBA diving and snorkeling businesses.

Despite having overall healthy reef ecosystems with high levels of coral cover, the reefs in Bermuda are experiencing the impacts of historical overfishing, invasive species (particularly lionfish, *Pterois spp.*), and global climate change.

Table 1 outlines many past studies and surveys performed at various reefs surrounding Bermuda.

**TABLE 1: Coral Reef Survey and Studies\***

| Authors/Contributors  | Timeframe | Location   |
|---|-----------|--|
| Bermuda Reef Ecosystem and Analysis (BREAM) program (Murdoch, 2018)                                 | 2015-2016 | 39 sites within the North Lagoon, on the rim reef and shallow fore-reef (fig. 2)   |
| BREAM program (Murdoch and Murdoch, 2016)   | 2009-2011 | 92 sites from the shallow reef (5 m) to the deep fore-reef (30 m)  |
| BREAM program (Murdoch and Murdoch, 2016)   | 2009      | 26 buoyed Marine Protected Areas on the rim reef   |
| BREAM program (Murdoch and Murdoch, 2016)   | 2004-2006 | 56 inshore lagoonal patch reefs  |
| Marine Environmental Program Synthesis Report (Hochberg, 2014)                                      | 2004-2011 | Multiple locations across Bermuda constituting different depths, reef zones, and habitats  |
| BBSR Marine Environmental Program (MEP) Annual Report   | 2004-2005 | Multiple locations across Bermuda constituting different depths, reef zones, and habitats  |
| Marine Environmental Program (MEP) Annual Report (Jones et al.)                                     | 2006-2007 | Time series studies at 14 sites, from inshore patch reefs to offshore northern and south shore rim reefs   |
| DENR Benthic Habitat Mapping, Monitoring and Assessment Programme (Manuel et al. 2013) <sup>1</sup> | 2006-2014 | 533 sites across the Bermuda Platform from the coast to a depth of 10 m outside the rim reef, encompassing different depths, reef zones and habitats |
| Marine Environmental Program Reports (Hochberg et al.)  | 2013-2019 | Multiple locations across Bermuda constituting different depths, reef zones, and habitats  |
| Benthic Community Mapping Program: Compiled Reefscape Survey Data (Hochberg et al., 2015)           | 2012-2014 | 1200 sites across the Bermuda platform, encompassing all reef zones and most habitats for depths in the range 0-30 m                                 |
| Benthic Community Mapping Program: Benthic Cover GIS Layers (Hochberg et al.)                       | 2017      | Complete coverage of the Bermuda Platform (except harbors) for depths in the range 0-30 m  |

<sup>1</sup> Manuel, S.A., Coates, K. A., Kenworthy, W.J. and Fourqurean, W.J., Tropical species at the northern limit of their range: Composition and distribution in Bermuda’s benthic habitats in relation to depth and light availability, Marine Environmental Research (2013), <http://dx.doi.org/10.1016/j.marenvres.2013.05.003>

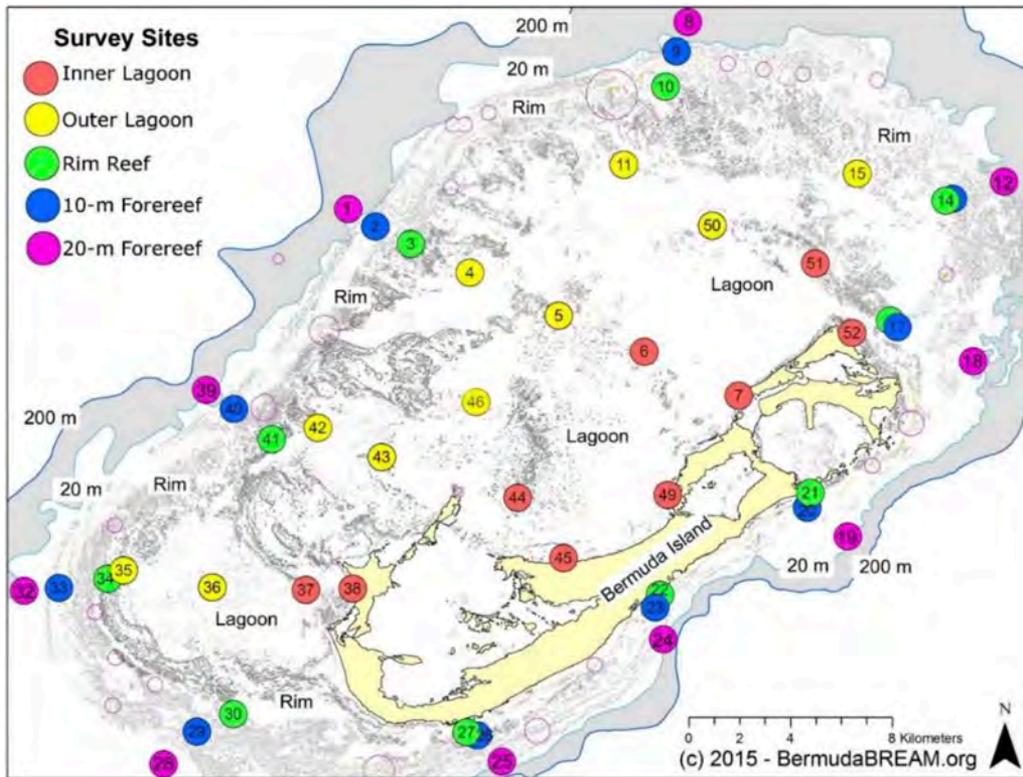


FIGURE 2: BREAM survey sites in 2016. The 20 m fore reef sites were not sampled (Murdoch, 2018)

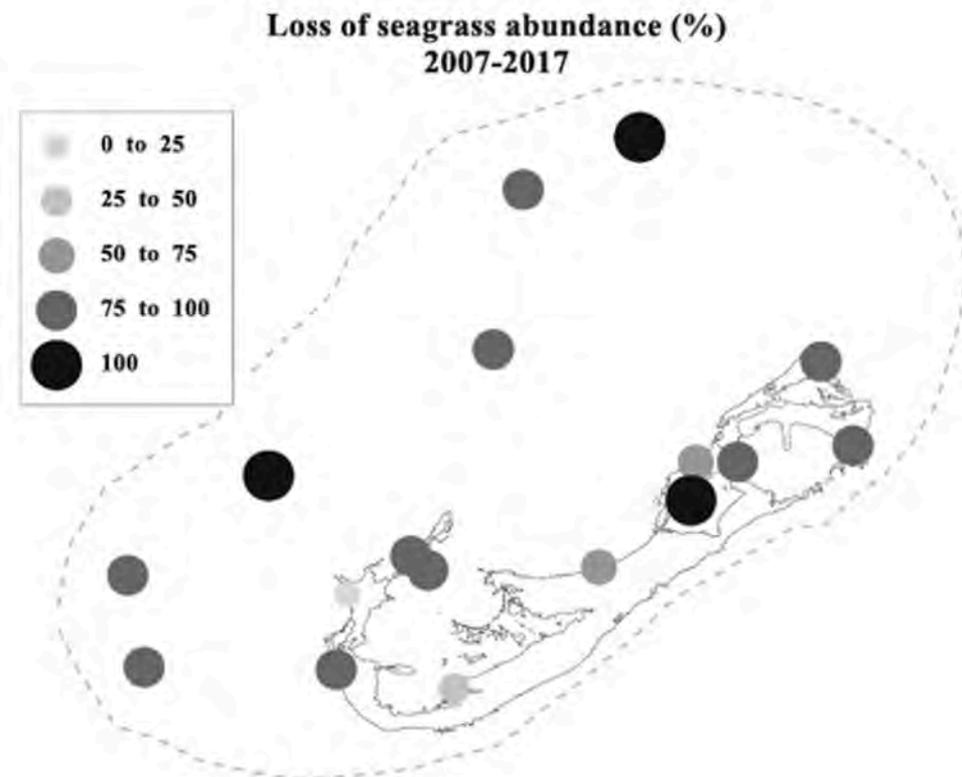


FIGURE 3: Percent loss of seagrass at long-term study sites in the BMAP program (Fourqurean et al., 2019)

## 1.2 Seagrass

Seagrass beds around Bermuda are often comprised of one species, but it is not uncommon to have a mix of two or more species. In recent studies, four open water species of seagrass were reported on the Bermuda Platform: *Syringodium filiforme*, *Thalassia testudinum*, *Halophila decipiens*, and *Halodule sp.* All four are protected under the Protected Species Act 2003 (Protected Species Order 2012).

Seagrass beds provide key ecosystem services, including habitat for endangered and endemic species; feeding grounds for many reef fishes and nursery habitat for juvenile reef fishes and lobsters; stabilization of soft sediments; regulation of water quality; protection for adjacent reef ecosystems from the impacts of ocean acidification; and serving as important carbon sinks.

The last two decades have seen the collapse of seagrass beds across the Bermuda platform, an alarming development considering their importance to the ecosystem (Murdoch et al., 2007; Fourqurean et al., 2019). Over a period of ten years from 2007-2017, a study of 17 seagrass beds in offshore and nearshore sites found that all displayed evidence of decline (fig 3). Three beds disappeared entirely, while others were greatly reduced in extent and functionality.

In contrast to what is happening in many places around the world, Bermuda's seagrass beds are not disappearing due to declining water quality. Instead, the main drivers of these changes are destruction during the development of Bermuda's inshore waters and most recently overgrazing by green sea turtles, which is putting unprecedented

pressure on the seagrass habitat (Fourqurean et al.; 2010; van Tussenbroek et al., 2014; Fourqurean et al., 2019).

## 1.3 Mangroves

Bermuda's mangroves, comprised of Black Mangroves (*Avicennia germinans*) and Red Mangroves (*Rhizophora mangle*), are situated in the intertidal zone of protected bays, where they provide ecosystem services that include protection from storm surges, nursery grounds for many species of juvenile fishes, and feeding grounds and habitat for a variety of organisms (e.g., fishes, crabs, birds, and snails). Another important ecosystem service provided by mangroves is serving as a carbon sink, similar to seagrass. Carbon sinks, or carbon sequestration, is the process by which large amounts of atmospheric carbon dioxide is trapped and stored in plants and the ground. Both are protected under the Protected Species Act 2003 (Protected Species Order 2012).

Unfortunately, mangroves have been devastated by centuries of coastal development and compromised by steady sea level rise. The pace of sea level rise has outstripped the ability of mangroves to recover from storm losses, because mangrove seedlings cannot establish in the deeper water. The magnitude of mangrove loss is enormous, as illustrated in Hungry Bay in fig. 4. Sea level rise resulted in multiple die backs of the seaward edge of the mangrove forest in Hungry Bay over the last few hundred years. Currently, the seaward margin is below sea level due to the combination of sea level rise and beach erosion, making it difficult for new growth to occur. Yet little action has been taken to try to restore this habitat or establish new mangroves communities.

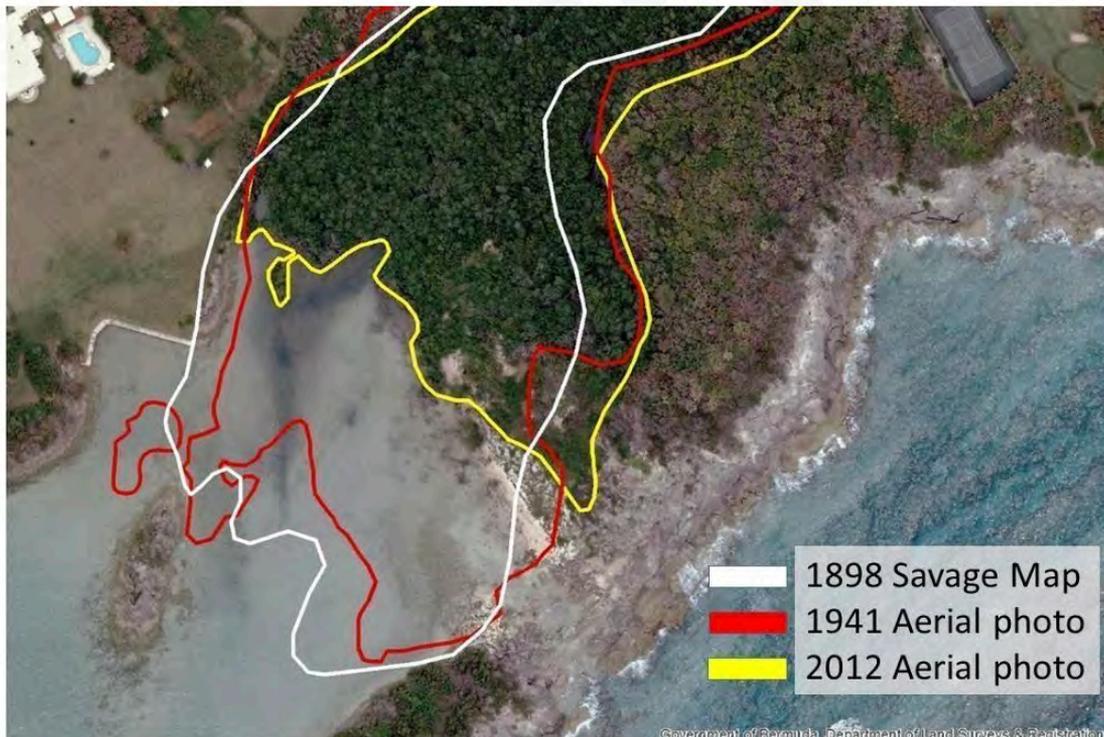


FIGURE 4: Mangrove retreat in Hungry Bay

## 1.4 Inshore Waters

Bermuda's inshore waters include sheltered bays and sounds that support higher densities of plankton than offshore waters. This, in turn, supports baitfishes such as anchovies, sardines ('chovies), and herrings (pilchards), which provide food for jacks, halfbeaks, and tarpon. Inshore fish communities are diverse in places but are dominated by grunts, with some parrotfishes, damselfishes, butterflyfishes, mojarras, juvenile snappers, and barracudas (Smith, in prep.; Zuill and Smith, 2019; Tavakolian, 2018; Blee, 2017). Juvenile spotted eagle rays are commonly seen in the Foot of the Lane (a bay near Hamilton, close to the Bermuda Underwater Exploration Institute) among the mangroves.

Water quality in Bermuda's inshore bays and sounds has improved since the 1970s and is generally good. New boat sewage pump-out regulations should sustain this trend. However, inshore waters face other challenges, including the decline of seagrass beds and coastal mangroves, and the over-exploitation of various shellfish fisheries (e.g., calico clam, scallop, and conch) resulting in their placement on the Protected Species list.

## 1.5 Offshore Banks and Seamounts

Challenger and Plantagenet (Argus) Banks are local offshore banks that are relatively shallow (50-60 m) and are important locations for several species, including pelagic fishes (e.g., marlins, wahoo, jacks); bait species (e.g., robins, small jacks, rainbow runners); top predators (e.g., tiger sharks and Galapagos sharks, tunas, and blue marlin); and marine mammals, including the humpback whale, bottlenose dolphin, and Cuvier's beaked whale. The Bowditch Seamount is deeper (~1000 m) but only ~10 nm to the northeast of Bermuda and occasionally targeted by fishers.

The deep slopes of the Bermuda Platform and the banks (50 m to 4500 m) support distinct coral, sponge, and fish communities. The upper 300 m was intensively studied by the NEKTON project in 2016 (Stephanoudis et al., 2019a,b). The survey found a decline in fish biomass and species richness with depth, the latter peaking at 30 m. Below that depth, there was a decline in herbivorous fishes believed to be associated with the lack of reef-building corals. The study highlighted distinct vertical zonation patterns for several species of fish that live in the shallow (<30 m), upper (60 m), lower mesophotic (90 m), and rariphotic (~150 m—300 m) coral reef habitats. When combined with evidence of anthropogenic stressors (in the form of benthic marine debris) this prompted study authors to advocate for explicit management of these areas.

There are several extensive seamounts within Bermuda's EEZ (fig. 5), including the extensive Muir Seamount range 150 to 200 nm to the northeast of Bermuda; the discrete George and Siboney Seamounts, also 150 to 200 nm to the northeast; and the isolated Crescent Seamount, about 70 nm to the northwest of the island.

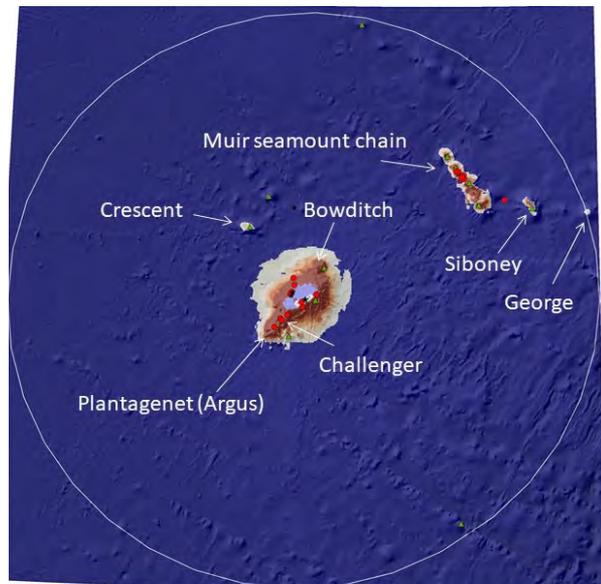


FIGURE 5: Seamounts in the Bermuda EEZ

## 1.6 Open Ocean

Bermuda lies within the Sargasso Sea, and open ocean habitats make up 95% of Bermuda's EEZ. The Sargasso Sea plays an important role in the life stages of many important fisheries species, such as mahi mahi, bluefin tuna, and blue marlin. Pelagic *Sargassum* mats host many species of fishes, including the endemic Sargassum fish, and a very diverse community of crabs, shrimps, barnacles, gastropods, polychaete worms, and hydroids (Laffoley et al., 2012). In addition, the floating mats of golden-brown algae serve as critical habitat for seabirds, spawning habitat for eels and flying fishes, and nursery grounds for all species of sea turtles.

Local seabirds (cahow, longtail) and diverse migratory seabirds (shearwaters, storm petrels) forage for squids and fishes in these surface waters. A number of other notable species have been researched and observed in Bermuda's open ocean waters including whales, dolphins, and a variety of pelagic fishes. The warming and acidification of the ocean and persistent plastic pollution are threats to many fishes, seabirds, and marine mammals.

Decades of research performed by local and visiting scientists and students working at the Bermuda Institute of Ocean Sciences (BIOS) mean that Bermuda is reasonably well-informed on the oceanography of the surrounding ocean. In particular, there is robust insight into the cycles of primary production, zooplankton, and the flux of organic matter to the ocean basin (Lomas et al., 2011; Conte, Weber, 2014). Since 2015, the multi-institution BIOS-SCOPE (BIOS—Simons Collaboration on Ocean Processes and Ecology) project has been investigating the microbial ecology of the Sargasso Sea, with a primary focus on the interactions between microbial processes and dissolved organic matter concentration and composition.



Sargassum Swimming Crab

Photo Credit // © Shayna Brody

The Sargasso Sea Commission is working to secure cooperative agreements to protect the Sargasso Sea in areas beyond national jurisdiction in recognition of its biological significance, ecological importance, and fisheries resources. Threats to the Sargasso Sea include impacts of fishing, pollution, impact of shipping, and impacts to the seafloor and seabed. Ten Atlantic nations and British Overseas Territories have signed the Hamilton Declaration to advocate for the protection of the Sargasso Sea.

## 1.7 Protected and Endemic Species

Bermuda has a number of pieces of legislation that protect threatened marine species and habitats, including the [Fisheries Act 1972](#), [Fisheries \(Protected Species\) Order 1978](#), the [Protected Species Act 2003](#), and the [Protected Species Order 2012](#), respectively. A few species are protected under more than one Act.

Bermuda's protected marine species fall into two broad categories: species that provide structural integrity for ecosystems and habitats, such as all corals and mangroves, and species that have suffered losses as a result of over-exploitation (e.g., queen conchs, scallops, Nassau grouper, cahow) or habitat loss (e.g., seahorses, giant land crab, land hermit crab, common tern).

The primary aim in listing protected species is to reverse the decline of their populations by preventing their harvest and promoting habitat restoration. But there is a general lack of up-to-date census information on the status of the majority of protected species. Recovery plans have been developed for the giant land crab, [Cardisoma guanhumii](#), the land hermit crab, [Coenobita](#)

[clypeatus](#), the queen conch, [Strombus gigas](#), now renamed [Aliger gigas](#), lined and long snout seahorses, [Hippocampus erectus](#) and [H. reidi](#), resident green and hawksbill turtles, [Chelonia mydas](#) and [Eretmochelys imbricate](#), the common tern, [Sterna hirundo](#), and the Bermuda petrel, [Pterodroma cahow](#).

Recent studies conducted as part of the NEKTON project revealed several new deep water black coral species (Wagner and Schuler, 2017). The lack of data for rare species on the shallow patch reefs, the rim reef, the fore reef, and deep mesophotic reefs makes an accurate assessment of these coral reef populations challenging. Bermuda has limited diversity of known marine endemic species (Sterrer, 2003). Endemic species include the Verrill's hermit crab (Murdoch and Murdoch, 2016), and some endemic marine fishes (such as the Bermuda bream, yellowfin chromis, and the Bermuda anchovy).

## 1.8 Underwater Cultural Heritage

Shipwrecks remain one of Bermuda's most distinctive identifying features and a primary international emblem of the island. The management and protection of Bermuda's underwater cultural heritage is not only important because of its inherent scientific, historical, and archaeological significance, providing a vital contribution to the understanding of Bermuda's past, but also because it provides direct educational, recreational, and economic value. As a result, Bermuda's maritime heritage is both locally important and internationally relevant.

Renewed public awareness, local stewardship, and international interest in Bermuda's shipwrecks and marine environment have added significant value to the nation's

economy. Taken alone, the value of Bermuda's reefs is estimated at over \$36.5 million annually (Sarkis et al., 2013). Other maritime assets, such as lighthouses, retain additional commercial value that is added to Bermuda's economic infrastructure.

### 1.8.1 Register of Wrecks

There are currently 215 historic shipwrecks in the official Register of Wrecks. These are divided into two categories: publicly known wrecks and private wrecks.

**Publicly known wrecks:** Of the public wrecks listed in the Register, 38 wrecks have been classified as *Open* and 13 have been classified as *Closed* (figs. 6 and 7). Wrecks listed as *Open* make up the major portion of Bermuda's most extensive no-fishing protected area network. These are the only year-round "no take" zones

on the Bermuda platform. They are the backbone of the island's recreational diving and tourism industry, and the main ones featured in the intense television attention that Bermuda's shipwrecks have received over the past decade.

