

A Review of the Ecology and Economics of Montserrat’s Marine Resources

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1. Executive Summary

Montserrat is a small, volcanic island in the Caribbean Sea that has undergone significant economic and ecological change over the past three decades due to disruption caused by a hurricane and prolonged volcanic activity. Montserrat's marine ecosystems face a variety of threats, including sedimentation from the volcano, storm damage, coastal development, and climate change-associated sea level rise.

While fishing plays a small economic role in Montserrat in terms of its contribution to national GDP, it is an important source of income and food security, and is culturally significant. There are currently about 100 fishers active in Montserrat, targeting over 200 species of fish and invertebrates. Landings are substantially lower than they were prior to the onset of volcanic activity, reflecting the lower number of fishers and the loss of access to productive fishing grounds. Needlefish, known locally as gar fish (*Belonidae*), are the most commonly landed species. Other important species in terms of volumes landed include reef fish such as red hind (*Epinephelus guttatus*), triggerfish (*Balistes vetula*), and squirrelfish (*Holocentrus marianus*), as well as coastal pelagic species such as ballyhoo (*Hemiramphus brasiliensis*). Although lobsters are only caught as bycatch in fish pots, they are the most valuable species in terms of unit price. There are currently very few fisheries management regulations that are enforced in Montserrat, but regulations proposed in 2009 would restrict fishing gear and seasons, protect certain species, and facilitate the creation of marine reserves. Montserrat currently does not have any ocean zoning aside from the Maritime Exclusion Zone, which restricts access to the waters adjacent to the volcano.

Prior to the onset of volcanic activity in 1995, tourism was an important industry in Montserrat, comprising up to 36% of the island's annual GDP. Since the eruptions began, the tourism industry has shrunk considerably, but Montserrat is hoping to rebrand itself as an "off the grid" destination with opportunities for ecotourism, including diving and snorkeling.

2. General Description

Montserrat is a volcanic island located in the northeastern Caribbean Sea about 45 km southwest of Antigua. It forms part of the Leeward Islands, which make up the northern portion of the Lesser Antilles Island chain. The island is about 17.7 km long and 11.3 km wide, with a total land area of 102.3 km², 45 km of coastline, and a maritime claim area of 8,120 km² (Cook et al. 1981; Godley et al. 2004).

A number of natural disasters occurring in Montserrat over the last 30 years have had a substantial impact on the island's ecosystems, population, and economy (JNCC 1991). Hurricane Hugo hit Montserrat in 1989, causing substantial damage to infrastructure and the coastal environment. Several tropical storms and hurricanes have occurred since Hurricane Hugo, contributing to the damage. The largest natural disaster was the eruption of the Soufriere Hills volcano from 1995 to 2010 in the southern portion of the island (Ramdeen et al. 2012), destroying the capital city of Plymouth and placing two thirds of the island off limits (Myers 2013; Figure 1). In 1980, prior to the natural disasters, the island had a population of 11,852 (JNCC 1991). Currently the population of Montserrat is 4,927 (CIA World Factbook 2013) and people only reside in the northwestern third of the island (Myers 2013).

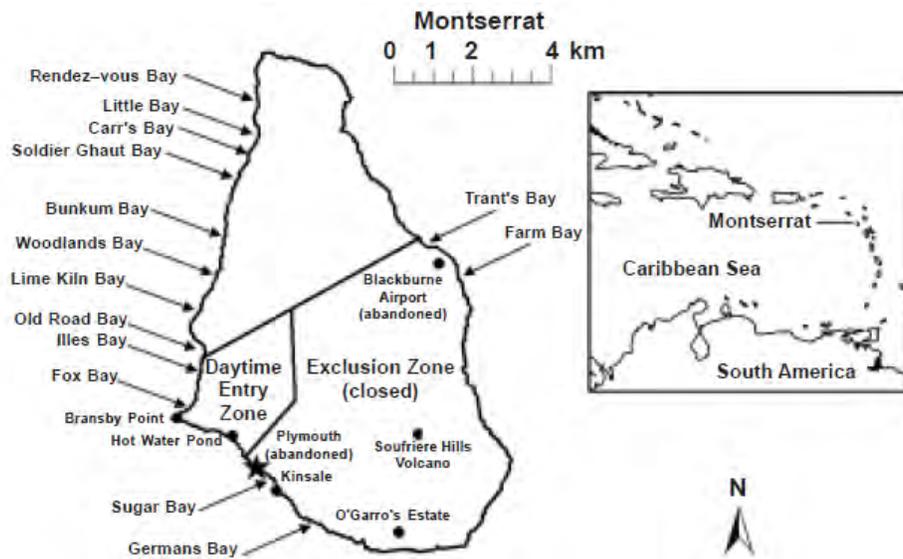


Figure 1. Map of Montserrat, showing the locations of the principal bays and the Exclusion Zone. From Martin et al. 2005.

3. Physical Description of Montserrat

Montserrat's volcanic landscape is rugged, with steep hillsides and an unprotected coastline lacking natural harbors (Cook et al. 1981). The eastern side of the island is the windward side: wind and water currents come from the east, split around the island to the north and south before coming together again on the western coast off of Bransby

Point. Upwelling occurs on the southern coast of Montserrat, where the coastal shelf is very narrow. Montserrat's waters are well mixed, leading to high levels of productivity. Sedimentation is concentrated on the eastern and western coasts (Wild et al. 2007). Most beaches are prone to erosion and exposed to high energy waves (Godley et al. 2004).

Montserrat has a narrow coastal shelf, with depths of 200 meters located only 650 m from the shoreline on the southern half of the island. The shelf has a gentler slope in the north and west: the 200 meter contour is about 5 km offshore (Godley et al. 2004).

In the aftermath of the volcanic activity of Soufriere Hills from 1995 through 2010, geologists and oceanographers on the E/V Nautilus have studied volcanic deposits on the seafloor and collected bathymetric data around the southeast and southwest coasts of Montserrat (Carey et al. 2014). In 2012, the HMS Protector collected bathymetric data along the northwest coast of the island.

4. Marine and Coastal Ecosystems: Status and Threats

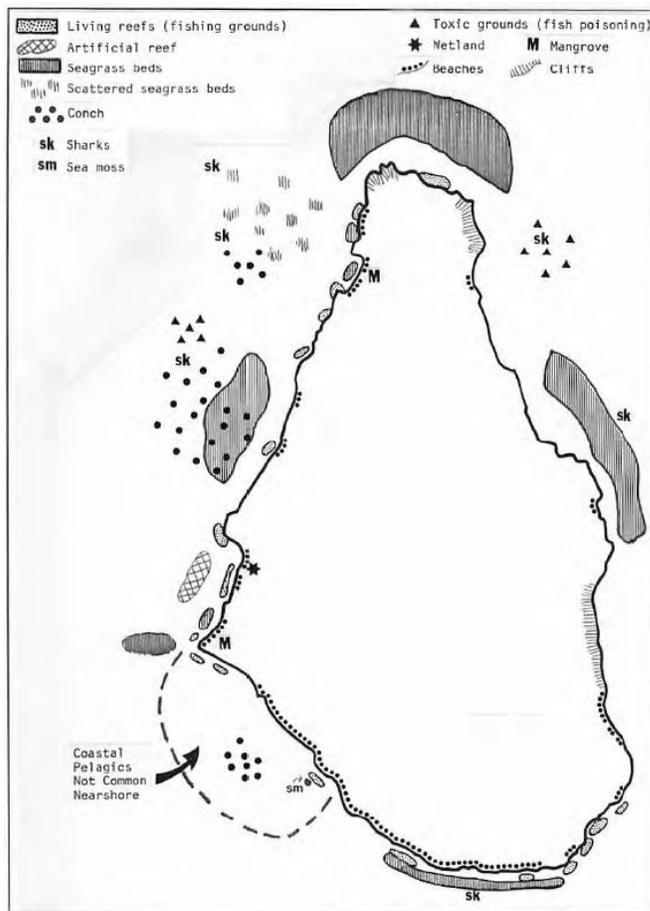


Figure 2. Map of the historic distribution of marine and coastal habitats in Montserrat. From IRF 1993.

Montserrat's marine and coastal ecosystems have not been surveyed comprehensively. The southern portion of Montserrat is particularly poorly known due to the prohibition on activities in the terrestrial and maritime exclusion zones. Nevertheless, Montserrat is known to have seagrass beds and coral reefs, and it historically had mangroves (Figure 2).

4.1 Seagrass Beds

Three species of seagrass have been identified in Montserrat: shoalgrass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudinum*) (Short et al. 2010a, Short et al. 2010b, Short et al. 2010c).

Prior to the volcanic activity, there were seagrass beds around Bransby Point and off of

Blackburne Airport (Maylan 1983). Since then, hurricanes, large storms, and boat anchor damage have impacted Montserrat's seagrass habitats (Gray 2011). Today there is a large seagrass bed of about 750 hectares at the northern tip of Montserrat, extensive seagrass beds between Bransby Point and Old Road Bluff, as well as south of Bransby Point in the Maritime Exclusion Zone, and smaller patches close to shore on the east, south, and west coasts (IRF 1993; Ferguson and Daniel 2015) (Figure 2).

Current major threats to Montserrat's seagrass habitats include severe storms and sea level rise associated with climate change (Gray 2011).

4.2 Mangroves

Historically, mangroves of the species *Rhizophora mangle*, *Avicennia germinans*, *Laguncularis racemosa*, and *Conocarpus erectus* were found in four locations around the island: Carr's Bay, Collin River, Fox's Bay, and Old Road Bay (FAO 2007) (Figure 2). Fox's Bay was the most important site, and was protected as a Bird Sanctuary by the Montserrat National Trust, beginning in 1979 (Wauer 1996).

