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Chapter 39

UK OVERSEAS TERRITORIES IN THE NORTHEAST CARIBBEAN: ANGUILLA, BRITISH VIRGIN ISLANDS, MONTSERRAT

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The United Kingdom Overseas Territories (UKOT) of Anguilla, British Virgin Islands and Montserrat are in the Lesser Antilles, in the northeast Caribbean. All are small. Tropical storms and hurricanes are the most common causes of natural disturbance in this region, and for the Atlantic basin as a whole there has been an increase in the number of strong hurricanes since 1995. In Montserrat, volcanic activity is the outstanding environmental problem, and this has caused extensive destruction in the last few years.

Shallow, sheltered habitats support large areas of seagrasses, mostly of shallow beds of *Thalassium testudinum* (turtle grass). Coral communities are also extensive. Mangroves are reduced in extent, mostly as a result of piecemeal destruction for waterside developments although mangrove felling is illegal. The beaches of the islands are one of their most important tourist attractions.

The northern islands have seen a phenomenally rapid increase in tourism, which has replaced traditional industries such as fishing and salt extraction, and contributed to a large growth in population. By contrast, Montserrat's population has more than halved in the last five years, mainly because of volcanic activity. Economic development from the two main industries (tourism and financial services) has generally reduced the importance of fishing as a livelihood, but even so, some fish resources appear to be declining, in part because the growth of tourism has increased demand for fish products. As overseas territories of the UK, these islands fall within the UK jurisdiction for many laws and regulations, but retain independence in others. Generally, the small sizes of the islands have meant that environmental aspects have been under-resourced, though various small government departments and several NGOs are active in the region.

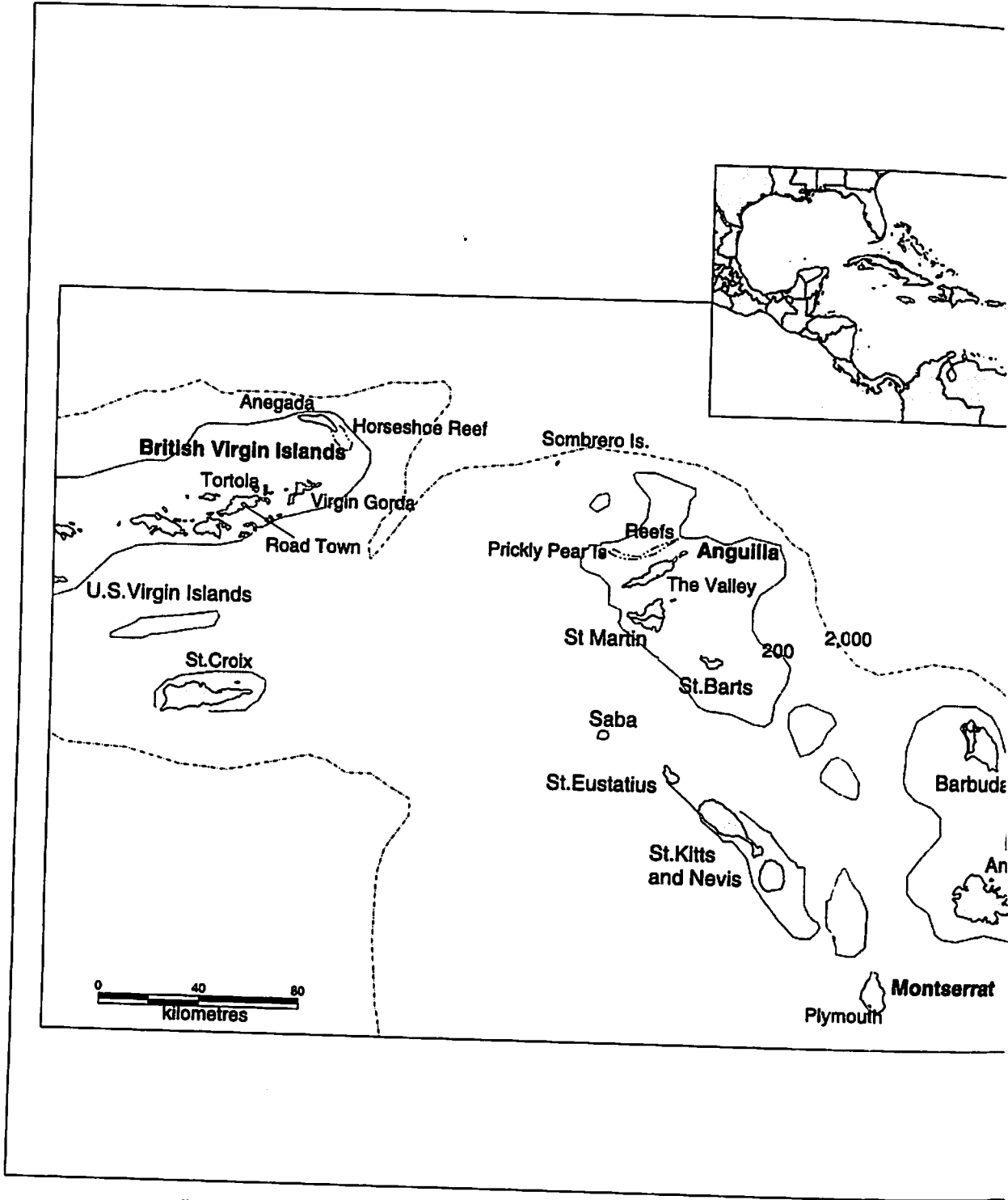


Fig. 1. Map of northeast Caribbean, showing the British Virgin Islands, Anguilla and Montserrat.

THE DEFINED REGION

The United Kingdom Overseas Territories (UKOT) of Anguilla, British Virgin Islands and Montserrat are in the Lesser Antilles, in the north of the Eastern Caribbean island arc (Fig. 1). The islands are small, and because of both this and their political diversity, most Caribbean Small Island Developing States (SIDS) are interdependent for natural resources such as fisheries.

