

Bermuda aquaculture site suitability

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Introduction

The purpose of this analysis is to identify areas of Bermuda’s waters that might be suitable for aquaculture.

The following cultivation methods will be considered:

- Offshore submerged cages for finfish/bivalves (40-400m depth requirement)
- Offshore floating (not anchored, GPS controlled) cages for finfish (40-400m depth requirement)
- Nearshore submerged longlines for bivalves/crustaceans (2-15m depth requirement)
- Nearshore bottom culture and surface longlines for molluscs and other species (e.g., sea cucumbers, queen conch, seaweed, turkey-wing mussels) (1-15m depth requirement)
- Coastal dock-based systems (FLUPSY- floating upwelling system) for nursery phase of majority of culture candidates (0-3m depth requirement)

Methods

Areas not suitable for aquaculture

The following areas are not suitable for the siting of any aquaculture cultivation technologies

- Protected areas (suitable for some aquaculture types, see following section for additional details)
- Two grouper boxes and seasonal closure areas
- Cable protection zone
- Ferries and shipping lanes

Protected areas

Offshore aquaculture technologies (submerged and floating cages) are not compatible with protected areas (Figure 1) as the installation and operation of aquaculture facilities could disturb habitats and species that are being protected.

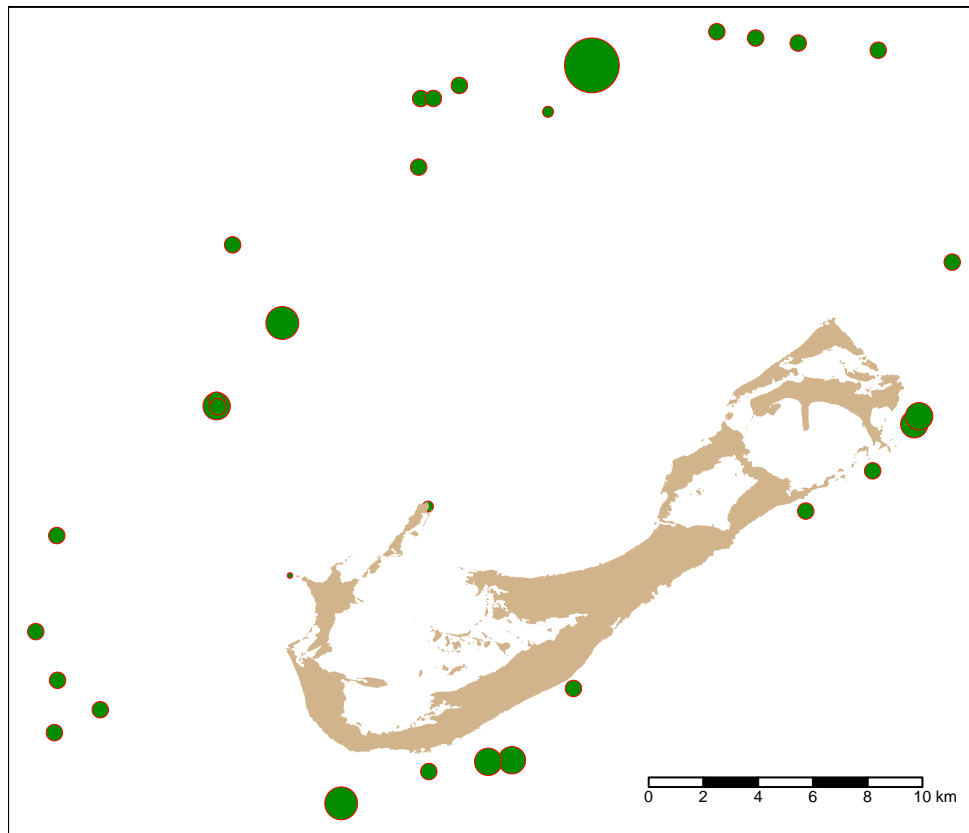


Figure 1: Protected dive site areas to be excluded as suitable sites for siting offshore aquaculture cultivation technologies, shown in green with red outlines.

Nearshore and coastal aquaculture may be compatible with protected areas (e.g., Figure 2), but should only be considered if it will enhance, or at a minimum, not impact the ecosystem.