Hurricanes, volcanic activity, and human activity have negatively impacted mangrove habitats in Montserrat (FAO 2007). In particular, grazing livestock and coastal development have destroyed most of Montserrat's mangroves (JNCC 1991, FAO 2007). Piper's Pond Wildlife Reserve and the associated Potato Hills Conservation Area covered Montserrat's last significant mangrove habitat, but most of the mangroves were felled as part of the Montserrat Development Corporation's Little Bay Master Plan in 2013 (CHL 2012). Due to a variety of factors, both natural and anthropogenic, there are no longer significant areas of mangroves in Montserrat (Gray 2011). As of 1991, there were an estimated 5 hectares of mangrove habitat in Montserrat (FAO 2007), and by 2010, the FAO reported that Montserrat had no remaining mangrove habitat (FAO 2010).

4.3 Coral Reefs

4.3.1 Description and Data

Small patch reefs are distributed all along Montserrat's coastline. Most are located close to shore, while a few reefs are located at greater depths (Smith et al. 1997) (Figure 2). In 1995-1996, benthic surveys identified 37 species of hard coral, 17 octocorals, 87 other invertebrates, 67 fish, and 37 species of algae, with live coral cover of 20-45% (Smith et al. 1997).

A variety of surveys have been conducted on Montserrat's coral reef communities over the past decade, including official Reef Check surveys and surveys by LTS International, an environmental consulting group, and Coral Cay Conservation, a UK-based conservation and ecological research organization (Figure 3).

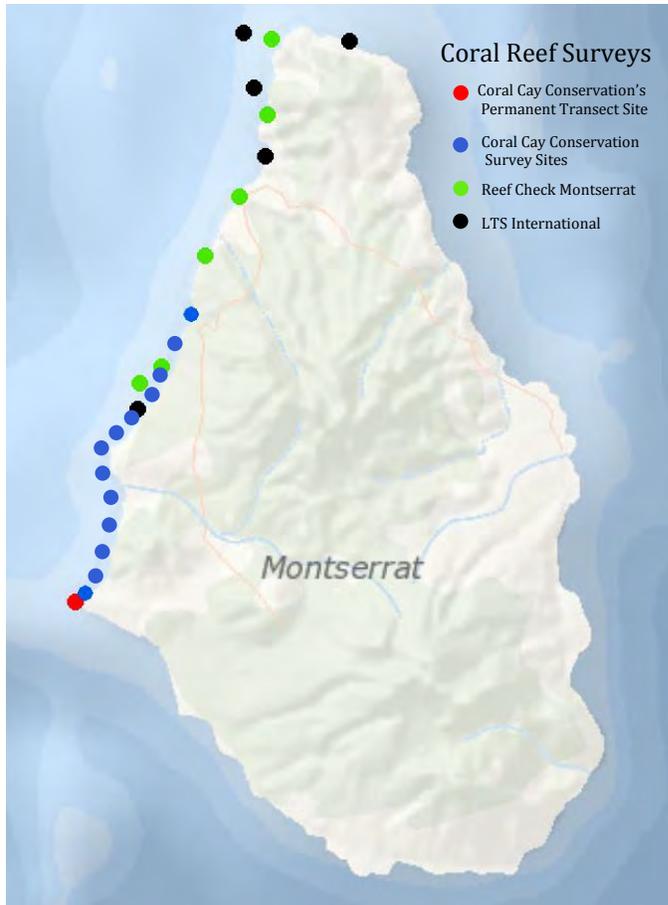


Figure 3. Map of coral reef survey locations in Montserrat, including surveys conducted by Coral Cay Conservation, Reef Check Montserrat, and LTS International.

sponge. The dominant coral species at the two sites were mustard hill coral (*Porites astreoides*), fire coral (*Millepora* spp.), and finger coral (*Madracis formosa*). In general, deeper sites had higher coral diversity (Wild et al. 2007).

Coral Cay Conservation has conducted fourteen reef surveys since 2013, and the highest hard coral cover that they have observed is 7.8%. They have observed low levels of anthropogenic and environmental impacts on the corals and found bleaching levels of less than 1% of the hard coral population. They have not encountered sharks, sea turtles, or rays during the surveys, and sand has been the most frequently observed substrate. Commercially important species of groupers and parrotfish have only been observed in low numbers (Ferguson and Daniel 2015).

4.3.2 Status and Threats

The health of Montserrat's coral reefs varies geographically. The healthiest reefs are located on the northern coast of the island, far from volcanic activity and in an area with

At five sites in western Montserrat, surveys conducted by LTS International recorded a total of 21 fish families, with an average of 10-12 families present at each site. Labridae (wrasse) and Pomacentridae (chromis or damselfish) were the most frequently observed families, comprising 5-15% of total fish observed at each site. The most common species were brown chromis (*Chromis multilineata*), bicolor damselfish (*Stegastes partitus*), and bluehead wrasse (*Thalassoma bifasciatum*) (Wild et al. 2007).

LTS International also collected data on coral cover, using Reef Check Protocols. Data collected in Rendezvous Bay in fall of 2007 found live cover of 19.4% hard corals and 3.5% soft corals, as well as 10.9% algae and 8.7% sponge. In Woodlands Bay, hard coral cover was 8.8%, soft corals were 4.4%, algae was 7.5%, and 3% was

constant currents. On the eastern coast of the island and in the flanks of Soufriere Hills volcano, reefs are subject to frequent sedimentation and burial, compromising their health. On the southernmost coast of Montserrat, the reefs are healthy due to water currents that wash sediment away from the reefs (Myers 2013).

Montserrat's coral reefs face threats from a variety of sources, both natural and anthropogenic. Hurricanes and severe storms threaten reef health: larger branching corals showed signs of significant damage following Hurricane Hugo in 1989 (Volk et al. 1993; Smith et al. 1997; Gray 2011). However, in the absence of human disturbance, these corals showed signs of recovery by the early 1990s (Volk et al. 1993). The volcanic activity that began in 1995 has had an impact on Montserrat's coral reefs: the eruptions in 1995-1996 deposited ash on the reefs of the southern and southwestern coasts (Smith et al. 1997). Continued sedimentation may be impacting the reefs of the southern part of the island, but there have not been recent surveys in that area (Wilkinson 2000; Nagel and Guinness 2006). Coral diseases are present in Montserrat: white-band disease has killed most of the elkhorn and staghorn coral colonies in the region, and there are beds of dead elkhorn coral on the northwest coast of Montserrat (Myers 2013).

Anthropogenic threats such as climate change, land use changes, fishing and boating, and invasive species also harm Montserrat's coral reefs. Severe storms and sea level rise associated with climate change are expected to damage coral reefs (Gray 2011). Because of Montserrat's steep topography, upland land use changes and coastal development can lead to increased siltation and sedimentation, as well as nutrient pollution of coral reefs (Burke and Maidens 2004; Myers 2013). The recent arrival of invasive lionfish may further damage the reef ecosystems (CHL 2012). As a result of both natural and anthropogenic causes, the reefs between Woodlands Bay and Little Bay have experienced degradation (CHL 2012).

4.4 Water Quality in Marine Ecosystems

There has been limited research into Montserrat's water quality. LTS International conducted sampling of seawater on the western shore of the island in order to better understand the physical parameters of Montserrat's marine ecosystems, and found salinity levels in the range of 35-37 parts per thousand (ppt), within the normal range for seawater (Wild et al. 2007).

The volcanic activity has impacted marine water quality in the southern half of the island (Wild et al. 2007), while coastal development threatens water quality in the northern half of the island, where human activity is currently concentrated. Land use change has led to increased sedimentation, as well as pollution in the form of oil, fuel, chemical spills, and untreated effluent. In order to manage land use change in the steep uplands, Montserrat's Physical Development Plan proposes the protection of several ghauts (rivers running down Montserrat's hillsides) to prevent soil erosion and minimize

run-off. Run-off from construction sites, gravel quarries, sand mines and stockpiles, and roads increases the sedimentation load in coastal waters: plumes of runoff are observed in Little Bay following heavy rainfall (Wild et al. 2007). The major potential sources of chemical and organic pollutants are the fuel terminal in Little Bay, the dump, sewage plants at Lookout and Davy Hill, the airport, and the power plant, as well as ships, which may discharge ballast. Montserrat relies on septic tanks and waste stabilization ponds for sewage, but there is concern that some waste is released into the sea without treatment. There are concerns about the water quality at Little Bay, Carr's Bay, and Rendezvous Bay for public health reasons, particularly as development at Little Bay intensifies (Wild et al. 2007).

4.5 Threatened and Protected Marine Life

Forty-nine species of concern on the IUCN Red List are found in Montserrat's waters, including five species classified as Critically Endangered and 10 species in the Endangered category (Table 1).

Another 34 species are classified as either Near Threatened or Vulnerable: six species of coral, one species of sea turtle, six species of elasmobranchs (sharks and rays), 16 fish species (grouper, snappers, tunas, and parrotfish), and two species of whales that migrate seasonally through the waters of Montserrat's west coast.

Table 1. Species found in Montserrat that are in the IUCN's Critically Endangered and Endangered categories.