The Territories considered here form part of the nation-state of the UK but are not represented in the UK parliament and have independent elected governments. The UK is responsible for defence, international relations and has some say in legislation (Pienkowski, 1999).

Anguilla was administered as a single federation with St. Kitts and Nevis but sought separation in the 1960s, came under direct UK administration in the 1970s and eventually became a separate British Dependent Territory in 1980. Anguilla is a Caribbean Community (CARICOM) observer and an associate of the Organisation of Eastern Caribbean States (OECS). It is a low island of 90.65 km² (highest point 65 m) rising from the Anguilla Bank. On the north coast cliffs are almost 30 m high and depths are 23–45 m within 1 km of shore, whilst the south coast is low, with 30–40 sandy bays. Anguilla has several small offshore cays and islands, including Sombrero, 61 km to the northwest.

The British Virgin Islands (BVI) comprise more than 50 islands and islets, covering 155 km², though only 16 islands are inhabited. Tortola is the largest and most heavily populated island. Virgin Gorda, Anegada and Jost Van Dyke are amongst the more important. BVI has been a UKOT since 1971 and is an associate member of OECS and CARICOM. The islands are made of Cretaceous sedimentary and metamorphic/volcanic rocks, rising to 543 m above sea level (Fig. 2), with the exception of Anegada to the north which is made from carbonates and reefs.

Montserrat lies 43 km south west of Antigua, with which it has strong historical links. Only 18 km by 11 km, it has an area of 102 km². A narrow coastal shelf drops quickly to

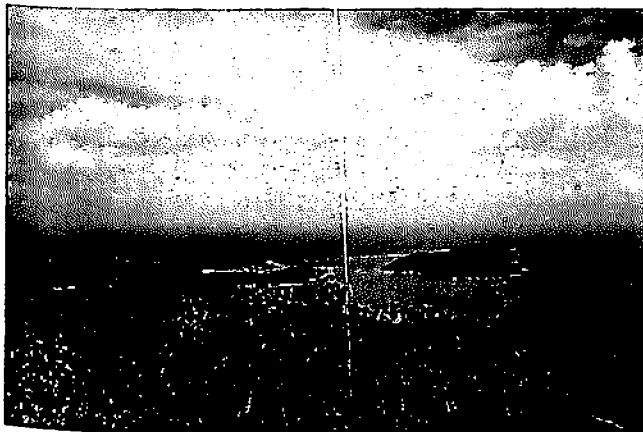


Fig. 2. 'High' islands of the British Virgin Islands (photo C. Sheppard).

nearly 200 m only 650 m offshore along the southern half of the island. In the north, the shelf slopes more gently and the 200 m contour is 4.6 km offshore (Bovey et al., 1986). The pear-shaped island rises to 915 m and is formed from exposed peaks of part of the Lesser Antillean Archipelago, the undersea mountain ridge that curves between Puerto Rico and Trinidad. The ridge was formed by subduction of the Atlantic plate beneath the Caribbean Plate during the Miocene period. After 350 years of dormancy, Montserrat became volcanically active in 1995, when the capital Plymouth was destroyed and approximately half the island became uninhabitable. Much may remain uninhabitable for the next decade.

SEASONALITY, CURRENTS, NATURAL ENVIRONMENTAL VARIABLES

In Montserrat, volcanic activity is the outstanding environmental variable. During the active phase from 1995 to early 1998, vegetation was completely lost in many areas, leading to severe erosion. Huge plumes of sediment entered the sea at several locations, some containing 150 g dry weight of sediment per litre of water (Brosnan, 1999). Most sediment settled out of the water column less than 300 m from shore, and the effects on reefs on the east and southwest of the island have been severe. The volcano has been quiet from March 1998, but in November 1999 there were reports of renewed activity.

Tropical storms and hurricanes are more common causes of natural disturbance in this region; an average of one direct hit every 20 years is often quoted. Twenty hurricanes passed between 10°N and 19°N at 60°W during 1950 to 1997, and in the last 90 years, roughly two thirds of intense Atlantic hurricanes crossed the 60°W meridian between 18°N and 25°N, closely approaching or passing over the northern part of the Eastern Caribbean island chain (Jones, 1999). For the Atlantic basin as a whole there has been an increase in the number of strong hurricanes since 1995 which may be part of a quasi-cyclic pattern alternating between active and quiet hurricane phases every 25–40 years. Such phases are probably related to surface temperatures in the Atlantic (Landsea, 1999). Hurricane-generated waves and high rainfall can devastate nearshore reefs and cause coastal erosion.

With the exception of these major disturbances, the climate of the islands is stable, with summer and winter temperatures around 29°C and 24°C respectively. Anguilla receives an average of 102 cm of rain a year—the lowest in the Leeward Islands. By contrast, rainfall on Montserrat varies between 107 cm near sea level to 205 cm at 365 m (Corker, 1986). Most rain falls in the summer months, with a dry period from January until around May. Northeast trade winds prevail.

The islands are influenced by the North Equatorial current which flows westwards from the open Atlantic. Anguilla experiences winter currents of 0.4–0.5 knots

flowing 280–290°, whilst summer currents are slightly stronger (0.6–0.9 kt) and take a more northwesterly course between 300 and 310°. However, the Anguilla Bank is an irregular, relatively shallow platform and water flowing over the platform interacts with coastal currents to generate short-lived reversals in current direction (Towle, 1979). Tidal range is approximately 23 cm on average, with a maximum range of 30–60 cm at Spring tides. The tidal cycle is 14 hours, i.e. approximately semi-diurnal. For Montserrat, currents from the east normally flow around the northern and southern ends, creating longshore currents that converge at Bransby Point on the island's southwest central coast. Montserrat's west coast is a leeward shore, but is occasionally affected by Atlantic storms. Swells reach heights of 1.2 m approximately 10 times every winter and are expected to reach 3.7 m approximately once a year (Cambers, 1981). Currents around the BVI are poorly documented but are generally less than 0.5 kt.