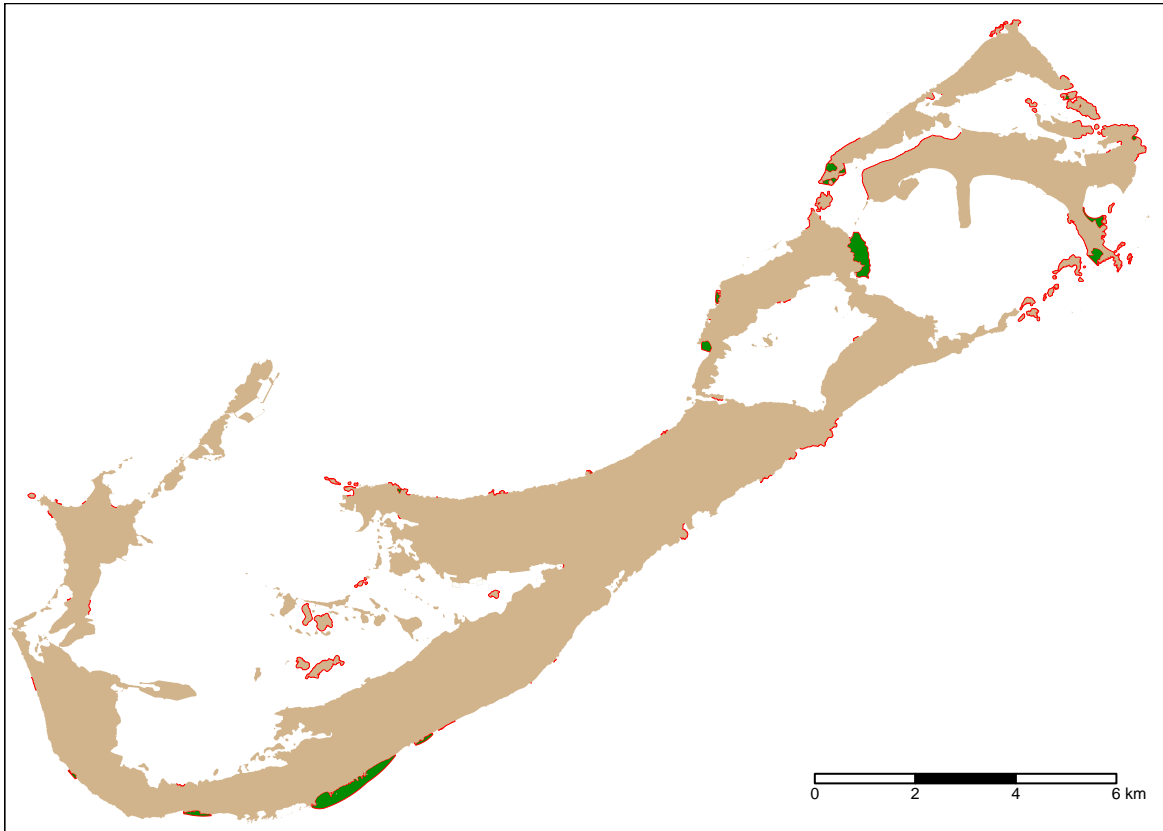


Figure 2: National Marine Park Areas, shown in green with red outlines

Spawning aggregation sites and seasonal closures

Installation and operation of aquaculture cultivation technologies in spawning aggregation areas could have significant impact on fish populations using those sites. To minimize this impact, and given that there are so few known grouper and red hind spawning aggregations in Bermuda, these areas and a 1km buffer around them, will be excluded as suitable areas for aquaculture activities.

In addition, no aquaculture technologies should be allowed in the Seasonally Protected Areas (see map) so these areas will also be excluded as suitable areas.



Figure 3: Fish spawning aggregation areas with 1km buffer zones and seasonal protected areas; not suitable for aquaculture siting

Shipping and ferry lanes

Aquaculture cultivation areas are likely to be incompatible with shipping lanes. The shipping lanes were buffered to a distance of 50m, i.e. areas within 50m of the shipping lanes are considered unsuitable for aquaculture siting. The 50m distance was chosen using information from the Canadian commercial setup. Note that we are not taking into account the width of the shipping route, which should also be considered, but is dependent on the sizes and numbers of vessels using the shipping lanes, as well as other considerations.

Aquaculture is also likely incompatible with ferry routes. These routes were also buffered to a distance of 50m.