**Private wrecks:** There are 164 wrecks in the Register of Wrecks that have not been classified (fig. 8), and information on these is not shared with the public. Many of these historic shipwrecks have been reported in confidence by private individuals and institutions or are the subject of ongoing archaeological assessments. Additionally, a subset of these wrecks pose a danger to recreational divers because they are in busy shipping channels, are beyond recreational diving depth limits, have dangerous physical attributes, or contain remains of dangerous cargo.

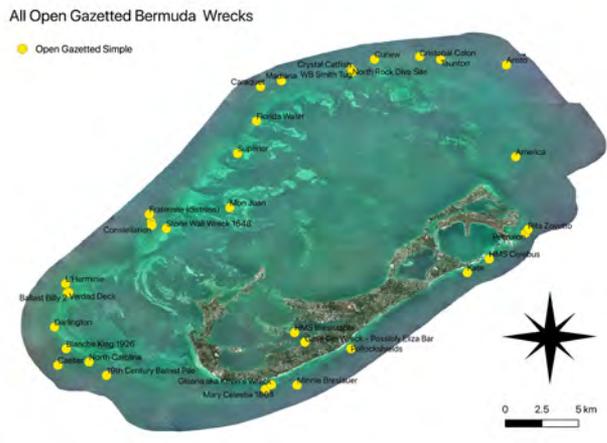


FIGURE 6: Open Bermuda Wrecks

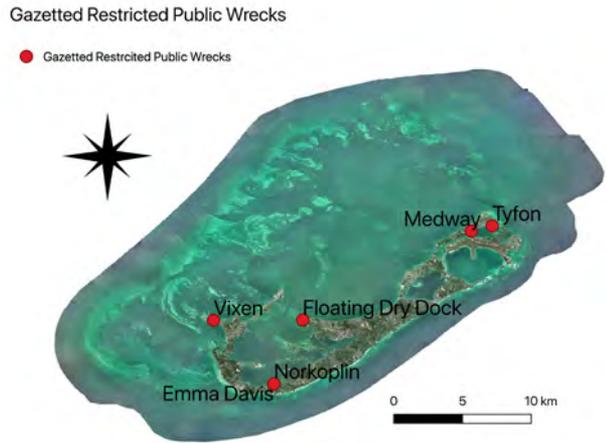


FIGURE 7: Closed Bermuda Wrecks

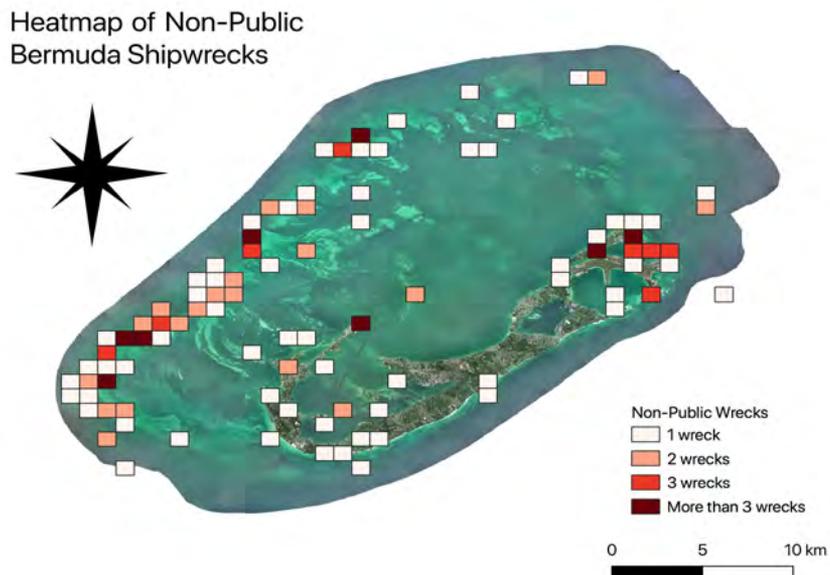


FIGURE 8: Heat map based on the records of these 164 wrecks in the Register of Wrecks that have not been classified

# 2 CURRENT USES OF THE MARINE ENVIRONMENT IN THE EEZ



## 2.1 Fisheries

Fishing, whether for subsistence, at a commercial scale, or for leisure, is the longest continuous human activity affecting Bermuda's marine environment, and it has both economic and socio-cultural significance. Although the commercial fishery employs fewer people (~300) and contributes far less to GDP (~0.25%) than other maritime sectors such as tourism (Dept of Statistics, 2019), it makes an important contribution to food security, supplying ~33% of marine fish, and ~15% of all fish and shellfish consumed locally (Skip, 2020). It has been estimated that approximately 25% of the population fishes recreationally at some level (Sarkis et al., 2010; Pitt and Trott, 2013), and those that do often refer to it as "a way of life" or cite it as an activity that they enjoy with friends or family (Pitt and Trott, 2013).

The resources targeted by commercial fishing have changed over time. Intensive trap fishing, particularly during the 1980s, led to declines in the abundance of some species, particularly the larger groupers (rockfish), and some of these populations still have not shown any signs of recovery. In recent years, changes in technology have made offshore fishing more practical, with modern vessels being able to more easily access deeper water. Currently, Bermuda imports over two thirds of its seafood and imported fish, especially wahoo, is cheaper than local fish, which often undermines the value of catch from local fishers. This is particularly the case when the same species that are caught locally are sourced from overseas.

In addition to commercial fishing, there is a substantial recreational fishery in Bermuda that, excluding recreational lobster and spearfishers, is largely

unregulated. It is illegal for recreational fishers to sell their catch, but it is nearly impossible for fisheries wardens to monitor for violations due to the dispersed nature of fishing and fish sales generally, and the lack of oversight over commercial sales specifically. Similarly, recreational fishers are not required to be licensed, so it is a challenge to estimate their numbers. However, it is estimated that 30% of all households in Bermuda have at least one member of the family who fishes recreationally. This means that resident recreational fishers could total 16,000, far outnumbering the registered commercial fishers.

Fishing in Bermuda has a correspondingly long history of management and regulation (Smith-Vaniz et al., 1999; Ministry of the Environment, 2000; Ministry of the Environment, 2005). Legislation aiming to manage fishing and its impact on the marine environment has existed in some form since the early 1600s, but has generally been more reactive than proactive. For a complete list of the regulations that govern the management of fishing in Bermuda please refer to [Appendix B](#).

### 2.1.1 Species and Locations

Bermuda's living marine resources are categorized based on their broad biological characteristics, where they occur, or how they are caught. Demersal species include various types of fishes, lobsters, and other invertebrates that are associated with the coral reefs and other seabed habitats of the Bermuda Platform and the outlying banks. Pelagic species are found in deeper water and offshore, and often migrate throughout the north Atlantic Ocean.

Fishing occurs across the spectrum of environments in Bermuda, from coastal waters to the deep ocean.



Spiny Lobster

Photo Credit // © Shayna Brody

**Inshore bays and baitfish resources:** The recent Bermuda Baitfish Project found that the three small baitfish species known collectively as ‘fry’ are generally abundant and widely distributed. Redear herring (pilchard) are also relatively common, but populations of the other two larger baitfish species—the round sardinella (‘chovy) and threadfin herring—appear to have declined. Baitfish are caught with cast nets and some commercial fishermen also target them with seine nets.

**Coral reefs:** Coral reef fishes were traditionally the mainstay of local fishing, with groupers and snappers the preferred species. Spiny lobsters and Guinea chick lobsters, the only shellfish caught commercially, also inhabit coral reef and hard bottom habitats. These species were captured primarily with traps until fish pots were banned in 1990. Although specially designed traps are now used for spiny lobsters and Guinea chicks, finfish—with a few exceptions that include bait, jacks, and mullet—may only be caught with hook and line.

**Outlying banks:** Diverse marine life is distributed along the 130 km-long perimeter, or “edge,” of the Bermuda seamount. Coupled with the banks, this area where the shallows meet the deep presents the perfect place to target pelagic fishes such as tunas and wahoo. The tops and sides of the banks are also fished, targeting deep water snappers, jacks, and some deep-dwelling grouper species.

**Deep ocean:** The deep ocean waters that make up ~95% of Bermuda’s EEZ are home to a variety of pelagic fish species, including wahoo, tunas, swordfish, and marlin. Such species make up approximately half of the landed catch and provide sport fishing opportunities for locals and visitors alike.

**Distant seamounts:** There is not much information on the marine resources associated with the more distant seamounts in Bermuda’s EEZ, but these areas are known to aggregate pelagic fishes, as well as provide a habitat for deep bottom-dwelling species. Importantly, many such deep-dwelling species are known to be slow-growing/late-maturing as a result of the effects of very cold temperatures and low food supply, so they are extremely vulnerable to overexploitation.

### 2.1.2 Patterns of Exploitation

The resources targeted by commercial fishing have changed over time (fig. 9). Heavy fishing, particularly during the 1980s, led to declines in the abundance of some species, particularly the larger types of groupers, and some of these populations have still not shown any signs of recovery. Following the ban on trap fishing in 1990, many in the industry transitioned to targeting pelagic species such as tuna and wahoo, and these species now make up approximately half of the commercial landings. In recent years, changes in technology have made offshore fishing more practical, with modern vessels being able to more easily access deeper water and target a wider variety of pelagic species. These migratory pelagic species are managed internationally by the International Commission for the Conservation of Atlantic Tunas. This helps ensure rigorous management, but places a heavy burden of reporting on local managers. Further, the quantities that may be caught by local fishers are limited by quotas in some cases.

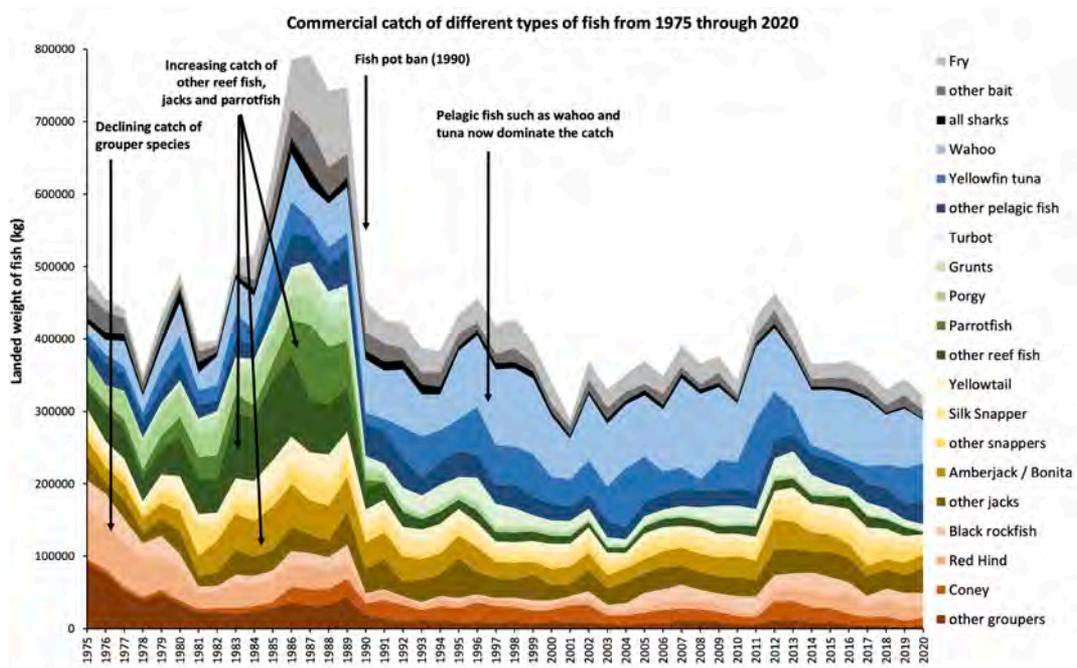


FIGURE 9: Commercial catch of different types of fish in Bermuda’s EEZ from 1975 through 2020

## 2.2 Tourism

The tourism industry represents an important portion of Bermuda's economy and employment opportunities. Prior to COVID-19, the industry accounted for approximately 5.3% of the GDP, versus 14% for the Caribbean region, and is responsible for approximately 3800 jobs (10.2% of employment).

Tourism in Bermuda has long-faced sharp seasonality, with 48% of visitors arriving in the summer months from June through August. Leisure travel is heavily dependent on three source countries, with 96.2% of travelers coming from Canada, the U.K., and U.S. Tourist spending, exclusive of tax revenue, totaled \$544 million in 2018, an increase of 28% from the year prior, and surpassing the previous peak in 2007 of \$513 million.

### 2.2.1 Air and Cruise Travelers

Given Bermuda's remote location, all visitors arrive via air or boat. Bermuda has a single airport and three ports used for cruise ships. The North Channel entering Royal

Naval Dockyard was dredged in 2015 to accommodate the latest generation of larger, quantum-class ships. Prior to COVID-19, four cruise vessels accounted for 51.8% of Bermuda's projected 2020 total cruise traffic. Air passenger traffic to Bermuda has seen periods of recent growth but has fallen significantly from levels seen in the 1980s. In 2019, 66% of visitors arrived via cruise, while 33% arrived via air (fig. 10).

While cruise travelers were becoming more numerous (pre-COVID-19), they are far less profitable per person than air travelers, yielding \$219.55 in spending outside of taxes per person, compared to \$1,567.08 for air travelers in 2019. Figure 11 shows the trends in estimated cruise and air traveler spending per person in Bermuda. Worldwide, cruise travelers spent an average of \$101 in ports visited during a cruise in 2018 (fig. 12). Some 52% of air travelers' spending went to accommodation while just 7% went to sightseeing and leisure, which would typically encompass the bulk of ecotourism dollars. In addition, the average air traveler's length of stay is declining (down 6.5% from 2014 to 2019).



FIGURE 10: Total visitor arrivals in Bermuda 1980-2020 (BTA)



FIGURE 11: Average estimated tourist spending per person in Bermuda (BTA)



FIGURE 12: Estimated revenue spending from air and cruise visitors in Bermuda (BTA)

## 2.2.2 Yacht Travel

Despite hopes that hosting the 2017 America's Cup would lead to stronger yacht traffic, this segment has been a nominal part of Bermuda's arrivals due to strict regulations. These regulations were relaxed in early 2020 with the passing of the "Superyachts and Other Vessels (miscellaneous) Act." The intent of the regulation is to allow large yachts to charter in Bermuda waters through local agencies, as well as to remove the departure tax. In addition, during COVID-19, the Ministry of Tourism and Transportation implemented a "Superyacht Tourism Economic Recovery Plan," making Bermuda one of a few destinations that allowed superyachts to berth in the island (albeit with significant restrictions limiting disembarkation). The intent of this plan was to signal that Bermuda is a good destination for superyachts. During Quarter 3 of 2021, superyachts contributed over 500,000 dollars to Bermuda's economy, which is only half of what they made right after the plan's passing during Quarter 3 of 2020.

## 2.2.3 Land Transportation

As part of the Government's commitment to protecting the island's environment, and in line with the National Fuels Policy (NFP), which aims to move Bermuda towards an affordable, sustainable, safe, and secure energy future, the Ministry of Transport has begun a process of progressively converting the existing diesel fleet of buses to electric, as well as investigating the viability of introducing more fuel-efficient ferries. This initiative will align Bermuda with international best practice and represents a commitment to meeting the aspirational overall reduction, outlined in the NFP, on dependency on fossil fuels by 2035 from the 2017 'business as usual' consumption figures, i.e. 34% reduction for diesel and a 68% reduction for petrol.

To date, the Ministry of Transport has purchased an initial 30 electric buses. These buses have been purchased from Golden Dragon Bus Company Ltd in China in August 2021 at a unit cost USD 114,200 per bus. By comparison, the last diesel bus purchased from Portugal in 2018 cost USD 250,000. Pre-delivery inspections have been completed and the Department of Public Transportation is currently preparing the buses to be shipped from Shanghai to Bermuda. These buses will be arriving on three shipments over the next few months and are scheduled to go into service in April 2022. It is envisioned that the entire bus fleet will be converted to electric over the next ten years.

Furthermore, as part of the Government's economic recovery plan, the Department of Public Transportation is in the process of constructing interim charging stations at Dockyard, St. George, and Fort Langton bus depots to support the initial 30 buses until a permanent charging infrastructure is ready. These initial charging stations will be fed from existing BELCO circuits and completed in March 2022. A permanent charging infrastructure project will accommodate the entire fleet comprising of a total of 30 charging stations servicing 60 bus bays, powered by a 450 kVA rooftop solar PV array and a battery energy

storage system at the Fort Langton bus depot. This will allow the DPT to achieve a more efficient and sustainable public bus fleet.

In addition, Government has begun to install roof top PV array systems on two Government buildings in Hamilton to service electric charging stations in anticipation of the transition of Government vehicles to electric vehicles. As a further initiative, tourists are currently able to rent small electric cars or electric scooters, creating an alternative eco-friendly way for visitors to travel and explore the island.

## 2.2.4 Taxes and Fees

Bermuda's visitor taxes vary by mode of arrival transit. Bermuda is notable for having some of the highest cruise head taxes in the world: \$25 per passenger up to a maximum of \$75 per head for ships in the Dockyard, and \$20 daily up to a maximum of \$60 in the lesser-used and smaller St. George's and Hamilton ports from April 1 to October 31. Bermuda also levies a \$35 per-head tax on passengers arriving via yacht. Visitors departing Bermuda by plane pay a \$35 departure tax, collected by and payable to the airport authority Skyport. Bermudian hotels pay a 4.5% tourism guest fee and 7.25% hotel occupancy tax. As of November 1, 2018, all Bermudian vacation rentals are required to register with the Bermuda Government prior to accepting guests and must remit a 4.5% vacation rental fee on the nightly rate of the rental to the Bermuda Tourism Authority. This tax rate is roughly equivalent to the tourism authority fee, which had previously been collected from all guests at licensed hotels and guest houses.

## 2.2.5 Bermuda National Tourism Plan

The 2019-2025 Bermuda National Tourism Plan, authored by the Bermuda Tourism Authority (BTA), contains robust analysis and makes several strong recommendations supported in this report. The National Tourism Plan identifies the "must-win" U.S. segments: experience enthusiasts and adventure seekers. Both segments are younger (below age 44), high-income (with household incomes more than \$100K), and travel frequently. The report further identifies seven pillars, one of which is making Bermuda "greener," with the goal of being "on the road to becoming one of the 'greenest' tourist destinations by 2025." It commits to green hospitality, partnerships with environmental groups, and to avoid new, large events in peak season in hopes of growing the year-round tourism season. Additionally, the report recognizes the crucial distinction between cruise and air travelers, seeking a better balance between the two groups.

## 2.2.6 Tourism During COVID-19

In April 2020, due to the impact of COVID-19, the Government of Bermuda stopped all commercial airlines from flying into Bermuda until July 1, 2020. In addition, air service resumed at a fraction of the prior year's airlift, and by October 2020 airlift was only at 35% of the same month in 2019. As a result, BTA reported that total leisure

arrivals were down 86.6%, cruise arrivals down 98.3%, and total leisure spending down 88.7% in 2020 (relative to 2019).

In 2020, the cruise business in Bermuda collapsed due to COVID-19. At the start of 2020, the season was expected to have 194 calls (up from 185 in 2019) and bring 540,000 people (vs. 525,000 people in 2019). However, only four calls were made before the shutdown, bringing 6,500 people.

### 2.2.7 Future Recovery

Bermuda’s tourism industry has begun to recover after the pandemic shut down most travel to and from the island. The amount of travelers and revenue has yet to recover to 2019 numbers. BTA has a hopeful outlook for tourism industry recovery in the near future. Their stated priorities as of the February 2021 outlook include a targeted recovery plan for the tourism industry to inject the local economy with visitor spending; a focus on visitors more likely to return to travelling first, such as adventure-seekers and jetsetters; making Bermuda an easier place to travel to via continued innovation post-crisis; re-engaging stakeholders through the National Tourism Plan, with rebuilding and reimagining business services safely; and focusing on sports and social group travel in the short-term, with an eye to boosting corporate business travel in 2022.

Blue Tourism represents one of the three industries chosen to develop and improve through the Bermuda Ocean Prosperity Programme’s Blue Economy Strategy. The creation of a sustainable tourism sector will further aid Bermuda’s economic recovery and growth to 2022 and in years to come.

## 2.3 Cultural Exploration and SCUBA Diving

Exploring Bermuda’s underwater historical cultural heritage is an educational and income-generating activity that has great value, both economically and in terms of national identity. There are 22 shipwrecks that have been designated as dive sites by DENR under the Fisheries (Protected Areas) Order 2000. Other historic shipwrecks and marine heritage sites are managed under the Historic Wrecks Act of 2001. A total of 42 additional dive sites are buoyed as part of the Bermuda Protected Dive Site Areas Moorings Program, which provides environmentally friendly moorings (buoys) on the reef and near shipwrecks at several popular dive and snorkel sites around Bermuda. 29 of these sites are wreck sites and 13 are natural sites. 30 of the buoyed sites maintained under the program are officially protected sites with designated areas of protection. The buoys are for everyone’s use on a first-arrival basis. For more information on the regulations and policies that regulate cultural exploration and SCUBA diving in Bermuda, please refer to [Appendix C](#).

### 2.3.1 International Media Representation of Bermuda

International media representation of Bermuda via its marine heritage has been very successful. These programs also represent free and compelling advertising for Bermuda, and can be considered a noteworthy source of national pride that contributes significantly to local education and stewardship of shipwrecks. Expanding on the many opportunities for media coverage and working towards a more detailed series featuring Bermuda heritage is a high priority.

**TABLE 2: Bermuda Media Coverage Examples**

| Past International Media Representation                                     | Synopsis   |
|---|--|
| <a href="#">Exploring Five of the Most Iconic Wreckage Sites in Bermuda</a> | Describes 5 of Bermuda’s most famous wreck sites and details how the island preserves its unique marine cultural heritage. |
| <a href="#">Charted Waters</a>  | Provides a description of Bermuda’s history and shipwrecks.  |
| <a href="#">Visualizing Bermuda’s shipwrecks</a>                            | Describes the digital dive experience that is currently in development for Bermuda’s marine heritage.                      |
| <a href="#">High-tech imaging lets anyone dive into a Bermuda shipwreck</a> | Interview transcript on new technology for exploring Bermuda’s shipwrecks in a non-invasive, digital platform.             |

## 2.4 Development of the Coastline and Inshore Waters

Development occurs all along the 197 miles of Bermuda's scenic coastline, with some areas already substantially built up and other areas more pristine, as the result of proactive planning decisions in the 1970s that limited hotel development and created a National Parks system. Robust management works to prevent ongoing development of coastal and inshore waters from causing undue negative effects on Bermuda's habitats and natural resources.

There are multiple regulatory frameworks in place for managing development and land use in Bermuda, including coastal development, conservation zones, and water resources protection areas. To read more about these, please refer to [Appendix D](#).

### 2.4.1 Opportunities for Development Planning

While the current planning framework of conservation zones and coastal development policies appears to be effective in limiting coastal development to that which is necessary and appropriate, there are nevertheless practices which could be improved. For example, the planning legislation lacks specific requirements to mandate the submission of Environmental Impact Statements (EISs) for certain development proposals.