MAJOR SHALLOW WATER COASTAL MARINE HABITATS AND BIODIVERSITY

Seagrass

Anguilla's seagrass beds cover 3400 ha (Olsen and Ogden, 1981) including an extensive bed at Crocus Bay (Wells, 1988) (Fig. 3). Large areas of seagrasses are found in sheltered bays around the BVI as well. As in Anguilla, most of the shallow beds are *Thalassium testudinum* (turtle grass), with some deeper beds of *Syringodium filiforme* (manatee grass) and some mixed beds. Tidal range is small, so intertidal seagrasses are limited. Montserrat has only three main seagrass beds. The largest (750 ha) is around the northern tip of island (IRF, 1993). The other two are on the east and west coasts (Jeffers, pers. comm., in IRF, 1993). There are three species of seagrass around the island (Brosnan et al., 1999) but available shallow water restricts the extent of this habitat.

Coral Reefs

Coral communities cover approximately 22% of the Anguillan shelf area (Olsen and Ogden, 1981). Living reefs are mostly on the north side of the island, with an extensive system running approximately parallel to the north coast several kilometres offshore. South coast reefs are more susceptible to hurricanes and in many places consist of a framework of dead *A. palmata*, with low diversity of living coral (Salm, 1980) Anguilla's reefs were badly damaged by Hurricane Donna in 1960, but in 1982 the 17 km long reef area along the southeast coast was considered to be the most important, largely unbroken, reef area in the Eastern Caribbean (Putney, 1982, in Wells, 1988). The reefs at Dog Island are reportedly in good condition and visitors are discouraged (Smith et al., 1997).

Extensive coral communities exist throughout the BVI with many well developed reefs. Horseshoe Reef (Anegada) covers approximately 77 km². Estimates of total coral reef area on several of the larger islands are given in Table 1. Figures reflect only shallow non-emergent reefs and therefore underestimate the total reef area which would include the numerous small patch reefs on the shelf area. The estimated area of *Acropora* communities destroyed by hurricanes, siltation, white band disease and other impacts is given in brackets (Table 1) (from Lettsome, 1998).

The cover estimates originated from a coastal inventory conducted in 1993 and may now have some inaccuracies (Lettsome pers. comm). More accurate and updated information on the distribution of habitats in the BVI will be available soon. An ongoing GIS project using satellite imagery and extensive ground truthing will begin in 2000, co-organized by the Conservation and Fisheries Department (CFD) and OECS. Some reefs, especially shallow water *Acropora*, were damaged by Hurricane Hugo in 1989, and Luis and Marilyn in 1995 also impacted the BVI (Smith et al., 1997). Most recently, high seas created by Hurricane Lenny (November 1999) damaged reefs on Virgin Gorda, the island closest to the storm centre.

Before the volcanic activity in Montserrat, coral communities were found in small patches interspersed with sand and sediment on the north, south and west coasts (Jeffers, pers. comm. in IRF, 1993). Lack of hard substrate, combined with high run-off, limits development of corals, and high nutrient input encouraged algal over-growth on many reefs. The Sustainable Ecosystems Institute (SEI) carried out reef surveys in 1995/96, and afterwards monitored the effects of the volcano. Brosnan et al. (1999) reported high coral diversity but small individual coral heads. The baseline data collected by SEI was from habitats already impacted by moderate fishing pressure and by natural environmental disturbances. They found 37 hard coral species, 17 gorgonians and other octocorals, 87 species of marine invertebrate, 37 algal species and 67 fish species. Fish abundance decreased significantly between 1995 and 1996, possibly as a result of Hurricane Luis. Volcanic sediments have had a severe impact on reef growth,

Table 1
Area of coral reefs on several islands and area of *Acropora* communities recently destroyed (Lettsome, 1998)

Location	Area of reef (ha)	Area recently destroyed (ha)
Tortola and Beef Island	987	159
Anegada	4589	382
Virgin Gorda and North Sound	743	341
Jost Van Dyke, Great and Little Tobago	540	314
Norman Island	709	25

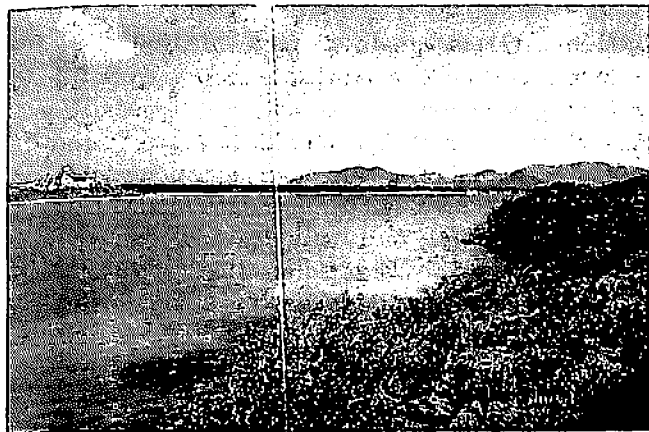


Fig. 3. Large bays in Anguilla contain abundant seagrass. Coasts are typically well vegetated, even in this driest island. Anguilla is a low carbonate island; in the background is the high island of St Martin (divided into Dutch and French sectors) (photo C. Sheppard).

particularly on reefs in the east and southwest of island. Direct deposits of ash and waterborne sediment led to coral bleaching, an increase in coral diseases and the disintegration of large sponges, once very common. Some areas of coral were completely covered and in places an algal film developed over the sediment, preventing it from dispersing. Where ash plumes fell, 64% of *Agaricia* coral colonies bleached. In February 1997 monitoring revealed increased degradation of reefs in the south of the island (Brosnan, 1999).

Mangroves

In the 1950s, mangroves lined much of the southern coastline of Tortola in the BVI (Lettsome, 1998) (Fig. 4). Mangrove stands at Road Town, Sea Cows Bay, Nanny Cay and at other sites have since largely been displaced by marinas, tourism complexes and housing (Lettsome, 1998). Extensive stands remain around Beef Island, and Paraquita



Fig. 4. Red mangrove *Rhizophora* in the British Virgin Islands (at very low tide) is an important but diminishing habitat (photo C. Sheppard).