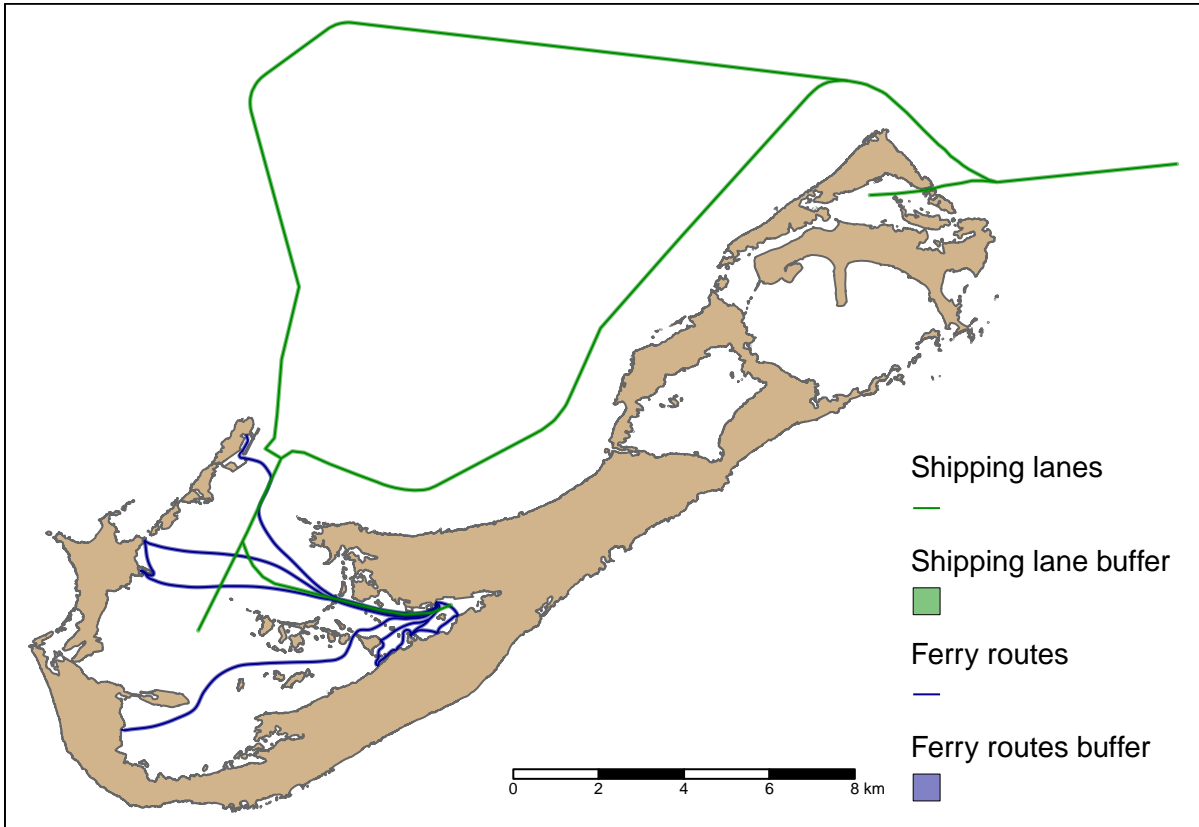


Figure 4: Shipping and ferry lanes buffered; not suitable for aquaculture siting

Submarine cables

Areas where existing cables are laid are assumed to be unsuitable for aquaculture. All cables were buffered to a distance of 50m to avoid aquaculture cultivation technologies placed too close.



Figure 5: Submarine cable areas to be excluded as suitable areas for aquaculture siting

Sensitive habitats

Coral cover Siting of bottom-contact aquaculture cultivation technologies on coral will destroy habitat. Anchors for offshore and nearshore submerged cages and longlines should be at least 50m from coral reef area.

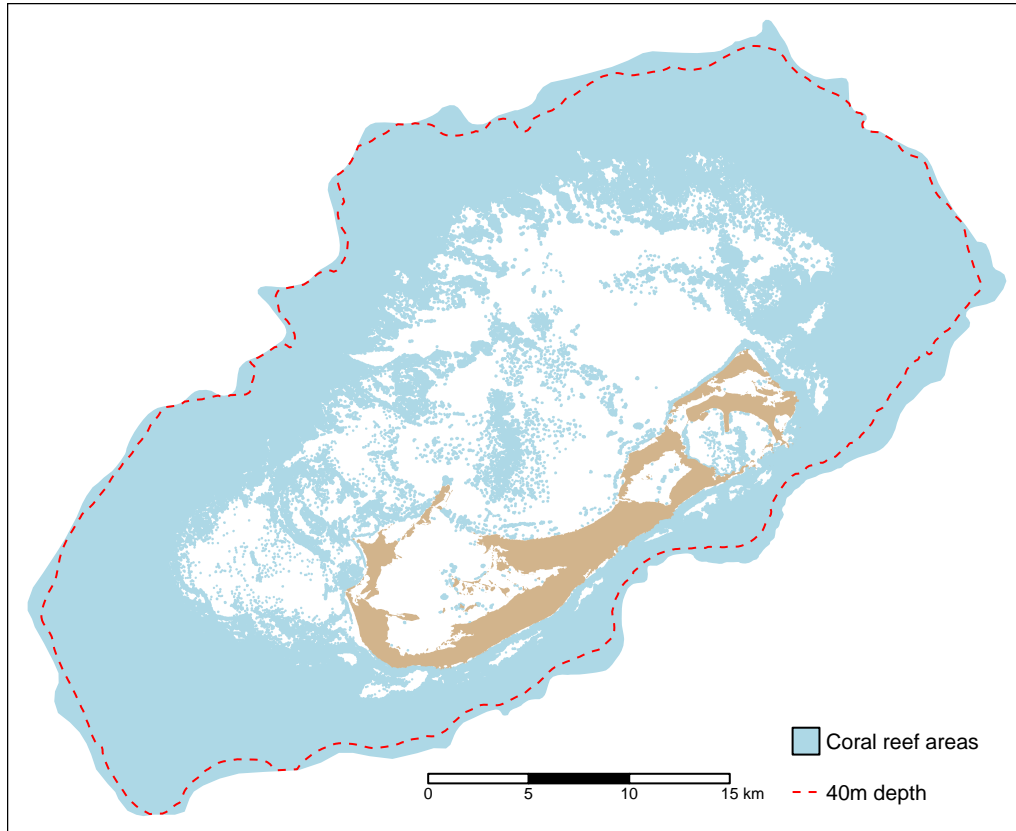


Figure 6: Coral reef areas to be excluded as suitable areas for offshore and nearshore bottom-contact aquaculture technologies

