Management Plan for the Marine Parks of Anguilla

Prepared for:
Organisation of Eastern Caribbean States
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1 Introduction

This management plan was developed by a project managed by the OECS Natural Resources Management Unit, with funding from the UK Dept for International Development in the Caribbean (DFIDC) Small Projects Facility at the NRMU. The project included 7 days' research in Anguilla including individual meetings with government and non-government stakeholders, and a public consultation held on 16th October 2001, attended by about 25 persons. The management plan was written up after the field work. It includes the feedback given at the public consultation on the following questions:

- What are the current impacts and threats to Anguilla's marine parks?
- What uses (activities) should be restricted in marine parks or any sub-zones; and which new areas should be set aside as marine parks, and why?
- Who should be responsible for what in managing the marine parks and monitoring habitats?

Given the short nature of the project and the preliminary nature of the feedback provided, this management plan should be regarded only as a first attempt at describing the status and management of Anguilla's marine parks. As guided by the terms of reference, the main focus was placed on assessing needs for monitoring the status of marine habitats. In this and other areas, much further analysis, consultation and design remains to be done. The institutional system for protected area management is also in a state of change, with several new pieces of legislation now under consideration of relevance to marine parks management. This management plan thus attempts to describe the current situation, and the future options, but will clearly require updating once firm management arrangements are in place.

- ► In this 'interim' management plan, this shaded box format is used to give recommendations for the various additional materials and activities required to complete the plan. Where appropriate, advice is given on the processes that may be followed to develop such materials. In future versions of the plan, these boxes should be replaced with the material developed, or statements on the progress made.

- ► This interim plan should be upgraded to a first full management plan upon completion of a further participatory planning process as described in the following sections. Anguilla's marine resource stakeholders need to agree the future goals and institutional arrangements for the marine parks system, and the objectives, zonation, and regulations specific to existing parks and any new parks.

- ► In future, this plan should be revised every three years.

This management plan is based on a number of guiding principles. Firstly, management should be based on an *integrated* and *inter-disciplinary* approach. This means recognising the links between the marine environment and the various activities taking place both on land and at sea. Changes in marine habitat quality may be due to pollution, fishing, tourism, hurricanes, ineffective management and so on, each of which must be understood and integrated into the wider picture. It also means taking an overall view of the system, balancing ecological, social and economic perspectives.

Secondly, the management of marine parks, like any other shared public resource, should be *people-centred and participatory*. Managing marine parks mostly requires managing people, rather than fish or corals. Stakeholder input is thus vital for success. Wherever people have

livelihoods that depend on the marine park areas, their needs must be taken into account. Local or 'traditional' knowledge can also provide valuable inputs to the design of the system, e.g. on the locations of the most valuable habitats, and any negative impacts taking place. Solutions developed in partnership with resource users are more likely to be well adapted to the local area, and more likely to be accepted by the users, than 'top-down' schemes that simply aim to suppress 'undesirable' activities.

Thirdly, these guidelines promote *flexible* management solutions, for coping with *dynamic* situations. Both environmental and socio-economic conditions change over time, both in the short term (e.g. due to hurricanes or oils spills), and in the long term (e.g. due to global warming, or gradual development of tourism industries or fishing pressure). What is appropriate today may not be appropriate tomorrow or in ten years time. An *adaptive* approach is thus recommended, that recognises the complexity of natural resource management and develops management strategies based on learning and feedback. Such feedback requires monitoring of both the state of the system and the various factors likely to be affecting it.

This management plan is divided into six main sections. Section 2 describes the distribution, and status of Anguilla's marine resources and their main current uses and impacts. The general and technical components of the marine parks system are described in Section 3, including details on the individual park areas, and the legislation and regulations applicable to them. Specific information on the institutional arrangements for marine parks is given in Section 4, including the roles and responsibilities of the different agencies. Monitoring needs are described in Section 5, while financial and physical requirements are briefly covered in Section 6. The final Section 7 collates the various recommendation boxes scattered through the document and provides an ordered sequence of future management actions.