Species	Common Name	IUCN Red List Status
<i>Acropora cervicornis</i>	Staghorn coral	Critically Endangered
<i>Etmochelys imbricata</i>	Hawksbill turtle	Critically Endangered
<i>Pristis pectinata</i>	Smalltooth sawfish	Critically Endangered
<i>Epinephelus itajara</i>	Atlantic goliath grouper	Critically Endangered
<i>Millepora striata</i>	Fire coral	Endangered
<i>Montastraea annularis</i>	Boulder star coral	Endangered
<i>Montastraea faveolata</i>	Mountainous star coral	Endangered
<i>Caretta caretta</i>	Loggerhead turtle	Endangered
<i>Chelonia mydas</i>	Green turtle	Endangered
<i>Sphyrna mokarran</i>	Squat-headed hammerhead shark	Endangered
<i>Epinephelus striatus</i>	Nassau grouper	Endangered
<i>Thunnus thynnus</i>	Atlantic bluefin tuna	Endangered
<i>Anguilla rostrata</i>	American eel	Endangered
<i>Balaenoptera borealis</i>	Sei whale	Endangered

4.5.1 Turtles

Green turtles (*Chelonia mydas*) and hawksbills (*Etmochelys imbricata*) are commonly found in Montserrat's waters and nesting on the shores.

Leatherbacks and loggerheads are rarely found on or around the island (Maylan 1983), but occasional nesting activities have been observed (Godley et al. 2004; Martin et al. 2005). Prior to Hurricane Hugo and the onset of volcanic activity, sea turtles nested at ten beaches (Jeffers 1983), although intensive human presence interfered with nesting activity at many sites (Maylan 1983). The populations of green and hawksbill turtles are regionally important, but the numbers of nesting individuals are critically low (Godley et

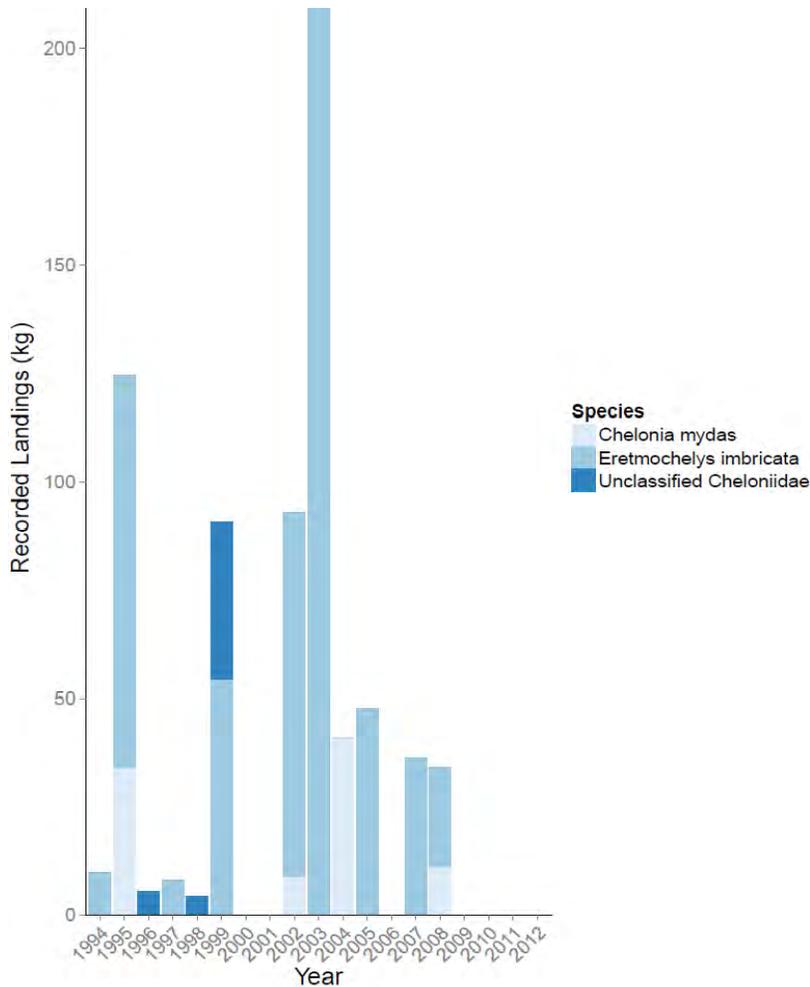


Figure 4. Reported turtle fishery landings in Montserrat from 1994-2012. Derived from the Montserrat Fishery Division’s landings data.

al. 2004). The Fisheries Division coordinates monitoring of turtle nests, and the Montserrat National Trust also participates in sea turtle monitoring and conservation (Jeffers 1983).

There has traditionally been a turtle fishery in Montserrat, with fishers targeting turtles with nets. Since the middle of the twentieth century, fishers have shifted away from using nets, and started using spearguns to target turtles (Maylan 1983). In 1983, there were landings of two species of turtles (*Chelonia mydas* and *Eretmochelys imbricata*), caught using spear guns and

nets (Jeffers 1983). From 1993-2003, fishers reported an annual average harvest of 0.9 turtles, but many more turtles may go unreported because they are processed at sea or not reported to the Fisheries Division (see Section 6.2 on data collection) (BOI 2006). Campbell et al. (2009) estimated an annual catch of 10-30 turtles in Montserrat.

From 1994-2012, total landings of turtles were reported at 710.79 kg (Montserrat Catch Data, 1994-2012). Hawksbill turtles (*Eretmochelys imbricata*) made up 80% of the catch, while 13% was green sea turtles (*Chelonia mydas*), and the rest of the catch was only identified to the family level (Cheloniidae) (Figure 4). The average reported unit price over that time period was 5.5 EC, but this information was not recorded for all landings.

The Fisheries Division manages the turtle population through a hatchery: turtle eggs are collected from three beaches and kept in the hatchery, then released. It is otherwise

illegal to remove turtle eggs from nests, but collection of eggs for personal consumption does occur at low levels (Godley et al. 2004).

4.5.2 Sharks and Rays

Eight Red List species of sharks and rays are found in Montserrat, including the critically endangered smalltooth sawfish (*Pristis pectinata*). The endangered squat-headed hammerhead shark (*Sphyrna mokarran*) is occasionally fished in Montserrat, with reported catches in 2003 and 2008, as is the vulnerable oceanic whitetip shark (*Carcharhinus longimanus*), which was landed in 2004.

4.5.3 Whales

Humpback whales (*Megaptera novaeangliae*) and sperm whales (*Physeter catodon*) pass through Montserrat's waters during their migrations, and there have been reported sightings of the sei whale (*Balaenoptera borealis*) (JNCC 1991).

4.5.4 Queen Conch

The status of Caribbean queen conch (*Strombus gigas*) has not been assessed by the IUCN Red List. As early as the 1960s, there were signs that overharvesting was depleting the stock of queen conch in Montserrat (Jeffers 1996). In addition, land use changes in the 1960s damaged productive conch habitat in southern Montserrat. By the early 1990s, fishermen reported having to fish much deeper waters to find conch and observed a decrease in the number of mature animals. In the early 1990s, Jeffers estimated annual conch harvests of 1000-3000 kg (Jeffers 1996). Conch landings were reported in Montserrat's official fisheries data collection program in 1995, 1996, 2002, 2008, and 2012, with a peak of 272 kg reported in 2002. The large difference between Jeffers' estimate and the reported catch may indicate substantial underreporting of catch, or it may reflect the ecological changes wrought by the volcanic eruptions of the late 1990s. The volcanic activities in the 1990s likely had negative impacts on Montserrat's conch stock as ash and pyroclastic flows damaged seagrass beds and reefs that serve as important conch habitat (Jeffers 1996).

5. Seafood Production

5.1 Fisheries

5.1.1 Economic Importance

Fisheries account for only a small percentage of Montserrat's GDP, but fishing is a culturally important activity and is an important source of food for local consumption. Fisheries have contributed less than 0.5% to Montserrat's GDP since at least the late

1990s (CARICOM 2014a; Ponteen 2013), although the actual percentage may be higher given unreported fishing.

There has been a decline in the number of active fishers since the beginning of the volcanic activity: before 1995, there were as many as 250 full and part time fishers, compared to just 60 in 2000 (Volk et al. 1993; CARICOM 2011). Today however, the numbers have begun to recover: currently, there are an estimated 101 fishers active on Montserrat, including full-time, part-time, and recreational fishers. The majority are men, and none are licensed or registered (Ponteen 2014). Most of the more regular fishers are at least fifty years old, while very few fishers in the commercial fishery are younger than thirty. As the fishing population ages, Montserrat may lose valuable knowledge about its fisheries and marine environment (Wild et al. 2007).

Most fishers do not depend entirely on fishing for their income, fishing only one or two days per week, and not going out every week of the year. Most are involved in other economic activities such as livestock rearing, construction, employment in bars or restaurants, and positions in the government (Wild et al. 2007).

In 2004, Montserratians consumed 120 tons of local and imported fresh, frozen, and salted fish, for a per capita consumption of about 30 kilograms per year, not including consumption of canned fish, compared to a global per capita fish consumption of 19.2 kg in 2012 and of 9.7 kg in the Caribbean (FAO 2014). The largest amounts of fish are consumed during Christmas and Easter. Local fish availability peaks in the spring, since bad weather conditions limit fishing activity during the hurricane season (June-July) and winter (October-February) (Wild et al. 2007). The average annual total landings in Montserrat from 1994 to 2012 was about 29 metric tons, indicating a large gap in the amount of seafood produced in Montserrat compared to the amount consumed. As a result, large amounts of fish are imported each year, especially frozen fish, shrimp, and conch (Ponteen 2010). Nevertheless, local catches are an important food source for locals and tourists. Montserrat does not export its fish products (Ramdeen et al. 2012).

Montserrat's formal fish market was destroyed in the 1995 volcanic eruption and a new one has not been built. As a result, fishers sell their fish directly to locals, including hotels and restaurants (Ramdeen et al. 2012). Due to a lack of facilities to handle and store fish, they are sold immediately upon landing to prevent spoilage (Ponteen 2013).