Bottom type restrictions

For nearshore bottom culture (1-15m depth), sandy bottom areas are optimal, but loose rubble bottom can also be used. Thus, sandy areas (50-100% sand cover according to remote sensing data) are classified as highly suitable for aquaculture siting, and areas with rubble (30-50% rubble) are classified as having low suitability. Allowing aquaculture in areas with high macroalgal cover should only be considered if it will not negatively impact the macroalgal ecosystem.

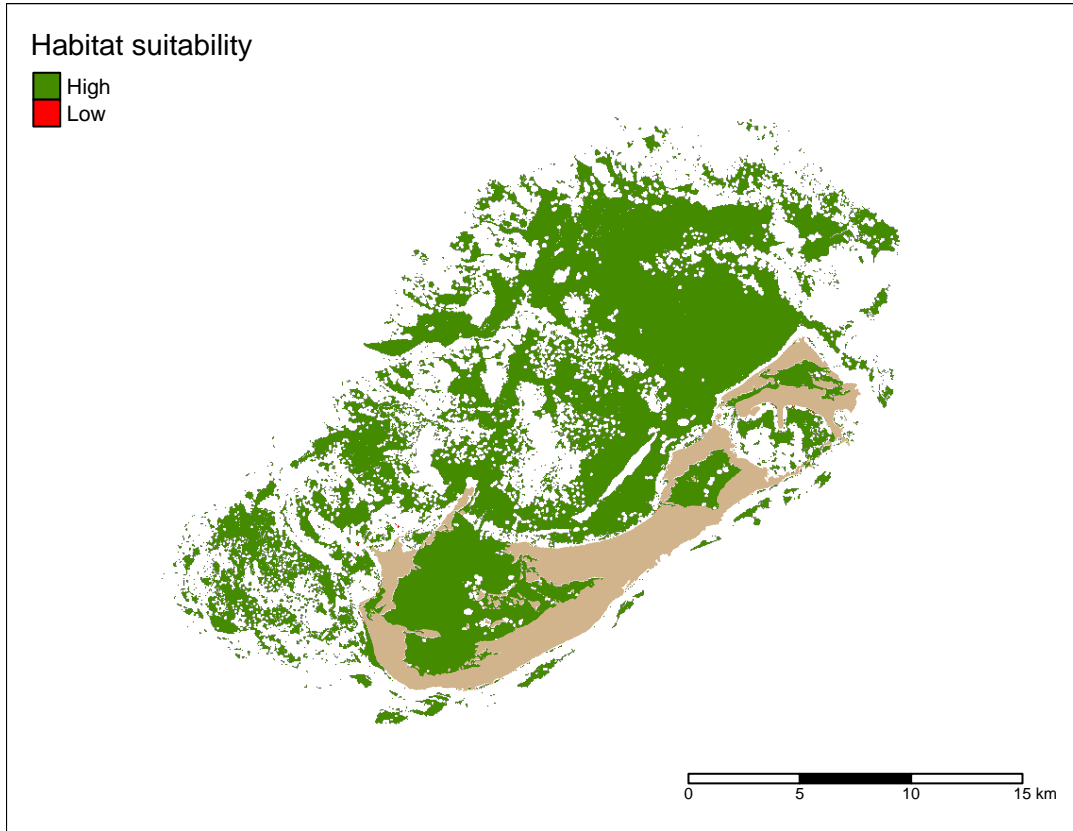


Figure 7: Suitability of habitat types for nearshore bottom culture technologies. Highly suitable areas are those with >50% sand cover; areas with low suitability have >50% sand cover and 30-50% rubble cover. Great, Little and Harrington Sound, and St. George's Harbour are all considered potentially highly suitable habitat areas (they could not be classified using habitat data since this was not available for these areas). Coral reef areas, as per Figure 6, have been removed

Proximity from point source pollution

All aquaculture sites must be at least 100m away from a pollution source. Types of pollution sources considered include:

