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### Island Overview

Montserrat is located within the Leeward Islands of the Eastern Caribbean at approximately 16° 45' 0" N, 062° 12' 0" W. The neighbouring islands are Antigua 45 km to the northeast; Redonda, a small uninhabited island 25 km to the northwest; Nevis 55 km to the northwest, and Guadeloupe 60 km to the southeast (Fig. 8.1).

The island is volcanic in nature with multiple peaks. Montserrat is divided into three distinct sections correlated to three volcanic ranges. Those ranges are, from oldest to newest: the Silver Hills in the north (403 m); Center Hills, site of the island's nature reserve (741 m); and the Soufriere Hills, the youngest, tallest and currently active volcano (1,070 m) (Le Friant et al. 2009). Montserrat is an island of steep mountains, dense forest, deep valleys and ghauts, multiple fresh water springs, seaside cliffs, several black sand beaches (there is one white sand beach on the northwest coast) and a large area affected by volcanic eruptions and lahars flows.

The island has a stated population of approximately 4,900 people. That population lives along the west coast and the northern sections of the island (2011 census, [www.gov.ms](http://www.gov.ms)), and over half of the island, the section south of the Belham River valley, is an exclusion zone which is not open for habitation. This zone varies in size with volcanic activity.

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### Modern Volcanic History

In July of 1995 the Soufriere Hills volcano became active again, and since that date there has been multiple dome growth and collapse events which caused both the evacuation and destruction of the capital city, Plymouth, and numerous

smaller villages. The Soufriere Hills is an explosive stratovolcano, whose volcanic events are characterized by the extrusion of rock, gases and ash from vents on the dome, often in the form of pyroclastic flows. Eruptions produce billowing ash clouds reaching over 10,000 m into the air; avalanches of super-heated gases, rocks and boulders, which at times reach and travel across the sea; and dense deposits of fine ash particles on land and sea ([www.mvo.ms](http://www.mvo.ms)). Repeated dome collapses and volcanic activity have buried extensive tracts of land and changed the contours of the coastline (Fig. 8.2). Dome collapses and lahars over the past 15 years have created and extended deltas of volcanic debris into the sea extensively on both the eastern and western southern sections of the island. Over 1 km<sup>3</sup> of material has been produced by the volcano with an estimated 75–90% of that material ending up in the sea (Trofimovs et al. 2006). Over 1 km<sup>2</sup> of new beaches and land have been formed, burying previously existing coastline and offshore habitat (Le Friant et al. 2009).