In addition, there is the opportunity to extend the spatial planning zoning system beyond Bermuda's terrestrial areas to Bermuda's marine environment. This would enable objectives and policies to be agreed to for the appropriate uses of different marine areas, and allow for

improved and integrated management of the island's coastal areas and marine resources.

Other opportunities that can be built on in the future include the following:

- Create new or amend existing legislation to manage development in coastal waters/the marine environment and require Environmental Impact Assessments (EIAs)/Statements (EISs) for certain development proposals, including coastal and marine-related development;
- Update the Coastal Vulnerability Study and Coastal Development guidelines to ensure coastal development policies are based on up-to-date evidence and data that anticipate climate change and sea level rise impacts;
- Establish a clear legal and policy framework for the integrated management of coastal and marine areas, which complements the land use planning system of plans, spatial zones, and policies;
- Ensure that marine heritage is formally considered in the planning process for any developments that impact the coastal and marine environment, either through independent Historic Impact Assessments (HIAs) or mandating that HIAs be formally included in the EIA process;
- Create a community planning initiative to raise awareness and engage the public in planning for improved management of coastal and marine resources and adaptation to climate change;
- Advance policies to encourage a "soft engineering approach," such as mangrove planting and seagrass bed restoration, to protect the coastal areas, rather than "hard engineering" shoreline protection methods.

### Views of the Bermuda Shore

Photo Credit // © Canon Purdy



## 2.5 Energy Provision and Telecommunications in the Marine Environment

The Department of Energy oversees the space, satellite, telecommunications, and energy industries in Bermuda, all of which are dependent on infrastructure located in the marine environment. This means the continued maintenance and security of the marine environment is essential to important industries and the nation's ongoing economic stability.

### 2.5.1 Energy Provision

**Fuel imports:** Like many other resources in Bermuda, fuel is imported by ship to the Rubis shipping terminal on St. George's Island, known as the "Oil Docks." The most frequently used fuels are petroleum oils and oils obtained from bituminous minerals, other than crude. The island also has a market for mineral fuels, mineral oils, and related products. See [Appendix F](#) for details on these imports.

**Electricity generation:** The Bermuda Electric Light Company Limited (BELCO) power plant generates the bulk of the island's electricity using imported fuel, which is supplemented by the incineration of local waste. Some renewable energy is generated from domestic solar power sources. This is to be bolstered in the near future by the opening of the Airport Solar Farm, which has an installed capacity of 6 megawatts (MW) that will supplement the >140MW total current electricity demand for the island. Table 3 breaks down electricity usage by sector over five years.

**Opportunities for electricity production:** The Integrated Resource Plan (IRP), released in June 2019, was the first to be approved for Bermuda by the Regulatory Authority. Notable key goals and objectives include that 80% of Bermuda's electricity is to come from renewable sources by 2035, particularly through solar and wind power, for which feasibility is currently being explored.

**"Sandbox" for testing new renewable energy solutions:** The Regulatory Authority of Bermuda has proposed to the Ministry of Home Affairs a "sandbox" concept for the commercialization of renewable energy solutions. This concept would allow new technologies to be deployed in Bermuda while containing the risks that may develop by amending the appropriate legislation and providing a framework for their deployment. Examples of such technologies are ocean-based floating photovoltaic systems and wave-powered electrical generation. Should an environmentally, economically, and commercially viable solution arise from the deployment, it would be eligible for potential inclusion in Bermuda's long-term energy planning process, the IRP. These new energy solutions are not part of Bermuda's IRP but will run in parallel to it.

### 2.5.2 Telecommunications

Telecommunications used by domestic and foreign ocean vessels within Bermuda's EEZ include UHF radio frequencies, VHF radio frequencies (both AIS and DSC), HF radio frequencies, satellite communication, and submarine communication cables.

## 2.6 Transportation in the Marine Environment

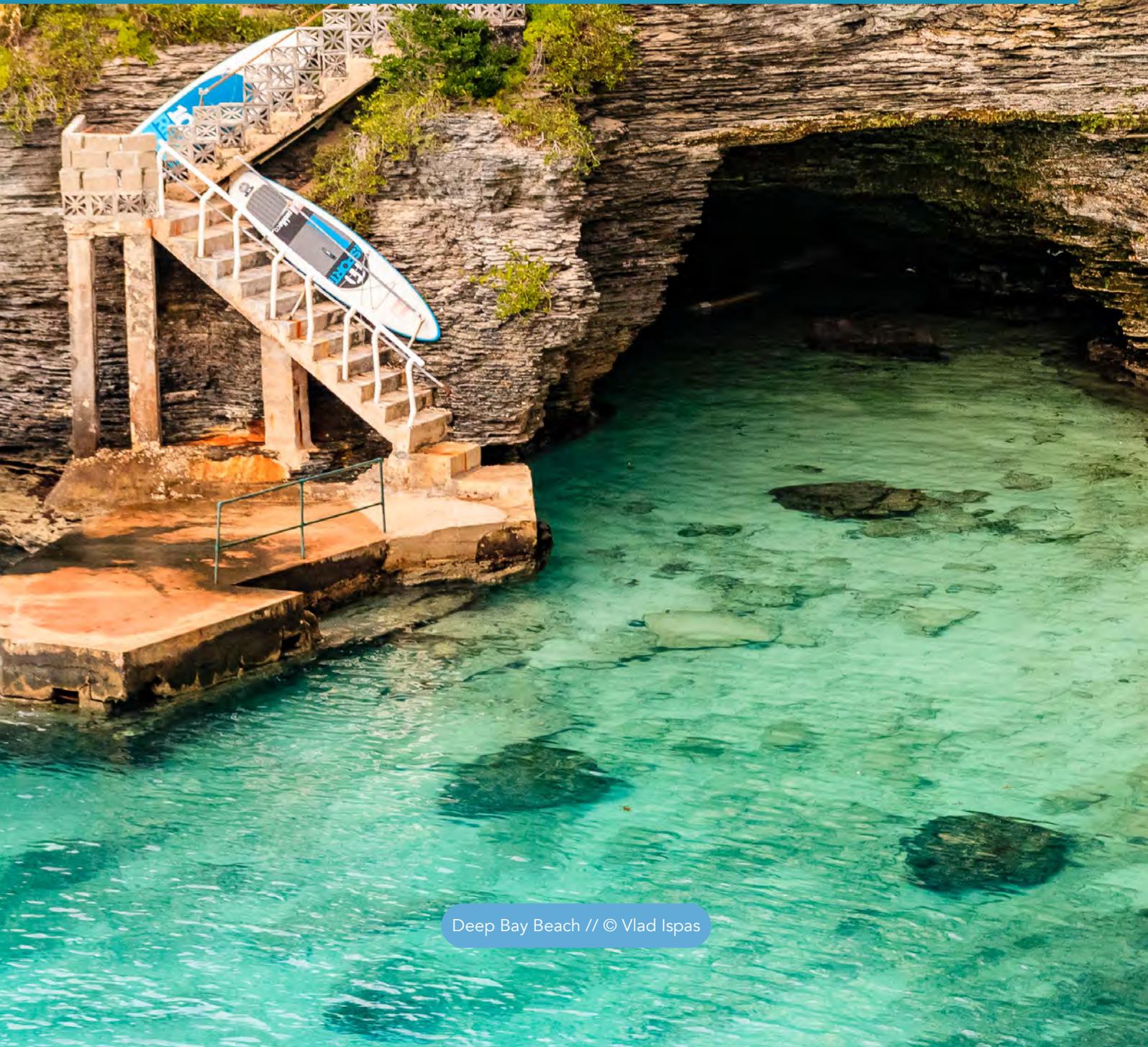
The Department of Marine and Ports Services runs the SeaExpress Ferry Service, which carries 600,000+ passengers every year. The ferry service is used primarily by visitors to the island, but its schedule does accommodate peak commuting times for residents. The main challenge is the flexibility of the ferry fleet to incorporate a schedule that is more extensive in terms of frequency and stops. The Government acknowledges that the current high speed ferries are expensive to run and, therefore, will switch to a fast ferry instead, as the fleet is replaced. This will enable more scheduling options. A variety of maritime legislation and policies have been enacted and/or are in the process of being updated to govern Bermuda's transportation systems; to view these, please refer to [Appendix E](#).

**TABLE 3: Electricity consumption by type of consumer, 2015-2019 (Source: Ascendant Group Limited)**

| Year | Total<br>(‘000 kWh) | Type                      |                          |                                  |
|------|---------------------|---------------------------|--------------------------|----------------------------------|
|      |                     | Residential<br>(‘000 kWh) | Commercial<br>(‘000 kWh) | Other <sup>1</sup><br>(‘000 kWh) |
| 2015 | 590,427             | 245,498                   | 290,552                  | 54,377                           |
| 2016 | 585,774             | 245,105                   | 286,588                  | 54,081                           |
| 2017 | 584,518             | 245,124                   | 284,866                  | 54,528                           |
| 2018 | 567,827             | 240,302                   | 274,770                  | 52,755                           |
| 2019 | 554,100             | 237,710                   | 263,793                  | 52,597                           |

<sup>1</sup>Includes street lighting paid by Parish Councils and sales to Government for offices, distillation plant, etc

# 3 THREATS TO MARINE NATURAL RESOURCES AND CULTURAL HERITAGE IN THE EEZ



## 3.1 Climate Change

The subtropical oceans are getting warmer and saltier, losing oxygen, and gaining carbon dioxide, resulting in acidic ocean water (fig. 13). The impacts have accelerated over the last decade (Bates and Johnson, 2020). In the open ocean, the sea offers hardly any visible signs of change. But data collected near Bermuda at Hydrostation 'S' and the Bermuda Atlantic Time-series Study (BATS) for nearly 70 years—taken together, forming one of the longest sets of prolonged observations in the open ocean anywhere on the planet—illustrates profound changes in the ocean's physical, chemical, and biological conditions with important implications for the island of Bermuda and its marine environment.

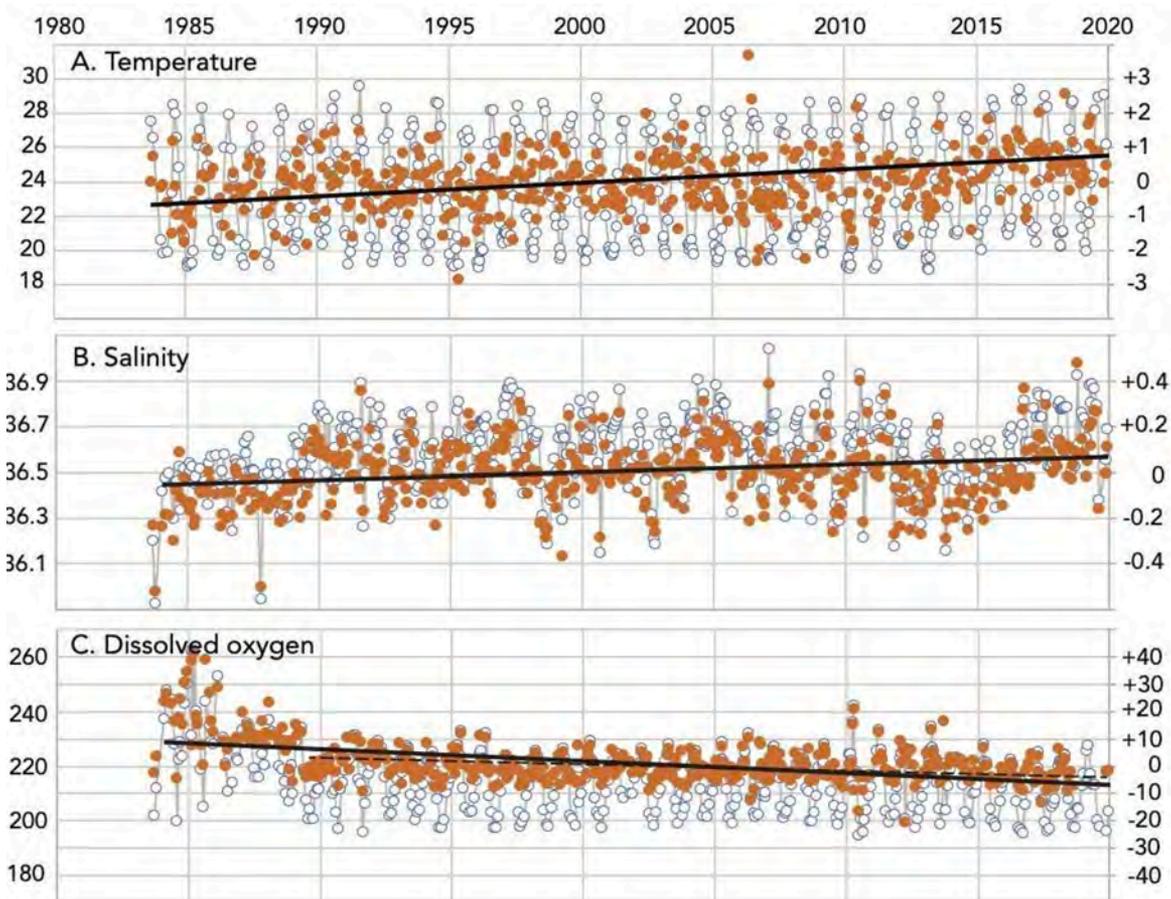
### 3.1.1 Effects of Climate Change on the Marine Environment

**Ocean warming:** Over the past 40 years, the surface ocean of the Sargasso Sea has warmed by nearly 1°C, with significant warming over the last decade (Bates and Johnson, 2020). As a result, the winter is shorter by almost a month and the summer period has lengthened by nearly a month. This dramatic shift is likely to have profound impacts on marine ecosystems around Bermuda and in the Sargasso Sea.

**Salinification:** Surface waters in the Sargasso Sea became measurably saltier by 3.1% between 1983 and 2020, reflecting global changes in the planet's water cycle and changes in oceanic circulation patterns. Changes in global ocean currents may have impacts on Bermuda's waters, as distinctive water masses play an essential role in providing the necessary conditions for the growth and success of phytoplankton, a food source that all other marine organisms depend upon.

**Deoxygenation:** Changes associated with ocean warming have resulted in a loss of dissolved oxygen of nearly 8% in the Sargasso Sea over the past 40 years. This can lead to complex interactions with other factors of ocean biology and nutrient cycling. For example, deoxygenation in deeper waters can cause the production of greenhouse gases, which could further contribute to global warming. Decreased oxygen concentrations could adversely affect large marine species such as tuna, marlin, swordfish, and sharks, that are especially sensitive to low ambient oxygen conditions. This could lead to reduced fish stocks and the potential collapse of local fisheries if this trend continues.

**Ocean carbon dioxide:** The Sargasso Sea has absorbed human-produced carbon dioxide (CO<sub>2</sub>) from the atmosphere, with anthropogenic CO<sub>2</sub> concentrations



**FIGURE 13:** Changes in temperature, salinity and surface dissolved oxygen at the BATS site (1988–present) with earlier data (1983–1988) from Hydrostation 'S' (Bates and Johnson, 2020)

almost doubling from the 1980s to the 2010s (Bates and Johnson, 2020).

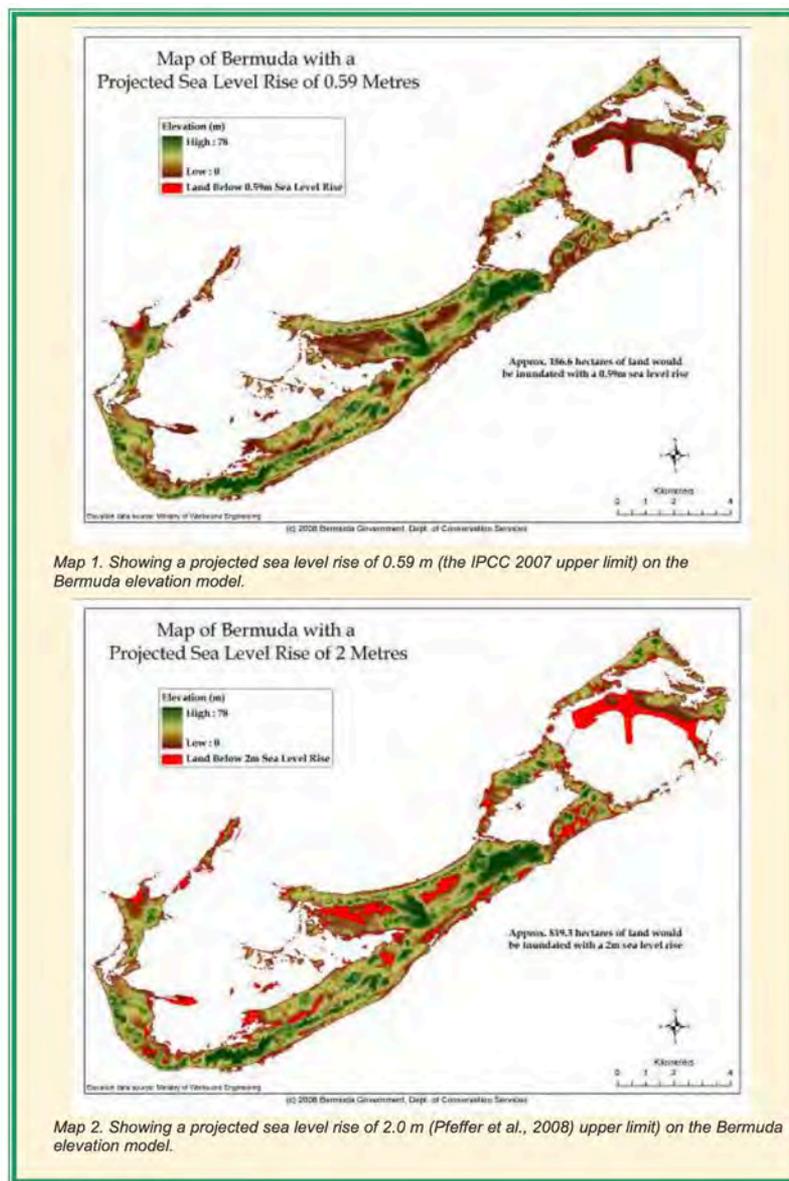
**Ocean acidification:** As carbon dioxide dissolves in the ocean, it forms carbonic acid, thereby decreasing the ocean’s pH and increasing the acidity. The pH value recorded in the Sargasso Sea has been substantially reduced such that ocean acidity has increased by about 30% over the last 30 years. The conditions suitable for calcifying organisms to build their skeletons and shells (such as corals, oysters and mussels, and many phytoplankton species that form the base of marine food webs) have also reduced over time.

**Sea level rise:** It is impossible to predict Bermuda’s sea level rise with certainty, but the Intergovernmental Panel on Climate Change (IPCC) predicts a rise of 0.59 meters. Bermuda’s National Oceanic and Atmospheric Administration tide gauge records ~2 mm of sea level

rise each year. The highest possible rise physically possible this century, with catastrophic loss of polar ice, would be 2 m (Pfeffer et al., 2008). In the former scenario, 186.6 ha of land would be submerged and 534 buildings would be affected, while in the latter scenario, 819.3 ha—or 14% of Bermuda’s land area—would be lost under sea water and 1,977 buildings would be damaged by the rise. *Figure 14* illustrates the land area of Bermuda under these two scenarios.

### 3.1.2 Consequences of Climate Change on Marine Resources and Heritage

**Massive, sudden fish die-offs:** Bermuda witnessed several fish “die-offs” over the past 20 years. One of the most notable was a mass die-off that occurred during the summer of 2017 over a period of higher-than-normal surface seawater temperatures. While no definitive cause



Map 1. Showing a projected sea level rise of 0.59 m (the IPCC 2007 upper limit) on the Bermuda elevation model.

Map 2. Showing a projected sea level rise of 2.0 m (Pfeffer et al., 2008) upper limit) on the Bermuda elevation model.

**FIGURE 14:** Map of Bermuda under a projected sea level rise of 0.59 m (top) and 2 m (bottom), respectively. (Source: Glasspool, 2008)

is often found, warm water is stressful to many fishes and can enhance microbial and/or parasitic infections that may lead to death. Planktonic algal blooms can also cause die-offs of marine life, either via the toxins that some species produce or via the depletion of oxygen in the water as the excessive amounts of plant material decompose. Such bloom events may be expected to increase under warmer temperatures.

**Ciguatera Fish Poisoning:** Phytoplankton species in the genus *Gambierdiscus* produce toxins that can build up through marine food chains and may reach levels in larger predatory fishes that result in ciguatera fish poisoning (CFP) in humans and other mammals that consume the fish. CFP is an unpleasant and debilitating illness that affects the nervous system. Ciguatoxins are not affected by cooking and are potent at very low concentrations, making it extremely difficult to test fish samples for their presence. CFP was rare in Bermuda until 2016, but the number of cases that have occurred in the past five years, most notably in species of large jacks, is a cause for concern. It is not clear whether this increase is linked to an increased abundance of *G. carolinanus*, which is known to occur in Bermuda, or whether another, more toxic *Gambierdiscus* species has now become established here. It is also possible that some of the fish responsible for CFP cases may have migrated to Bermuda from another area where *Gambierdiscus* species are more abundant. Whether the cause is a different or expanded local toxin source, or increased or altered migratory behavior of fishes, it seems that ciguatoxic fish are likely to enter local markets more regularly now, with consequences for public health and knock-on impacts on the commercial fishery and food security. Other phytoplankton groups that are not known to be present in Bermuda produce similar toxins, and there is a possibility these species may become established here under future climate scenarios. This is an area that requires more research and management attention going forward.

**Coral bleaching and disease:** Bleaching events have been observed infrequently since 1988 and do not appear to cause extensive coral mortality, in part because the warm water periods last only four to eight weeks, shorter than in Caribbean reefs. The last extensive bleaching was observed in 2013 (S. R. Smith, pers. comm.). However, warmer temperatures also alter the microbial community living on the surface of coral (the microbiome) and may promote coral microbial disease diversity and spread. A new coral disease termed Stony Coral Tissue Loss Disease (SCTLD) is now widespread in the Caribbean but has not yet appeared in Bermuda. The lack of a current reef monitoring program limits the ability to detect the disease but increased surveillance of coral health began in 2021.

**Limited growth in corals:** An increase in ocean acidity can limit the growth of corals, clams, and coralline algae. Coralline algae are the key structural element in Bermuda's 'boiler' reefs and are known to be negatively affected by rising ocean acidity. Slowing 'boiler' growth, coupled with rapidly rising sea level, puts Bermuda at risk of losing the effectiveness of this natural storm wave

barrier. These conditions will make maritime infrastructure and South Shore beaches vulnerable to the stronger hurricanes expected in the next century.