- Dumps
- Boatyards
- Marinas
- Sewage outfalls

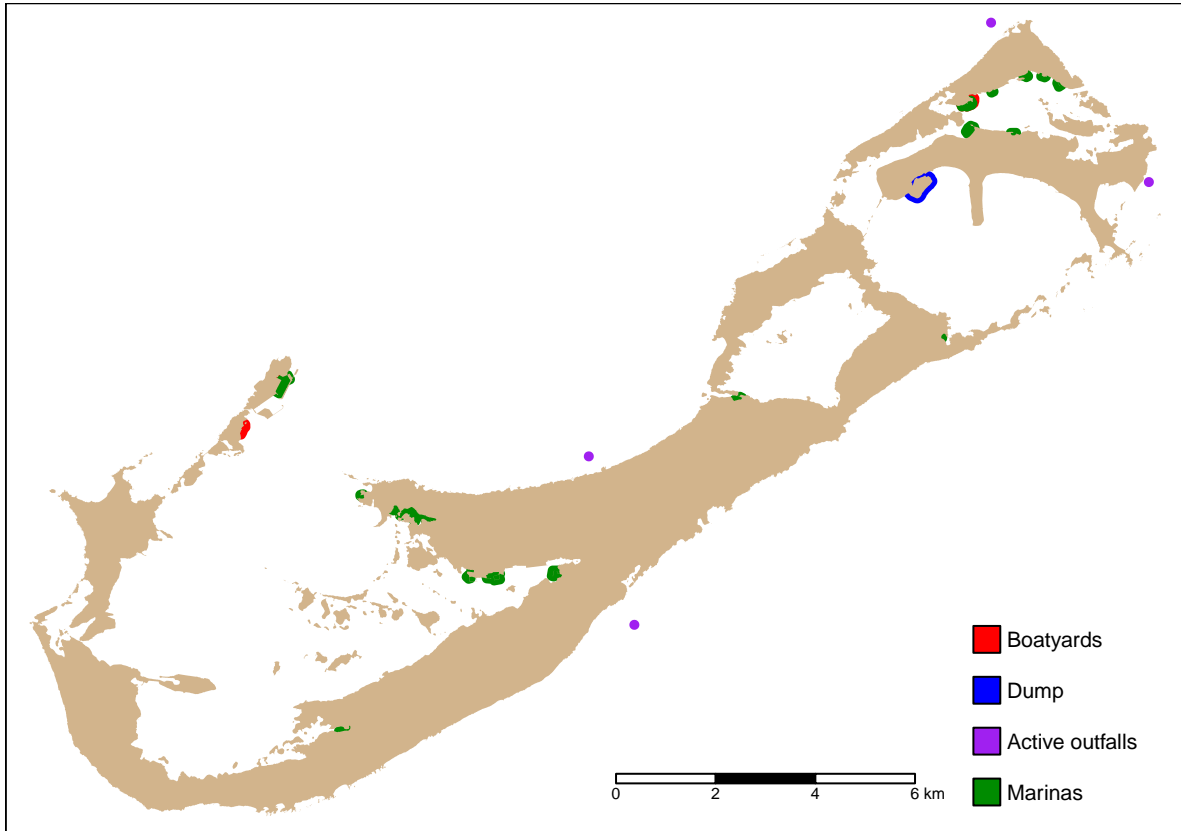


Figure 8: Pollution sources and the surrounding areas to be excluded for aquaculture siting. Each pollution source has an exclusion area extending outwards around it.

Depth limitations

Each aquaculture cultivation technology has different depth limitations. Sources of bathymetry: LIDAR data for shallow areas (<15m), and the 40 and 400m contours are from the NOAA DEM with contours depth corrected using the nearest Admiralty map contours.

Technology	Minimum depth (m)	Maximum depth (m)
Offshore submerged cages (anchored)	40	400
Offshore floating	40	400
Nearshore submerged longlines	2	15
Nearshore bottom culture and surface longlines	1	15
Coastal dock-based systems (FLUPSY)	0	3