Needlefish (Belonidae) have been the most productive fishery over the past twenty years in terms of value, as calculated by annual landings multiplied by average unit prices. Other highly valuable species include longjaw squirrelfish (*Holocentrus marianus*), ballyhoo (*Hemiramphus brasiliensis*), red hind (*Epinephelus guttatus*), northern red snapper (*Lutjanus campechanus*), and jacks and scad (Carangidae). Lobsters are the most valuable catch in terms of unit price (price per kilogram), but landings of lobsters are very low because there is no directed lobster fishery.

5.1.2 Fisheries Description

Montserrat's fisheries are small-scale, employing a small number of full-time and part-time fishers. About 90% of the fishing activity occurs in the nearshore area, within three miles of the coast, while the remainder takes place outside of Montserrat's territorial waters, including around the nearby islands of Antigua, Nevis, and Redonda (BOI 2006; Ponteen 2014).

The capital city, Plymouth, was historically the principal fishing port, with Carr's Bay and Bunkum Bay serving as minor ports (Figure 3). Prior to the 1995 volcanic activity, fishers were able to access pelagic fisheries on the southern coast in addition to trap and line fisheries along the western coast and pelagic fisheries around Redonda Island. Since 1995, fishing activity has shifted northwards, with the new principal fishing port located at Little Bay and the southern fishing grounds closed due to safety concerns and siltation (Wild et al. 2007). Fishing grounds on the eastern side of the island are less accessible due to rough ocean conditions, and sedimentation from pyroclastic flows is believed to have decreased the area's productivity (Wild et al. 2007).

About half of Montserrat's fishers are members of the Fishermen's Cooperative, which helps coordinate bulk purchase of equipment and supplies and distributes government subsidies. The cooperative has also organized local and international sports fishing competitions (Wild et al. 2007).

Thirty-two boats are active in Montserrat's fishery, ranging in length from 12-30 feet (Ponteen 2013; Ponteen 2014). Most are open boats built of wood or fiberglass and powered by 20-25 horsepower outboard motors. There are a handful of larger boats with larger engines, and one or two use inboard diesel engines. As of 2007, 21 of the boats were moored in Little Bay, 2-3 were kept on the beach in Bunkum Bay, and the rest were stored on their owners' properties (Wild et al. 2007).

Over 200 species of fish, other marine vertebrates, and invertebrates are landed in Montserrat's fisheries. Fisheries target primarily demersal species, coastal pelagics, and ocean pelagics. 98% of reported landings are of fish, while other marine vertebrates and invertebrates make up 1% of the reported catch, and 1% is not taxonomically identified. Of the fish landings, 46% are pelagic species, 48% are reef fish, and the remaining 6% are demersal (Montserrat Fisheries Data, 1994-2012). Target species and landings vary seasonally. For example, monthly landings of needlefish (*Belonidae*) vary widely and decrease dramatically from September through December (Jeffers 1984). According to Montserrat's national fisheries data (1994-2010), a variety of gear types and fishing techniques are used by Montserratian fishers, including beach seines, traps and pots, bottom lines, handlines, cast nets, gill nets, longlines, pole and line, rod and reel, and spearfishing.

The main species landed in the reef fishery are: red hind (*Epinephelus guttatus*) and other species of grouper (Serranidae), queen triggerfish (*Balistes vetula*), longjaw squirrelfish (*Holocentrus marianus*), tangs and doctorfish (*Acanthurus* spp.), honeycomb cowfish (*Lactophrys polygona*), snappers (Lutjanidae), grunts (Haemulidae), and parrotfish (Scaridae). Fishers use fish pots, hand and long lines, and spear guns in this fishery. Fish pots are the most frequently used gear, as measured by the number of fishing trips that use them, but their use has declined since 1995 (CRFM 2012). Fishers use wire pots in waters of 15-100 meters to catch reef fish, allowing the traps to soak for three days to several weeks. Since the volcanic eruption, trap fishing has been pushed to deeper waters, which has increased the likelihood of trap loss due to bad weather, as well as damage to reefs caused by ghost fishing. Spearfishing occurs at depths of 20-25 meters, and many people fish from shore for subsistence purposes, utilizing handlines and rod and reel. In addition, bottom lines are used in depths greater than 90 meters to catch deep water snappers and groupers (Wild et al. 2007).

Fishers targeting coastal pelagic species use gill nets and beach seines to catch needlefish (Belonidae), ballyhoo (*Hemiramphus brasiliensis*), jacks and scad (Carangidae), and king mackerel (*Scomberomorus cavalla*). Seine fishing occurs only on the leeward side of the island (Jeffers 1984), but it accounts for over half of all landings by weight (CRFM 2012). There are only four seine nets on the island, but they are used effectively to catch shoaling pelagic species (Wild et al. 2007). The number of beach seine deployments has declined from more than 300 per year in 1995 to just over 50 in 2011 (CRFM 2012).

In the ocean pelagic fishery, fishers use lines to catch dolphinfish (Coryphaenidae), wahoo (*Acanthocybium solandri*), tunas (*Katsuwonus pelamis* and *Thunnus* spp.), sharks (Squalidae and Carcharinidae), and bonito (*Sarda sarda*) (Ponteen 2013). Some fishers troll for large pelagic species, but because trolling is fuel-intensive, it is only used incidentally, often on the way to and from fishing grounds (Wild et al. 2007).

There is no directed lobster fishery, but three species of lobster are caught as bycatch in fish traps: Caribbean spiny lobster (*Panulirus argus*), spotted spiny lobster (*P. guttatus*), and slipper lobster (*Parribaricus antarcticus*). Historically, there was a conch fishery in Montserrat, but the stock was badly depleted by the early 1990s (Jeffers 1996).

5.1.3 Fishery Status

5.1.3.1 Data Collection

Montserrat has collected fisheries data in some form since earlier than 1976 (Jeffers 1984). Since 2007, Montserrat has participated in the Caribbean Regional Fisheries Mechanism's (CRFM) data collection system, a semi-centralized database used by the CRFM member states.



Figure 5. Fishery landing sites on Montserrat.

There are currently three fish landing sites on the island: Isle's Bay, Bunkum Bay, and Little Bay, which is the principal landing site (Figure 5). Two data collectors working for the Department of Fisheries collect catch and effort data from Monday to Friday during working hours (8 am-4 pm). The data collectors record data from the roadside sites where the fishers sell their catch (Ponteen, personal communication). The recorded catch accounts for an estimated 75% of the total catch (Ponteen 2014). The remainder of the catch is sold to local customers before it has been recorded because 1) fishing activity occurs outside of the data collectors' working hours, including on the weekend, and 2) the data collectors do not record the catch at the landing site, so some of the catch has been purchased by

the time the fishers encounter the data collectors. For example, some fishers sell their catch as they drive it from the landing site to their roadside selling locations, complicating the efforts of data collectors to record the catch (personal observation, 2015).

Until recently, the data collectors recorded landings data in the Caribbean Fisheries Information System (CARIFIS) database. Using the CARIFIS database, data collectors assembled a centralized database on the island. Each year, they sent Excel files recording that year's landings to the CRFM Secretariat. In 2012, due to software changes, the CARIFIS database stopped working for multiple island governments, including Montserrat's. Montserrat has not submitted data to CRFM since 2012, and it did not report fisheries statistics to the FAO from 2003-2009 (Ramdeen et al. 2012).

The Fisheries Division has an Excel file of all recorded landings between 1994 and 2012. Hard copies of data exist for years prior to 1994, but their location is unknown. Hard copies also exist for the fisheries landing data for 2013-2015, but they have not been shared yet.

In response to the failure of the CARIFIS database, the Fisheries Division is working with Manish Valechha of the software company Lavabits to create a new database tailored to Montserrat's needs. The Fisheries Division is planning to use the Lavabits database for a

three-month trial before committing to the partnership (A. Ponteen, personal communication).

Since 2013, the Fisheries Division has worked with fishers to improve data collection by providing materials for recording catch and effort data. In 2013, this program resulted in an additional recorded catch of 3250 kg, or about 13% of the reported catch in 2012 (Ponteen 2014).

In 2014, the government of Montserrat initiated a project with Succorfish, a UK-based company that provides GPS and vessel monitoring systems in order to facilitate the monitoring and mapping of fishing activity. The Succorfish project is intended to help Montserrat collect fisheries data for use in future management plans. The project has run into some technical difficulties due to the nature of Montserrat's fishing boats, but Succorfish is working to develop a version of the system better suited to local conditions (Tom Rossiter, personal communication).

5.1.3.2 Status and Trends

Annual recorded landings in Montserrat between 1994 and 2012 ranged from 21,000 kg to 46,000 kg, with an average annual catch of 29,000 kg (Figure 6). There was no clear trend in landings from 1994-2012: landings peaked in 1995 and 2005, and increased

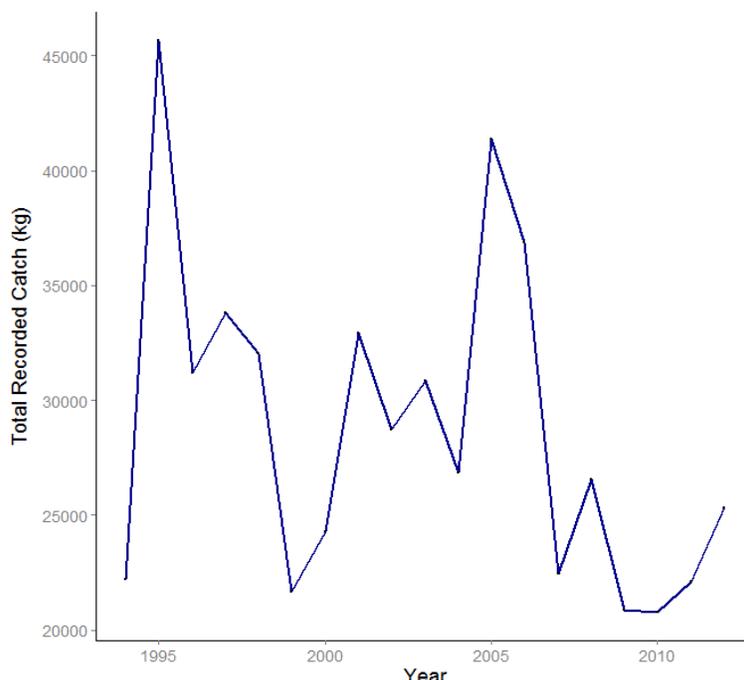


Figure 6. Total recorded fishery landings in Montserrat from 1984- 2012. Landings were obtained from Montserrat's Fisheries Division.

steadily between 2010 and 2012. The low reported catches in 1994, 1999, and 2009 do not appear to correspond to particular events such as hurricanes or volcanic activity. To compare current rates to historic (pre-volcanic eruption) catch rates, in 1980, total yearly fisheries production was estimated at around 50,000 kg (BOI 2006), while in 1984, annual landings were estimated to be 79,000 kg (Jeffers 1984).