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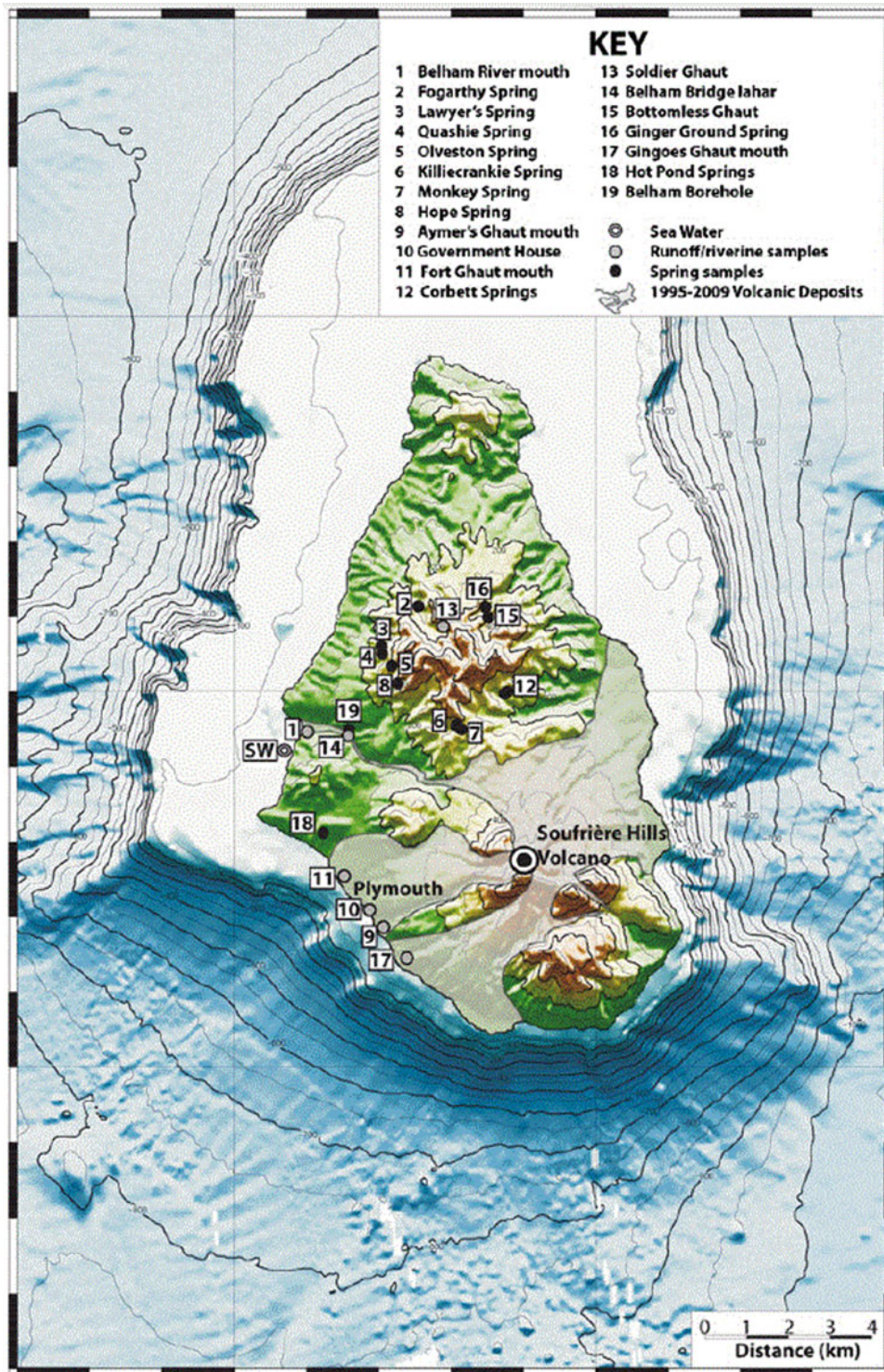
### Montserrat's Marine Habitat

The island has approximately 40 km of coastline, mostly backed by towering sea cliffs with occasional beaches. The submarine shelf, at depths from 20 to 60 m, varies greatly in width around the island, extending approximately 5 km off the northern section but only 0.5 km off the southern coast (Le Friant et al. 2004). Habitat on the deeper section of the shelf is comprised of sand flats with scattered low profile rock platforms with coral coverage. Between the 20 m depth contour and the shoreline habitat density increases.

This typical inshore habitat (<30 m depth) is composed of erosional material from the sea cliffs (large boulders and varying sized rocks), ridges and low profile rock shelves and sand gullies and plains. The reef system of Montserrat is not created by coral growth exclusively but includes much coral growth on rock, boulders, and hard, low profile substrate. Each of these zones support different marine life.

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**Fig. 8.1** Map view of Montserrat displaying bathymetry and the submarine shelf (From Jones et al. 2010, Springer book chapter)

**Shallow Water Boulder and Rock Zone**

Extending from shore to approximately the 10 m depth contour, much of the island is surrounded by the remnants of the erosional decay of the island, with varying sized rocks. Within

this zone evidence of the island’s volcanic roots are clearly apparent. As the softer material eroded/erodes from the sea cliffs an intricate marine topography and habitat is formed. Some of the boulders found here measure over 20 m across and 15 m tall (Fig. 8.3).



**Fig. 8.2** Repeated dome collapses and volcanic activity have buried extensive tracts of land and changed the contours of the coastline. This photo was taken after the most recent partial dome collapse in February of 2010 which extended 600 m into the sea (© Henry Odbert)



**Fig. 8.3** Example of the biodiversity found on the large boulder structures in shallow water. This one is at 5 m depth on the northwest coast (© Kim Guinn)

The resulting substrate hosts an extensive variety of corals, invertebrates, sponges, juvenile and adult fish species, marine creatures, and marine plants and algae which are typical of Caribbean coral reef areas. This zone appears to be significant in terms of providing juvenile fish nursery areas.