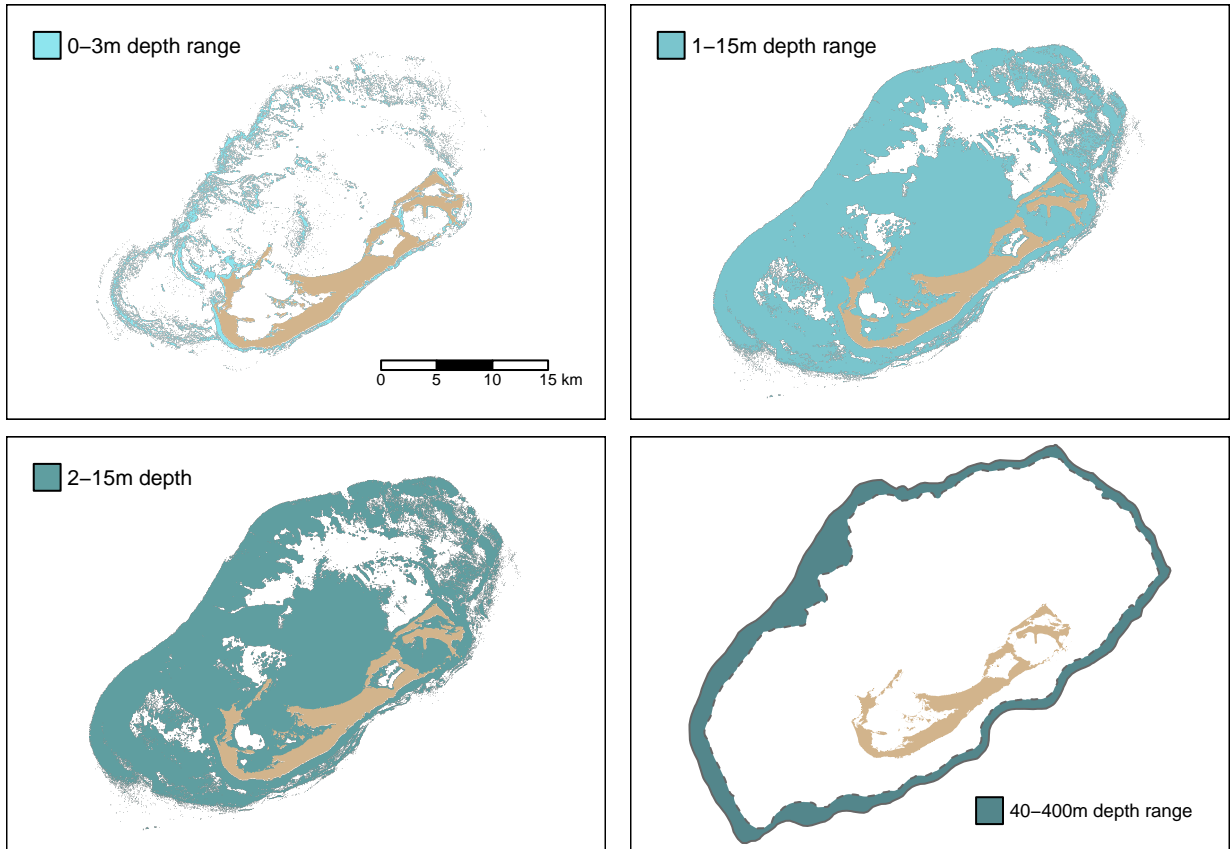


Figure 9: Depth ranges suitable for different aquaculture cultivation technologies

Results

Offshore submerged (anchored) and floating cages (40-400m depths)

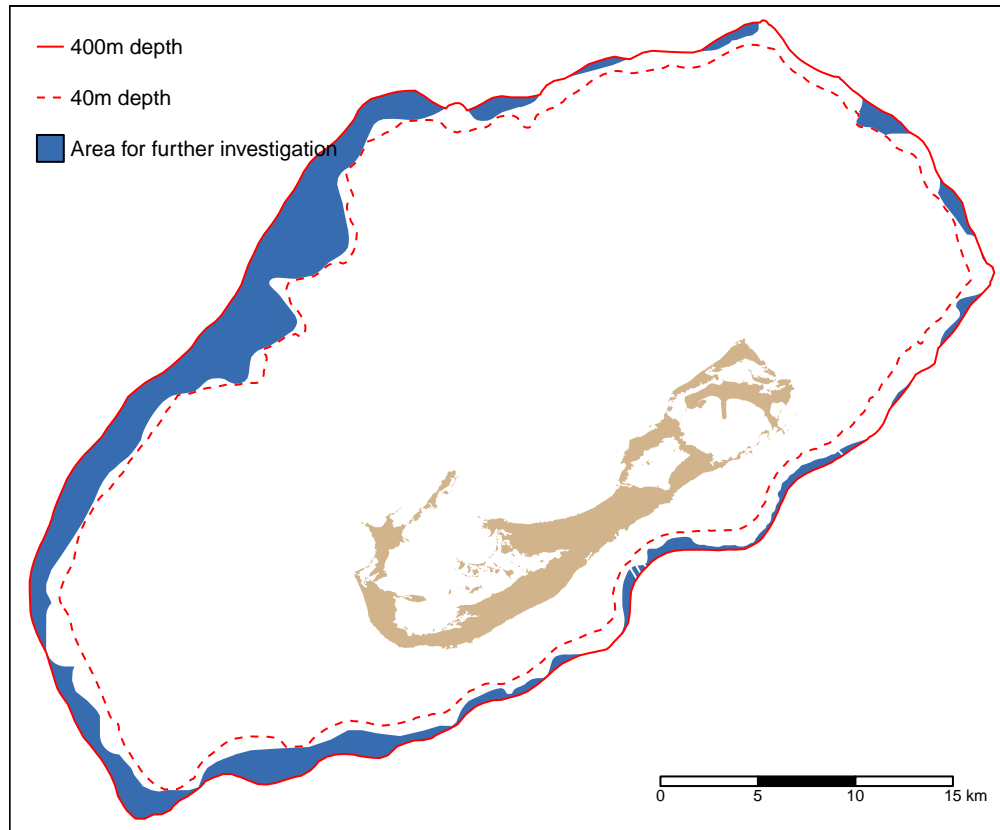


Figure 10: Offshore areas suitable for further investigation for submerged cages for finfish/bivalves and floating finfish cages (40-400m depth requirement)