**Calcification and dissolution of reefs:** The observations at the Bermuda Atlantic Time-series Study (BATS) also provide a critically important context for understanding the present status of calcification and dissolution of the Bermuda coral reef system. While Bermuda's coral reefs remain relatively healthy, the reef system now experiences seasonal net dissolution for several months each year due to ocean uptake of anthropogenic CO<sub>2</sub> (Bates et al., 2010; Yeakel et al., 2015; Bates, 2017; Courtney et al., 2017). Net dissolution means the ocean's pH lowers to a point where calcium carbonate does not precipitate out, so organisms like coral and molluscs don't have it available to build their skeletons and shells.

**Destruction of mangroves:** The major threat to mangroves is sea level rise. Coastal mangrove communities thrive and cope with rising sea level by trapping their leaves and other organic material in the sediments within their complex root structures. The current rate of sea level rise in Bermuda is preventing this process from occurring. The pace of sea level rise has also outstripped the ability of mangroves to recover from storm losses, because mangroves seedlings cannot establish in the deeper waters at the seaward edge of the forests. However, the bulk of the losses of mangroves in Bermuda has been driven by coastal development, particularly the creation of the Kindley Airfield during World War II (Sterrer and Wingate, 1983).

**Loss of seagrasses:** Seagrass beds are at risk from climate change. Sea level rise will increase water depths over existing seagrass beds and as a consequence, the amount of light available to the seagrass beds will be reduced. Seagrasses require a certain amount of light to thrive and a reduction in light is predicted to cause a decline in the deeper seagrass beds. If conditions, particularly the substrate, are suitable, new seagrass habitat may form in the shallow newly inundated areas. However, 'hardening' of Bermuda's coastline by docks and seawalls will prevent the inland migration of seagrass habitat in many places where other conditions are good for seagrass growth.

**Damage to shipwrecks:** Environmental impacts coupled with climate change already had a significant impact on underwater cultural heritage in Bermuda. Rising sea levels lead to changes with real impacts on Bermuda's coast and shallow reef platform. Several shipwrecks in Bermuda have suffered damage because of the increased frequency and intensity of storm events, winter gales, and hurricanes. The impact and reach of these storm events have also increased with the rising sea levels, allowing a more dynamic ocean state to reach farther onto the reef platform and higher up the coasts. In addition, warming seas can increase the relative activity in Bermuda's waters of biological agents that degrade wooden ship structures, such as the *Teredo navalis* worm.

## King's Wharf Cruise Ship Terminal

Photo Credit // © Shayna Brody



**Abandoned and derelict boats:** Increased storm activity continues to lead to the stranding of local boats. Some of these vessels are abandoned by their owners to become ecological and health hazards. Stranded vessels often contain fuel that leaks over time and causes physical damage to habitats or become obstacles to boat traffic. Investigation has been undertaken in regards to new legislation and insurance products to compel owners to remove these stranded boats. However this has proved problematic. Until this issue can be resolved the Department of Marine and Port is working with Keep Bermuda Beautiful to create a pro-active solution to address this issue.

### 3.2 Shoreline Development

Bermuda's coast, reef, offshore areas, and seabed are increasingly exploited and used for economic activities. Infrastructure projects in coastal areas such as cruise ship dock creation, dredging of channels and bridge construction, sand extraction, pipeline and cable laying, and land reclamation have had major impacts on the benthos around Bermuda.

#### 3.2.1 Development's Effect on Seagrasses and Mangroves

Development of Bermuda's inshore waters with docks, marinas, dredging, land reclamation, and dense swinging moorings has had, and continues to have, a devastating impact on some of the island's most important and sensitive ecosystems. Along with overgrazing by sea turtles, development is causing a historic collapse of Bermuda's seagrass beds, which provide habitat for a range of species and offer a host of other ecosystem services. Development has also long had a negative impact on Bermuda's mangroves, which have been declining for decades.

#### 3.2.2 Reconciling Development with Protecting Historic Shipwrecks

Underwater cultural heritage discoveries have occurred across the full range of marine habitats in Bermuda during nearshore and offshore development projects and even during onshore development projects on landfill areas. Many of these activities also impact the marine environment by creating pollution, erosion, and destruction of natural habitats, many of which are critical to healthy ecosystem functioning.

The necessary elements to reconcile social and economic interests linked to development while protecting historic shipwreck and marine heritage sites are monitoring, accurate data gathering, asset inventory, and interdepartmental data sharing.

Heritage surveys need to be considered when planning all current and future marine development activities. While many of these activities are deemed necessary for the health of the Bermuda economy and society, the value of ecosystem services and cultural heritage deserves full consideration. An underwater cultural heritage policy document called *Guidelines for Interactions with Shipwreck and Marine Heritage Sites* lays out the recommended process for engaging with submerged heritage during development activities.

### 3.3 Alterations to Marine Food Webs

#### 3.3.1 Overfishing

Overfishing is a threat to habitat health because it can disrupt the careful balance of species within an environment with unintended consequences. The 1990 ban on fish traps, together with the protection of important grazing herbivores such as parrotfishes, protected Bermuda's coral reefs from the type of large scale 'phase shift' seen in some Caribbean ecosystems where seaweeds have come to dominate coral reef habitats. However, other consequences of overfishing are not always easy to anticipate. The removal of key predators, such as large groupers and sharks, from an

ecosystem can result in 'predation release,' allowing prey populations to expand to levels where their own food sources cannot sustain them.

### 3.3.2 Overgrazing

In recent years green sea turtle grazing has put unprecedented pressure on Bermuda's seagrass habitat resulting in the collapse of local beds, thus creating a conservation dilemma where one protected species, the green sea turtle, is causing the decline of other protected species, the seagrasses. The offshore seagrass beds, which are far from man's direct impact, were the first beds to disappear (Murdoch et al., 2007; van Tussenbroek et al., 2014; Fourqurean et al., 2019). The disappearance of seagrass meadows has also stripped protection from known and unknown shipwrecks and marine heritage sites, exposing them to erosion, biological elements, and unregulated discovery.

Most green sea turtles around Bermuda hatch on nesting beaches around the Caribbean Sea or Florida and arrive on the Bermuda Platform via ocean currents as small juveniles. Bermuda's nesting population became extinct in the 1800s. Successful conservation efforts on the nesting beaches to the south have resulted in increasing numbers of sea turtle hatchlings, which has most likely led to the increase in juvenile green sea turtles that have taken up residence on the Bermuda Platform.

In a healthy marine ecosystem, seagrass and green sea turtles co-exist. However, sharks, the natural predator of green sea turtles, have been overfished in the north Atlantic and the scarcity of sea turtle predators may possibly be causing an imbalance in the ecosystem of the Bermuda Platform. In other places sharks not only control the size of the green sea turtle population, but also restrict the amount of time that sea turtles spend eating seagrasses.

### 3.3.3 Non-Indigenous Species

Globalization and the resultant increase in trade and traffic has increased the movement of a wide variety of plants and animals between distant regions, whether by design or unintentionally. In the marine context, the rise of the aquarium trade and the live seafood trade are examples of the former, while ballast water and biofouling organisms on vessels are examples of the latter route. In addition, ongoing changes to the global climate mean certain species that were once constrained by the temperatures they could tolerate are now able to survive and thrive in new locations, extending the range of habitats they can occupy.

**Invasive lionfish:** Two species of lionfish from the Indo-Pacific, *Pterois volitans* and *P. miles*, were released into waters off the east coast of the United States during the 1980s and have since become invasive throughout the western Atlantic, Caribbean, and Gulf of Mexico. In 2000, Bermuda was the first location outside of U.S. waters to detect invasive lionfish. The local population initially increased very slowly, then began expanding faster in the late 2000s. Between 2014 and 2019, the

population continued to expand, but at a relatively slower rate. Lionfish are now found frequently in habitats from the shoreline to 60 m depth, and have been observed as deep as 350 m (Gress et al., 2017; Goodbody-Gringley et al., 2019). Lionfish are predators, and their feeding has the potential to impact local populations of fishes and invertebrates, as well as other predatory fishes that feed on the same species. At present, it appears that the variability in the recruitment of juvenile fishes to an isolated location such as Bermuda is a more important driver of local fish populations than the impacts of lionfish predation. However, it has not been possible to assess the impact of lionfish predation on the small invertebrate species, such as shrimps and crabs, that make up a significant proportion of their diet. Aside from the incidental catch of lionfish in commercial lobster traps, lionfish control efforts in Bermuda remain reliant on volunteer cullers in the shallows, while deep-water culling with technical diving equipment, dedicated lionfish trapping, and remotely operated vehicles is heavily subsidised. The lionfish invasion is a long-term problem, and sustained removal efforts are required to keep the lionfish population under control and minimize their impact on Bermuda's marine ecosystems. This should be coupled with regular monitoring of the population to evaluate the effectiveness of these measures.

**Cow nose rays:** Cow nose rays, *Rhinoptera sp.*, have also recently appeared in Bermuda. This appears to be a natural range extension, possibly mediated by water movements during storm events. Their population is growing more rapidly and more visibly than that of the lionfish, in part because they bear live young that are likely to survive and remain in the area. The potential consequences of this addition to Bermuda's marine fauna are uncertain, and the type of management response required is unclear.

Given past experiences, Bermuda has relatively strict biosecurity policies in place to control the importation of plants and animals, and policies related to vessel hull fouling are being implemented. However, Bermuda cannot control what happens in other jurisdictions and the expanse of ocean between Bermuda and other similar habitats is no longer the barrier that it once was. Going forward, there is a need for regular monitoring for non-indigenous marine species, especially for the invertebrate and plant species that are most readily transported, but more difficult to detect.

## 3.4 Wastewater, Pollution, and Durable Waste

Pollution in Bermuda's waters can originate from both overseas and local sources, including ships transiting past Bermuda; cruise ships, merchant ships, and oil tankers; transport on the ocean's currents from other countries; oil pipelines; sewage outfall; stormwater and road runoff; contaminants leached from groundwater; antifoulant paints and sewage from local boats; and waste material at the marine landfill at the Airport Waste Management Facility (AWMF).

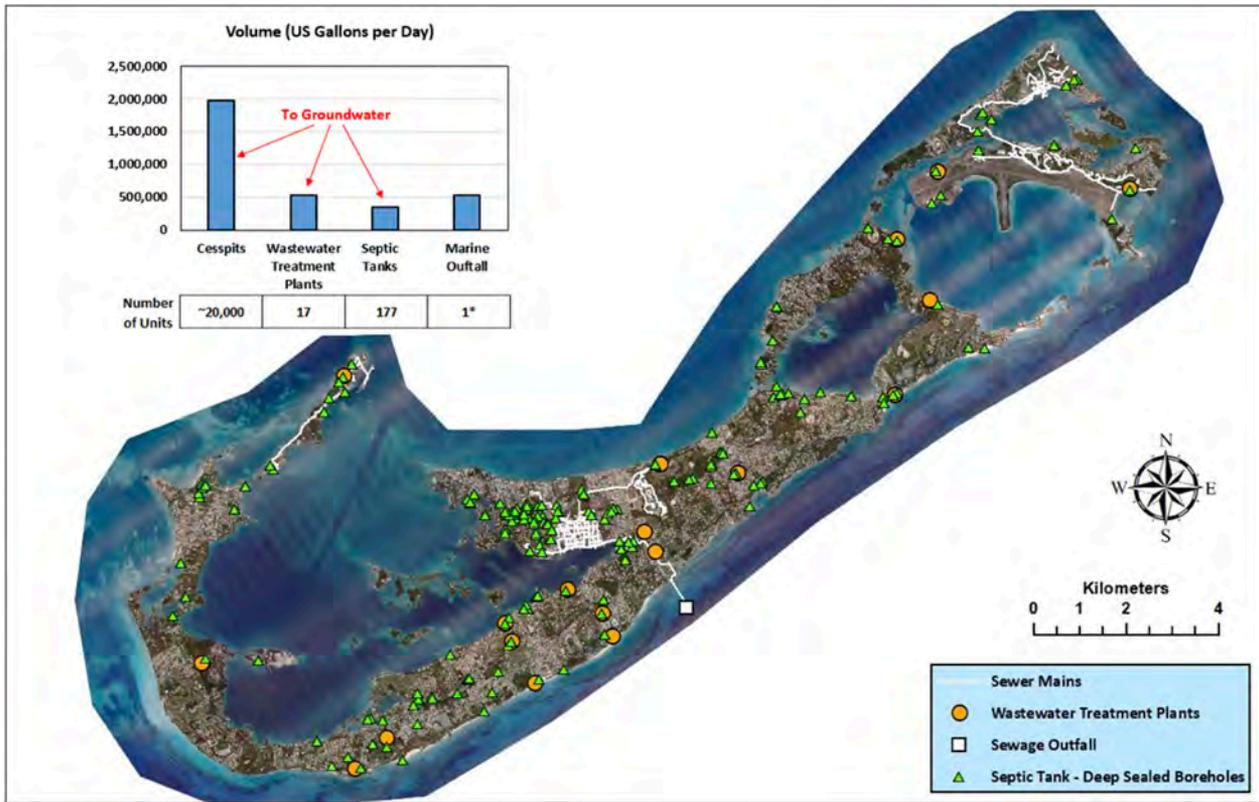


FIGURE 15: Wastewater Generated in Bermuda: Outfall and Groundwater Sources to Seawater

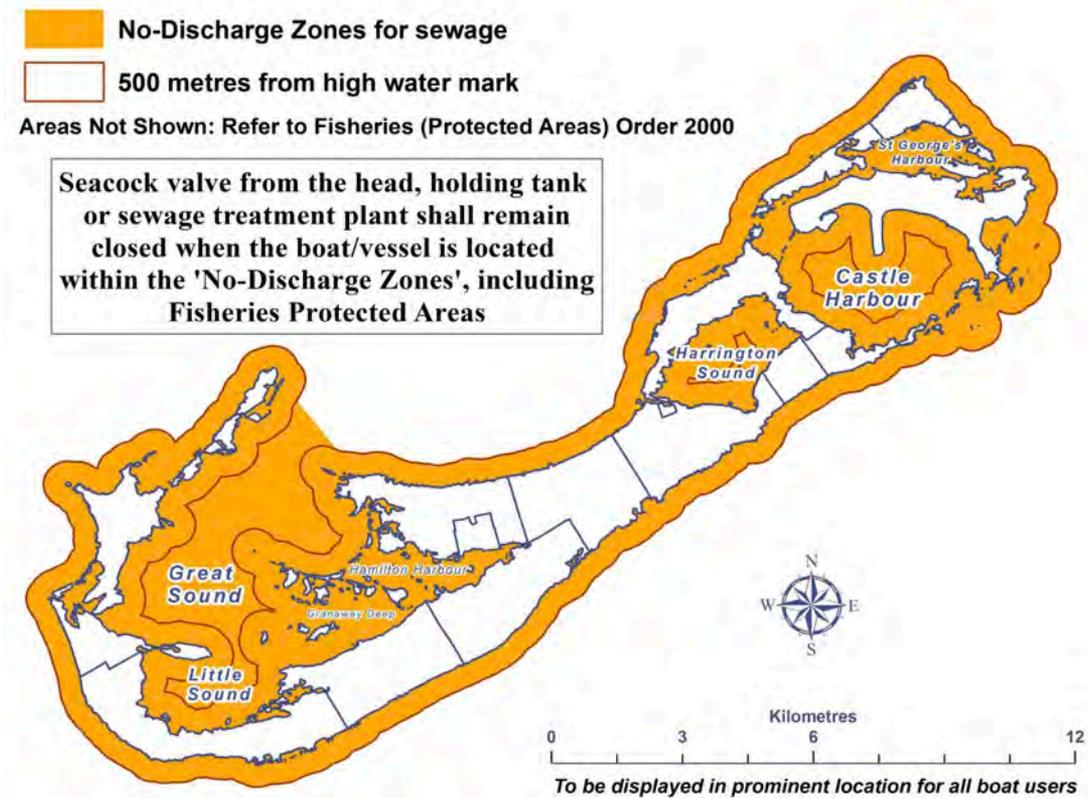


FIGURE 16: Sewage – No Discharge Zones: Water Resources (Prevention of Pollution by Sewage from Boats) Regulations 2018: Instruction Card for Boat Users

Pollution in Bermuda's near-shore waters is generally well-understood and has been partly mitigated in many instances. However, consistent water quality monitoring has not been sustained, which limits understanding of the current condition of inshore waters, in particular Castle Harbour, the site of the AWMF. Monitoring must be conducted to ensure that any future mitigation methods are suitably targeted to minimize impacts on the marine environment.

**Sewage discharge:** There is evidence that sewage discharged to the sea and nutrients leaching from the groundwater due to cesspits and other waste treatments systems can cause observable impacts to Bermuda's environment (fig. 15). Certain impacts have been partly mitigated, but potential remains for additional environmental damage to occur to the nearshore marine environment. One such threat is the risk of phosphate in the groundwater exceeding the absorptive capacity of the limestone, leading to leaching of phosphate to the nearshore environment. This can cause increased algal growth that may change the ecology of this ecosystem and become another stressor to coral growth.

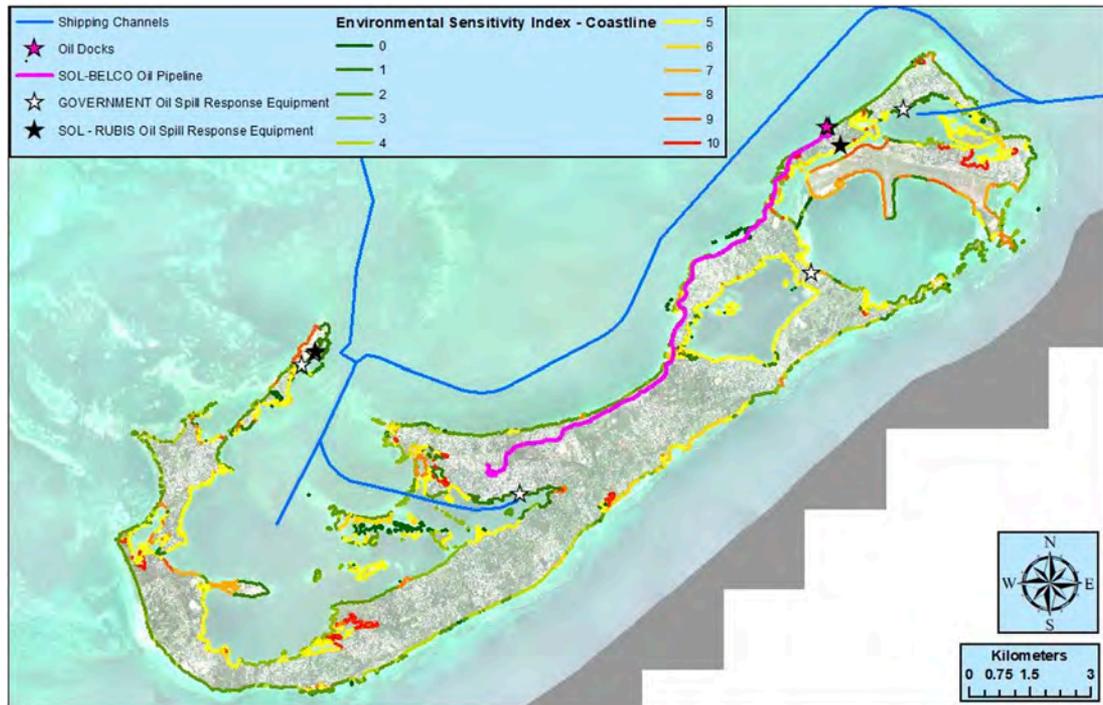
Current efforts by government to increase the coverage of sewer mains will help ward off the worst consequences. The imminent re-direction of the sewerage from St. George's to a deep sealed bore hole will eliminate a direct discharge outfall. Visiting ships abide by the national legislation and, as such, do not discharge sewage or treated effluent to the sea. For all boats the 'no-discharge-zones' provided in the Water Resources (Prevention of Pollution by Sewage from Boats) Regulations 2018 for sewage and treated effluent also exist (fig. 16).

**Stormwater runoff:** Stormwater runoff from roads is known to significantly impact certain fauna, such as cane toads, that live in Bermuda's ponds. Contaminants from road vehicle emissions are present in significant concentrations in soakaways that receive stormwater from road-side drains, in addition to some of the local ponds and marshes. The risk of road runoff to nearshore marine flora and fauna is not as well understood. If research indicates impacts, legislative changes will be required.

**Oil spills:** Oil spills from ships and pipelines pose threats to Bermuda's waters. The environmental risk of oil spills from ships running aground on Bermuda's outer reefs has been assessed as a high risk as part of the Risk Register for the National Oil Spill Contingency Plan. Visiting oil tankers also present a risk of oil spills when delivering oil to the storage depot at the oil docks located at the northeast of the island.

However, the combination of legislation concerning shipping routes and the ongoing efforts to improve Bermuda's readiness to respond to an oil spill will help to reduce the overall severity of any spill (fig. 17).

**Waste management:** The government-operated AWMF receives inert materials including incinerator ash-concrete, white goods, vehicles, and demolition materials (fig. 18). It is understood that these materials have caused some environmental impacts to Castle Harbour. The most recent environmental study of the impacts, undertaken during 2014, showed that contaminants in the marine sediments of Castle Harbour are above the biological effects-based sediment quality guidelines for many metals, PAHs, PCBs, and dioxin and furans within



**FIGURE 17:** Environmental sensitivity map of Bermuda, used to help prioritize oil spill responses by protecting mangrove areas, key channels, and water ways *Instruction Card for Boat Users*



**FIGURE 18:** Airport Waste Management facility in Castle Harbour, a “seafill” for bulk wastes and incinerator concrete-stabilized ash waste

an 80 m radius of the AWMF. With the steady creation of a new landfill in an easterly direction, plans to cap the top of the finished western portion of the site will help limit the ingress of rainwater and associated leaching of materials located above the water table. Changes to the acceptance criteria for electronic waste in the U.S. will mean more e-waste items being disposed of at the AWMF. These and other impacts from this facility will be monitored. (See: Jones, 2010; Prouty et al., 2013; Chapman, 2008)

**Durable waste:** The most pronounced difference in the Sargasso Sea since the 1970s is the amount of plastic marine debris, ranging from large snarls of discarded commercial fishing gear to microscopic particles, derived from the breakdown of diverse plastic

consumer products trapped in the sea for decades (Law et al., 2008; Moret-Ferguson, 2012). Surveys of stranded marine debris on beaches from 2010-2016 show a near-constant input (Hyde et al., 2018). Nathan (2019) and Lorimer-Turner (2017) have found that ~40% of baitfishes (herrings, robins) and their predators (jacks, rainbow runners, yellowtail snappers) in both Bermuda’s inshore and offshore waters had microplastics in their guts. Longtails and some migratory seabirds also appear to ingest microplastic pieces, perhaps via their prey.

