



Grand Cayman, British West Indies

Phillippe G. Bush

Protection and Conservation Unit, Department of the Environment, PO Box 486 GT, Grand Cayman, BWI

*The Cayman Islands are situated on a major submarine ridge that extends west from the Sierra Maestra range in southeastern Cuba. The ridge parallels the Cayman Trench, which is more than 6,000 m deep and is located 6 km to the south. The islands are low-lying limestone formations of an older Bluff core of mid-Tertiary limestone origin, fringed by younger Ironshore formations, Pleistocene calcareous deposits, and recent carbonate sediments. Their narrow insular shelves support prolific coral reef communities. Grand Cayman is the largest of the three Cayman Islands, with a surface area of 197 km². The two dominant features of Grand Cayman are the Central Swamp and the North Sound. The large Central Swamp, which has a unique geomorphology, measures 50 km² and borders the North Sound on the east and southeast. The North Sound is a 85 km², semi-enclosed, shallow lagoon, historically fringed with mangrove swamp to the west, south, and east, and with an exposed acroporid fringing reef to the north. Approximately 60% of the sound is covered by well developed beds of *Thalassia testudinum*. There is limited runoff from surrounding lands during the rainy season, May-November. The CARICOMP transect for mangroves, seagrass beds, and coral reefs begins at the coastal edge of the Central Swamp, traverses the seagrass beds of the North Sound, and finishes to the north at the outer shallow reef terrace.*

Introduction

The Cayman Islands are situated along the Cayman Ridge, which extends from southeastern Cuba into the bay of Honduras and is flanked by the 6,000 m deep Cayman Trench 6 km to the south ([Fig. 1](#)). The largest of the three islands, Grand Cayman is located at 19°18'N, 81°16'W). It is an oddly shaped island, 35 km long and oriented east-west. The two most conspicuous features of Grand Cayman are the contiguous Central Swamp and North Sound ([Fig. 2](#)). The main portion of the island, 8 km at its widest point, lies east of North Sound, and the other portion is a hook-shaped peninsula south and west of the sound. Narrow reef-protected lagoons occur along much of the northern, eastern, and southern coasts. The western or leeward side of the island has no lagoons and is exposed to open sea. Together, the Central Swamp and North Sound are the ecological heart of Grand Cayman, and their fringing mangroves and seagrass beds are critical breeding and nursery habitats for marine fauna ([Ebanks-Petrie, 1993](#)). The CARICOMP monitoring transect lies within these two contiguous features and crosses the outlying reefs to the north.