2 Anguilla's Marine Resources

Anguilla is the most northerly of the Caribbean Leeward Islands. Besides the main island, of 91km^2, Anguilla includes several small sandy islets and cays, most of them protected as marine parks. The 3392km^2 Anguillan Bank includes the island shelves of Anguilla, St Martin/St Maarten and St Bartholemew. The approximate shelf area under Anguilla jurisdiction is 1388km^2, while Anguilla's extended fishery zone covers approximately 85 500km^2.

The current distribution and status of Anguilla's marine resources is largely unknown. Hurricane Luis in 1995 reportedly destroyed 61% of live corals and 45% of seagrass beds. No regular monitoring of fisheries or marine habitats has been in place since Hurricane Luis.

This section then presents information on habitat status and distribution from the years prior to Hurricane Luis, mainly derived from the two following studies:

- the 1990 Bellairs Research Institute survey of 8 marine sites including Little Bay, Dog Island, Scrub Island and the north and south coasts of Anguilla (Oxenford and Hunte, 1990); and
- the Natural Resources Institute's 1995 mapping of coastal and marine habitats, based on 1991 photographs.

Summary information on the impact of Hurricane Luis was obtained from the 1996 impact assessment study (Bythell, Cambers and Hendry, 1996), though the main ecological impact study report could not be located.

2.1 Hurricane Luis

Hurricane Luis passed Anguilla in September 1995. With sustained wind speeds in excess of 140 mph (225km/hr), and the hurricane centre only 28km from the north east tip of Scrub Island, Hurricane Luis devastated both the island's infrastructure and natural resources. Following the hurricane, the impacts on marine and coastal resources were assessed by Bythell, Cambers and Hendry (1996).

Hurricane Luis caused severe damage to all of Anguilla's major coastal and marine ecosystems – mangroves, dunes, beaches, sea grass beds and coral reefs – throughout the country (Bythell et al, 1996). Mangroves stands, which were not abundant before the hurricane, were virtually eliminated. Red, black and white mangrove stands were all destroyed, with mortality rates varying between 68% and 99%. Recovery is not expected for many years. Both sand dunes and beaches were severely eroded, especially on the north shore. Sand dune bases retreated an average of 9m, with a maximum of 30m in Meads Bay on the north coast. Many beaches were eroded to their bedrock foundations. Beach volume decreased by an average 40% and beach width by 9m. Neither the beaches nor the dunes are expected to fully return to their pre-hurricane levels. The hurricane also created demand for sand resources, for rebuilding beaches in front of tourist hotels.

At sea, seagrass bed cover was reduced by 45%, leaving carpets of dead seagrass up to 1m thick on most beaches. Coral reef damage was also extensive, with 61% of intact live reefs, both hard corals and soft corals, being degraded to rubble or bare rock. Many elkhorn (*Acropora palmata*) reefs, were destroyed, removing their natural breakwater effect and increasing the wave energy reaching the beaches. Damage was reported by Bythell et al

(1996) to be most severe at the inshore sites, which may have been more weakened by man-made impacts and lower water quality. Recovery may be slower at these sites. The offshore reefs around Prickly Pear and Dog Island were reported to be less damaged, and expected to recover faster. Both fishers and divers however claim that damage was worse on the offshore reefs, that took the full force of the storms.

2.2 Habitat Distribution

Anguilla's coastal area comprises an interdependent system of salt ponds, limited mangrove stands and extensive coral sand beaches. Dog Island, Prickly Pear East, Crocus Bay, Meads Bay and Long Bay are known as turtle nesting beaches, though other beaches on the north and south shores are also used. Beyond the coastline, Anguilla is surrounded by several islands, a diverse variety of coral reefs, including an extensive barrier reef on the north coast, and patches of sea grass beds both on the north and south shores.

► Prepare and insert summary map of Anguilla's marine and coastal systems, indicating major habitat distributions, bathymetry and water currents.