Fig. 5. Salt pans in Anguilla. Most low-lying islands have embayments where traditionally salt has been obtained by evaporation (photo C. Sheppard).

Bay with smaller stands at the west side of Fat Hog's Bay, including some on land recently donated to the National Parks Trust. There are small areas of mangrove on Anegada, Virgin Gorda and Jost van Dyke (Lettsome, 1998). Although mangrove felling is illegal, many areas have been lost through piecemeal destruction for waterside developments. The Conservation and Fisheries Department demonstrate the importance of mangroves through a number of awareness-raising activities such as local radio programmes, schools visits and replanting activities. For example, a replanting scheme on Tortola combines habitat restoration with education. However, recent storms, especially Hurricane Lenny in November 1999, have damaged many newly established propagules (Evans, pers. comm.). Around Montserrat, mangroves are quite limited. IRF (1993) notes only two sites, with the most important being approximately 6 ha at Fox's Bay on the west coast. On Anguilla a few areas of mangrove are found in enclosed bays (Wells, 1988).

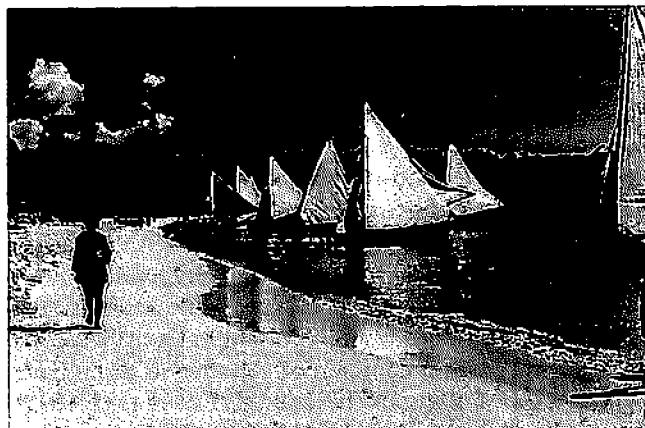


Fig. 6. The main income of these islands is tourism, attracted by water sports and beaches (Anguilla) (photo C. Sheppard).

Salt Ponds

Salt ponds are a significant habitat for resident and migratory birds in the islands (Fig. 5). In BVI, ponds are found on Tortola, Beef Island, Jost van Dyke, Anegada and Norman Island. However, they have suffered from development. Of 30 identified in a survey in 1984, only 10 remained in 1993 (Lettsome, 1998), with resultant losses of coastal protection (see below). In Anguilla, some salt ponds, for example Maunday's Bay Pond, have been developed (Wells, 1988) but 20 remained in 1990 (Pritchard, 1990).

Beaches

Beaches are one of the Caribbean's most important tourist attractions (Fig. 6). Anguilla has more than 30 spectacular beaches (Proctor, 1997, Pritchard, 1990) whilst Lettsome (1998) estimated almost 80 km of white sand in the BVI. However, development has caused conflicts of interest, and access to beaches for traditional uses has been identified as a serious problem on both islands (Cambers, 1997). Montserrat has extensive beaches, but a large proportion are in the unsafe south section of the island.

Biodiversity

The islands provide important habitat for both resident and migratory birds. According to the Anguilla National Trust, nearly 30% of the 120 bird species recorded on Anguilla are considered globally or regionally threatened or endangered. Outlying cays (including Sombrero) are especially important for seabirds, the most internationally significant facet of Anguilla's wildlife (Pritchard, 1990).

In BVI, roseate tern, frigate bird, brown boobies, least tern and noddy tern are amongst those protected from interference during their nesting season (CFD, 1997a). Caribbean flamingoes were once common in the British Virgin Islands, with thousands of pairs reported in the last century. The young were a popular source of food and so, by the middle of the 20th century, the species had become locally extinct (Lazell, 1999). In 1983 several agencies, including the BVI National Parks Trust and the Conservation Agency, began a programme to reintroduce the flamingo to Guana Island and Anegada. In 1995 five young were successfully fledged at Anegada. Transient Flamingos occasionally arrive, and the flock (now more than 20) is expected to expand further (Petrovic, 1998).

Turtles are found throughout the Lesser Antilles, and green, hawksbill and leatherback are all present. IRF (1993) records seven turtle nesting areas around Montserrat. Historically turtle fisheries were important in the BVI but the territory was never a commercial exporter so turtle have only been fished at a subsistence level (Eckert et al., 1992). Recently the fishery has declined but, unusually for such a developed economy, turtle fishing is still permitted outside the nesting season from December 1 to March 31 (Jarecki,

1996). Hawksbill and green turtles are caught using nets. Local environmental groups are opposed to the fishery but turtle meat is still sold in local supermarkets. Turtle fishing was unregulated in Anguilla in 1981, with catches of up to 15 per day (Olsen and Ogden, 1981). Now, years can go by without a successful nest (Anguilla National Trust, 1999).

The islands have a number of endemic species, such as the Anegada ground lizard, the endangered Anegada Rock Iguana and the Virgin Gorda Gecko in BVI. A benthic invertebrate study at Guana Island (BVI) will span three years from 1999, and may already have found new species. On Sombrero (Anguilla), the endemic black lizard *Ameiva corvina* is threatened by development. At least one other endemic species has been identified in ongoing EIAs (Petrovic pers. comm.). Montserrat has five regionally endemic birds, and one single island endemic—the Montserrat Oriole (*Icterus oberi*).

POPULATIONS AFFECTING THE AREA

For Anguilla and BVI, the most significant factor affecting human populations over the last few decades has been a phenomenally rapid increase in tourism, replacing traditional industries such as fishing and salt extraction. Anguilla's tourist industry flourished in the 1980s and 90s. In 1911 the population was just 4075, and by 1990, that had approximately doubled to 8000 (Proctor, 1997), but by 1999 the figure had increased again to an estimated 11510 (CIA, 1999). Visitor numbers increased dramatically from 17,561 in 1982 to 125,780 in 1995 (Proctor, 1997; IRF, 1996). This expansion led to a construction boom in the 1980s, and GDP was \$165.1 million in 1995, of which 91% came from tourism.