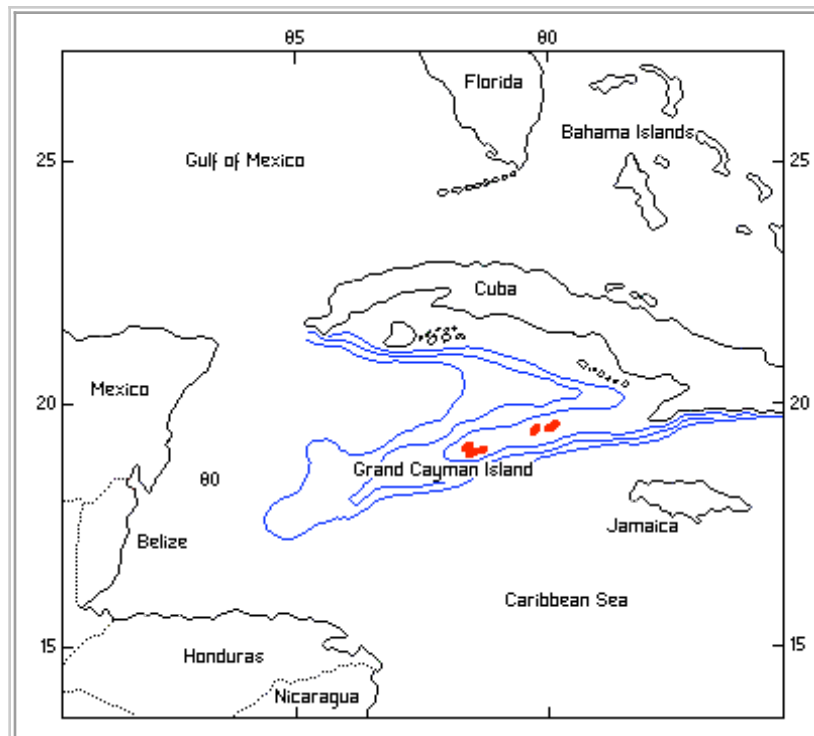


Fig. 1. Location of Grand Cayman, British West Indies

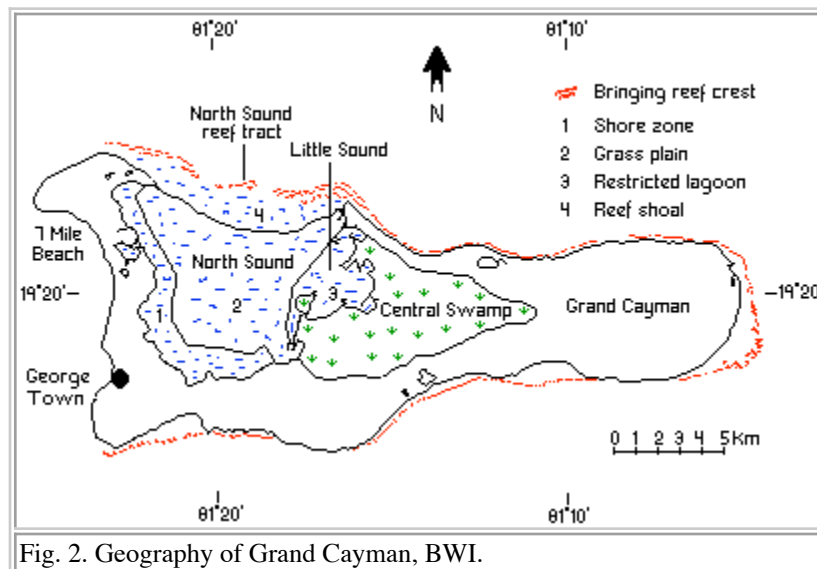


Fig. 2. Geography of Grand Cayman, BWI.

Central Swamp

Over 50% of Grand Cayman is covered by swamp communities. The Caymans inter-tidal swamps are very different from others (Watson, 1928; Thom, 1967); they are not deltaic, having developed on autochthonous peat substrate rather than on allochthonous silts (Burton, 1994). Fringing the eastern portion of North Sound, the Central Swamp, which measures 50 km², is geomorphologically unique. While there is some evidence of zonation in small areas, it does not demonstrate the classical zonation pattern representative of a typical mangrove swamp. Instead, it is a complex mosaic of swamp

communities with varying degrees of mixing of the three principal species, *Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemosa*, along its coastal fringe ([Burton, 1994](#)).