The distribution of Anguilla's coastal resources was mapped by Blair-Myers et al (1995) from colour air photographs taken by the Anguilla Marine Resource Inventory field surveys in 1991, and ground truthed at 750 sites. Blair-Myers et al's analysis identified two types of mangrove stands; algae and seagrass beds; and seven types of coral reefs in addition to bare sand and submerged rocks. As tabulated in Table 4 and summarised in Table 1, the distribution of these different habitat types varied significantly around the islands.

In 1991, when the photographs were taken, soft corals dominated most of Anguilla's shelf waters, from Dog Island, along the Prickly Pear reefs to the Island Harbour area, and also on the eastern parts of the south shore.

Hard corals were found both along the coastal waters and on the fringing offshore reefs. *Montostraea* star corals were especially common around Seal Island, on the north shore, and in Forest Bay on the south shore. *Porites* finger corals were less abundant, but were most frequent in the Seal Island and Shoal Bay areas. Crest reefs, including *Millepora* fire corals were the least abundant coral type, with only two small outcrops each on the north and south shores.

The offshore cays were dominated by soft corals, with seagrass beds and hard coral reefs increasing in abundance towards the coast, moving from Dog Island to Seal Island. North shore habitats were also dominated by soft corals, especially on the eastern shores, with some sea grass / algae traces in Sandy Island / Little Bay areas. The south shore was dominated by sea grass on the western side, and by soft corals and bare sand on the east side. The richest hard reefs were found in the middle sections (including *Montostraea* and *Porites* star corals, and *Millepora* fire coral types).

Though healthy corals exist on both Anguilla's north and south shores, the south coast is more exposed to the prevailing easterly wind, and the rougher seas make snorkelling less attractive on this side.

Mangrove habitats were virtually all found on the south shore, both in the middle sections from Rendezvous Bay to Forest Point, and in Scrub Island (Table 4).

Table 1. Relative distribution of marine habitats in 1991, based on the Anguilla Atlas of Marine Habitats (Blair-Myers et al, 1995, see also Table 4)

Location	Hard corals	Soft corals	Seagrass	Algae
Dog Island		● ●		●
Prickly Pear / Seal Island	●	● ●		
North Shore (W)			●	● ●
Sandy Island	●	● ●	●	
Little Bay	●	●	● ●	●
Shoal Bay / Island Harbour	●	● ●		●
South Shore (W)	●	●	● ●	●
South Shore (mid)	●	●	●	● ●
South Shore (E)		● ●		●
Scrub Island		● ●	●	●

● ● Dominant; ● Common

2.3 Uses of Anguilla's Marine Resources

2.3.1 Fishing

The Anguillan fishing industry is largely artisanal, with approximately 400 fishers operating from open, outboard-powered boats of 18-32ft (OECS-NRMU, 1998). The fishery may be divided into two main sectors, directed at lobster and finfish. Both of these fisheries mainly use fish pots and traps, though finfish are also taken by lines and seine nets. Most fishing boats have a crew of two or three and operate within 40 miles from the shore. A recent DFID-funded project has established the viability of an offshore long-line industry for large pelagic species. Detailed information on the background and operations of the different fisheries is given in the draft Fisheries Management Plan (OECS-NRMU, 1998)

Lobster are the most valuable fishing target on Anguilla's shelf area. Two species are caught – spiny lobster (*Panulirus argus*) and the smaller crayfish (*Panulirus guttatus*). Lobster boats mainly operate from the north-eastern harbours, especially Island Harbour, and nowadays market their catch mainly to Anguilla's expanded hotel sector. The lobster fishery is highly seasonal, with catches declining during the tourist low season of July to September, coinciding with the spawning season for spiny lobster. This period is a *de facto* though not legal close season for lobster, with some fishers switching to finfishing at this time. Lobster fishers mostly work in the Prickly Pear area, especially for crayfish, rarely going as far as Dog Island. Spiny lobster are caught with large pots dropped in deep water on the edge of the reef shelves. The smaller crayfish pots are hand-set carefully by divers among shallow corals. Gear damage to coral habitats is thus likely to be less for crayfish than lobster fishing. Risk still exists, however, of overexploitation of crayfish stocks, particularly in their nearshore grounds.