From 1994-2012, needlefish (Belonidae) dominated the catch, comprising an average of 32% of the annual catch by weight. Over the course of the nineteen years of data, the

other top taxa by landed weight were red hind (*Epinephelus guttatus*), queen triggerfish (*Balistes vetula*), ballyhoo (*Hemiramphus brasiliensis*), and longjaw squirrelfish (*Holocentrus marianus*). Over this time period, the catches of the top ten taxa varied, but Belonidae dominated the catch in every year (Figure 7).

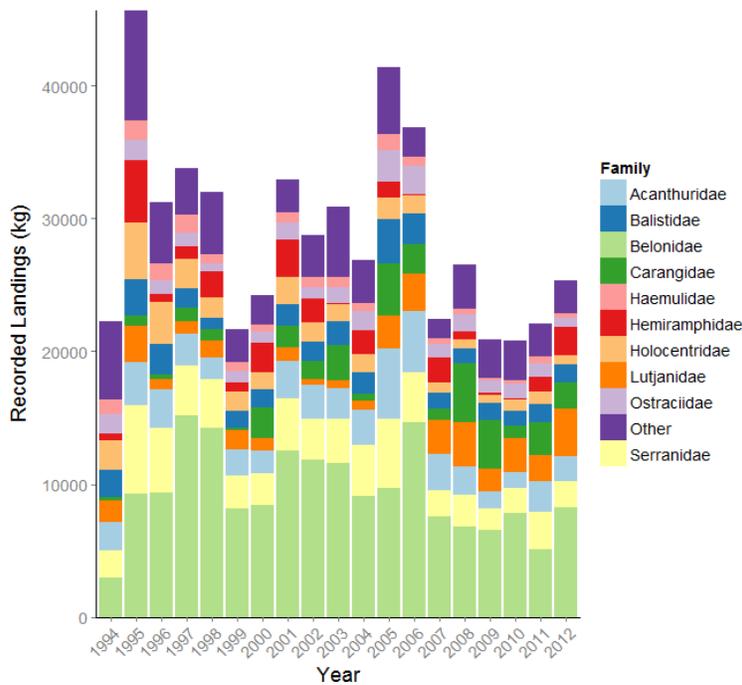


Figure 7. Annual recorded landings by family from 1994-2012. Landings data obtained from Montserrat’s Fisheries Division.

In total, landings of 224 taxa were recorded from 1994-2012, representing individuals from 59 families of fish and invertebrates. On average, <1% of the annual recorded catch was not taxonomically identified.

Researchers have used the fisheries data that Montserrat reports to the FAO to estimate the total catch in Montserrat since 1950, using assumptions about the amount of unreported catch (Ramdeen et al. 2012). Ramdeen et al. (2012) calculated a total catch of about 13,300 tons for

1950-2010, a figure that is significantly larger than the 4,288 tons that Montserrat reported to the FAO during that time period. The authors based their assumptions about unreported catch on the data collection methods used in Montserrat, including a calculated ratio of monitored to unmonitored fishing vessels and a per capita catch rate. Ramdeen et al. (2012) found that the taxonomic composition of Montserrat’s catch from 1950-2010 is similar to the current taxonomic breakdown reflected in the Fisheries Division’s landings data.

Currently, reef fish and coastal pelagics are thought to be moderately to heavily exploited, and demersal species are believed to be underexploited (CARICOM 2011). The status of large pelagics is not well known (CARICOM 2011). In 2012, the Caribbean Regional Fisheries Mechanism, an organization that promotes sustainable fisheries policy in the Caribbean, conducted a preliminary assessment on the status of red hind (*Epinephelus guttatus*) in Montserrat. After needlefish, red hind is the most important species by landed weight. A preliminary assessment by CRFM found that the catch rate (or CPUE, as measured by catch in kilograms per trip) of red hind increased from 1995 to

2011, while total annual catch has varied year-to-year and effort has declined. CRFM concluded that given the decline in effort combined with the increase in catch rate, the stock was not in danger of collapse (CRFM 2012).

5.1.3.3 Management Regulations

The Fisheries Division, which manages Montserrat's fisheries, falls under the Ministry of Agriculture, Housing, Land, Trade, and the Environment, and is overseen by the Director of Agriculture (Wild et al. 2007). The fisheries management regime consists of a number of national-level regulations, often driven by commitments Montserrat has made in international agreements.

Montserrat is party to several international agreements pertaining to fisheries management: the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, the Code of Conduct for Responsible Fisheries, the United Nations Fish Stocks Agreement, and the Caribbean Community Common Fisheries Policy, all of which require certain levels of monitoring and data collection (BOI 2006; Montserrat Fisheries Division 2014).

The Organization of Eastern Caribbean States requires all member states to develop a national ocean policy under the Eastern Caribbean Regional Oceans Policy. In response, the Montserrat Fisheries Division is currently drafting a National Ocean Policy (Ponteen 2014).

Key national regulations that influence fisheries management include the Fisheries Acts of 2000 and 2002, the Turtle Act of 2002, and the 2009 Fisheries Regulations (Table 2). The Fisheries Acts of 2000 and 2002 govern Montserrat's fisheries, granting authority for their management and development to the Minister of Agriculture, Lands, Housing, and the Environment and the Chief Fisheries Officer. The 2002 Act describes the roles of the Chief Fisheries Officer, Minister, and Governor in managing the fisheries and establishes a number of baseline regulations. The Chief Fisheries Officer is responsible for developing a National Fisheries Plan, handles applications for boat registration and fishing licenses, and has the power to establish conservation measures to prevent over-exploitation and maintain and restore targeted populations. Under the 2002 Act, fishers are required to register their boats and acquire fishing licenses. The Minister has the power to create marine reserves in order to protect living resources, breeding grounds, and habitats; facilitate regeneration of depleted areas; promote scientific research; and preserve natural beauty. The Governor has the power to create priority areas for fishing and protected areas where fishing is prohibited, declare fish a protected species, and designate fisheries management areas, as well as create regulations for fisheries management.

The Fisheries Act of 2002 also created a Fisheries Advisory Committee to advise the Minister on issues related to fisheries management. The Committee consists of a

representative from the Montserrat Chamber of Commerce, the Montserrat Tourism Board, and the Montserrat National Trust, as well as two fishermen and the Chief Fisheries Officer. In addition, the Act created a Fisheries Deposit Account, a fund for fisheries management expenses such as purchasing boats to use for enforcement and other expenses related to promoting good fishing practices. While the Fisheries Act of 2002 facilitated the creation of fisheries regulations, such regulations have not yet been put in place (Ponteen 2014).

The Turtle Act of 1951, updated in 2002, permits the capture of turtles of more than 9 kg in weight outside of the closed season, which runs from June 1-September 30. It is illegal to harvest turtle eggs during the closed season (Jeffers 1983).

The 2009 Fisheries Regulations built on the regulations introduced by the Fisheries Act of 2002. The regulations include the establishment of three categories of fishing licenses: commercial, pleasure, and sport, each with its own restrictions. The regulations include specific rules governing the catch of certain species, the use of nets, and the activities of sport fishers, as detailed in Table 2. However, the 2009 Fisheries Regulations have not yet been put into place.

Table 2. Summary of species- and gear-specific regulations proposed under the 2009 Fisheries Regulations (Government of Montserrat 2009).

Target of Regulations	Regulations
Lobsters	No taking egg bearing or molting lobsters Minimum size of 3.75 inch carapace length or tail weight of 12 ounce (oz). No hooking or spearing lobsters Closed season from March 1 to June 30
Conch	Minimum size of 7 inches, 8 oz, and must have flared lip Closed season from June 1- Sept. 30
Whelk	Minimum size of 2.45 inches Closed season from June 1- Sept. 30
Margate Fish (<i>Haemulon album</i>)	Closed season from January 1- March 31
Nassau Grouper (<i>Epinephelus striatus</i>)	Closed season from March 1 to May 31
Atlantic Goliath Grouper (<i>Epinephelus itajara</i>)	Proposed moratorium beginning in 2009
Red Hind (<i>Epinephelus guttatus</i>)	Closed season January 1 - March 31
Turtles	No taking or disturbing turtle eggs No taking turtles with seine nets within 100 m from shore Green turtle- Minimum size is 34.02 kg. Closed season from April 1- Nov. 30 Hawksbill- Minimum size is 27.22 kg. Closed season from June 1- Nov. 30 Leatherback- Minimum size is 294.84 kg. Closed season is April 1- Nov 30. Proposed moratorium beginning in 2009 Loggerhead- Minimum size is 3.4.02 kg. Closed season is April 1- Nov 30. Proposed moratorium on capture beginning in 2009.
Corals, sponges, and algae	Illegal to collect or damage in fisheries waters
Marine mammals	Illegal to catch, kill, or harm
Nets	Cast net minimum mesh size is 25.4 mm Beach seine minimum mesh size is 31.75 mm Gill net minimum mesh size is 76.2 mm Flying fish gillnet is 19.05 mm Trammel net less than 76.2 mm No leaving nets for over 8 hours in the ocean Fish trap and pot size minimum mesh is 38.1 mm

Montserrat's Fisheries Division hopes to improve the island's collection and management of fisheries data in order to better manage their natural resources and to come into compliance with the international agreements to which Montserrat is party. The Eighth Annual Scientific Meetings of the Caribbean Regional Fisheries Mechanism (CRFM) made several recommendations for Montserrat's data collection and management, including the location of catch and effort data from earlier than 1995, collection of catch and effort data from additional landing sites, the introduction of quality control measures for data collection and recording, and increased vigilance on the part of the data collectors (Montserrat Fisheries Division 2014). In order to improve data collection and management, the Fisheries Division has laid out several guidelines, including the use of fisheries data logbooks on the part of data collectors, weekly quality control procedures, and the expansion of data collection beyond the current working hours.