Additionally, Bermuda lacks an effective means to recycle a wide range of metals such as iron, aluminum, copper, tin, or lead. Bulk metals are disposed of at the AWMF, but tin and aluminum cans and bottles collected through curbside recycling are exported to the U.S.



**FIGURE 19:** Significant losses in the bay adjacent to the causeway at Blue Hole Hill Park due to 2003’s Hurricane Fabian

### 3.5 Storm Events

Storms, such as winter gales and hurricanes, are increasing in frequency and intensity as the climate changes and sea levels rise. Recent research shows that Bermuda's hurricanes have been twice as strong as they were six decades ago. These impacts make for more dynamic air and water movement to penetrate farther onto the reef platform and higher up the coasts. Significant coastal erosion, including sand displacement from beaches and cliff collapse, has occurred over the past two decades. Steadily rising sea level, combined with more intense hurricanes, will undoubtedly result in more erosion and impacts on coastal infrastructure. Hurricanes in particular have progressively destroyed the mangrove forest at Hungry Bay, which has been de-stabilized by rising sea levels, and at Blue Hole Hill Park (fig. 19).

Intense storms have also damaged several shipwrecks. In 2019, Hurricane Humberto badly damaged the iconic wreck of the Montana, a Civil War blockade runner that sank off Bermuda's northern coast in 1863.

### 3.6 Tourism and Treasure-Hunting

Recreational diving is an important economic activity, and shipwrecks are the cornerstone of this industry in Bermuda. Recreational diving clearly enhances awareness of the island's cultural heritage, but these activities can also threaten preservation if not conducted in an appropriate manner. Key dive sites can become congested with dive boats, and anchoring practices can damage shipwrecks.

A few potential threats that tourism poses to underwater cultural heritage sites include:

- Commercial tour operators bringing visitors to sites can damage wrecks and unknowingly provide access for uninformed tourists to sensitive sites;
- Souvenir hunting and pillaging can be an unfortunate consequence of public access;

- Tourism developments that are poorly planned can undermine the value they aim to share with their guests through irresponsible environmental practices that damage cultural heritage sites.

It is illegal to remove any historic artifact from an historic shipwreck or marine heritage site in Bermuda without authorization, but the illegal removal and damage of historic shipwrecks and marine heritage sites remains a problem. These activities range from accidental discovery and recovery of artifacts by construction workers, beachcombers, and recreational swimmers to occasional and opportunistic souvenir hunting by sport divers and specialized treasure-hunting enterprises.

The discovery of underwater cultural heritage by non-professional heritage enthusiasts in Bermuda is becoming more likely due to the increased impact of storms shifting underwater sediments; significant large-scale development activities; chronic sediment disruption by large marine vessels; loss of seagrass and other habitats; and modern equipment and technological tools that allow committed amateurs to make discoveries that would have previously been unimaginable, even in the deep ocean.

Cruise ships are one of the largest modes of transportation in coastal tourism and account for a significant amount of economic revenue for destination countries. However, the growing size of the cruise ship industry has severe negative impacts on marine and coastal environments. Food and human waste cannot be disposed of onboard, leading ships to dump refuse into the ocean despite pollution regulations implemented both domestically and internationally. Another concern is the possibility of cruise ship fuel leakage into the marine environment. In the past, cruise ships have been fined for violating floating pollution rules.

Environmental concerns persist even after a cruise ship is harbored. Potential damages caused by harboring include dredging to accommodate several cruise ships a day, which produces silt that is harmful to coastal ocean habitats, and anchors that threaten the health of coral reef ecosystems.



Underwater Caves

Photo Credit // © Joe Lepore

# 4 THE IMPORTANCE OF MARINE MANAGEMENT AND SPATIAL PLANNING



The current system of local marine management can be described as a patchwork of dozens of ocean-relevant laws in which authorities—often independently—make decisions about how to utilize ocean resources. While many existing laws do provide adequate authority for effective implementation, some areas present opportunities for improvement.

## 4.1 Operational Areas of EEZ Management

The management of marine-related activities in the EEZ can be broken down into four operational areas: onshore, inshore, offshore, and oceanic (fig. 20).

### 4.1.1 Onshore

The onshore area comprises terrestrial land upwards from the high-water mark and includes rocky coastal areas, docks, beaches, and foreshores. Bermuda’s coastline, which extends for some 197 miles, is significant for its natural and scenic qualities. It contains important flora and fauna, such as nesting sites for the longtail and cahow, ponds, and salt marshes.

Onshore areas are increasingly at risk from coastal development, erosion, sea level rise and storm surge, as well as illegal fishing from the shoreside and docks, illegal selling of fish, smuggling, and illegal dumping. Enforcement of various requirements and regulations is undertaken by Fisheries Wardens, the Bermuda Police Service, the Department of Parks, HM Customs, and the Department of Health.

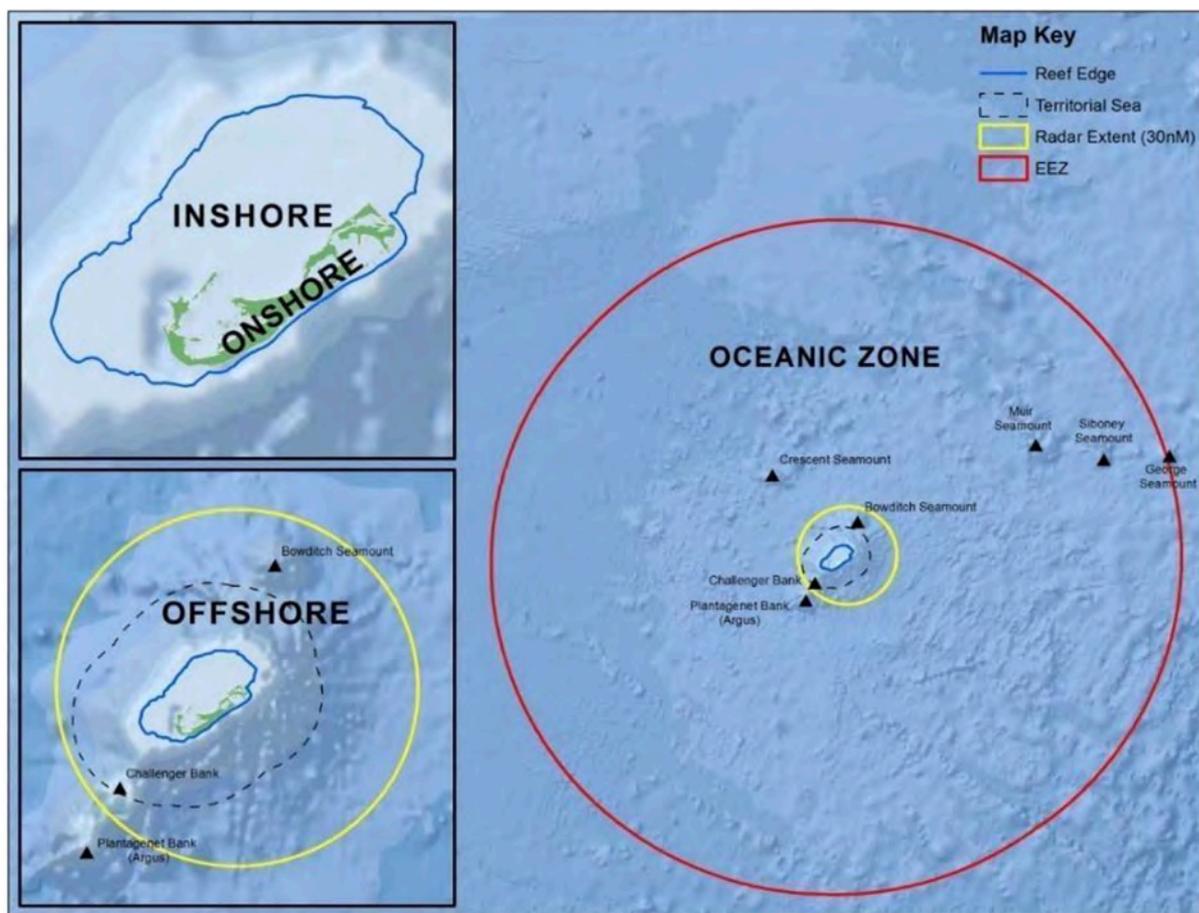


FIGURE 20: Operational zones of marine management in the EEZ

### 4.1.2 Inshore

The inshore area comprises the zone from the high-water mark on the landward side to the vicinity of reef platform edge. This zone includes protected areas such as the intertidal zone, mangroves, and coral reefs, as well as seagrass beds, protected fish spawning areas, marine cultural heritage, bays, sounds, and islands. It also includes docks, marinas, ship channels, and boat moorings.

Inshore areas are increasingly at risk from coastal development, infrastructure development, erosion, storm surge, illegal fishing, illegal selling of fish, smuggling, and illegal dumping. Enforcement of various requirements and regulations is undertaken by Fisheries Wardens and Coast Guard, while the Bermuda Marine Operations Centre (BMOC) provides radar coverage and vessel traffic control.

### 4.1.3 Offshore

The offshore area covers the zone from the vicinity of the reef platform edge to 30 nm, and includes the island's 12 nm territorial waters and Challenger Bank. (It does not include Plantagenet Bank, which is just outside the boundary.) This area is differentiated from the inshore zone by the type of enforcement coverage and activities. This area is covered by shoreside radar but is not accessible to inshore patrol craft.

Enforcement in the offshore zone is undertaken by Fisheries Wardens and the Coast Guard, with the BMO providing radar coverage to a maximum of 30 mile radii. Offshore areas are increasingly at risk from local vessels and foreign vessels fishing illegally in territorial waters, smuggling, illegal dumping, illegal interference with marine heritage, enforcing vessel safety requirements, and enforcing International Maritime Organization regulations for pollution control and other regulations.

### 4.1.4 Oceanic

The oceanic area comprises deep ocean, including the seamounts of Plantagenet, Crescent, Muir range, Siboney, and George outside of 30 nm range of shoreside radar to EEZ edge. The open ocean makes up the largest part of Bermuda's EEZ. It is important to remember that the prime targets of pelagic fisheries (tunas and wahoo) are migratory fishes. Their long-term fate will be determined by the state of the open ocean and better management of fisheries in areas beyond national jurisdiction.

No local enforcement is currently undertaken in this area. Vessels with their AIS activated can be monitored by organizations such as Global Fishing Watch and BMO. However, enforcement must be through external enforcement agencies such as the U.S. Coast Guard, U.K. Royal Navy, and others. Oceanic areas are increasingly at risk from illegal foreign vessels fishing in Bermuda's EEZ for pelagic species, as well as illegal mining and illegal dumping. Bermuda has very limited capacity to enforce various requirements and regulations. There is a high level of ships transiting through Bermuda's EEZ,

including cruise ships, merchant ships, oil tankers, and yachts sailing to and from Bermuda.

## 4.2 Management Issues to be Addressed

Appendix G illustrates the types of management issues that need to be addressed, as identified during consultation with the DENR marine enforcement team, the Marine Resources Board, and Commercial Fisheries Council. Issues are listed by theme and management zone in which the issue predominantly takes place.

## 4.3 Status quo Marine Management

Bermuda's current marine management situation is similar to many countries without strategic marine spatial plans. The main issues with status quo marine management are listed below.

### 4.3.1 No Planning System for the Ocean

In Bermuda, there is no comprehensive planning system operating below the mean high-water mark, except insofar as features are connected to the land, as with a dock. Thus, there is no system for producing an integrated forward plan for marine spaces, and no marine planning strategy to guide such plans. Leases for use of the seabed are managed locally by the Ministry of Public Works. However, this does not constitute a planning authority that considers local and environmental interests in the marine context. In addition, there is no plan or policy framework to provide consistent and coordinated decision-making for ocean spaces. The Development and Planning Act 1974 is unique among relevant legislation because it applies to development generally, rather than to specific types of activities. Such a framework could be used by regulators to review the compliance of any new development or use proposals.



### 4.3.2 Marine Regulations are Fragmented Among Sectors

Bermuda has not enacted laws comprehensively governing certain new and emerging activities, including offshore mining, energy development (e.g., wind, tidal, wave, current, thermal, and petroleum facilities), and aquaculture. While some legal provisions do apply to these activities, enhancement of existing governance frameworks can improve regulatory effectiveness.

Some existing laws are duplicative, adding little value for management, and potentially complicating implementation and increasing associated costs. For example, important areas for corals are protected by the Coral Reef Preserves Act 1969 but, as of 2016, all corals have been protected under the Protected Species Order under the Protected Species Act 2003. Also in 2016, corals were removed from the Fisheries (Protected Species) Order 1978—a current example of how the government can simplify and consolidate legal protections. Laws sometimes appear to conflict, but most such cases can be resolved by interpreting the laws to work together.

On land, the Department of Planning prepares plans and regulates proposals for most forms of development. For the marine environment, many forms of development have a specific regulator for that type of activity, such as Transport, Energy, or Tourism. There is an array of regulatory processes and agencies by which marine licenses or permits may be obtained. These regulatory systems evolved independently over time in response to changing needs for marine purposes. Consequently, the regulations tend to be related to particular sectors or activities, such as shipping, fishing, conservation, or navigation. As a result, there is often a lack of coordination between agencies. For example, marine piles are approved within the Ministry of Transport without the need for consultation with the Ministry of Home Affairs. Likewise, in some circumstances, the provisions of the Fisheries Act 1972 can override those of the Planning and Development Act 1974, but this is not explicitly defined. Land-based regulations are generally related to the Planning Act, which defines a central decision-making process that relates to other regulations and agencies. The public mostly has to interact with the Department of Planning through which other agencies are consulted. However, little such coordination exists for marine activities.

### 4.3.3 Complying with International Obligations

Some marine activities are subject to international regulations or conventions. The Merchant Shipping Act, for instance, contains regulations to address such conventions for international shipping. Other areas, such as environmental or species protection, are increasingly under international review. Bermuda must ensure that it complies with international conventions while respecting local circumstances. See [Appendix H](#) for a list of International Obligations to which Bermuda is a Party.

### 4.3.4 Monitoring and Enforcement are Difficult

Monitoring and enforcement at sea are more difficult than on land. There is a large area to cover, and enforcement resources must be deployed from the land base. Weather and sea conditions can also hamper efforts to spend time on the ocean. In addition, because regulatory management is fragmented, marine enforcement is often focused on specific sectoral activities. Because there are fewer people active on the ocean than on the land, marine enforcement resources are also less able to rely on the policing and reporting of matters by the public.

### 4.3.5 More Information and Analysis are Needed

Marine planning necessarily involves the interaction of human activities with the functioning of natural marine systems. It, therefore, relies heavily on scientific data and information. Bermuda has been home to a prolific marine science community for over a century. Aspects of Bermuda's marine environment have been well-studied compared with many other jurisdictions. However, compared to Bermuda's land resources, there is less known about the general distribution of resources and activities of the marine environment due to its relative inaccessibility for data collection. There has also traditionally been less investment in the conservation, planning, and understanding of Bermuda's ocean ecosystems in comparison to its terrestrial environments.

Fully comprehensive mapping of the island's seabed topography has not been conducted in over 200 years since the 1797 Hurd Survey. Despite this, more recent, smaller-scale studies exist and help to paint a picture of Bermuda's underwater environments. In 2010, Hallett compared the findings of the Hurd Survey to Bermuda's current maps in GIS; Murdoch, et. al mapped all of Bermuda's patch reefs in GIS in 2008; and Hochberg, et al. mapped coral cover for the reefs on the Bermuda Platform in GIS in 2017. BIOS has high-resolution satellite imagery of the Bermuda Platform from 2009-present. The NEKTON Project mapped Plantagenet Bank in 2016 and corrected a significant error in its location. The Government has recently collected LIDAR data (2020) from the U.K. Hydrographic Office and is in the process of operationalising it at the time of writing; however, a 2003 LIDAR survey of a small section of the South Shore also currently exists.

It is worth noting that comprehensive GIS databases do exist within government, but they could be better integrated to facilitate information exchange, improve collaboration, and reduce errors.

Most of the data generated from studies is stored in piecemeal fashion, without a central system to integrate information and form a basis for marine spatial planning. As a consequence of Bermuda's marine governance structure, departments may not be aware of potential cumulative impacts or user conflicts when making sector-specific decisions. Thus, more frequent and more effective interdepartmental collaboration and consultation are

needed. Such collaboration and consultation can be achieved informally through personal connections among government staff or formally as a result of legal requirements (consultation mandates, ex officio board membership, etc.). Increasing the frequency and quality of collaboration within the government on marine issues may be among the most promising first steps Bermuda can take on the path to marine spatial planning.

#### 4.3.6 Increasing Pressure on Marine Resources and Potential Conflicts

Marine protected areas (MPAs) have been established in Bermuda's inshore waters to protect seasonal fish spawning grounds, restrict fishing equipment, and ease conflict among divers and fishermen at particular sites. However, Bermuda lacks a coherent strategy for the design and objectives of MPAs for conservation purposes that also contributes to an overall marine use plan. The past initiatives on protected areas can be used to build a more comprehensive MPA strategy.

With increases in marine activity and development, there are corresponding increases in demand for natural marine resources and potential for user conflict. On land, incompatible developments are preempted or addressed retroactively by the planning approval process. As already stated, there is no existing mechanism for conflict resolution in ocean spaces. The Marine Resources Board provides advice to the Minister responsible for the Environment and policy advice to the DENR. However, there is not a mandate beyond the Ministry for the Board as a decision-making body. The Department of Planning seeks comments from the Marine Resources Board on land-based development proposals that may affect the marine environment. It is permissible within that planning process for these comments to be merely considered and not followed, so the decision-making still lies with the Development Applications Board.

#### 4.3.7 Increasing Recognition of the Need for Marine Spatial Planning

Internationally, most developed nations are developing marine spatial plans (MSPs), as recognition spreads that ocean spaces need a planning framework similar to that which has existed for land resources for decades. Marine officers in the Government of Bermuda have recognized this need, and many elements of marine spatial planning are evident in past white papers and strategies for marine resources.

#### 4.3.8 Relative Lack of Value from the Public

Compared to the value placed on land spaces, the marine environment often suffers from a relative lack of public understanding due to an "out of sight, out of mind" phenomenon. It may be argued, however, that Bermuda's population engages with marine spaces more readily than populations in other jurisdictions.

#### 4.3.9 No Private Ownership of the Marine Environment

The seabed and water column are owned by the Crown, while the water surface is owned by the Crown within the Territorial Sea. These marine spaces are community resources, although the government can legitimately pursue economic benefit from leases and permits. Whereas a legal interest in land is required for private terrestrial developments, there is no corresponding requirement for ocean spaces.



Flatts Village

Photo Credit // © Shayna Brody

# 5 MINISTRIES DECISION FOR OPERATIONALIZING MARINE SPATIAL PLANNING



Bermuda Dock // © Guille Pagano

Although there are several ways to operationalize marine spatial planning within Bermuda’s EEZ, the Government of Bermuda has decided to create, design, and implement an entirely new legislative and policy framework for marine spatial planning and any associated marine protected areas through the Bermuda Ocean Prosperity Programme (BOPP).

In many countries, marine spatial planning policy is implemented through new primary legislation that, among other things:

- Designates a lead ministry for marine planning or establishes a new implementing body;
- Creates a marine advisory body;
- Establishes the planning process;
- Identifies the contents of a plan, including formal categories of zones that may be used where a MSP is implemented through zoning (e.g., recreation, fisheries, mixed-use, etc.);
- Provides for the plan’s binding legal effect

Bermuda appears to have contemplated such an approach in 2010 in the Strategy for the Sustainable Use of Bermuda’s Living Marine Resources, which calls for replacing the Fisheries Act with a Marine Resources Act that would include new or expanded elements on “marine protected areas and zoning.” This option would allow for a “clean” approach, whereby the scope, principles, goals, objectives, and development process for the MSP can be clearly identified.

Creating new legislation would recognize and incorporate the use of existing processes such as:

- Continued oversight of marine resources, fisheries, and marine heritage by the DENR;
- Continued oversight of the development process by the Department of Planning;
- Continued oversight by the Department of Marine and Ports for operations and management of channels and navigation routes;
- Continued oversight of telecommunication and energy by the Regulatory Authority;

Through BOPP, the Government of Bermuda is currently undertaking the five year process of establishing and implementing an MSP for Bermuda’s EEZ. Progress to date includes the establishment of a Steering Committee, detailed mapping and modeling of Bermuda’s offshore and nearshore waters, and extensive stakeholder consultation and involvement. The MSP will be accompanied by a Blue Economy Strategy that will help diversify and sustain Bermuda’s economy, and the incorporation of sustainable fishery management and monitoring plans.



Sargassum Mat

Photo Credit // © Joe Lepore

# 6 IN CONCLUSION: BERMUDA'S APPROACH TO MARINE SPATIAL PLANNING

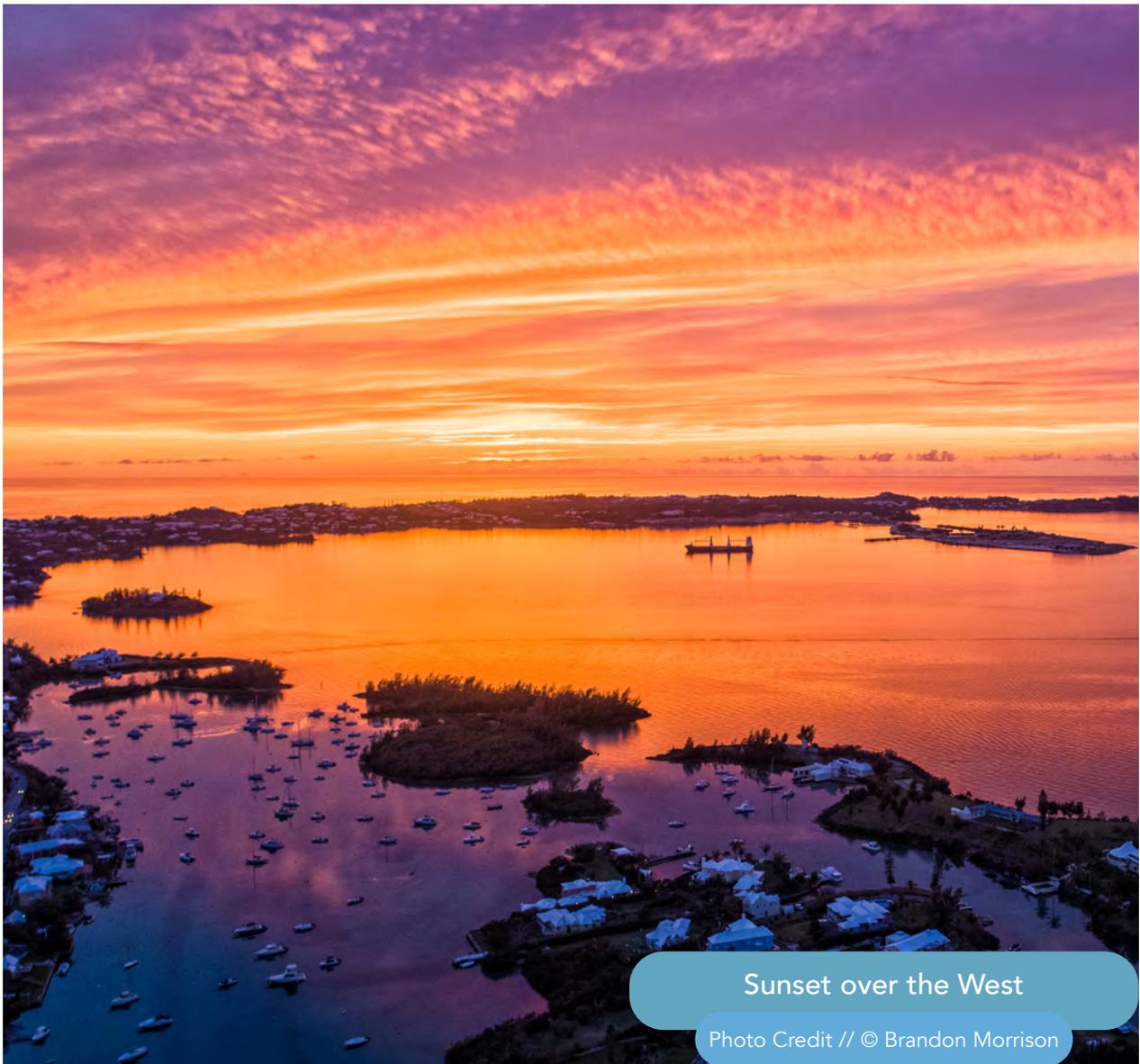


Pink Sand on Elbow Beach // © Canon Purdy

The ocean surrounding Bermuda contains natural beauty unlike any other place in the world. Its unique marine environment is filled with opportunities and resources that will help facilitate the island nation's rise towards a future of sustainability and longevity as a global leader in ocean conservation. However, coordination and extensive planning are necessary to safeguard Bermuda's waters from environmental and anthropogenic threats for both present and future generations. Climate change threatens Bermuda's diverse marine ecosystems and shoreline developments through coral bleaching, ocean acidification, and sea level rise. Certain fishing practices threaten Bermuda's fish populations and wastewater deposits harmful pollutants in the EEZ.