The population in the BVI underwent a similar expansion to about 18,000 in 1999. Tourism, contributes 45% of GDP, which was US\$183 m in 1997 (CIA, 1999). Visitor arrivals increased 103% between 1984 and 1994. In 1995 there were 65 hotel rooms per 1000 people, but a large part of tourism comes from live-aboard yachting holidays and from the cruise ship industry. In season, cruise liners can deposit more than 5000 visitors per day, and each year the islands are visited by an estimated 300,000 tourists (Miller and Louisy, 1995).

By contrast, Montserrat's population has more than halved in the last five years. In 1995 Montserrat had a population of 11,000, but after the eruption of the Soufriere Hills Volcano in 1995 and 1997, as many as 8000 people were evacuated. Although some people have begun to return, the present population is estimated at just 4500. The population is now concentrated in the north of the island.

In 1995 Montserrat's GDP was \$58 m, with tourism accounting for 31% (CTO, 1995, in IRF, 1996). Tourism is only just starting again after the volcano, and the main activity now is construction. Montserrat received £59 million between 1995 and 1998 to aid the recovery process, and

the UK government has pledged a further £75 million for 1999 to 2001 (FCO, 1999). The UK and the Government of Montserrat have formulated a comprehensive Sustainable Development Plan. The impact of so many people concentrated in the northern third of the island is impacting the environment and concentrating pressure on natural resources.

FISHING

Economic development has generally reduced the importance of fishing as a livelihood. At the same time the growth of tourism has increased demand for fish products. Throughout the northeast Caribbean the most important fishing gear are fish pots. These often target demersal or reef fish, and are placed in water from 5 to 30 m.

Anguilla

Although small-scale and artisanal, fishing was once a major industry for Anguilla. Most fishers use pots, but seines are used in the calmer summer months. Olsen and Ogden (1981) estimated the maximum sustainable yield (MSY) for demersal stocks to be 2740 tonnes for finfish and 230 tonnes of lobster and 230 tonnes of conch and other shellfish, with 80% of the production potential coming from the 22% of the shelf area containing coral reef communities. Although inshore stocks were heavily fished, shelf stocks were considered to be under-exploited. Government statistics record a conservative estimate of 280 fishers in 1980 (Government of Anguilla et al., 1992). In 1993, Mokoro Ltd estimated around 400 people were involved in the fishing industry, producing between 300 and 500 tonnes of fish, lobster and conch worth 3.3% of the 1991 GDP.

Nearshore resources have declined under increasing pressure. Export duties allow an estimate of lobster exports in 1979 of at least 28,364 kg, though the true value is probably much higher. In 1980, fishers were discarding scarids and snappers up to 2–3 kg as trash fish and fish pots used *Epinephelus striatus*, now commercially extinct in many parts of the Caribbean, as lobster bait (Salm, 1980). However by 1987, signs of overfishing were apparent for lobster and potfish (Stephenson, 1992). Unfortunately no landing data were kept.

Anguilla has an Exclusive Fisheries Zone (EFZ) that covers approximately 85,500 km². This zone extends a full 200 miles to the north, but is limited to the west by the British Virgin Islands, to the east by Antigua and to the south by St Maarten and St Bartholomew. Anguilla is on the migratory route of a number of species of large pelagic fishes, so there is also a seasonal fishery for species such as kingfish and dolphinfish, by domestic fishermen using small boats. Longlining for deep-swimming tuna has been tried by a few domestic fishermen, but most have gone back to trapping and handlines.

British Virgin Islands

Fishing was traditionally a major source of food and income in BVI. The islands are surrounded by a number of shallow areas and fishing banks, attracting demersal fish as well as invertebrates such as lobster and conch. One source of fishing pressure comes directly from tourists and casual fishers, many of whom take conch, lobster (often undersized) and fish for their own consumption. This is illegal but unenforceable. Management actions concentrate on education for this sector.

Commercial trap fishing in the BVI has increased over recent years, leading to a decline in fish populations and a change in catch composition (Smith et al., 1997). Pomeroy (1999) made an extensive study of the domestic fishery. He estimated 174 fishers mainly used traps or traps and handlines, with a few using seine nets, fishing rods, SCUBA (now illegal) or other fishing methods. Fish traps were set throughout the year, for an average of 40 weeks. Longline use was seasonal, from October to May. Seine nets are used all year round but particularly from November to March for jacks and from March to August for bonito (*Sarda sarda*), yellowtail snapper (*Ocyurus chrysurus*) and other species. The total BVI commercial catch for 1998 was estimated at 819,329 kg, with a value of US\$6,652,221 (Pomeroy, 1999). The total area of shelf available to BVI fishers is 3130 km², giving an estimated 259 kg/km² or 2.94 trips/km² for 1998. A major problem with the commercial nearshore fishery is ciguatera poisoning from predatory demersal fish. This limits the market for some nearshore fish and many businesses prefer to import fish or serve pelagic species.

The BVI has an Exclusive Fishing Zone of 84,000 km², stretching almost due north into the central Atlantic, but bounded on other sides by the United States Virgin Islands, Puerto Rico and Anguilla (CFD, 1997b). The islands lie in the migratory path of a number of large pelagic species (MRAG, 1993) and host an active sport fishery which targets blue marlin, mackerels, barracuda, wahoo and bonitos. However, the domestic sport fishing and longline industry is not well developed. In 1993 there were only two local longline vessels, which fished 15–20 miles offshore out of Anegada. In the same year, 82% of USVI sport fishing occurred in BVI waters under licences costing only \$200 a year per boat (MRAG, 1993). A lot of fish were sold back to hotels in the BVI. Licence fees and penalties for illegal fishing have since been increased, but developing a stronger BVI industry could potentially produce a higher revenue than licensing foreign commercial vessels, with less impact on fish stocks.