North Sound

The periphery of North Sound has the most extensive development of coastal fringing mangroves of the entire island. Except for a few small sheltered areas where new *Rhizophora* seedlings can establish, the physical conditions and shoreline topography of the North Sound are now unsuited for new mangrove establishment ([Burton, 1994](#)). Like the mangroves around most of the North Sound, the fringe of the Central Swamp is not progressing, and in fact, there is evidence that this fringe is receding. As illustrated in [Figure 2](#), four bottom communities are recognized in the North Sound: shore zone, grass plain, restricted lagoon, and reef shoal ([Roberts, 1976](#)). The shore zone occupies the shallowest (average depth 1.0-2.5 m) part of the sound and is an area 1-2 km wide along the western and southern periphery of the lagoon. Sediments are thin, and the benthos is made up of stunted *Thalassia*, various species of alcyonarians and calcareous green algae, loggerhead sponges (*Speciospongia vesparium*), and small colonies of *Porites* and *Siderastrea*. The grass plain occupies the largest and central portion of the lagoon. Here, thick beds of *Thalassia*, abundant green algae, and the sediment mounds of burrowing marine worms and crustaceans dominate the bottom. The CARICOMP seagrass site is located in this zone; however, no data on productivity are yet available. The restricted lagoon of Little Sound, so called because of its partial isolation from the main body of North Sound, is similar to the grass plain in its assemblage of benthic organisms. The sediments are darker, owing to the abundance of organic detritus produced by fringing mangroves of the Central Swamp where peats presently are being formed. Some *Thalassia* in this zone exhibit leaf growth of up to 45 cm in length. The reef shoal zone consists of both hard and soft carbonate substrate communities and exhibits the high-energy conditions associated with such backreef environments. Stony corals such as *Acropora*, *Diploria*, *Montastraea*, and *Siderastrea* are abundant, along with *Millepora* and various coralline algae. Sand and rubble areas support brown and green algal assemblages. This zone is bounded on its outer side by a tidally exposed acroporid reef ridge that is perforated in places by outflow channels through which strong tidal currents are generated. In proportion to the size of the island, this lagoon, which has an area equal to 43% of the total land mass, is of major ecological value.

Coral Reefs

Grand Cayman has a narrow, insular, carbonate shelf, rarely exceeding 1.5 km in width and frequently less than 0.75 km. The submarine topography past the fringing reef of North Sound is characterized by two well developed spur-and-groove terraces ([Rigby and Roberts, 1976](#)), a shallow terrace reaching to a depth of 9 m, and a deeper one at 15 m that plunges into the abyss. Past the reef crest, the shallow rocky sill is dominated by alcyonarians, along with sparse colonies of *Agaricia agricites*, *Siderastrea sidera*, and *Montastraea annularis*. The latter two are the least abundant but form large prominent heads. Stony corals gradually increase in number seaward and away from this bedrock zone to a depth of 12 m, where large heads of *Montastraea annularis* (some up to 5 m in height) dominate.

CARICOMP data indicate live benthic cover (excluding algae) and rugosity to be 24.15% and 1.7%, respectively. This is and may be attributed to the fact that the sampling area, as determined by the prescribed methodology at the 10 m contour, was more shallow than the best developed reef. Typically, there is a deep sand plain of varying width and depth separating this shallow terrace and the deeper terrace. The deep terrace is distinctive in that it has a dramatic relief, the highest diversity of stony corals, the greatest percentage cover of sponges, and the highest density of fish ([Burgess et al., 1994](#)).