Nearshore submerged longlines (2-15m depths)

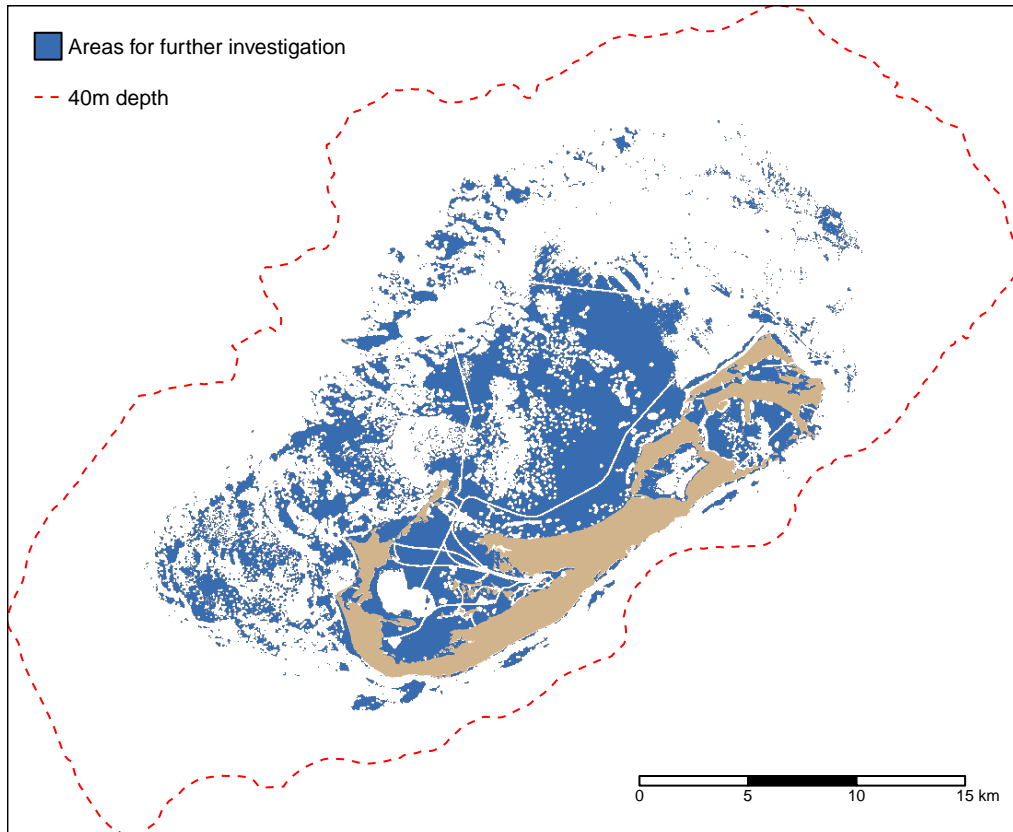


Figure 11: Areas suitable for further investigation as nearshore submerged longline cultivation sites (2-15m depth requirement)

Nearshore bottom culture and surface lines (1-15m depths)