Montserrat

Montserrat has a very small EFZ of only 6000 km² (MRAG, 1993) and a small coastal shelf of 140 km². The coastal shelf is too small to support large demersal stocks so pelagic stocks are important. Many of these pelagic species are migratory,

providing a seasonal fishery from November to March. The main target species in the early 1990s were snapper, grouper, kingfish, barracuda and skipjack tuna, many of which can be ciguateric. Also important were conch, spiny lobster, some reef and demersal fishes, turtles and shark, which were all often taken undersize (Jeffers, pers. comm. in IRF, 1993).

In 1991 there were 250 fishermen (33% full time) fishing mainly with handlines and fish traps from 53 dory-style fishing vessels of 4.5–6 m (Jeffers, pers. comm. in IRF, 1993). Fisheries development is also limited by a lack of safe harbours due to the geography of the island. Large vessels are forced to seek shelter in Antigua. Commercial longlining has been proposed but in 1993 there was only one local vessel capable of commercial long-lining, and this had stopped fishing (MRAG, 1993). Fish catches for 1997 were estimated at 46 tonnes (FAO, 1999).

Before the eruptions, the main threat to coral reefs of Montserrat was thought to be fishing, predominantly trap and spear-fishing. The concentration of people in the safe area at the north of the island has had a serious impact on the marine resources of this area. Fishing effort has been particularly intense here, and decreases in catches were noticed in 1997 (Brosnan, 1999).

COASTAL EROSION AND LANDFILL

Waves and excessive rain from hurricanes and tropical storms lead to erosion and sedimentation damage in near-shore waters. Even moderate rainfall over land cleared for development or agriculture can result in heavily sedimented water extending offshore more than 1 km (Cambers, 1999). Such effects are mitigated by coastal protection from salt ponds, mangroves and sand dunes. However, extended periods without major hurricane damage may encourage inappropriate development (e.g. mangrove felling or sand mining). Anguilla, BVI and Montserrat have all experienced construction booms of various intensities in recent years, with subsequent effects on the marine environment. During the 1980s, Anguilla underwent a phase of extremely rapid tourism development. The need for building sand encouraged indiscriminate beach mining; for example at Sile Bay extensive dunes up to 6 m high were heavily exploited, resulting in encroachment of the sea 46 m inland after Hurricane Luis in 1995. Sand mining was prohibited after 1994 except on licensed beaches. Sand is currently mined from areas at Windward point but this will be depleted within a couple of years (Hendry and Bateson, 1997). The government is committed to restricting beach mining, but offshore sand mining is being considered as an economical alternative to imports (Hendry and Bateson, 1997).

After Hurricane Donna in 1960, Anguilla had almost four decades without a severe hurricane. Hurricanes Luis and Marilyn (which struck only a week or so apart in 1995)

caused some damage to both BVI and Anguilla (Smith et al., 1997) but were relatively small systems. However in November 1999 the centre of powerful Hurricane Lenny passed very close to Anguilla, devastating sea defences, infrastructure and many hotels. Several coastal areas were seriously eroded, including Bankie Banx Preserve, Covecastles and Sonesta Beach, and heavy rains caused floods 2–3 m deep in places. By contrast, although only approximately 80 km north of the hurricane centre, BVI suffered minimal damage.

Hurricane Hugo passed close to BVI in September 1989, and battered Puerto Rico. It generated heavy rainfall and waves approximately 4 m high. Beaches where sand had been mined were eroded 5–10 m inland and seawater encroached 30 m (Lettsome and Potter, 1997). Coastal reclamation projects suffered severe erosion and shallow *Acropora* reefs were impacted. The Beach Protection Ordinance prohibits beach mining without the permission of the Minister of Natural Resources, but this has proved ineffective in protecting these coastal resources (Lettsome, 1998). Between 1982 and 1996, 10416 m³ of sand were legally mined, with 94% coming from Josiah's Bay, Fat Hog's Bay, Brewers Bay and Cane Garden Bay (Tortola) and Little Bay (Virgin Gorda). Eight dredging operators and one unlimited beach sand mining permit are not included in this total (Lettsome, 1998).

Hugo was also the most damaging hurricane to hit Montserrat in recent years. Sustained winds of 140 mph and gusts of 180 mph battered the island for 12 hours. Ninety eight percent of homes were damaged (20% completely destroyed) and total losses exceeded US\$300 million (UNDP, 1989; Butler, 1991). The hurricane compounded erosion problems caused by hurricane David in 1979. Building for a growing tourist industry and a cultural switch from wooden to stone (with cement) houses in the 1960s had already resulted in serious beach excavation which was exacerbated by reconstruction attempts after both hurricanes (Cambers, 1999). Beaches suffered a mean erosion rate of 1.05 m/year between 1966 and 1990 (Cambers, 1990).

EFFECTS FROM URBAN AND INDUSTRIAL ACTIVITIES

The main industries on Anguilla are tourism and financial services. The impact of urban development on nearshore coastal resources (especially coral reefs) may have been lessened by the dry climate. Oxenford and Hunte (1990) concluded the reefs and seagrasses were in relatively good condition despite a decade of tourism expansion, but noted high macro algae cover and turbid water which are often associated with land-based pollution. They considered the minimal rainwater run-off an unlikely cause and attributed the conditions to slow recovery of *Diadema* (after the 1984 Caribbean wide die-off) and naturally fine sediments. Nonetheless, Proctor (1997) notes scrub clearance and dune

reconfiguration for building space and development has increased the sedimentation load on the reefs through beach erosion and subsequent beach re-nourishment without adequate environmental controls.

The most significant industrial activity currently proposed for Anguilla is construction of a rocket launching site. The Anguillan Government has agreed to grant Beal Aerospace a 98-year lease for the remote islet of Sombrero. Only 388 m across, Atlantic swells often crash right over the island. Beal plans to launch communication satellites via the yet untested BA-2 rockets, carrying 800 tonnes of hydrogen peroxide and kerosene (Pearce, 1999). The company plans to launch 12 rockets a year, and industrial accidents are a significant threat. An environmental impact assessment has been heavily criticised as incomplete by the Anguilla National Trust, RSPB, American Bird Conservancy, BirdLife International and regional NGOs such as Island Resources Foundation. So far, many of the arguments have centred on terrestrial life including the endemic *Ameiva corvina* lizard. The Anguilla National Trust describes Sombrero as the most important seabird nesting site in the east Caribbean. Although too exposed for well developed shallow reefs, marine life is rich (Ogden et al., 1985) but poorly documented. The planned facility has not yet been licensed by the British National Space Agency, and discussions continue.