Both Bermuda's marine environment and economy will greatly benefit from capitalizing on the opportunities available within the EEZ. By leveraging Bermuda's rich underwater cultural heritage through blue tourism and creating new jobs within the renewable energy sector, conservation action and policy will have long-lasting positive impacts for the island. A Marine Spatial Plan (MSP) is one tool to promote integrated planning in Bermuda's marine environment so as to unlock the balance of sustainability and economic prosperity.

A comprehensive and stakeholder-driven marine spatial plan can further unlock the possible sustainable benefits within Bermuda's EEZ, as well as a multitude of economic advantages. Harnessing Bermuda's Blue Economy through sustainable fish stocks, ocean renewable energy, blue tourism, and more will diversify revenue streams and create new opportunities for the people of Bermuda. The Government of Bermuda believes the best option for an MSP is to create, design, and implement an entirely new policy framework. Marine spatial planning will help to mitigate climate change impacts, restore fish stocks, protect biodiversity and ecosystems, and ensure long-term prosperity for Bermuda. This report is an important source to utilize when prioritizing important areas for protection within Bermuda's marine environment, as well as a current baseline with which to compare future conservation progress.



# 7 SUMMARY



The State of Bermuda's Waters has examined Bermuda's marine environment and some of the challenges it faces, as well as some of the opportunities presented with the enactment of a Marine Spatial Plan (MSP). The following represents a summary of these key challenges and opportunities as discussed:

- Bermuda's EEZ defines an area of the sea stretching 200 nautical miles (nm) seaward.
- Bermuda's main ecosystems include coral reefs, seagrass, mangroves, inshore waters, offshore banks and seamounts, and open ocean.
- Within Bermuda's EEZ are a variety of protected and endemic species, as well as an underwater cultural heritage consisting of shipwrecks and a rich maritime history.
- Bermuda's waters contain multiple marine endemic and protected species, but—in many cases—lack the fine-scale scientific data required to successfully manage and protect these species.
- Bermuda's shipwrecks have significant income-generating potential, but they need to be managed with the utmost care as they represent the island's heritage and are at dual risk from tourism and factors related to climate change.
- Current and potential uses of Bermuda's EEZ include recreational and commercial fishing, tourism, commercial/residential coastal development, energy provision and telecommunications, transportation, and shipping.
- Fishing in Bermuda has both important cultural and socio-economic significance. Recreational fishing is largely unregulated and commercial fishers often must compete with lower-priced illegally sold local fish and imports.
- Tourism represents a major portion of Bermuda's economy and the island is committed to "green tourism" in partnership with local environmental groups.
- The current planning framework of conservation zones and coastal development policies has opportunities to extend the spatial planning zoning system beyond Bermuda's terrestrial areas to the marine environment.
- Threats to marine natural resources and cultural heritage in the EEZ include climate change; sea level rise, shoreline development; overfishing; overgrazing; invasive species; wastewater, pollution, and durable waste; storm events; and tourism and treasure hunting.
- Infrastructure projects and shoreline development have had major impacts on mangroves, seagrass beds, and known and unknown underwater cultural heritage sites.
- The lack of data on recreational fishers and their harvest limits an understanding of how much fishing occurs on the Bermuda Platform and places the regulatory burden on commercial fishers.
- In recent years, sea turtle grazing has put unprecedented pressure on seagrass beds, resulting in the collapse of local beds.
- The agencies responsible for the protection of Bermuda's marine environment and natural resources tend to work independently, focused on each of their specific areas of interest, with some ad hoc cooperation when a common interest is identified.
- Internationally, most developed nations are developing marine spatial plans, as recognition spreads that ocean spaces need a planning framework similar to that which has existed for land resources for decades.
- Bermuda's existing planning structure contains all the elements needed to develop a comprehensive MSP, including a process for plan development and a planning permission process that includes interdepartmental consultation and environmental impact assessment (EIA) requirements.

# LIST OF ACRONYMS

|            |   |        |   |
|------------|---|--------|---|
| AIS        | Automatic Identification System   | IBRD   | International Bank for Reconstruction and Development               |
| AWMF       | Airport Waste Management Facility   | ICAAT  | International Commission for the Conservation of Atlantic Tunas     |
| BAMZ       | Bermuda Aquarium, Museum & Zoo  | ICSID  | Investment Disputes between States and Nationals of Other States    |
| BATS       | Bermuda Atlantic Time-series Study  | IDA    | International Development Association                               |
| BBMAP      | Benthic Mapping, Monitoring and Assessment Programme                            | IFC    | International Finance Corporation                                   |
| BBSR       | Bermuda Biological Station for Research (former name of BIOS)                   | IMO    | International Maritime Organization                                 |
| BELCO      | Bermuda Electric Light Company Limited  | IPCC   | Intergovernmental Panel on Climate Change                           |
| BIOS       | Bermuda Institute of Ocean Sciences   | IRP    | Integrated Resource Plan  |
| BIOS-SCOPE | BIOS—Simons Collaboration on Ocean Processes and Ecology                        | ISBM   | Island Boat Safety Management Code                                  |
| BOPP       | Bermuda Ocean Prosperity Programme  | KVA    | kilovolt-ampere   |
| BOT        | British Overseas Territory  | LIDAR  | light detection and ranging   |
| BMOC       | Bermuda Marine Operations Centre  | MARPOL | International Convention for the Prevention of Pollution from Ships |
| BREAM      | Bermuda Reef Ecosystem and Analysis   | MEP    | Marine Environmental Program  |
| BSCV       | Bermuda Small Commercial Vessel Code  | MOU    | Memorandum of Understanding   |
| BSMA       | Bermuda Shipping and Maritime Authority   | MPA    | Marine Protected Area   |
| BTA        | Bermuda Tourism Authority   | MRB    | Marine Resource Board   |
| CARICOM    | Caribbean Community   | MSP    | Marine Spatial Planning   |
| CBD        | Convention on Biological Diversity  | MW     | megawatt  |
| CFC        | Commercial Fisheries Council  | NFP    | National Fuels Policy   |
| CFP        | ciguatera fish poisoning  | NGO    | Non-Governmental Organization                                       |
| CITES      | Convention on International Trade in Endangered Species of Wild Fauna and Flora | PAH    | Polycyclic aromatic hydrocarbons                                    |
| COLREG     | International Regulations for Preventing Collisions at Sea                      | PCB    | polychlorinated biphenyls   |
| DENR       | Department of Environment and Natural Resources                                 | PE     | population equivalent   |
| DPLB       | Department of Public Lands and Buildings  | PV     | photovoltaic  |
| DPT        | Department of Public Transportation   | SAR    | Search and Rescue   |
| DSC        | Digital Selective Calling   | SCTLD  | Sudden Coral Tissue Loss Disease                                    |
| EIA/EIS    | environmental impact assessment/ statement                                      | SOLAS  | Safety of Life at Sea   |
| EEZ        | Exclusive Economic Zone   | TAC    | Total Allowable Catch   |
| FAO        | Food and Agriculture Organization   | UHF    | Ultra high frequency  |
| GDP        | Gross Domestic Product  | UNCAC  | United Nations Convention Against Corruption                        |
| GIS        | geographic information system   | UNCLOS | United Nations Convention on the Law of the Sea                     |
| GT         | gigatons  | UNESCO | UN Educational, Scientific, and Cultural Organization               |
| HA         | hectare   | UNFCCC | United Nations Framework Convention on Climate Change               |
| HF         | High Frequency  | VHF    | Very High Frequency   |
| HIA        | Historic Impact Assessments   | WHO    | World Health Organization   |
| HWA        | Historic Wrecks Act   | WMO    | World Meteorological Organization                                   |

# A PPENDICES



# APPENDIX A | GOVERNANCE OF MARINE RESOURCES AND UNDERWATER CULTURAL HERITAGE IN THE EEZ

This section summarizes the current state of the jurisdiction and governance of Bermuda's marine environment within the 200 nautical miles of Bermuda's EEZ. Bermuda has a Territorial Sea limit of 12 nautical miles, as defined in the Bermuda (Territorial Sea) Order in Council 1988, as amended by the Bermuda (Territorial Sea) (Amendment) Order 1997.

Below is an accounting of many of the regulators, advisors, and other stakeholders that are involved in various aspects of marine management and enforcement.

## Regulatory Agencies

The agencies listed below tend to work independently, focused on each of their specific areas of interest, with some ad hoc cooperation when a common interest is identified. The exception is **Bermuda Maritime Operations Centre (BMOOC)**, the 24-hour operational hub of the Bermuda Government's maritime support program, which feeds information to various agencies and recently the Coast Guard.

- **Department of Environment and Natural Resources (DENR):** DENR formulates and implements legislation, policy, and standards to protect Bermuda's natural environment; monitors and provides guidance for the prevention and control of pollution; and manages marine activities. The Department also supports Bermuda's agriculture and fisheries sectors; researches and promotes awareness of Bermuda's biodiversity, protected species, threatened habitats, and marine cultural heritage; and conducts environmental education on Bermuda. Bermuda's officers participate in international working groups, committees, regulatory bodies (ICAAT), and the Sargasso Sea Commission.
- **Department of Marine and Ports Services:** The Department's primary role is to oversee marine affairs to ensure the safe movement of both international shipping and the operation of commercial and recreational boat traffic in local waters. The department operates the Ferry Service and oversees port operations. Other areas of responsibility are salvage work; boat and mooring registration; oil spill response; offshore marine search and rescue, seaport security; and management of channels, channel markers, docks and all matters related to shipping and inspection of vessels, with the exception of commercial fishing vessels, which fall under the purview of DENR.
- **Ministry of Works and Engineering:** The Ministry controls and approves dredging of any part of the sea below the high-water mark or deposition of any object or any material on any part of the seashore or on the bed of the sea below the high-water mark and extends to the edge of the EEZ.
- **Department of Planning:** The Department manages all matters related to development of land and/or structures attached to land above the high-water mark, including enforcing the Development and Planning Act 1974 and subsequent regulations.
- **Department of Parks:** The Department manages the amenity parks portion of the National Parks System—approximately 1,000 acres—and enforces the Bermuda National Parks Act 1986 and regulations. Of note, the Department manages most of the public beaches.
- **Ministry of Tourism:** The Ministry develops government transportation policies and programs, ensures that all transportation systems work together, ensures the efficiency and quality of Bermuda's transportation system, and monitors Bermuda's broadcasting content.
- **Department of Telecommunications:** The Department is responsible for developing telecommunications policy in Bermuda, as well as monitoring broadcasting content and controlling political broadcast on the Island.
- **Department of Energy:** The Department develops policy, legislation, and regulation in order to ensure a secure energy future for Bermuda, including developing energy policies, conducting public education about energy issues and conservation, and consults with the Department of Planning on energy-related development applications.
- **Marine Police Section, Bermuda Police Service:** The Service maintains law and order under the Police Act 1974. The Service is named as an enforcement agent under most if not all legislations pertaining to the marine environment.

- **Coast Guard, Bermuda Royal Regiment:** The Royal Bermuda Regiment and members of the Bermuda Police Service joined together to form the Bermuda Coast Guard, which first became functional in March 2020. The Coast Guard helps prevent illegal fishing and drug smuggling, enforces sea-going safety regulations, and assists with search and rescue.
- **HM Customs:** The Customs Department is responsible for collecting and protecting the revenue and for enforcing import and export prohibitions and restrictions. Customs officers work in partnership with the Bermuda Police Service to prevent smuggling and other criminal activity. Customs officers are stationed at Bermuda's main ports of entry: St. George's, L. F. Wade International Airport and Hamilton.

## Other Government Entities

- **Marine Resources Board:** This Board advises the Minister on matters relating to the Fisheries Act 1972 and its subordinate legislation, and on matters relating to the protection and use of marine natural resources.
- **Commercial Fisheries Council:** The Commercial Fisheries Council is responsible among other things for the issuing of licenses, specified in Regulations made under the Fisheries Act 1972, as well as evaluating the eligibility of applicants for licenses, full time status, and benefits.
- **Environmental Authority:** The Environmental Authority considers applications for constructing and operating controlled plants as defined under the Clean Air Act 1991; importing and exporting Controlled Chemicals; and for abstracting water via a well or disposing of water via a borehole to the groundwater.
- **Historic Wrecks Authority (HWA):** The HWA provides guidance and policy advice to the Minister responsible for the Environment on all matters related to marine cultural heritage, including historic shipwrecks and other underwater cultural heritage.
- **Marine and Ports Authority:** The Marine and Ports Authority provides guidance and advice on all marine matters in Bermuda, such as commercial shipping and recreational boating use, aids to navigation, regulating moorings, diving regulation, and public and commercial transport matters related to marine safety.
- **Regulatory Authority:** The Regulatory Authority promotes fair business practices; protects consumer and industry stakeholders; encourages innovation and integrity in these markets; promotes sustainable competition in the telecommunications sector; and regulates electricity licences. It also created the Integrated Resources Plan (IRP) for energy production.
- **Development Applications Board:** Sitting within the Department of Planning, this board is responsible for the review of planning and subdivision applications to ensure compliance with the Development and Planning Act 1974, the Bermuda Plan, and local plans.
- **Water Safety Council:** The Water Safety Council's mission is to promote water safety on land and at sea.
- **Bermuda Aquarium Museum and Zoo:** Founded in 1926, the Bermuda Aquarium, Museum & Zoo (BAMZ) is owned and operated by the Bermuda Government and is managed by DENR. BAMZ is one of the world's oldest aquariums. It is an important centre for science education, research, and species conservation.

## Other Stakeholders

Other government and non-governmental departments, quangos, and organizations are consulted and/or advised as necessary, including:

- West End Development Company
- Bermuda Land Development Company
- Corporations of St. Georges
- Corporation of Hamilton
- Atlantic Conservation Partnership
- Bermuda Audubon Society
- Bermuda Dive Association
- Bermuda Environmental and Sustainability Task Force
- Bermuda Institute of Ocean Sciences
- Bermuda National Museum

- Bermuda National Trust
- Bermuda Shark Project
- Bermuda Sub-Aqua Club
- Bermuda Turtle Project
- Bermuda Underwater Exploration Institute
- Bermuda Zoological Society
- Humpback Whale Research Project
- Sargasso Sea Commission
- Ocean Support Foundation
- Fishermen’s Association Bermuda and individual commercial fishermen
- Anglers clubs and individual recreational fishermen/lobster divers
- Boat marina operators
- Boat and yacht clubs and sailing associations
- Bermuda Powerboat Association
- Dive and tour boat operators
- Hotel representatives (via BTA)
- Telecommunications providers, plus BELCO, Bermuda Waterworks and Esso Bermuda
- Bermuda Container Line Ltd, Somers Isles Shipping Ltd, Bermuda Ship Agencies Ltd

## Marine Legislation by Activity

### Commercial Activities

- **Commercial fishing:** The Fisheries Act 1972 regulates commercial and recreational fishing activities in Bermuda’s waters, establishing the licensing of fishermen and vessels, regulating the use of fishing methods and gear, and placing restrictions on certain species or areas. The Act provided for the creation of the Marine Resources Board (advisory) and Commercial Fisheries Council (Statutory) and is enforced by the Department of Environment and Natural Resources with advice from the Marine Resources Board. Of note are the Fisheries (Protected Areas) Order 2000, which prohibits the taking of fish or use of any anchor other than a Danforth (sand) anchor in 32 sites and further restricts other areas. The Fisheries (Protected Species) Order 1978 protects a range of fish from being taken anywhere within the exclusive economic zone.

- **Legislation:** The Fisheries Act 1972
- **Oversight/enforcement:** Department of Environment and Natural Resources, Commercial Fisheries Council, Marine Resources Board

Spatial restrictions on commercial and recreational fishing include:

- Fishing prohibition in the seasonal protected areas from April 15 through August 14, with prohibition of fishing in the Black Grouper sites is extended to November 30. Trolling for game fish is permitted outside of the 30-fathom depth contour.
- Permanent fishing closure in several protected dive sites within a certain radius of a central buoy or tower. The size of the circle on the map is proportional to the area protected and the radius varies from 300 m to 1 km.
- Fishing prohibition in the area off St Georges from May 1 through June 30 to protect breeding fishes.
- **Aquaculture:** The Fisheries Act 1972 regulates fishing-related activity but activities such as commercial aquaculture require further regulations, which are currently pending. Any marine-related aquaculture activities fixed to the sea bottom would require licensing under the Public Lands Act 1984. Any enterprise on land would require planning permission under the Bermuda Plan.
- **Legislation:** The Fisheries Act 1972, Public Lands Act 1984

- **Oversight/enforcement:** Department of Environment and Natural Resources, Commercial Fisheries Council, Marine Resources Board, Ministry of Public Works
- **Development and land reclamation:** The Development and Planning Act 1974 does have some restricted powers regarding development below the high-water mark and in the marine environment. The Minister may make regulations dealing with any sea wall, breakwater, jetty, wharf, or pier but subject to any other relevant legislation. The Development Applications Board shall not grant planning permission that would result in development at variance with the Act, a development plan, the regulations, a zoning order, a municipal bye-law, or other statutory provision. The Development and Planning Act 1974 contains regulations pertinent to shoreline development, such as marinas, although the Act does not pertain to ocean spaces. The Public Lands Act 1984 is the primary legislation pertaining to the seabed, and a permit would need to be approved to destroy protected habitats under the Protected Species Act 2003.
  - **Legislation:** Development and Planning Act 1974, Public Lands Act 1984, Protected Species Act 2003
  - **Oversight/enforcement:** Ministry of Public Works, Department of Planning, Department of Environment and Natural Resources, Department of Marine and Ports
- **Seafloor development:** As the Government of Bermuda has freehold title to all the foreshore and seabed within the territorial sea (12 nautical miles), the government has the authority to authorize any development on the seafloor. Foreshore licenses/leases are regularly enacted for any development or occupation of the seafloor, such as the building of docks, marinas, or the laying of undersea cabling or pipelines. The Public Lands Act 1984 establishes the minister's powers with respect to dredging on the seabed generally. The Minor Dredging Works Act 1945 establishes the locations of bays and anchorages where dredging by the government is authorized. The Channels Improvement Act 1937 relates to the shipping channels specifically.
  - **Legislation:** Public Lands Act 1984, Minor Dredging Works Act 1945, Channels Improvement Act 1937
  - **Oversight/enforcement:** Ministry of Public Works, Department of Planning
- **Mining:** Potential seabed mining would be managed under the Public Lands Act 1984 for leasing of the seabed. It would likely consider issues under the Merchant Shipping Act 2002, Marine Board Act 1962, Protected Species Act 2003, and Fisheries Act 1972.
  - **Legislation:** Public Lands Act 1984, Merchant Shipping Act 2002, Marine Board Act 1962, Protected Species Act 2003, Fisheries Act 1972, UK Environment Protection (Overseas Territories) Order 1988
  - **Oversight/enforcement:** Ministry of Public Works, Department of Marine and Ports Services, Ports Authority, Department of Environment and Natural Resources

## Recreational Activities

- **Recreational fishing:** The Fisheries Act 1972 regulates recreational fishing as well as commercial fishing. See special restrictions on fishing activities under "commercial fishing," above.
  - **Legislation:** The Fisheries Act 1972, Marine Board Act 1962, Bermuda National Parks Act 1986, Bermuda National Parks Regulations 1988
  - **Oversight/enforcement:** Department of Environment and Natural Resources, Minister of Tourism Development and Transport, Department of Parks
- **Recreational boating:** The Marine Board Act 1962 and its several regulations govern the nature and use of ports, ships, channels, navigational aids, moorings, and boating operations. The Act includes a set of Marine Board Regulations that regulate much of the activity regarding small local boats, including diving operations, boats for hire, moorings, use of the ship channels, and navigation areas to be avoided.
  - **Legislation:** Marine Board Act 1962
  - **Oversight/enforcement:** Department of Marine and Ports Services
- **Swimming:** Legislation governing recreational swimming is limited. At times of storm activity, the Department of Parks can restrict access to the water in the National Park System under the Bermuda National Parks Act 1986, and Bermuda National Parks Regulations 1988.
  - **Legislation:** Bermuda National Parks Act 1986, Bermuda National Parks Regulations 1988
  - **Oversight/enforcement:** Department of Parks, Water Safety Council

- **SCUBA diving and snorkeling:** As with recreational swimming, there is limited legislation governing snorkeling. The Department of Marine and Ports regulates and manages commercial SCUBA diving under the Marine Board Act 1962
  - **Legislation:** Fisheries Act 1972 & Regulations, Marine and Port Services Act 2021, Merchant Shipping Act 2002, Historic Wrecks Act 2001
  - **Oversight/enforcement:** Department of Marine and Ports Services, Department of Environment and Natural Resources, Historic Wrecks Authority