5.2 Marine Aquaculture

There are currently no aquaculture operations in Montserrat. Under the 2009 Fisheries Regulations, operators must apply to the Chief Fisheries Officer for aquaculture licenses. If the Chief Fisheries Officer finds that the application meets the requirements laid out in the regulations, a recommendation is made to the Minister of Agriculture, Health, Lands, Trade, and the Environment, who can then issue a license. The application must be accompanied by a plan for the proposed location of the project, an operation plan, an environmental impact assessment, and at least two references regarding past aquaculture operations, if possible. The 2009 regulations also lay out the following rules for aquaculture operations: diseased fish must be disposed of in a way that does not threaten the marine environment; tanks and holding areas must be cleaned regularly; a Fisheries Officer must inspect the operation; aquaculture products must be sold to any market authorized by the Chief Fisheries Officer; and hazardous materials must be properly disposed of (Government of Montserrat 2009). The 2009 Fisheries Regulations have not yet been put in place, and it is unclear if any aquaculture operators have submitted applications for new projects.

An FAO report on the potential for aquaculture in 1980 found that Montserrat would not be a suitable place for inland fish culture or mariculture due to the limited supply of freshwater, nor for conventional oyster or shrimp aquaculture, due to the lack of protected shore lines. The report found that the sea grass beds at Fox's Bay and Farm Bay could be good areas for seeding queen conches. The FAO report concluded that Montserrat should focus on developing its wild fisheries rather than investing in aquaculture (Cook et al. 1981). However, it is worth noting that there have been significant developments in marine aquaculture technology over the last several decades, and therefore these findings may be out of date.

6. Tourism

Before the volcanic activity began in 1995, tourism comprised 20-36% of Montserrat's annual GDP, and Montserrat was well-known as a high-end travel destination (CHL 2012). Montserrat received 20,000-30,000 visitors per year prior to 1995 (Wild et al. 2007). The onset of volcanic activity, with concurrent loss of natural resources and

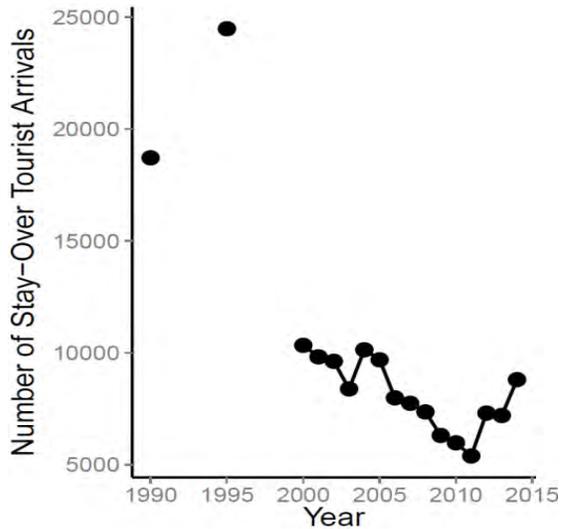


Figure 8. The number of tourist arrivals in Montserrat from 1990-2014. Data from 1990-2009 from the Caribbean Community Secretariat (CARICOM 2014b), and data from 2010-2014 from the Caribbean Tourism Organization (CTO 2015).

infrastructure, as well as safety concerns, greatly reduced the size of the tourism industry. Tourism now accounts for less than 5% of GDP (CHL 2012).

The number of stay-over visitors decreased from 2000-2010 (Figure 8), despite investments in infrastructure and development of tourist attractions by the UK government (CHL 2012). Local tourism operators cite lack of high-end accommodation, attractions, or easy access by air or sea as reasons for the lack of growth in the tourism industry (CHL 2012). Since 2011, there has been a 63% increase in the number of stay-over tourists. Tourists who come to Montserrat are drawn by opportunities for diving, interest in the volcano, and the desire for a quiet, remote vacation destination (Wild et al. 2007).

In 2011, the last year with available data, Montserrat saw 5395 stay-over arrivals (CTO 2015), as well as an estimated 2000 excursionists (people who visit for less than twenty-four hours), 500 cruise ship passengers, and another 2000 yacht visitors (CHL 2012). Total expenditure by tourists was about EC\$17 million (CHL 2012). A few cruise ships come to Montserrat, but Little Bay lacks the facilities needed to accommodate large cruise ships (Wild et al. 2007).

6.1 Dive Tourism

Montserrat has 16 dive sites, including 10 permanently moored sites. There have not been any detailed studies into dive sites' carrying capacities or mapping of dive sites and reefs (CHL 2012). The most frequently used dive sites are Rendezvous Bay and Pot of Gold. Sites in the north and east are subject to rough conditions, while sites in the southwest have poor visibility. Montserrat's dive sites offer attractions such as large barrel sponges and schools of chromis, damselfish, and wrasses (Wild et al. 2007).

Until 2012, there were three dive operators on the island: Green Monkey and Scuba Montserrat, both based in Little Bay, and Sea Wolf Diving School, based out of Woodlands Bay. In 2007, Green Monkey was the only full-time dive operator. Since 2012, Green Monkey has gone out of business. Green Monkey had been involved in biannual reef monitoring activities through Reef Check. Sea Wolf is based in Antigua but runs dive trips in Montserrat upon request, while Scuba Montserrat lacks its own dive boats and instead relies on local fishing boats (Wild et al. 2007). Aqua Montserrat runs snorkeling, free-diving, and spear fishing trips.

6.2 Sport Fishing

Recreational fishing occurs from boats and from the shore. Each October, the Fisherman's Cooperative hosts the Montserrat International Fishing Tournament, which attracts fishers from around the world. Three operators take guests on recreational fishing trips (Wild et al. 2007). Boat trips target marlin, wahoo, dorado, kingfish, and tuna (Peachin 2011). Under the proposed 2009 Fisheries Regulations, sport fishers would be required to have a license and be restricted to landings of 30 lbs. per boat. They would be prohibited from using spears, fish traps, nets, or more than six rods. Catching turtles and snappers or other bottom dwelling fish and hooking lobsters would also be prohibited. Finally, they would be required to release any billfish they caught and keep a log book, which would be deposited with the Chief Fisheries Officer (Government of Montserrat 2009). Montserrat does not currently collect data on the total catch of sports fishers or the value of this sector of the tourist industry.

6.3 Other Ocean-Based Tourist Activities

Montserrat has a variety of snorkeling sites, including Bunkum Bay, Rendezvous Bay, Old Road Bay, Woodlands Bay, Carr's Bay, and Little Bay (CHL 2012). Other water-based activities include kayaking, boat tours, and yachting. There are seven beaches that are currently used by locals and visitors for recreation, including swimming, snorkeling, fishing and spearfishing, and beach events. Those beaches are: Rendezvous Beach, Little Bay, Carr's Bay, Bunkum Beach, Woodlands Beach, Lime Kiln Beach, and Old Road/Fox's Bay (Wild et al. 2007).

7. Other Ocean Uses

7.1 Shipping Lanes

A ferry runs between Antigua and Montserrat, terminating at the jetty in Little Bay. Cargo boats, barges, and fuel tankers also unload at the Little Bay jetty. Regular dredging occurs in Little Bay to maintain channel depths (ECLAC 2011).

7.2 Other

Maritime Exclusion Zones cover the waters around the southern part of the island out to a distance of 4 km offshore because of the danger of volcanic activity. Day-time transit is permitted in order to access sites outside the zones, but boats are not allowed to stay in the zones for more time than is necessary for transit (Government of Montserrat 2014).

8. Conservation and Management Efforts

8.1 Ocean Zoning

The Conservation and Environmental Management Bill of 2013 lays out the different types of protected areas that the government can create and establishes a process for gazetting new protected areas. The bill states that protected areas may be managed by the Montserratian government or responsibility may be given to a nongovernmental organization (Government of Montserrat 2013). However, there are currently no marine or coastal protected areas in Montserrat.

In the early 1990s, the Montserrat National Trust tried to establish marine protected areas (MPAs), but they were unsuccessful due to the disruptions caused by the volcano. They produced a report on their proposed MPAs, which is currently located at their headquarters (S. Francis, personal communication).