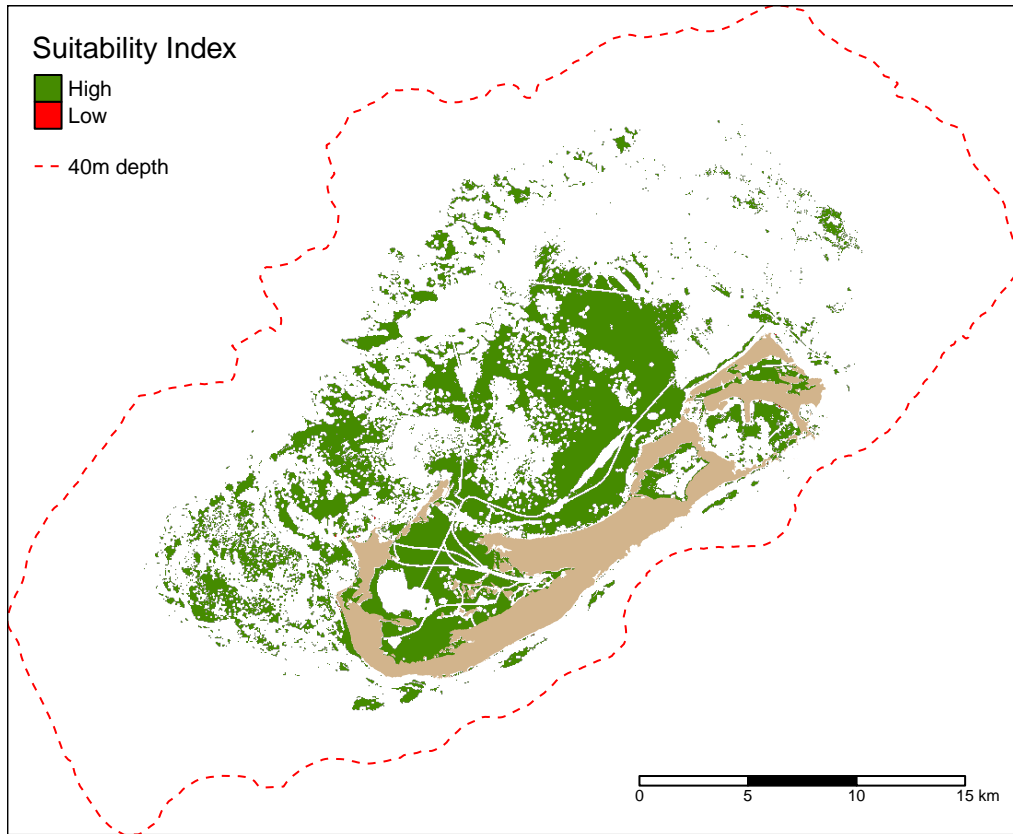


Figure 12: Suitability of areas for further investigation as sites for nearshore bottom culture and surface lines (1-15m depth requirement)

Coastal dock based systems (0-3m depths)

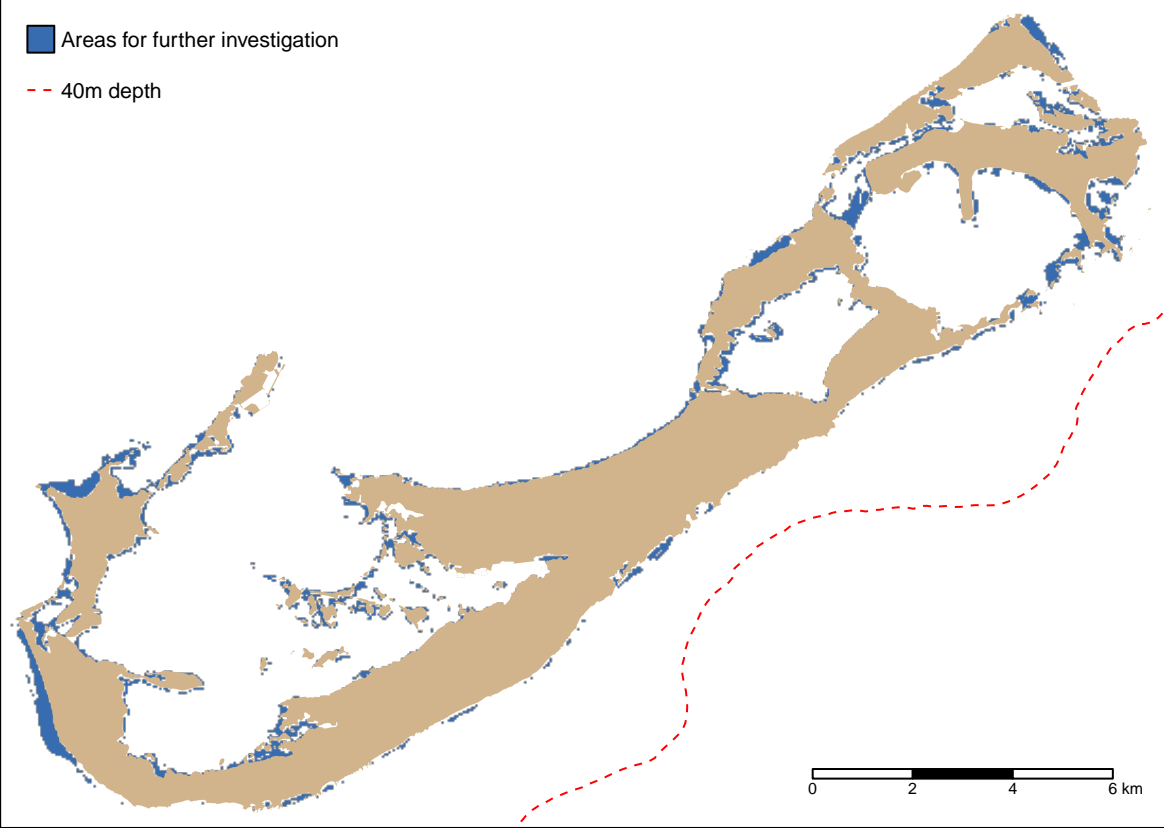


Figure 13: Areas suitable for further investigation as sites for coastal dock-based systems (0-3m depth requirement)