## Utilities

- **Cables:** The Submarine Communications Cables Act 2020 manages the licensing, laying of, management, and enforcement of international cables, including the Submarine Cable Protection Area. Domestic lines are predominantly managed under the Public Lands Act 1984 for issues related to the seabed and the Development and Planning Act 1974 at landing points.
  - **Legislation:** Clean Air Act 1991, Public Lands Act 1984, Development and Planning Act 1974, Water Resources Act 1975, Liquefied Petroleum Gases (Handling, Storage, Supply & Transport) Regulations 1988, Telecommunications Act 1986, Submarine Communications Cables Act 2020
  - **Oversight/enforcement:** Department of Environment and Natural Resources, Environmental Authority, Department of Planning, Department of Marine and Ports, Development Applications Board, Department of Telecommunications, Regulatory Authority, Ministry of Public Works
- **Energy:** The Energy Act 2009, Regulatory Authority and Department of Energy regulate the production and supply of electricity, including the control of licenses for such activities. There are no specific provisions related to electricity generation in the ocean environment.
  - **Legislation:** Clean Air Act 1991, Development and Planning Act 1974, Telecommunications Act 1986
  - **Oversight/enforcement:** Regulatory Authority, Department of Energy, Department of Environment and Natural Resources, Environmental Authority, Department of Planning, Development Applications Board

## Shipping and Maritime Activities

- **Passenger and cargo transport:** The Merchant Shipping Act 2002 and its several sets of Merchant Shipping Regulations establish the registration of ships and regulates the activities of Bermuda-registered ships regarding topics such as maritime safety and environmental pollution in accordance with international conventions. However, the regulations also apply to ships operating in Bermuda waters regardless of their flag states. The Marine Board Act 1962 establishes the Ports Authority to provide advice to the Minister of Tourism Development and Transport to control activities on all maritime matters in Bermuda, including control of ship channels, control of marine traffic, navigational aids, improvement and dredging of channels, restriction of dumping in a ship channel, clearance of wrecks from a ship channel, control of diving, and control of vessel movement through bridges. It carries various Marine Board Regulations that mostly apply to local small boats, but some also apply to larger ships with respect to ship pilotage. The Marine and Ports Authority Regulations regulate the passage and mooring of ships, the handling of cargo, the role of the Harbourmaster, and associated port fees. The control of tour boats is governed by the Marine Board Regulations of the Marine Board Act 1962. Cruise ship actions are governed by the relevant provisions for any large ship.
  - **Legislation:** Marine Board Act 1962, Merchant Shipping Act 2002, Passenger Ships Act 1972
  - **Oversight/enforcement:** Department of Marine and Ports Services, Ports Authority
- **Maritime security and law enforcement:** The Maritime Security Act 1997 and Maritime Security (Harbour Areas) (Restricted Zones) Order 2010 establish specific locations of zones for maritime security (particularly ship terminals), and the offences relating to the safety of ships in these zones. The Protected Waters (Castle Harbour) Act 1951 still maintains a security zone around the shoreline of the former Kindley Air Force Base, now L.F. Wade International Airport.
  - **Legislation:** Bermuda Constitution, Police Act 1974, Marine Offences Procedure Act 2006, Merchant Shipping Act 2002, Marine Board Act 1962
  - **Oversight/enforcement:** Bermuda Coast Guard, Bermuda Police, authorized officers under various Acts

## Environmental Concerns

- **Conservation:** The Fisheries Act 1972 established the Marine Resources Board, which advises the Minister on matters pertaining to the marine environment. The Act allows protective measures to be defined by Regulations, Orders, and through the Official Gazette. For example, the Fisheries (Protected Species) Order 1978 defines the species that are protected anywhere within Bermuda's 200-mile EEZ. Similarly, the Fisheries (Protected Areas) Order 2000 defines specific locations in which fishing is prohibited. The Protected Species Act 2003 and associated Orders identify specific protected species and establishes the powers to give a species or area a protected status. The Protection of Birds Act 1975 establishes offences, licenses, and feeding and nesting areas for the protection of birds, which includes sea-going birds. The Coral Reef Preserves Act 1966 identifies Bermuda's reef preserves and prohibits the taking or damaging any organism attached to the seabed within the area. Protected areas/marine parks can be designated under the Fisheries Act 1972, and the Bermuda National Parks Act 1986 includes provision for marine reserves and the protection of plants, animals, and natural features therein.
  - **Legislation:** Fisheries Act 1972, Protected Species Act 2003, Bermuda National Parks Act 1986, Bermuda National Trust Act 1969, Coral Reef Preserves Act 1969, Protection of Birds Act 1975, Development and Planning Act 1974
  - **Oversight/enforcement:** Department of Environment and Natural Resources, Department of Parks, Bermuda National Trust, Department of Planning, Development Applications Board
- **Runoff, seepage, and water pollution:** The Pembroke Marsh Act 1851 defines the responsibility of the Minister to maintain the Pembroke Marsh Canal and controls dumping into and development near the canal. The Hamilton Sewerage Act 1917 and the St. George's Sewerage Act 1943 govern the establishment and maintenance of sewer infrastructure for the municipalities. The Public Lands Act 1984 covers many activities of the Minister for Public Works including sewerage, refuse, and highway drainage, all of which can represent sources of material flow to the ocean. The Water Resources Act 1975 also prohibits the pollution of public water, including sea water.
  - **Legislation:** Marine Board Act 1962, Merchant Shipping Act 2002, Waste and Litter Control Act 1987, Water Resources Act of 1975, Development and Planning Act 1974
  - **Oversight/enforcement:** Department of Marine and Ports Services, Ports Authority, Ministry of Public Works, Department of Environment and Natural Resources, Department of Planning, Development Applications Board
- **Dumping:** The U.K. Food and Environment Protection Act 1985 and Environmental Protection (Overseas Territories) Order 1988 provide delegated power to the Minister of the Environment to license the deposit of substances either in the sea or under the seabed from a vehicle, container, vessel, aircraft, hovercraft, or marine structure; for the deposit of substances or articles, for the scuttling of vessels, for the loading of the above noted with substances or articles for deposit anywhere in these or under the seabed, and for the towing or propelling of a vessel for scuttling anywhere at sea in order to minimize damage to the environment. Marine and Ports Authority (Berthing & Anchoring) Regulations 1967 prohibits the depositing or throwing of any ballast, rubbish, or filthy water into waters of the harbor or near to the foreshore and the building of any wharf, pier, jetty, or other structure below high-water mark of the harbors of Bermuda without permission of the Authority. Punishment on summary conviction could be imprisonment for three months or a fine of \$360 or both.
  - **Legislation:** U.K. Food and Environment Protection Act 1985 & Environmental Protection (Overseas Territories) Order 1988, Marine and Ports Authority (Berthing & Anchoring) Regulations 1967
  - **Oversight/enforcement:** Department of Environment and Natural Resources, Department of Marine and Ports

## Scientific and Cultural Concerns

- **Scientific research and education:** Education is not regulated, and marine related research is managed by the Protected Species Act 2003 for all named species, the Fisheries Act 1972 for commercial and biological research activities, the Historic Wrecks Act 2001 for underwater cultural heritage.
  - **Legislation:** Fisheries Act 1972, National Parks Act 1986, Historic Wrecks Act 2001, Merchant Shipping Act 2002
  - **Oversight/enforcement:** Department of Environment and Natural Resources, Bermuda Aquarium Museum and Zoo (DENR), Commercial Fisheries Council, Historic Wrecks Authority, Department of Parks

- **Underwater cultural heritage:** The Historic Wrecks Act 2001 protects marine heritage sites and regulates any examinations of historic wreck sites. The Act is enforced by the Department of Environment and Natural Resources with the Historic Wrecks Authority sitting as the advisory body to the Minister responsible for the Environment. It relies on the Fisheries Protected Areas Order 2000 to protect certain individual historic sites.
  - **Legislation:** Historic Wrecks Act 2001
  - **Oversight/enforcement:** Historic Wrecks Authority, Department of Environment and Natural Resources

## Ownership of the Queen’s Bottom

Ownership of the seabed below the high-water mark, known colloquially as the Queen’s Bottom, rests with the Crown and is managed by the Department of Public Lands and Buildings (DPLB) on behalf of the Government of Bermuda. Under the Sale of Reclaimed Lands Act 1951 and the Public Lands Act 1984, the authority to dispose of interests in seabed rests with the Minister of Public Works.

This area of bed extends from the high-water mark for 200 nm to the edge of the Bermudian EEZ. Any development that takes place on or above the Queen’s Bottom will need legal consent from DPLB. In the immediate vicinity of the shoreline, an example of development needing such consent would be a dock or a seawall that is constructed past the high-water mark. Further seaward, examples of other development that would require legal consent from DPLB would be offshore energy generation development or undersea cables. If any development is being planned over the seabed, then it is recommended that the developer contacts the Chief Surveyor of DPLB early in their process to begin consultation to ensure the appropriate consent is put in place.

# APPENDIX B | REGULATORY CONTEXT FOR BERMUDA'S FISHERIES

The Fisheries Act 1972, Fisheries Regulations 2010 and associated Orders are the main pieces of legislation governing the management of fisheries. Some of the species previously protected under the Fisheries Act have now been transferred to the Protected Species Act 2006.

**Fixed fishing gear ban:** Attempts to regulate the use of fish pots or traps has been a recurrent theme of legislation and policy, culminating in the 1990 amendments to the fisheries legislation that prohibited the use of fixed fishing gear. This is arguably Bermuda's most significant piece of marine resources legislation. While highly controversial at the time, it is now largely accepted 30 years later. The Marine Resources Section of the Department of Environment and Natural Resources (DENR) is tasked with its implementation and enforcement. A specially designed trap is now used to target lobsters and a limited number of trap licences are issued for this purpose each year.

**Total allowable catch:** The 2005 State of the Environment report noted that the fisheries legislation has traditionally been focused on managing fishermen rather than fish stocks, but that a move towards establishing a Total Allowable Catch (TAC) for key fishery target species would be desirable. Unfortunately, little progress has been made in this area over the past 15 years due to insufficient data on Bermuda's fish populations to generate reliable estimates of population size and dynamics. A collaboration with emLab at University of California, Santa Barbara as part of BOPP is currently underway to gather data and conduct population analyses for spiny lobster, black grouper, and red hind.

Best practices for the management of marine resources recommend the involvement of stakeholders in decision-making. The primary stakeholders in the way that marine resources and fisheries are managed are Bermuda's commercial fishers, along with those that fish recreationally to varying degrees. Secondary stakeholders include the restaurants, grocery stores, and householders who purchase locally caught fish, as well as the local dive industry and other marine tourism operators. These latter two groups regularly utilize sites that are closed to fishing under the Fisheries (Protected Areas) Order 2000, and that are provided with buoys to identify the sites and minimize anchor damage to the reef.

**TABLE 1:** *Recent reports on marine fishery management*

| Year | Report  |
|------|---|
| 2005 | State of the Environment Report (Ministry of the Environment, 2005): the last major review of the state of Bermuda's marine environment and its associated resources. |
| 2006 | White Paper on the Marine Environment and the Fishing Industry in Bermuda (Ministry of the Environment, 2006): provided a foundation for later strategies.            |
| 2010 | Strategy for the Sustainable Use of Bermuda Living Marine Resources (Department of Environmental Protection, 2010): outlines future directions for management.        |

# APPENDIX C | BERMUDA'S UNDERWATER HISTORICAL CULTURAL EXPLORATION REGULATION AND POLICIES

In order to allow for safe and sustainable exploration of shipwrecks, Bermuda requires and regulates the identification, protection, and management of historic shipwrecks and marine heritage sites under the Historic Wrecks Act 2001 (HWA). The objectives of the Act are to license activities on shipwrecks; classify shipwrecks to manage activities thereon; ensure adequate monitoring and reporting; protect the rights of both the Government and finders; and provide adequate enforcement.

Policies are developed to implement the HWA in coordination with the mission and mandate of DENR. Policies also take into account opportunities in the private sector with NGOs, universities and research groups, media, motivated stakeholders, and businesses. Policies are communicated primarily through the DENR web portal and a dedicated shipwreck website: [www.bermuda100.ucsd.edu](http://www.bermuda100.ucsd.edu).

A significant priority in the ongoing conservation of shipwrecks is a comprehensive review of the HWA to assess its functionality as a legislative instrument. Several key pieces of the legislation have been identified as unworkable, and there are some significant gaps, such as a lack of direction on how to manage marine development and planning applications that could affect underwater heritage. For example, it is critical to add a detailed planning section to the HWA that mandates the use of Historic Impact Assessments (HIAs) in the planning process that clarifies for developers and planning applicants their responsibilities toward underwater heritage.

**Bermuda Protected Dive Site Areas Moorings Program:** Anchoring on coral reefs is strictly prohibited at protected area wreck and dive sites that are part of the Bermuda Protected Dive Site Areas Moorings Program. The program provides environmentally friendly moorings (buoys) on the reef and near shipwrecks at several popular dive and snorkel sites around Bermuda. There are 42 sites buoyed under the program, and the most popular sites can contain multiple buoys. 29 of these sites are wreck sites and 13 are natural sites. 30 of the buoyed sites maintained under the program are officially protected sites with designated areas of protection. The buoys are for everyone's use on a first-arrival basis.

Under the Bermuda Moorings Program, the Marine Conservation Section of the Department of Conservation Services (now DENR) has supplied workspace, storage, and manpower for the management and monitoring of these sites. The material costs for mooring creation and deployment continue to be paid by a single primary donor, the Ernest E. Stempel Foundation, with the Bermuda Zoological Society acting as fiduciary. In 2016, the management responsibility for the Bermuda Moorings Program was shifted to the office of the Custodian of Historic Wrecks under DENR.

**2021 Marine Heritage Strategy:** The new 2021 Marine Heritage Strategy policy document lays out several avenues that will further protect marine heritage for future generations and maximize their significant role in advancing Bermuda's other interests. The document has four strategic aims:

1. Resource threat reduction through protection, enforcement, conservation, and stewardship of shipwrecks and marine heritage sites;
2. Record-keeping and advancing knowledge, education, outreach, and available information for the appreciation and enjoyment of Bermuda's shipwreck assets;
3. Integration of shipwreck relevance across sectors;
4. Developing wider understanding and enjoyment of marine heritage

# APPENDIX D | BERMUDA'S DEVELOPMENT POLICY FRAMEWORKS

## Legislation and Policies

The regulatory framework for managing development and land use in Bermuda is provided by the following planning and building acts, regulations and codes:

- Development and Planning Act 1974
- Development and Planning (Applications Procedure) Rules 1997
- Development and Planning (General Development) Amendment Order 2015
- Building Act 1988
- Building Amendment Act 1998
- Bermuda Building Code 2014
- Bermuda Residential Building Code 2014

The Development and Planning Act 1974 is the most significant in that it defines what constitutes “development” that requires planning approval. It also establishes designated areas of special environmental value and provides general policy direction for the preparation of development and local plans. The Fourth Schedule of the Development and Planning Act 1974, section 28 identifies six heads of protection as designated areas of special environmental value, five of which relate to coastal areas and bodies of water/waterways: woodlands protection, beach protection, cave protection, habitat protection, and other natural features protection.

The current development plans for Bermuda include the Bermuda Plan 2018 and the City of Hamilton Plans 2015 and 2001. The Bermuda Plan 2018 establishes the zonings and policies which help to regulate development along the coastline to ensure its appropriateness in terms of siting, scale, design, and materials to protect the coastline and inshore marine environment (fig. 1). The Bermuda Plan 2018 has the following five goals:

1. To conserve open space and protect the Island's natural and built heritage;
2. To provide sufficient development potential to meet the community's needs;
3. To facilitate community improvements in neighborhoods to create better, healthier, and safer places to live and visit;
4. To encourage a more efficient and sustainable use and development of land and buildings;
5. To ensure a high quality of design and accessibility in all new developments

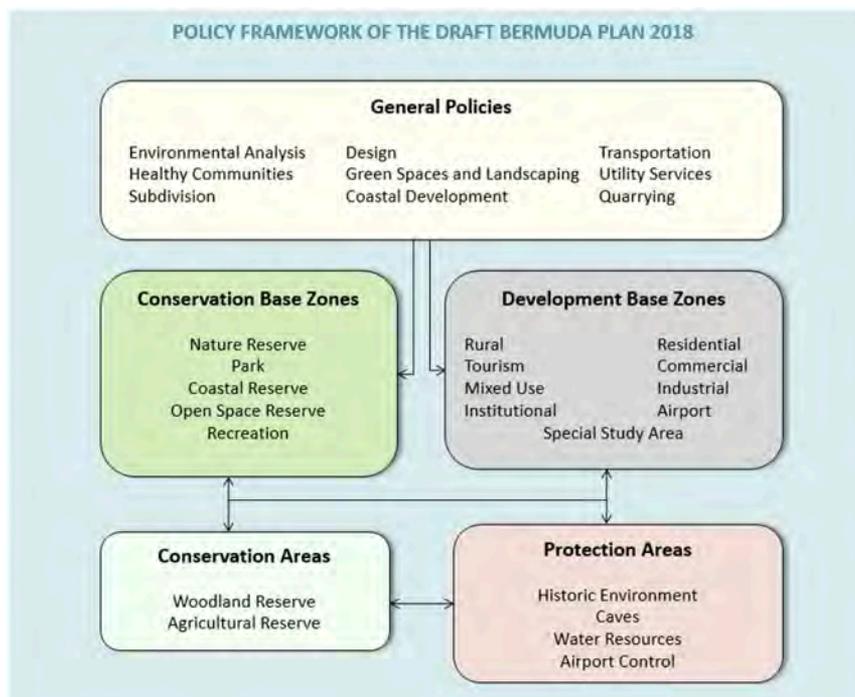


FIGURE 1: Policy framework for the Bermuda Plan 2018

The Bermuda Plan 2018 designates the lands of Bermuda (excluding the City of Hamilton) into four zoning types (color-coded below to match Figure 1).

- The **Development Base Zones** designate land for housing, hotels, and other tourist establishments; health and welfare facilities; shops and offices; industrial lands, schools, and other educational establishments; and airport uses to meet the community's needs.
- The **Conservation Base Zones** designate important nature reserves, parklands, coastal areas, open space, and woodland areas; and sports and playing fields for their ecological conservation, environmental, recreational, and visual and amenity value. Many of these zones are protected as designated areas in accordance with section 28 of the Development and Planning Act 1974.
- The **Conservation Areas** designate those important woodland and agricultural areas that should be conserved and protected in conjunction with any development permitted within these areas.
- The **Protection Areas** designate historic areas, sensitive cavernous areas, important water resources, including coastal waters, and restricted areas around the airport.

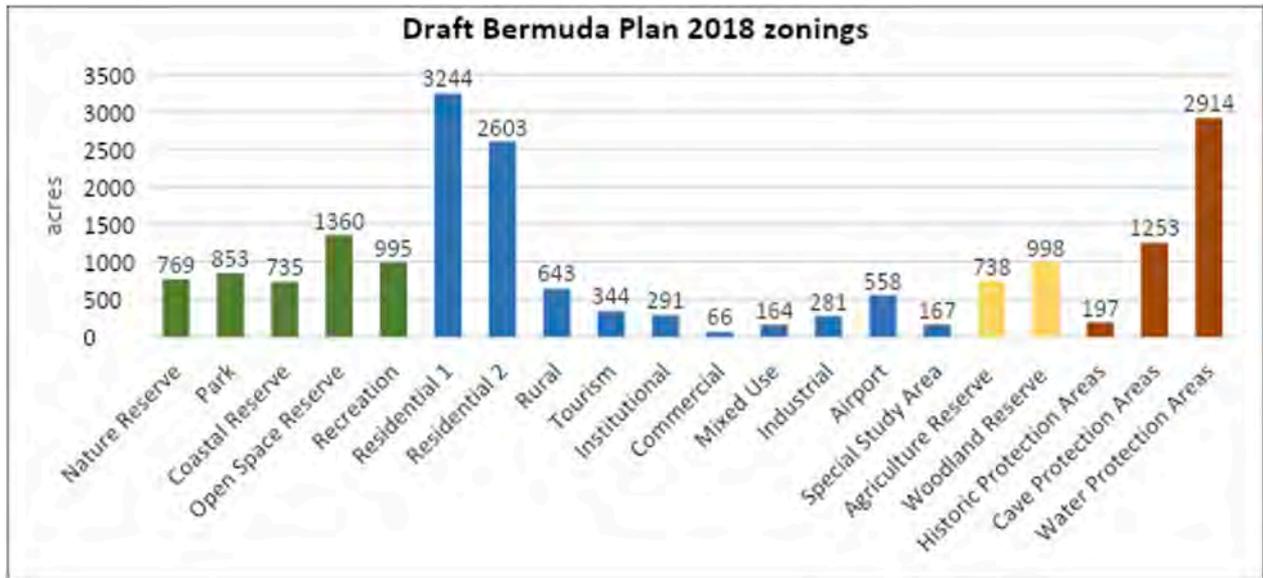


FIGURE 2: Bermuda Plan 2018 zones and their acreage

Three quarters of Bermuda's coastline is designated under the Bermuda Plan 2018 as within a Nature Reserve, Park, or Coastal Reserve Conservation Base Zone (fig. 2). The coastline in these areas is designated under section 28 of the Act and afforded protection to ensure preservation of the coastline's environmental and scenic qualities and to minimize development. Some of the remaining coastal areas are extensively built up and are designated as Development Base Zones.

In addition to policies that relate to specific zones, the Bermuda Plan 2018 also contains general policies that relate to any zone or area. They include policies for environmental analysis, healthy communities, subdivision, design, green spaces and landscaping, coastal development, transportation, roads and parking, utilities, and quarrying.

The policy chapters and objectives in the Bermuda Plan 2018 that relate specifically to coastal areas and coastal development are shown in Table 1.