In 2003, the Montserrat Tourism Board developed a National Tourism Strategy and Plan that called for the creation of a marine park (CHL 2003). In response, the tourism board contracted the consulting group LTS International to write a report on the feasibility of establishing a marine reserve in Montserrat (Wild et al. 2007). Based on ecological surveys, interviews, a stakeholder workshop, and a literature review, LTS created maps of marine resource use and created a proposal for marine zoning, including a Marine Access Zone around the port of Little Bay, a Conservation Zone from Rendezvous Bay north to Statue Rocks on the east side of the island (out to a depth of 30 meters), a Fishing and Recreation Zone from Carr's Bay south to the Maritime Exclusion Zones (out to 30 meters depth), a Marine Recovery Zone in what are now the Maritime Exclusion Zones and the south coast of the island, and a Fisheries Management Zone encompassing the remainder of Montserrat's nearshore waters, out to a depth of 100 meters (Figure 9; Wild et al. 2007).

The proposed Conservation Zone would be managed for conservation, tourism, and education, with possible subzones for snorkeling and swimming. Limited traditional fishing would be permitted in the zone. The Fisheries and Recreation Zone would be managed for fishing, diving, recreation, and marine conservation, including turtle nesting, while the Fisheries Management Zone would be managed exclusively for fisheries. The Marine Access Zone would be managed for shipping lanes, marine safety, moorings, and offloading. The Marine Recovery Zone would be divided into a No-Take

Zone, managed for fish stock and habitat recovery, and a Limited Take Zone. The No-Take Zone would be located in the current Maritime Exclusion Zones, while the Limited Take Zone would be between the two zones, from Roches Bluff to Shoe Rock (Wild et al. 2007).

The marine zoning plan proposed by LTS International was not adopted by the Montserrat government due to lack of consensus over the locations of the zones (James Hewlett, personal communication); there currently are no established ocean zones in Montserrat except for the Maritime Exclusion Zone.

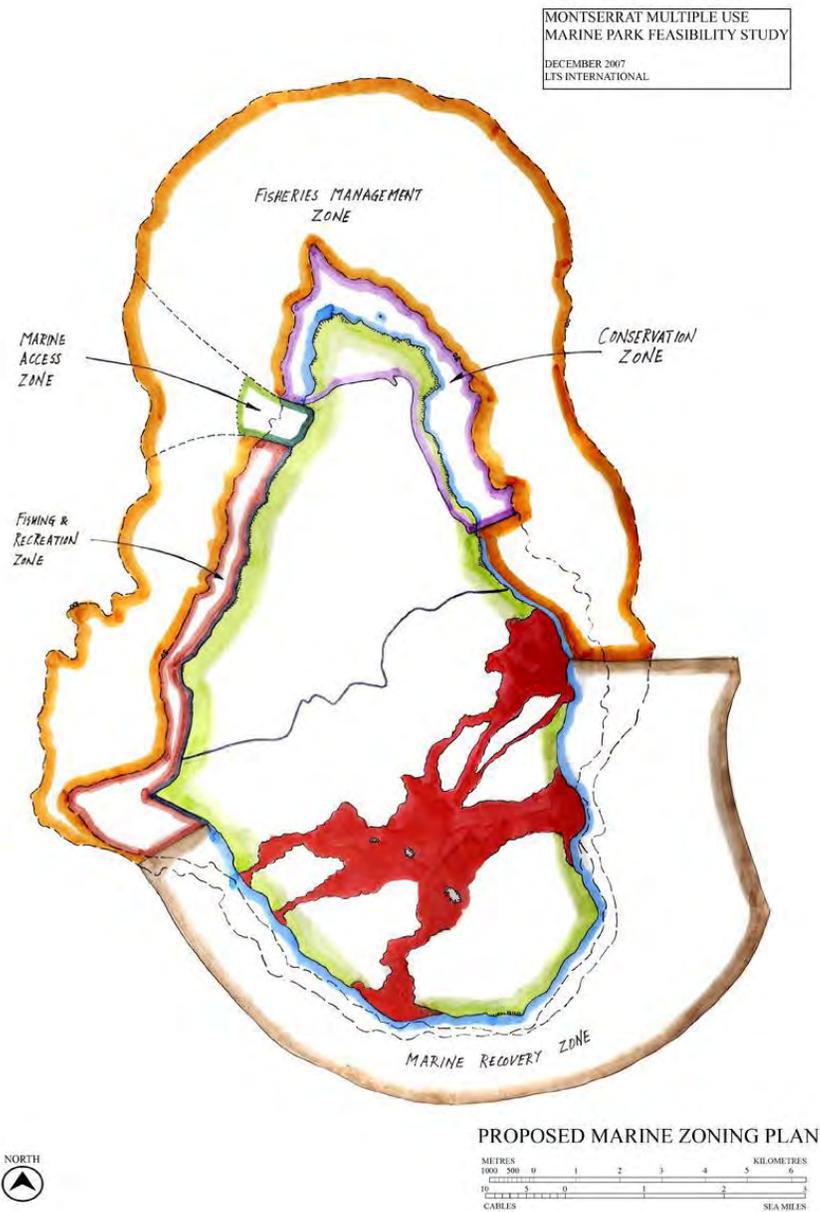


Figure 9. Map of proposed ocean zones (from Wild et al. 2007).

8.2 Other Conservation Measures

Through its relationship with the United Kingdom, Montserrat is party to several international environmental agreements: the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), the United Nations Convention on the Law of the Sea (UNCLOS), and the United Nations Conference on Environment and Development (Ponteem 2014).

There have been two artificial reef projects in Montserrat. The first artificial reef project was launched in 1981, using abandoned vehicles as reef substrate between Iles Bay and Fox's Bay (Volk et al. 1993). The goal was to provide additional fish habitat for fisheries development, and up until Hurricane Hugo in 1989, monitoring showed successful establishment by fish and benthic invertebrates (Volk et al. 1993). Since 2010, Scuba Montserrat, a dive operator on the island, has worked to install artificial reefs. With funding from the Montserrat Tourism Board and the Overseas Territories Environmental Programme, Scuba Montserrat has installed more than 200 concrete reef balls in Woodlands Bay. This has created a tourist attraction, as well as new habitat for reef fish (Myers 2013; Government of Montserrat, 2015). Scuba Montserrat plans to continue its project by gathering coral fragments damaged during the construction of the Little Bay breakwater and transplanting them onto reef balls in order to facilitate recovery from the disturbance (Romero-Cesareo 2010).

9. Key Researchers, Research Programs and Organizations

Montserrat Fisheries Division

The Montserrat Fisheries Division, which falls under the Ministry of Agriculture, Trade, Housing, Lands and the Environment, manages Montserrat's fisheries and marine resources. The Chief Fisheries Officer is responsible for developing a National Fisheries Plan and establishing conservation measures to prevent over-exploitation.

- <http://www.gov.ms/ministries-and-departments/ministry-of-agriculture/>
- Honourable Minister Claude Hogan, Minister of Agriculture, Trade, Lands, Housing and Environment: malhe@gov.ms
- Alwyn Ponteem, Chief Fisheries Officer: alwyn.ponteem@myport.ac.uk

Coral Cay Conservation

This UK-based conservation science organization began working in Montserrat in July of 2013. Using teams of volunteers, Coral Cay conducts ecological surveys of coral reefs and seagrass beds, as well as terrestrial ecosystems. In its marine monitoring program, Coral Cay uses a modified Reef Check protocol, collecting information on the diversity and abundance of fish and invertebrates, categorizing substrate types, and recording the presence of coral disease, bleaching, and other forms of damage. So far, Coral Cay has completed surveys at fourteen sites on the western coast of Montserrat and established a permanent transect at Fox's Bay, which it plans to survey on a monthly

basis. In addition to its ecological monitoring, Coral Cay also engages in environmental education in the local community.

- Coral Cay Conservation: <http://www.coralcay.org/>
- Coral Cay Montserrat Team: montserrat@coralcay.org

Professor James Hewlett

Professor Hewlett, from Finger Lakes Community College in New York, worked as the Reef Check Coordinator for Montserrat from 2005-2013. During that time period, fourteen surveys were completed with assistance from Green Monkey Dive Shop, which closed in 2013. Using Reef Check protocols, Professor Hewlett collected data on the coral, other invertebrate, and fish diversity and abundance at various sites around Montserrat. His team also completed one survey following the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol in 2013, recording benthic cover and coral species. He plans to return to Montserrat in the next three years to begin a five year reef monitoring program.

- Contact information: james.hewlett@flcc.edu

Robin Ramdeen

Robin Ramdeen worked with Alwyn Ponteen, Montserrat's Chief Fisheries Officer, to reconstruct Montserrat's landings from 1950-2010 for the paper, *Reconstruction of total marine fisheries catches for Montserrat (1950-2010)* (Ramdeen et al. 2012).

- Contact information: r.ramdeen@fisheries.ubc.ca

Montserrat National Trust

This NGO's mission is to conserve and enhance Montserrat's natural beauty and cultural heritage. MNT has been involved in previous efforts to attempt to establish marine protected areas.

- <http://montserratnationaltrust.ms/>
- Sarita Francis, Executive Director: mnatrust@candw.ag

LTS International

LTS International worked with the Montserrat Tourism Board to develop an ocean zoning proposal in 2007. As part of their work, LTS International conducted ecological surveys on the west coast of Montserrat, collecting fish abundance and diversity data from Rendezvous Bay and Woodlands Bay, as well as species presence/absence data from Bunkum Bay, Lime Kiln, Pot of Gold, Little Redonda, Little Bay, and Carr's Bay.

- <http://www.ltsi.co.uk/projects/montserrat-a-study-for-the-establishment-of-a-multiple-use-marine-park-2007-2008-montserrat-tourist-board/>
- Contact information: mail@ltsi.co.uk

Turtle Conservation Montserrat

This conservation NGO was established in 2014 to bring international volunteers to Montserrat to help monitor sea turtle nests and release hatchlings.