As on Anguilla, the two main industries in BVI are tourism and financial services. The most severe impacts on the marine environment stem from both the shortage of flat coastal land and population pressure intensified by high visitor numbers. Several coastal areas have been reclaimed in Road Town Tortola, and other smaller reclamations occur elsewhere in the Territory. Tortola produces an estimated 40 tonnes of garbage a day (Lettsome, 1998). At Pockwood Pond, one of Tortola's largest stands of red mangroves stood next to a power station, incinerator, cement plant, and rock quarry. The mangroves impeded plans for commercial expansion until an oil spill devastated the area. Rather than restore the habitat, permission was granted to reclaim the area for industrial use. The reclamation extended beyond the mangrove, and also affected nearby reefs (Petrovic, 1998).

Dredging to deepen harbours and boat channels, build marinas and reclaim land requires a permit, but a recognized problem is mining beyond the area of the permit in order to sell mined sand (Jarecki, 1996). Even within coastal bays, dredging operations are rarely screened.

Roads cut on steep hillsides to increase the value of undeveloped real estate generate substantial sediment run-off. Where development does proceed near the coast, topsoil cleared from the building site has sometimes been pushed down the slope to end up in the sea. Such impacts are localized in the BVI at present, but development is occurring at an alarming rate.

Sewage presents another disposal problem to small islands, and is compounded by the high number of visitors. Although a few hotels and commercial enterprises have

installed small treatment works, such facilities in BVI are minimal (Petrovic, 1998). Most houses have septic tanks although a few coastal dwellings discharge directly into the sea. In BVI urban areas, drainage channels designed for rainwater are sometimes contaminated with sewage (Lettsome, 1998). At Cane Garden Bay, Tortola's flagship beach and an important anchorage, algal blooms, bacterial contamination and public opinion galvanized government into constructing the first public sewage treatment works. However, few yachts are equipped with holding tanks and even fewer marinas have pump-out facilities. In crowded marinas such as Wickhams Cay and Virgin Gorda Yacht harbour, sewage is a problem, compounded with pollution from boat yards including paint residues, solvents and leaking engine oil (Petrovic, 1998).

Before the volcanic activity, Montserrat was becoming one of the Caribbean's premier retirement destinations. Beginning in the 1960s, tourism had developed into the leading economic sector and the island was a cruise ship destination. Industrial impacts were moderate although the ship-to-shore pipeline transferring oil to the Texaco and Delta tank facilities has been indicated as a potential threat (IRF, 1993). Waste oil from private vehicles and generators is often disposed in storm drains or poured directly on the ground, where it washes into the sea (IRF, 1993).

LEGISLATION AND PROTECTIVE MEASURES

As UKOTs, Anguilla, BVI and Montserrat cannot be parties to international conventions and treaties in their own right. Where necessary or desirable, conventions to which the UK has acceded may be extended to the OTs. In most cases local legislation is also required. For example the requirement to designate a wetland on joining the Ramsar Convention on Wetlands of International Importance is technically already discharged by the UK (Pritchard, 1990). No initial provision was made for Anguilla or BVI in the Ramsar Convention, although Montserrat proposed a site (Pritchard, 1990). In 1994 BVI suggested the Western Salt Ponds of Anegada as a RAMSAR site (Lettsome, 1998) and this site was finally accepted in 1999. Twenty-six international conventions and treaties with an environmental theme have been extended to the BVI, but domestic regulations do not cover them all (Lettsome, 1998).

The UK Government has produced a White Paper dealing with biodiversity issues in overseas territories (FCO, 1999). Although UKOTs have 10 times more endemic species than the UK (FCO, 1999), most of the UK's financial contribution to international conservation is via Global Environment Fund (GEF), earmarked for developing countries and not available to UKOTs (Pienkowski, 1999). UKOTs are eligible for Darwin Initiative funds for biodiversity conservation from the UK government, but little work has been done. Finding money for resource management can be a challenge, especially where resource use

does not contribute a large part to GDP. For example, fisheries administration might be expected to cost approximately 5% of annual production value, but the 1993 budget for the Anguillan Fisheries Department, although equalling 20% of the 1991 production value, was not enough to cover costs of elementary catch and effort recording (Mokoro Ltd, 1993). In the BVI, the combined budget of the Conservation and Fisheries Department and the National Parks Trust averaged only 1% of the overall budget between 1990 and 1996 (Lettsome, 1998). However, an important development in the region is a program to harmonize fishing regulations between OECS states, including harmonized fishery management legislation, common fisheries surveillance zones and common fishing zones (OECS, 1999).

Coastal Protection

Anguilla has several laws which can be used to regulate coastal resource use. There is a Beach Control Ordinance 1988 which prohibits damage to plants, shrubs and trees, and allows beaches to be declared as protected from sand mining. Seventeen beaches were so designated in 1988. The Cruising Permit Ordinance of 1980 applies to the coastal region, out to 3 nautical miles. Permit fees are charged, and anchoring is prohibited around Sandy Island, Prickly Pear Cays, Seal Island, Dog Island and Rendezvous Bay (Pritchard, 1990).

BVI drew up Coast Conservation Regulations in 1990 but they are not yet enacted. Similarly, the Land-use Planning Bill, legislation on ground water monitoring and control and the Parks and Protected Areas System Plan of 1986 are all still in the pipeline. The Conservation and Fisheries Department's jurisdiction over development projects is largely limited to the Land Development (Control) Ordinance which is administered by the Development Control Authority and Town and Country Planning (Lettsome, 1998). There is no legal requirement for EIAs before development in BVI, and where penalties exist, rapid economic development makes them less effective as a deterrent (Lettsome, 1998). No specific legislation exists to control the import, use, storage or disposal of toxic chemicals. However, many of these issues should be addressed under the new National Integrated Development Plan which provides a framework to promote, plan and rationalize the sustainable development of natural resources.