**TABLE 1: Bermuda Plan 2018 policies which relate to coastal development**

| Policy Chapter                  | Description  | Objectives  | Acres       |
|---------------------------------|--|---|-------------|
| Environmental Analysis Policies | Planning application proposals to include all necessary information to indicate the environmental effects of a proposed development and may include an EIA for major projects including major port infrastructure, reclamation projects and marinas  | ENV (1) To ensure that the use, scale, density, form, and design of development are sensitive to a site's physical and environmental characteristics;<br><br>ENV (2) To ensure that a development has minimal detrimental impact on the natural, human or built environments of the area; and<br><br>ENV (3) To ensure the proper maintenance and management of important flora and fauna, woodland, and natural habitats   | Island-wide |
| Healthy Communities Policies    | Policies to encourage communities to plan how to mitigate potential effects including increased storms and flood risks, higher temperatures, and sustained periods without food or electricity   | HEA (5) To help build community resilience to climate change  | Island-wide |
| Coastal Development Policies    | Policies which regulate coastal development i.e., development that must be located adjacent to the shoreline and/or attached to the land at or above the mean high-water mark and extends into the water (including marinas, boat maintenance facilities, docks, slipways, floating docks, seawalls, revetments, breakwaters, and beaches) | COA (1) To protect and conserve areas and natural features of biological and ecological significance along the coastline and in the marine environment;<br><br>COA (2) To protect the natural and scenic qualities of the coastline and minimize the physical and visual impact of development on the coastline and adjacent inshore waters; and<br><br>COA (3) To protect the coastline from coastal erosion through appropriate coastal development and shoreline protection measures | Island-wide |

## Coastal Development

The policies contained in the Coastal Development chapter of the Bermuda Plan 2018 are particularly important in the regulation of coastal development. The Plan defines coastal development as that which is located adjacent to the shoreline and/or attached to the land at or above the mean high-water mark and extends into the water. Types of coastal development include marinas, boat maintenance facilities, boat houses, docks and slipways, floating docks, seawalls, revetments, breakwaters, and the replenishment of beaches. Coastal development that constitutes development as defined by section 14 of the Development and Planning Act 1974 requires planning approval and the issuance of a building permit. Proposals for coastal development are typically submitted to the Ports Authority, Marine Resources Board, Estates Department, and/or DENR for comments and advice.

Coastal developments may be permitted at the discretion of the Development Applications Board in any Development or Conservation Base Zone providing they meet the following criteria:

- The scale, massing, siting, design, and extent of development is appropriate for its coastal location;
- The proposal will not cause measurable damage to any natural feature of biological, ecological, and geological importance;
- The proposal provides adequate planting of vegetation for environmental, aesthetic, and soft coastal protection measures;

- Adequate provisions are made to dispose of sewage, waste, and storm water in a manner that avoids any detrimental impact on the coastal waters and marine environment;
- Consideration has been given to the Coastal Protection and Development Planning Guidelines (2004).

There are a number of Department of Planning guidance notes that assist decision-making about coastal development proposals. The most relevant are the following:

- Coastal Protection and Development Planning Guidelines (2004)
- Dock Development, Planning Guidance Note 109
- Environmental Impact Assessments and Environmental Impact Statements, Planning Guidance Note GN106
- A Guide for Sea Walls, Revetments, Breakaways and Beaches, Planning Guidance Note GN110
- Storm Water Control, Planning Guidance Note GN11

## Coastal Reserve Conservation Zone and the Water Resources Protection Area

The policies of the Coastal Reserve Conservation Zone and the Water Resources Protection Area relate most specifically to the regulation of development in coastal areas. Table 2 summarizes the purpose and objectives of both zoning designations.

**TABLE 2: Coastal Reserve Conservation Zone and Water Resources Protection Area**

| Zone                                   | Description   | Objectives  | Acres |
|--|---|---|-------|
| Coastal Reserve Conservation Base Zone | Policies to regulate development within the Coastal Reserve zone which includes the coastline, cliffs, beaches, dunes, rock formations, trees, vegetation, caves and islands, and adjoining inshore waters  | COR (1) To protect and conserve the ecological, natural, historic, and scenic features and qualities of Bermuda’s coastal areas, inshore waters, and islands; and<br>COR (2) To protect the coastal areas and islands from coastal erosion by minimizing development within these areas and maintaining their open, natural state | 735   |
| Water Resources Protection Area        | Policies to regulate the method of sewage disposal and disposal of other effluent to protect water resources in areas which are at an elevation of 4 m (13 ft) or less above sea level, all areas within 12 m (40 ft) from the Atlantic Ocean coastline or 17 m (55 ft) from the Harrington Sound coastline | WAT (1) To protect the Island’s water resources through the sensitive and appropriate siting, scale, density, and design of development   | 2,914 |

The Coastal Reserve Conservation Zone covers the coastline, cliffs, beaches, dunes, rock formations, trees, vegetation, caves, and islands that are important for their natural and scenic qualities. These areas and their adjoining inshore waters also contain important flora and fauna, nesting sites, and habitats including longtail nests, seagrass beds, corals, mangroves, salt marshes, and historic fish ponds. *Figure 3* is an extract of the Bermuda Plan 2018 zoning for the Flatts Village area and illustrates the Coastal Reserve zone (light blue) along most of the coastline, as well as other zoning designations such as Residential (peach color), Park (pink) and Institutional (purple), and Open Space Reserve (light green).



**FIGURE 3:** Bermuda Plan 2018 zoning for Flatts Village area

Global climate change will mean that Bermuda’s coastline is increasingly at risk from sea level rise, wave energy, storm surge, flooding, and erosion. One of the main purposes of the Coastal Reserve Conservation Zone is to act as a buffer or setback between the shoreline and development areas. The policies of the Coastal Reserve Zone and the Coastal Protection and Development Planning Guidelines (2004) aim to preserve and protect Bermuda’s coastline and inshore marine environment from inappropriate development, and to permit only limited coastal development, minor siteworks, accessory structures, additions, conversions, and the demolition and rebuilding of existing buildings.

Within the Coastal Reserve Conservation Zone, there are an estimated 200 residential valuation units (less than 1% of all residential valuation units) and approximately 50 vacant Coastal Reserve lots. The recent Bermuda Plan 2018 Objections Tribunal highlighted the argument from some property owners that the Coastal Reserve zoning policies are too restrictive and should allow more permissive residential development. In reviewing the objections from property owners, the Department took a precautionary approach. Planners reviewed the objections on a case-by-case basis and supported slight amendments where there was clear planning merit. An up-to-date coastal vulnerability study for Bermuda is necessary to provide more evidence-based data to better inform decisions regarding the boundaries of coastal conservation zones.

The Water Resources Protection Areas include all areas that are at an elevation of 4 m or less above sea level, within 12 m from the Atlantic Ocean coastline, or 17 m from the Harrington Sound coastline. These areas include marshes, ponds, lakes, bays, inshore and coastal waters, and the Pembroke Canal.

Bermuda’s water resources are vulnerable to the discharge of effluent and waste, directly or via groundwater flow. Alternative means to cesspit disposal of sewage and wastewater are therefore required for coastal locations, low lying areas, and for high density development that produces large quantities of sewage and effluent.

# APPENDIX E | BERMUDA'S TRANSPORTATION LEGISLATION AND POLICIES

## Legislation and Policies

The operation of the ferry service is authorized under the Marine Board Act 1962. The following regulations are currently relevant to its operations:

- The Marine Board (Ferry Services Fares) Regulations
- The Marine Board (Island Boat) Regulations, 1965
- The Marine Board (Safety) Regulations
- The Prevention of Oil Pollution Act 1971 (Bermuda) Order 1980
- The Marine and Ports Authority (Dumping) Regulations
- The Marine Board Declaration of Speed Limits for Boats (Mariners) Notices
- The International Regulations for the Prevention of Collisions at Sea 1972, amended 1981.

All relevant maritime legislation is being updated at this time to enable Bermuda to maintain compliance with the International Maritime Organization (IMO) Instruments Code or Triple III Code. The following regulations are currently being updated:

- Marine and Ports Services Act 2021
- Bermuda Small Commercial Vessel Code (BSCV)
- Crew training for personnel serving on Island Boat passenger vessels
- Island Boat Safety Management Code (ISBM) regulations
- Island Boat Safety Management Code (ISBM)
- Marine and Ports Act (Licensing of Island Boats and Crews) Regulations 2021
- Marine and Ports Island Boat Regulations 2021
- Marine and Ports Services (Ship Channels) Regulations 2021
- Marine and Ports Services Act 2020
- Marine Pilotage Regulations 2021

# APPENDIX F | BERMUDA'S ENERGY PROVISION IMPORTS

Value and quantity of Bermuda's fuel imports by type and year from 2017-2019 (two tables).

Source: Department of Statistics

| Type   | 2017        |             | 2018        |             | 2019       |             |
|--|-------------|-------------|-------------|-------------|------------|-------------|
|  | Value       | Quantity    | Value       | Quantity    | Value      | Quantity    |
|  | (\$)        | (kg)        | (\$)        | (kg)        | (\$)       | (kg)        |
| Total  | 102,503,736 | 226,371,307 | 125,771,352 | 224,051,499 | 97,593,222 | 184,782,215 |
| Percentage change (%)                            | 20.1        | 26.5        | 22.7        | -1          | -22.4      | -17.5       |
| Light oils and preparations (i.e. motor spirits) | 16,070,815  | 18,204,666  | 21,151,146  | 21,472,971  | 13,504,338 | 13,819,065  |
| Gas oils (diesel)                                | 39,203,843  | 69,961,446  | 26,399,712  | 37,088,222  | 20,757,302 | 28,793,199  |
| Gas oils (heavy)                                 | 2,015       | 213         | -           | -           | -          | -           |
| Kerosene and other (not including gas oils)      | 8,237,528   | 15,387,924  | 21,034,479  | 30,170,302  | 14,474,603 | 25,851,350  |
| Fuel oils not elsewhere                          | 35,144,801  | 122,073,991 | 54,250,523  | 134,601,158 | 45,794,276 | 115,422,850 |
| Other lubricating oils                           | 3,723,735   | 733,046     | 2,916,711   | 713,767     | 3,045,498  | 891,539     |
| Other waste oils                                 | 120,999     | 10,021      | 18,781      | 5,080       | 17,205     | 4,213       |

Value and quantity of imported fuel by type,<sup>1</sup> 2017-2019 (Source: Department of Statistics)

<sup>1</sup>Petroleum oils and oils obtained from bituminous minerals, other than crude

|  | 2017        |             | 2018        |             | 2019        |             |
|--|-------------|-------------|-------------|-------------|-------------|-------------|
|  | Value       | Quantity    | Value       | Quantity    | Value       | Quantity    |
| Type   | (\$)        | (kg)        | (\$)        | (kg)        | (\$)        | (kg)        |
| Total  | 106,840,391 | 232,510,172 | 129,818,819 | 240,463,839 | 100,302,740 | 199,736,387 |
| Percentage change (%)                        | 21.6        | 13.1        | 21.5        | 3.4         | -22.7       | -16.9       |
| Coal, briquettes                             | 97,505      | 5,666       | 36,956      | 15,921      | 14,301      | 8,125       |
| Lignite                                      | —           | —           | 214         | 18          | 760         | 72          |
| Peat   | 486,080     | 46,951      | 158,333     | 43,432      | 165,783     | 78,180      |
| Coke and semi coke                           | 48,082      | 30,049      | 82,437      | 49,623      | 46,019      | 30,786      |
| Coal gas, water gas                          | —           | —           | 2,027       | 50          | —           | —           |
| Tar distilled                                | 4,603       | 4,470       | —           | —           | —           | —           |
| Oils and other products                      | 49,347      | 615         | 3,275       | 702         | 1,967       | 626         |
| Pitch and pitch coke                         | 167         | 16          | —           | —           | —           | —           |
| Petroleum oils                               | —           | —           | —           | —           | —           | —           |
| Petroleum oils other than crude              | 102,503,736 | 226,371,307 | 125,771,352 | 224,051,499 | 97,593,222  | 184,782,215 |
| Petroleum gases & other gaseous hydrocarbons | 2,614,178   | 4,389,752   | 3,215,651   | 15,538,081  | 1,560,651   | 13,825,338  |
| Petroleum jelly                              | 76,129      | 5,433       | 41,681      | 5,221       | 47,161      | 4,610       |
| Petroleum coke                               | 184,523     | 32,402      | 42,648      | 3,628       | 38,659      | 3,919       |
| Other bitumen and asphalt                    | 162,106     | 331,730     | 38,040      | 67,341      | 588,921     | 647,407     |
| Bituminous mixtures                          | 613,935     | 1,291,781   | 426,205     | 688,323     | 245,296     | 355,108     |
| Electrical energy                            | —           | —           | —           | —           | —           | —           |

Value and quantity of imported mineral fuels, mineral oils, and related products consumed by type, 2017-2019 (Source: Department of Statistics)

## APPENDIX G | MARINE MANAGEMENT ISSUES

The following table illustrates the types of management issues that need to be addressed, as identified during consultation with the Marine Enforcement team, the Marine Resources Board, and the Commercial Fisheries Council. Issues are listed by theme and the management zone in which the issue predominantly takes place.

| Theme                     | Issue  | Oceanic Zone (30nm to 200nm EEZ) | Offshore Zone (Platform to 30nm) | Inshore Zone (Coast to Platform) | Onshore Zone |
|---------------------------|--|----------------------------------|----------------------------------|----------------------------------|--------------|
| Dumping of pollutants     | Illegal dumping of pollutants by foreign vessels (Greater than 400GT OR Registered to carry more than 15 pe)       | *                                | *                                | *                                | *            |
|                           | Use of environmentally harmful antifoulant paints on boat hulls.   |                                  |                                  | *                                | *            |
|                           | Illegal sinking of vessels   | *                                | *                                | *                                |              |
|                           | Illegal sinking or abandonment of vessels  |                                  |                                  | *                                |              |
|                           | Ballast water disposal   | *                                | *                                |                                  |              |
|                           | Cleaning of boat hulls   |                                  |                                  | *                                | *            |
| Unlicensed taking of fish | Unlicensed foreign vessels fishing long lining   | *                                | *                                |                                  |              |
|                           | Taking of fishery target species from protected areas (seasonal aggregation areas and dive sites) without a permit |                                  | *                                | *                                |              |
|                           | Taking of commercial fish from seasonally protected areas  |                                  | *                                |                                  |              |
|                           | Taking of commercial fish from seasonally protected areas and other offences cont.                                 |                                  | *                                | *                                |              |
|                           | Taking of Bait Fish from protected bays  |                                  |                                  | *                                |              |
|                           | Taking of undersized fish, Lobsters, guinea chicks, by commercial fisherman  |                                  | *                                | *                                |              |
|                           | Taking of protected commercial fish over bag limit   |                                  | *                                | *                                |              |
|                           | Taking of fish with illegal gear and/or misuse of gear   |                                  | *                                |                                  |              |
|                           | Taking of fish with illegal trap gear and/or misuse of gear (underwater activities)                                |                                  |                                  | *                                |              |
|                           | Taking of fish with illegal spearfishing equipment   |                                  |                                  | *                                |              |
|                           | Importation of illegal gear  |                                  |                                  |                                  | *            |

| Theme   | Issue  | Oceanic Zone (30nm to 200nm EEZ) | Offshore Zone (Platform to 30nm) | Inshore Zone (Coast to Platform) | Onshore Zone |
|---|--|----------------------------------|----------------------------------|----------------------------------|--------------|
| Selling of illegally caught fish                            | Landing of illegally caught fish   |                                  |                                  |                                  | *            |
|   | Recreational fishers selling to commercial fisherman or public e.g., lobsters  |                                  |                                  |                                  | *            |
|   | Commercial fisherman purchasing fish from Recreational fishers   |                                  |                                  |                                  | *            |
|   | Selling fish over the bag limit  |                                  |                                  |                                  | *            |
|   | Unlicensed selling (Consortiums)   |                                  |                                  |                                  | *            |
|   | Restaurateurs catching for restaurants   |                                  |                                  |                                  | *            |
| Misrepresentation of selling imported fish as local (Fraud) | Misrepresentation of imported fish as local catch - Red Hind, Black Grouper, fish associated with ciguatera e.g., jacks for Bonita |                                  |                                  |                                  | *            |
|   | Misrepresentation of fish associated with ciguatera e.g., jacks for Bonito   |                                  |                                  |                                  | *            |
| Vessels and Gear  | Noncompliance with Boat inspections  |                                  |                                  |                                  | *            |
|   | Gear allocation, tampering and theft   |                                  | *                                | *                                | *            |
|   | Vessels not marked properly  | *                                | *                                | *                                | *            |
| Harassment and injury of protected species                  | Harassment and/or injury of protected species, e.g., whales, dolphins, turtles   | *                                | *                                | *                                |              |
|   | Illegal commercial use of resources collected under a research permit. (aquaculture, medicine)                                     | *                                | *                                | *                                | *            |
|   | Permitted harvesting of sand, dredging etc.  |                                  |                                  | *                                |              |
|   | Illegal dumping on foreshore and inshore zone  |                                  |                                  | *                                |              |
|   | Illegal development impacting corals, seagrasses and mangroves e.g., docks   |                                  |                                  | *                                |              |
|   | Illegal dredging/destruction of corals and seagrasses  | *                                |                                  | *                                |              |
|   | Illegal sand harvesting  |                                  |                                  | *                                |              |
|   | Illegal clearance of mangroves - landscaping   |                                  |                                  | *                                | *            |
|   | Vessel groundings destroying corals & seagrass and mangroves   |                                  |                                  | *                                |              |
|   | Moorings destroying corals and seagrass  |                                  |                                  | *                                |              |
|   | Abandonments of vessels  |                                  |                                  | *                                |              |

| Theme  | Issue   | Oceanic Zone (30nm to 200nm EEZ) | Offshore Zone (Platform to 30nm) | Inshore Zone (Coast to Platform) | Onshore Zone |
|--|---|----------------------------------|----------------------------------|----------------------------------|--------------|
| Illegal activities in dive sites and marine heritage areas | Unlicensed Interference with Historic Wrecks  | *                                | *                                | *                                | *            |
|  | Speeding in protected dive sites  |                                  |                                  | *                                |              |
|  | Dropping anchor in protected dive sites   |                                  |                                  | *                                |              |
|  | Taking of artefacts from historic wrecks  | *                                | *                                | *                                |              |
|  | Seaglass (not in protected areas - and not protected under the act)                 |                                  |                                  | *                                |              |
|  | Illegal development impacts to coastal sites and features                           |                                  |                                  |                                  | *            |
|  | Impacts to unknown marine heritage by coastal development                           |                                  |                                  |                                  | *            |
|  | Damaging mooring buoys - improper use   |                                  |                                  | *                                |              |
| Illegal importation/exportation                            | Illegal importation of CITES protected items  |                                  |                                  |                                  | *            |
|  | Illegal exportation of CITES items  |                                  |                                  |                                  | *            |
|  | Seaglass, sand, artefacts, scientific samples, exportation etc. leaving via airport |                                  |                                  | *                                | *            |
|  | Seaglass, artefacts exportation etc. leaving via cruise ships and yachts            |                                  |                                  | *                                | *            |
|  | CITES, Seaglass, artifacts exportation etc. leaving via forwarders in containers    |                                  |                                  | *                                |              |
|  | Illegal importation of marine organisms   |                                  |                                  |                                  | *            |
|  | Illegal exportation of historic artefacts   |                                  |                                  |                                  | *            |
| Research management  | Research in Bermuda's waters  | *                                | *                                | *                                |              |
|  | Intellectual property for organism found in Bermuda's EEZ, e.g., bio-prospecting    | *                                | *                                | *                                |              |

## APPENDIX H | BERMUDA'S SELECT INTERNATIONAL COMMITMENTS

| Instrument <sup>1</sup>   | Year entered into by Bermuda (mostly by Extension) <sup>2</sup> |
|---|---|
| UN Convention on the Law of the Sea (UNCLOS)  | 1997  |
| Agreement Relating to the Implementation of Part XI of UNCLOS   | 1997  |
| Agreement for the Implementation of the Provisions of UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN Fish Stocks Agreements, or UNFSA) | 1999  |
| Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)   | 1976  |
| Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) <sup>3</sup>  | 1985  |
| International Commission for the Conservation of Atlantic Tunas (ICCAT)   | 1997  |
| Hamilton Declaration on Collaboration for the Conservation of the Sargasso Sea  | 2014  |
| Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention)   | 1984  |
| International Convention for the Prevention of Pollution from Ships (MARPOL)  | 1988  |
| Protocol Relating to MARPOL   | 1988  |
| Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention)   | 1975  |
| 1996 Protocol to the London Convention  | 1998  |
| Amendment to Article 6 of the 1996 Protocol to London Convention  | 2011  |
| Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)  | 1976  |
| Protocol to Amend the Ramsar Convention   | 1984  |
| Amendments to Articles 6 and 7 of the Ramsar Convention   | 1990  |
| United Nations Framework Convention on Climate Change (UNFCCC)  | 2007  |
| Kyoto Protocol  | 2007  |
| Vienna Convention for Protection of the Ozone Layer   | 1987  |

<sup>1</sup> The contents of this chart derive from sources provided by the Legal Directorate of the United Kingdom's Treaty Enquiry Service.

<sup>2</sup> Bermuda is a British Overseas Territory and has limited rights to enter into external relations arrangements with certain countries, such as the United States and Commonwealth countries, in relation to specific subjects. International treaties to which the United Kingdom is party can be extended to Bermuda at its request. (See Freestone, David, et al. "Place-based dynamic management of large-scale Ocean Places: Papahānaumokuākea and the Sargasso Sea." *Stan. Envtl. LJ* 33 (2013): 191, citing Anthony Aust, *Modern Law and Treaty Practice* 72 (2d ed 2007)).

<sup>3</sup> The United Kingdom is a party to the Convention on Biological Diversity (CBD), but its commitment thereunder has not been extended to Bermuda. Despite this, Bermuda has worked extensively with the CBD with respect to the Sargasso Sea.

|  |      |
|--|------|
| Montreal Protocol on Substances that Deplete the Ozone Layer   | 1988 |
| International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers 1978 (STCW) | 1989 |
| Protocol on Environmental Protection to the Antarctic Treaty   | 1995 |
| International Convention on Maritime Search and Rescue (SAR)   | 1980 |
| International Convention for the Safety of Life at Sea (SOLAS)   | 1988 |
| Protocol of 1998 Relating to SOLAS   | 2004 |
| International Regulations for Preventing Collisions at Sea (COLREGs)   | 1963 |
| International Convention for the Regulation of Whaling   | 1947 |
| Protocol to the International Convention for the Regulation of Whaling                                       | 1957 |
| Convention and Statute on the International Régime of Maritime Ports   | 1925 |
| Nairobi International Convention on the Removal of Wrecks  | 2021 |
| Convention on the Protection of Submarine Telegraph Cables   | 1884 |
| United Nations Convention Against Corruption (UNCAC)   | 2018 |
| Convention on the Settlement of Investment Disputes between States and Nationals of Other States (ICSID)     | 1966 |
| Memberships  |      |
| United Nations Agencies  |      |
| Food and Agriculture Organization (FAO)  |      |
| UN Educational, Scientific, and Cultural Organization (UNESCO)   |      |
| World Health Organization (WHO)  |      |
| World Meteorological Organization (WMO)  |      |
| World Bank Group   |      |
| International Bank for Reconstruction and Development (IBRD)   |      |
| International Development Association (IDA)  |      |
| International Finance Corporation (IFC)  |      |
| Other Entities and Memberships   |      |
| CARICOM Caribbean Community (Associate Member)   |      |
| World Customs Organization   |      |
| Universal Postal Union   |      |
| International Monetary Fund  |      |