Climate and Hydrology

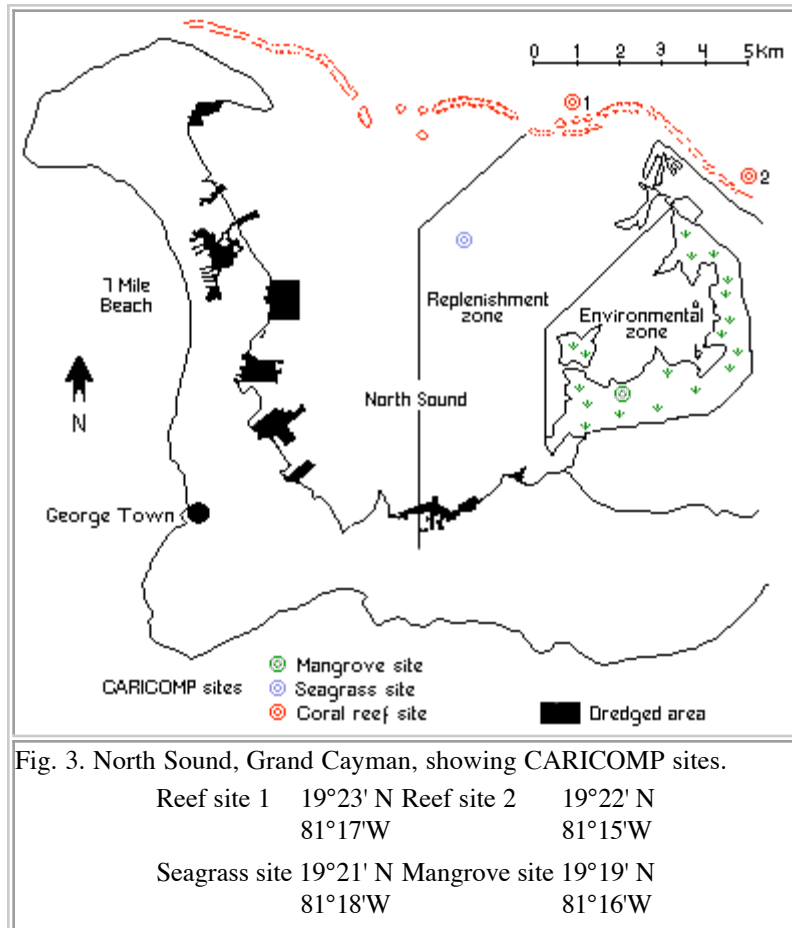
Lying midway within the northeast tradewind belt, Grand Cayman has a subhumid tropical climate with distinct seasonal variation. There are no large land masses within a 200 km radius and the climate is strongly moderated by the sea (Burton, 1994). The wet season occurs from May through November, with an average maximum daily midday temperature of 28.4°C, occurring in July. The dry season, December-April, has an average minimum daily midday temperature of 24.8°C, occurring in February. Average annual rainfall is 1,107 mm in the eastern portion of the island and 1,595 mm in the western portion (Burton, 1994). Although weather patterns are generally stable, low pressure systems in the form of tropical waves, depressions, storms, and hurricanes frequently affect the island during the summer months. Also, during the winter, sporadic cold fronts from the north bring cooler air and strong winds from the north and northwest, a weather pattern locally known as a norwester. Grand Cayman has an average tidal range of 26 cm (Burton, 1994); the tidal pattern is mixed, primarily semi-diurnal, (Rigby and Roberts, 1976). Although tidal fluctuation is slight, there is a seasonal variation in mean sea level; surges during the late summer months bring mean high tides above 31 cm throughout July, August, and September (Burton, 1994). This elevation corresponds to the general flooding threshold for coastal mangroves on Grand Cayman (Brunt and Burton, 1994) and is significant for the fringing mangroves of North Sound. While evidence suggests that frequent tidal inundation of the Central Swamp mangroves extends only 200-300 m inland, the opposite movement of rainwater towards the lagoon is more common (Burton, 1994). After heavy rains, the entire Central Swamp may become covered by sheet flow. From mid-dry to mid-wet season, the maximum drainage of tannin-stained water from the surrounding mangroves flows into the sound and may cover substantial areas. The maximum area of staining was calculated to be 30.04 km² (Giglioli, 1976). It has been suggested that significant quantities of available organic detritus affect the food web and therefore the nursery potential of the sound. Sustained southeast winds periodically push this plume of organically laden water from the Central Swamp as far out as the shallow reef terrace, more than 6.5 km away.

There is a strong correlation (0.92) between temperature and litterfall within this mangrove fringe, and while there is a correlation of only 0.54 between rainfall and litterfall (CARICOMP data, 1994), the fact that maximum litterfall, rainfall, and drainage occur simultaneously suggests detrital outflow from the mangrove fringe. With the recent decline in fringing mangroves to the west and south, the contribution of organic material may now be reduced. Currents on the narrow shelf of Grand Cayman generally flow from east to west, but they experience large and periodic variations in both magnitude and direction (Rigby and Roberts, 1976). Salinity varies between 35‰ and 38‰ in open ocean waters around Grand Cayman (Moore 1973). Salinity within shallow sounds varies in relation to amount, duration, and periodicity of rainfall, as a result of coastal topography, upwelling, and circulation. Because the Cayman Islands lack rivers, the waters of the open sea and the narrower, shallower sounds around Grand Cayman are very transparent. Average visibility is 30 m (Rigby and Roberts, 1976), and clarity is affected at any particular location by conditions of wind speed and direction, as well as by sediment concentration.