An area where BVI has pioneered conservation is in the use of mooring buoys to prevent anchor damage to coral reefs. The mooring system, now maintained by the National Parks Trust, was originally conceived, funded and operated by BVI Dive Operators in the 1980s. In addition, private enterprises operate moorings in several popular anchorages, demonstrating the potential for synergy between private enterprise and conservation.

Fisheries Legislation

Fishing within Anguilla's territorial waters and EFZ is regulated by the Fisheries Protection Ordinance of 1988, which repealed the Turtle Ordinance of 1984. Under the new legislation, regulations were set out in 1990, including sports fishing regulations (Pritchard, 1990). Anguilla has a policy of reserving most of the fish resources in its exclusive fisheries zone for domestic fishermen. In the past, foreign fishing vessels caused serious conflicts of interest, for example illegal Taiwanese longline vessels were caught hauling traps belonging to local fishermen in the EFZ. By 1993, Anguilla was reported to have effective surveillance and enforcement of shelf areas and of unlicensed foreign fishing (Mokoro, 1993). Foreign vessels are not totally excluded, but are only licensed north of 19°. Within the OECS framework, the Anguillan Government is an informal observer, and accepts OECS conditions for licensing foreign fishing vessels, but has yet to make a decision on common fishing zones.

The perception that large foreign fishing vessels deplete near and inshore resources to the detriment of local users is shared by BVI. Previously, United States longliners were licensed to target swordfish in the BVI EFZ, but since 1990 there has been a moratorium on large-scale foreign commercial long-line fishing, including several rejected applications from Taiwan. Under the BVI's recent Fisheries Act (1997), locals and visitors alike require a licence to take any marine life. Fishing using scuba, or spearguns attracts a US\$15,000 fine. The Act provides for the declaration of fishing priority areas, marine protected areas, species protection, gear restrictions, and spatial or temporal closures. Local fisheries management areas can be set up where local users help devise by-laws. Under the law, anti-pollution measures can be enforced, and the Chief Fisheries Officer is mandated to ensure stocks are not overexploited, through implementation of a fisheries management plan. The Act sets out wide ranging stop, search and seize powers for enforcement officers, and sets fines up to US\$500,000 in addition to confiscation of foreign vessels infringing the Act. However, enforcement procedures are not yet well worked out. In March 1999 all foreign vessel licences were suspended, but the resulting outcry from the neighbouring United States Virgin Islands led to temporary licences being issued from June 1999. Although the Act has a sound basis in sustainable management, its impact will be diminished unless sufficient resources are made available for enforcement. For example, collection of undersized lobster and conch, particularly by tourists and non-professional fishermen remains a problem.

Montserrat's fishing regulations were enacted in 1982, but were generally not enforced. More recent legislation has been drafted to correspond with OECS-harmonized fisheries legislation, with specific habitat-protection measures including provision for the adoption of MPAs (IRF, 1993).

Marine Protected Areas (MPAs)

Anguilla's Marine Parks Ordinance of 1982 empowered the Governor to designate MPAs and acquire private land. The legislation was amended in 1992 so as to restrict damaging activities and impose fines or imprisonment as penalties. After a history of discussions and plans for multi use/zoned marine protected areas in Anguilla which dated back to the early 1970s, five marine parks were established in 1993 (Smith et al., 1997). Four of these (Sandy Island, Prickly Pear—including the Seal Island reef system, Island Harbour and Dog Island) are designed to protect reefs and are managed by the Department of Fisheries.

The BVI has marine protected areas at the Wreck of the Rhone National Park, The Baths (Virgin Gorda), and Anegada's Horseshoe Reef. However, these are not 'no take' areas. Commercial fishing around the Rhone and the Baths is somewhat restricted because of day-to-day conflicts of interest with the tourist industry. Horseshoe Reef is off-limits to both commercial and recreational use. All anchoring is forbidden, and despite its isolation, few charter boats venture there because of the treacherous waters. Fishing was initially banned, but permits were later issued to Anegadian fishers. Pomeroy (1999) estimated the annual catch from Horseshoe reef as 47.7 tonnes, of which over 16.4 tonnes was lobster.

Montserrat has no designated MPAs although proposals have been put forward for the northernmost tip of the island (Bovey et al., 1986), Fox Bay in the west (IRF 1993) and an extensive zoning system encompassing fishery zones, recreational zones and no-take preserves (Brosnan et al., 1999). Since 1979, the mangroves and pond at Fox's Bay have been leased to the Montserrat National Trust as a bird sanctuary.

PROSPECTS AND PROGNOSIS

The immediate outlook for the marine environment of Montserrat does not seem good. The impacts of the volcano on nearshore systems have been serious and it may take a long time for the ecosystems to recover. The concentration of the population in the north will inevitably increase the pressure on the marine resources less heavily impacted by the volcano, but it must be hoped that the sustainable development plan will be effective. Restricted access to the south coast may provide a *de facto* marine protected area which could help maintain the island's fisheries in the long term.

In the British Virgin Islands and Anguilla the future of the marine environment looks relatively good. Both territories are wealthy, reducing the pressure on marine resources through subsistence use. There is an awareness of environmental issues at all levels of society. The present financial reliance on tourism provides every incentive to maintain healthy marine environments as a major source of revenue, although development is rapid and in some places badly planned and implemented. However, a change in rules

governing offshore financial service industries could decrease the revenue of these islands, and the tourist market is fickle. The loss of either one of these industries would lead to an increased dependence on marine resources, particularly nearshore fish and invertebrates. Revenue currently gained from schemes such as mooring buoy programmes would be lost. Government departments and NGOs must continue to work with local communities and tourism operators to implement long-term sustainable management strategies for coastal development and conservation. With these in place, the marine habitats of these beautiful islands should be sustained well into the new millennium.

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