Finfish boats mainly work from the south-western harbours, including Sandy Ground. Catches are marketed via licensed market vendors in St Martin, Monday through Friday. Some of the more valuable species such as the deep reef snappers and groupers and the coastal large pelagics are sold directly to Anguillan hotels. Pots are most commonly used for reef fish, set around the island shelf and offshore banks. Vertical long lines or 'rigs' are also used for deep slope finfish, while beach seines and encircling seines are set for shoaling species. The use of gillnets is banned (see Section 3.6).

► Research and insert information on numbers of fishers and vessels operating from different ports and in different fishing grounds, indicating the dependence of livelihoods on different marine parks and other areas.

2.3.2 Tourism

In the decade from 1985 to 1995, Anguilla's gross domestic product more than trebled (from EC$ 47m to EC$ 165m), largely due to a rapid expansion in the tourist industry. Annual visitor arrivals jumped from 17 561 in 1982 to 125 780 in 1994. The hotel and restaurant sector contributed 36% of the total gross domestic product in 1994 (Proctor and Hodge, undated). The 2001 Official Island Guide 'What We Do In Anguilla' lists 40 resorts/hotels/guest houses and 55 restaurants. This development of Anguilla's tourism industry is largely due to the country's attractive and largely unspoilt white sand beaches and the recreation prospects of the waters beyond.

Anguilla's tourists enjoy a range of yachting, diving and snorkelling opportunities, with several local operators based in Anguilla. Non-resident tourists also visit the offshore cays with operators from St Martin and other islands, after clearing customs etc at Road Bay. Diving opportunities have been enhanced by the deliberate sinking of nine wrecks, between 1982 and 1993, by the Department of Fisheries and Marine Resources. The wrecks range from 110 to 230 feet in length and were sunk off Seal Island Reef, off Meads Bay and Sandy Island and off Flat Cap Point. After only a few years, these wrecks have developed into substantial artificial reefs, providing habitats for a wide variety of corals and other marine life.

► Research and insert information on numbers of tour operators working from different ports (including St Martin) and in different waters, marine parks etc.

2.3.3 Sand extraction

The boom in the tourism industry increased the demand for sand, both for building hotels, and for new homes and commercial premises linked to the expanding economy. Sand was initially extracted from sand dune areas such as Sile Bay on the south east coast, now exhausted and further degraded by Hurricane Luis. In 1994, the Government prohibited sand mining at all beaches except at Windward Point at the eastern end of the island (Proctor and Hodge, undated). Dune sand supplies at Windward Point are depleted, and consideration has been given to the dredging of sand from offshore sandbanks. The potential impacts of such activities on nearby marine habitats will need to be monitored.

2.4 Impacts and Threats to Marine Resources

Coral reef communities are extremely diverse with high levels of interdependence between species. This fragile balance can be easily upset by changes in water quality, or by impacts on grazing species such as parrot fish and sea urchins. Where such species are reduced by overfishing, algae can grow unchecked by their natural predators to the point of smothering the reefs. Both coral reefs and sea grass beds are also vulnerable to both water quality and physical damage. Corals have low tolerances to both temperature (25-29 °C) and salinity (32-36 ‰). They also require good light conditions for photosynthesis of their symbiotic algae. Any factors which reduce light penetration may thus stress corals.

Negative impacts on coral reefs will affect more than their own biodiversity. Coral reefs act as important coastal defense structures, protect the beaches from storm waves, stabilise nearshore sediments, produce beach sand, provide habitats for exploited fish stocks and attractions to the tourist industry.

Corals are also slow growing, with a large coral head taking decades to form. Sea grasses also take time to recover from physical damage, with reproduction only taking place from vegetative reproduction from rhizomes.