### Ridges and Low Profile Rock Shelves

Further offshore, with increasing depths, the reef has a lower profile, with elevations and ridges typically less than 2–3 m high. Heavily sloping bottom contours create ridges in the



**Fig. 8.4** Typical low profile reef biodiversity in 15 m of water; west coast of Montserrat (© Marcus Merrin)

15–20 m depth span, and within this zone “islands” of rock create scattered patch reef between 10 and 30 m depth (Fig. 8.4).

The reef substrate is often eroded into a honeycombed rock base. Though many of the same species of corals and sponges are found on these reefs as occur on the shallower ones, there is a greater abundance of gorgonians and far larger barrel sponges, again typical of reefs in the eastern Caribbean region. Pelagic species, such as jacks and mackerels, are most common in this depth zone.

### **Sandy Bottom Gullies and Plains**

This zone supports species that live or feed off of the sand flats. Several reef inhabitants leave the shelter of the protective coral reef to forage for molluscs, crustaceans and marine plants within the sand flats near the reef. Within this zone, Montserrat’s marine habitat supports a healthy population of southern stingrays, flying gunards, and spotted snake eels, as well as tobacco fish and conch.

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### **Differences in Marine Habitat Around the Island**

As noted earlier Montserrat’s submarine shelf varies greatly in width from the northern and southern regions of the island. This factor, as well as volcanic activity and prevailing sea

conditions, have created varying topography and health of the reef system (Fig. 8.5).

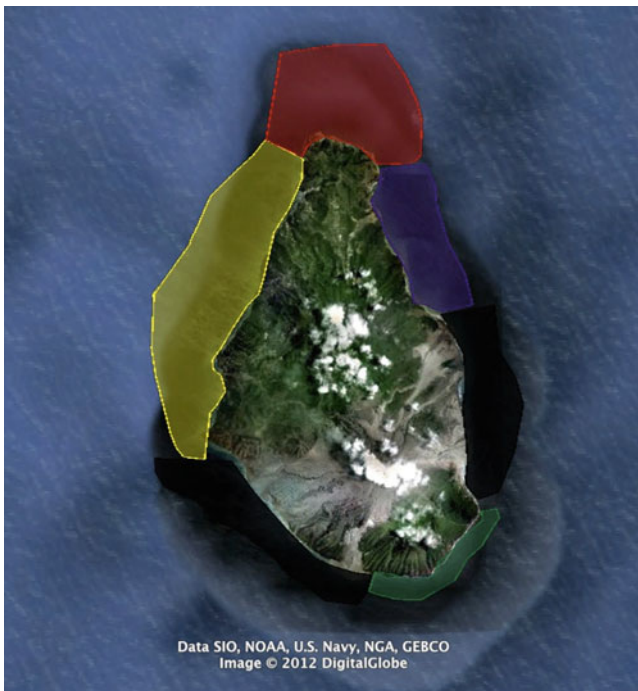
### **Northern Reef System**

The hard substrate shelf extends to 5 km off shore in this region, and consistent wave action and open ocean currents have created bunkers within the reef that allow for protective areas for reef life. The corals of this area are exposed to constant water movement and, as a consequence, appear to be amongst the most healthy around the island. This region is affected only occasionally by sedimentation from the volcano.

### **Western Leeward Reef System**

As the shelf narrows the extent of the reef from the shore reduces. Dense reef coverage is found within 300 m of shore, with patch reef extending to over 1 km offshore to depths of >30 m.

Coral health varies greatly along this coast with healthier reefs, in general, existing further from the volcanic runoff plains, but there are anomalies to this, where multiple, small reefs exist close to these runoff plains where they still support healthy reef habitat, possibly as a result of water currents redirecting sediment though the area.