Human Impacts

The major population centers are situated within the peninsular region, particularly on the western side along 7-Mile Beach, where hotels, condominium housing, and shopping amenities cater to tourism that is based largely on the marine environment. Over 900,000 visitors come to Grand Cayman annually to experience the "sun, sea, and sand" activities that this center of scuba diving has to offer. The majority of tourists participate in some form of water sports. Although most of the scuba diving takes place off 7-Mile Beach, many sites have been established outside the North Sound's acroporid reef ridge, where visitors come to experience the thrill of diving the "North Wall" and its associated reefs. Other recreational activities within the outer reef shoal zone of North Sound include day trips to experience "Stingray City" and "Sand Bar," excellent areas for snorkeling and also harvesting queen conchs. Despite earlier efforts to establish marine conservation laws and the marine park system, the sheer numbers of visitors and watercraft are cause for concern over issues such as the carrying capacities of dive sites, pollution, over-fishing, and overall environmental degradation from overuse. Since the 1960s,

large-scale speculative development has resulted in the destruction of 61.6% of the mangroves within a half-kilometer of the western periphery of the North Sound (Ebanks-Petrie, 1993). Approximately 2.15 km² of the shallow lagoon bedrock facies of the shore zone of the North Sound has been dredged (Fig. 3) to supply marl for the reclamation of swampland (Ebanks-Petrie, 1993). During heavy rainfall in the wet season, runoff is evident from these developments, where the marl fill level is higher than retaining bulkheads. During heavy noreasters in the winter season, fine sediments from dredged borrow pits are stirred up and redistributed over a much wider area of the seabed. Over 83% of the total waterfront canal lot developments that were built on speculation since the late 1970s remain unoccupied, calling into serious question the benefit of continued development without proper management of the coastal zone.



Conclusion

The CARICOMP transect of mangrove, seagrass, and coral reef sites was established where these three habitats are contiguous, functionally integrated, and left largely undisturbed (Fig. 3), and the monitoring sites are located in legally protected areas. This should ensure the environmental quality and ecological integrity of these habitats. The mangrove site lies within an "Environmental Zone," the most strictly regulated of the three marine park zones of Grand Cayman. It includes all of Little Sound (the restricted lagoon area east of the North Sound) and the coastal fringe of the Central Swamp, a distance of approximately 300 m. It was set aside to preserve the pristine nature of this area of mangroves and sea grasses, and it is also currently being considered for declaration as a RAMSAR site. Because the Central Swamp is so important in terms of its environmental role in rainfall, wildlife refuge, and groundwater maintenance, the National Trust for the Cayman Islands, in conjunction with the government, is actively pursuing the purchase of remaining inland parcels not already protected by the Environmental Zone.

The seagrass site is located within a replenishment zone, so designated for the protection of breeding stocks of conch and lobster. Regulations prohibit harmful types of fishing such as spearing, trapping, netting, and trawling. This monitoring station is also quite distant from any coastline or other in-water area where human activities may possibly impact the seagrass beds. The coral reef site, located seaward of the fringing reef, is also protected by marine conservation laws that control anchoring, polluting, and the taking or harming of marine life. Like all dive sites, permanent moorings are installed at the CARICOMP sites, thereby eliminating the need for any vessel to anchor.

In the face of increasing development, both locally and regionally, the government of the Cayman Islands is looking to establish a comprehensive environmental policy. The legislation will include an integrated approach to managing the coastal zone. Such a move can only be complemented by more in-depth scientific studies of the functional integrity of coastal and marine resources. The CARICOMP program provides an effective means to help achieve such knowledge through research.

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