- <http://ccoleby2001.wix.com/turtlesmontserrat>
- Carolyne Coleby, Founder and Director: ccoleby2001@yahoo.co.uk

10. References

- Blue Ocean Institute (BOI). (2006). Country profile: Monserrat. Project Global: Global Bycatch Assessment of Long-Lived Species. Retrieved May 15, 2014, from <http://bycatch.env.duke.edu/regions/Caribbean/Montserrat.pdf/>
- Burke, L., & Maidens, J. (2004). Reefs at risk in the Caribbean. World Resources Institute.
- Campbell, L. M., Silver, J. J., Gray, N. J., et al. (2009). Co-management of sea turtle fisheries: biogeography versus geopolitics. *Marine Policy*, 33, 137-145.
- Carey, S., Bell, K. L. C., Sparks, S., et al. (2014). Impact of volcanic eruptions on the seafloor around Montserrat, West Indies. *Oceanography*, 27(1), 36-37.
- Caribbean Community Secretariat (CARICOM). (2014a). Montserrat. Retrieved April 13, 2015, from <http://www.caricom.org/jsp/community/montserrat.jsp?menu=community>
- Caribbean Community Secretariat (CARICOM). (2014b). Selected tourism statistics of CARICOM member states: Montserrat. Retrieved May 21, 2015, from <http://www.caricomstats.org/Tourism.html>
- Caribbean Community Secretariat (CARICOM). (2011). Chapter 1: Montserrat – A Profile. Retrieved May 29, 2015, from [http://www.caricom.org/jsp/community/regional issues/montserrat profile c1.jsp?menu=community](http://www.caricom.org/jsp/community/regional%20issues/montserrat_profile_c1.jsp?menu=community)
- Caribbean Regional Fisheries Mechanism (CRFM). (2012). *Report of the eighth annual CRFM scientific meeting- St. Vincent and the Grenadines, 20-30 June, 2012* (CRFM Fishery Report 2012 Vol. 2). Fishery Management Advisory Summaries.
- Caribbean Tourism Organization. (2015). Latest tourism statistics tables (2014, 2013, 2012, 2011,). Retrieved from April 20, 2015, from <http://www.onecaribbean.org/statistics/latest-tourism-statistics-tables/>
- CHL Consulting Limited. (2012). *Tourism development plan 2012-2022 (incorporating TDP3 and 5-Year business plan), Draft Final Report*.
- CIA World Factbook. (2013). Central America and the Caribbean: Montserrat. Retrieved March 18, 2015, from <https://www.cia.gov/library/publications/the-world-factbook/geos/mh.html>
- Cook, H. L., Vincke, M. M. J., & Wijkstrhom, U. N. (1981). *Aquaculture development in the Caribbean: report of a mission to Antigua, Haiti, Jamaica, Montserrat and St. Lucia, June-July 1980*. Rome, Italy: United Nations Development Programme, Food and

Agriculture Organization of the United Nations. Retrieved May 9, 2015, from <http://www.fao.org/docrep/006/p4495e/p4495e00.htm>

Economic Commission for Latin America and the Caribbean (ECLAC). (2011). *An assessment of the economic impact of climate change on the transportation sector in Montserrat*. Subregional Headquarters for the Caribbean.

Food and Agriculture Organization (FAO). (2007). Montserrat. In *Mangroves of North and Central America 1980-2005: country reports* (pp. 101-104). Rome, Italy: Forestry Department, Food and Agriculture Organization of the United Nations.

FAO. (2010). *Global forest resources assessment 2010: country report: Montserrat* (FRA2010/138). Rome, Italy: Forestry Department, Food and Agriculture Organization of the United Nations. FRA2010/138, Rome.

FAO. (2014). *The state of world fisheries and aquaculture 2014: opportunities and challenges*. Rome, Italy: Food and Agriculture Organization of the United Nations.

Ferguson, A., & Daniel, S. (2015). Montserrat: Coral Cay Conservation annual marine survey report, year 2013-2014. Coral Cay Conservation Expeditions.

Godley, B. J., Broderick, A. C., Campbell, L. M., Ranger, S., & Richardson, P. B. (2004). An assessment of the status and exploitation of marine turtles in Montserrat. In *An assessment of the status and exploitation of marine turtles in the UK Overseas Territories in the wider Caribbean* (pp. 155-179). Final Project Report for the Department of Environment, Food and Rural Affairs and the Foreign and Commonwealth Office.

Government of Montserrat. (2015). *Artificial reef strengthening Montserrat's marine ecosystem*. Retrieved April 7, 2015, from <http://www.gov.ms/2012/04/30/artificial-reefs-strengthening-montserrats-marine-ecosystem/>

Government of Montserrat. (2014). Emergency powers (maritime unsafe areas) order 2014. Montserrat Statutory Rules and Orders.

Government of Montserrat. (2013). Conservation and environmental management bill. Montserrat Statutory Rules and Orders.

Government of Montserrat. (2009). Fisheries regulations 2009. Montserrat Statutory Rules and Orders.

Gray, G. A. L. (2011). Montserrat. In T. Pelembe & G. Cooper (Eds.) *UK Overseas Territories and Crown Dependencies: 2011 biodiversity snapshot* (pp. 79-86).

- Island Resources Foundation (IRF). (1993). *Montserrat environmental profile*. St. Thomas, U.S. Virgin Islands.
- Jeffers, J. (1996). Status of queen conch, *Strombus gigas* in Montserrat. In *Proceedings of International Queen Conch Conference*. San Juan, Puerto Rico 29-31 July 1996.
- Jeffers, J. (1984). Status of the artisanal fisheries of Montserrat. *Proceedings of the Gulf and Caribbean Fisheries Institute*, 36, 21-23.
- Jeffers, J. (1983). *National report for the country of Montserrat* (WATS I Vol. 3, 323-328). San Jose, Costa Rica: Western Atlantic Turtle Symposium.
- Joint Nature Conservation Committee (JNCC). (1991). *Montserrat*. Retrieved March 25, 2015, from http://www.jncc.gov.uk/pdf/OT_Monserrat.pdf
- Martin, C. S., Jeffers, J., & Godley, B. J. (2005). The status of marine turtles in Montserrat (Eastern Caribbean). *Animal Biodiversity and Conservation*, 28(2), 159-168.
- Maylan, A. B. (1983). Marine turtles of the Leeward Islands, Lesser Antilles. *Atoll Research Bulletin*, 278, 1-24.
- Montserrat Catch Data. (1994-2012). Provided by A. Ponteen, Montserrat Fisheries Division.
- Montserrat Fisheries Division. (2014). Guidelines for improving Montserrat's fisheries data management and information collection (Version 1). Government of Montserrat.
- Myers, A. (2013). Coral reefs of Montserrat. In C. R. C. Sheppard (Ed.) *Coral reefs of the United Kingdom Overseas Territories, coral reefs of the world* (pp.89-96). Dordrecht, Germany: Springer Science + Business Media.
- Nagel, G., & Guinness, P. (2006). Coral reefs in crisis. Geocases: access to geographical case studies for A level. Retrieved May 15, 2014, from <http://www.geocases2.co.uk/coral1.htm>
- Peachin, M. L. (2011). *Sport fishing in the Caribbean*.
- Ponteen, A. R. (2014). Montserrat national fisheries report. Fisheries Division, Government of Montserrat.
- Ponteen, A. R. (2013). *The future of fisheries in Montserrat: a proposed framework for management and governance reform* (Master's thesis). University of Portsmouth, Department of Geography.

Ponteen, A. R. (2010). *Montserrat National Fisheries Report 2009/2010*. The Department of Agriculture of the Ministry of Agriculture, Trade, Lands and Housing, Government of Montserrat.

Ramdeen, R., Ponteen, A., Harper, S., & Zeller, D. (2012). Reconstruction of total marine fisheries catches for Montserrat (1950-2010). In S. Harper, K. Zylich, L. Boonzaier, F. Le Manach, D. Pauly, & D. Zeller (Eds.), *Fisheries catch reconstructions: islands, Part III* (pp. 69-76). Vancouver, British Columbia: Fisheries Centre Research Report.

Romero-Cesareo, I. (2010) *The Montserrat Reef Project to enhance marine ecosystems*. Retrieved April 16, 2015, from <http://repeatingislands.com/2010/10/29/the-montserrat-reef-project-to-enhance-marine-ecosystems/>

Short, F. T., Carruthers, T. J. R., van Tussenbroek, B., & Zieman, J. (2010a). *Halodule wrightii*. The IUCN Red List of Threatened Species, Version 2014.3. Retrieved April 13, 2015, from www.iucnredlist.org

Short, F. T., Carruthers, T. J. R., van Tussenbroek, B., & Zieman, J. (2010b). *Syringodium filiforme*. The IUCN Red List of Threatened Species, Version 2014.3. Retrieved April 13, 2015, from www.iucnredlist.org

Short, F. T., Carruthers, T. J. R., van Tussenbroek, B., & Zieman, J. (2010c). *Thalassia testudinum*. The IUCN Red List of Threatened Species, Version 2014.3. Retrieved April 13, 2015, from www.iucnredlist.org

Smith, A. H., Rogers, C. S., & Bouchon, C. (1997). Status of western Atlantic coral reefs in the Lesser Antilles. *Proceedings of the 8th International Coral Reef Symposium, 1*, 351-356.

Volk, R., Horwith, B., & Towle, J. (1993). Montserrat and the sea. In E. L. Towle (Ed.) *Montserrat: Environmental Profile* (pp. 69-84).

Wauer, R. H. (1996). *A birder's West Indies: an island by island tour*. Austin, Texas: University of Texas Press.

Wild, R., Slade, L., Pardee, M., & Carleton, C. (2007). *Towards multi-user marine management in Montserrat*. LTS International.

Wilkinson, C. (2000). *Status of coral reefs in the world 2000*. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre. Townsville, Australia.