**Fig. 8.5** Satellite image depicting the distinct reef systems around Montserrat. Northern reef system in *red*; Western Leeward is *yellow*; Eastern Windward is *purple*. Volcanic zones shown in *black*; and southern reef system area is *green* (From Google Earth)

### Eastern Windward Reef System

The reefs here are consistently subject to heavy wave action. Exploration of this region has been limited, although visits have found eroded rock substrate forming overhangs and ‘swim throughs’. Corals are affected and stressed by frequent heavy sedimentation from volcanic runoff.

### Southern Reef System

This zone is also only visited rarely because of sea conditions. The reefs are found close to shore and quickly drop to considerable depths. Visits have shown healthy corals and abundant fish populations. Though flanked by two volcanic plains, water currents direct sediment away from these reefs.

### Volcanic Flanks of the Volcano: East and West Coast

Exploration of this area is often unsafe because of volcanic activity. Reefs experience heavy sedimentation and frequent burial.

## Reef Species of Note

**Pillar Coral.** Montserrat has several large and healthy pillar coral colonies (*Dendrogyra cylindrus*) as well as numerous smaller colonies (Fig. 8.6). This species is listed as ‘vulnerable’ by IUCN. Elkhorn coral (*Acropora palmata*) also exists, and is listed as a critically endangered species. Throughout the Caribbean region huge tracts of Elkhorn have been lost to white band disease and tropical storm conditions, and what was once a very abundant coral in Montserrat is now rarely found healthy. Though white band disease has devastated most of the island’s Elkhorn, Montserrat still has scattered healthy colonies within the northern and north-western region of the island (Fig. 8.7). As with many regions, Montserrat has abundant populations of barrel sponges, but whereas these are in some areas common mostly deeper than 15 m (Humann and Deloach 2002), in Montserrat they are common on reefs less than 8 m deep.

## Invasive Species

The Lionfish is an Indo-Pacific predatory fish that was first reported within the region (Florida) in the early 1990s. Since that time sightings have been reported throughout the whole region. The lionfish is an aggressive predator of juvenile fish and a prolific breeder. Coupled with no natural predators the population quickly explodes once established (USGS/NAS website). The first sightings occurred in Montserrat the summer of 2011, and by 2012, multiple lionfish can be found on every dive.

The Orange Cup Coral is another Indo-Pacific introduction which has established itself within the region since the 1940s. It is believed to be the only stony coral introduced within the Caribbean/Western Atlantic. It is found abundantly on several shallow reefs, often in shaded areas, around Montserrat (Humann and Deloach 2002).

## Coral Reef Stresses

Montserrat’s reefs are experiencing many of the same stresses that found throughout the region, but in addition has the unique one (amongst the Overseas Territories) of volcanic activity, which, over the past 15 years has been destroying and damaging the island’s marine ecosystem. The processes which created the island have buried extensive tracts of the inshore reefs around the lower half of the island. Heavy sedimentation, not only occurs during active volcanic dome growth and collapse but also occurs during non-active times through erosional runoff, and this sedimentation smothers



**Fig. 8.6** A large healthy colony of pillar coral located off the northwest coast of Montserrat. Pillar coral is considered a vulnerable species (© Kim Guinn)



**Fig. 8.7** A healthy specimen of critically endangered Elkhorn Coral in tin 3 m of water. This coral will be affected by planned development (© Andrew Myers)



**Fig. 8.8** Green turtle killed by the February 17th 2010 partial dome collapse. Volcanic dome collapse can create pyroclastic flows across the surface for several kilometres offshore depositing super heated rocks and ash (©Henry Odbert)

beaches and its life including nesting turtles (Fig. 8.8) and offshore it buries corals.

Coral Diseases are also prevalent, as they are in much of the Caribbean, and extensive areas of dead Elkhorn coral can be found on the northwest coast. While healthy colonies exist, others exhibit White-band Disease (WBD) which, with other White Syndromes, has killed a majority of Elkhorn and Staghorn colonies within the region. Other diseases that most likely are affecting Montserrat's reefs are black-band, red-band, and yellow blotch diseases (reported sightings though not confirmed) (Humann and Deloach 2002).

Collateral damage from the volcano is occurring due to redevelopment in the northern end of the island as the nation rebuilds its lost infrastructure. With the loss of its capital

Plymouth, both the port facility and most commercial and many residential buildings were lost. Currently there is a plan to build a new port facility (the second port development since the volcano) and a breakwater which will result in the loss of habitat.

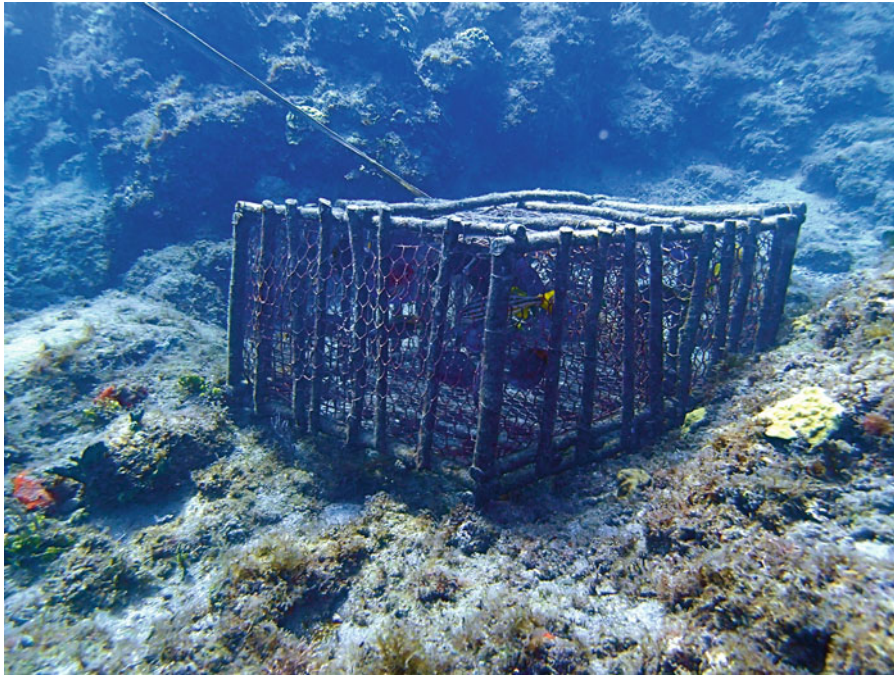
Antiquated fishing practices, and un-regulated fishing and over fishing are prevalent. Montserrat fishermen use hand-made fish traps or pots, gill nets and seine nets to catch most of the fish that are landed. Fish pots are often poorly placed on the reefs, left unchecked because of sea conditions, or become lost when the marker buoys get cut. This results in damage not only to the corals but also causes loss of fish that die due to these lost "ghost" pots that continue to kill. Because of volcanic activity and the change in the island's population base, accessible fishing areas have been reduced and overfishing in some areas is occurring (Fig. 8.9).

There are few fisheries laws and currently there is no enforcement of those that exist. According to the Caribbean Regional Fishing Mechanism (2006) the island does not export any fish and has 60 fishermen at this time ([www.caricom-fisheries.com/members/montserrat.asp](http://www.caricom-fisheries.com/members/montserrat.asp)).

### Marine Protective and Damage Mitigation Measures

Montserrat does not have marine protected areas, though discussions into the possibilities are being conducted. Currently a program known as the Montserrat Reef Project (MRP) is creating new reef habitat through the installation of designed artificial reefs. The project also identifies imperilled corals for propagation to the new reef system. The MRP is a grant funded project and is currently finishing the second phase of reef creation. The project has created over 240 reef structures known as Reef Balls since late 2010 whose intent is to generate new areas of hard substrate and bottom relief.

In summary, the coral reefs of Montserrat provide rich habitat for hundreds of reef species and typically support healthy and diverse corals and abundant juvenile fish, despite the elimination of substantial areas from volcanic action in the last 18 years. As with many of the other islands within the region, the reefs have suffered from various coral diseases and from damage caused by fishing and development issues. All will need to be addressed, and Montserrat with its small population has a great opportunity to make the necessary changes to optimise the condition of its reefs and the benefits they may accrue to the small island.



**Fig. 8.9** The use of fish pots damage the reef system by poor placement, lack of recovery by the fishermen, and indiscriminately killing when lost. This fish pot is on the reef and filled with various reef fish; northwest Montserrat (© Andrew Myers)

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