The current impacts and threats to Anguilla's coastal and marine resources were reported by a range of stakeholders to include the following:

- anchor damage;
- diver damage, reef walking and boulder turning etc;
- collection of reef materials (coral, sand or shell) for construction;
- fishing;
- domestic pollution, sewage etc;
- sedimentation;
- dredging and other coastal engineering; and
- conversion of mangroves to 'economic' uses.

Other threats to conservation value reported in other countries that may affect Anguilla in future include (Salm, Clark and Sirila, 2000, Part 2):

- introduction of alien species;
- collection of corals and shells by tourists, or for commercial export;
- collection of aquarium fishes;
- destructive fishing, e.g. with explosives or poison; and
- construction practices affecting turtle nesting.

The potential impacts of **fishing** on marine resources include both the overexploitation of target fish and invertebrate stocks and the damage to habitats caused by fishing gears. Both commercial and recreational fishing contribute to both problems, with fish pots and coastal line fishing potentially damaging both hard and soft corals. Speargun fishing may also damage corals.

The marine **tourism** sector is blamed for sewage pollution, littering and gas spills from boats in swimming areas. Sewage problems have been reported both in Prickly Pear and Sandy Island marine parks, arising both from visiting yachts and beach restaurants. Little Bay is reportedly vulnerable to both oil/gas pollution from visiting boats and to sewage effluent from coastal housing. Sun-tan oil is sometimes noticeable in swimming areas.

Physical damage is caused by careless anchoring over non-sand bottoms, boat groundings, and diver damage. Both divers and snorkellers may stand on corals, touch the fragile surfaces, or deliberately break off coral souvenirs. Such damages can be small individually but can build up to significant long term damage if not controlled. Though perhaps negligible compared to the devastation caused by hurricanes, diver damage can cause significant harm within locally popular areas. Little Bay has been a particular focus of concern in November 2001, with yachts

anchoring too near the beach, campfires being lit on the beach on evenings, coral being cut and mud being removed from the base of the Little Bay cliff.

The main **land-based impacts** on marine resources are caused by domestic sewage treatment problems and siltation from coastal construction. Facilities such as the desalination plant, the Corito Bay oil terminal and the Road Bay harbour may also pose some risk of occasional spills or more regular leakage. Most private houses in Anguilla use 3-chamber septic tanks, many of which have not been well installed on the hard, rocky ground and do not work as well as in other areas. Leakage from such domestic tanks has been observed in both the West End and Island Harbour areas. Most of the larger hotels have their own well-constructed sewage treatment systems. Sedimentation can arise from both dredging, e.g. for sand, or from land development activities increasing the runoff of materials from bare earth during heavy rain. The settlement of such sediments on the corals reduces available light and may also stimulate high levels of bacterial activity. This in turn reduces oxygen levels around the corals, and provides good conditions for the development of bacterial diseases.

Elevated levels of nutrients – nitrates and phosphates – increases the levels of phytoplankton in the water column again decreasing light penetration. High nutrient levels also stimulate the growth of benthic macroalgae, which compete for space on the reef and can quickly smother the slow growing corals. Epiphytic algae can also grow on sea grass blades in these conditions, reducing their light reception.

Natural (or at least non-local) factors affecting marine resources include hurricanes, the 'Orinoco plume' and global warming. Scientific predictions based on climate records, suggest that the next two or three decades will be a period of increased hurricane activity in the Caribbean (Bythell et al, 1996). Pathogen's from South American rivers have caused fish kills in the south east Caribbean for at least the last three years. Coral bleaching associated with raised water temperatures was widespread globally in the warm summer of 1998, but had limited impact in Anguilla.

The main threats to Anguilla's marine resources include:

- the lack of public awareness about environmental problems and involvement in solutions;
- the lack of coordination and communication between stakeholders (both between government departments and between the government and the public); and
- the lack of political will to enforce environmental regulations, particularly against powerful interests such as the tourism sector.

A potential threat to the marine parks is the risk of tourism development within or adjacent to the park areas. Dog Island and Prickly Pear both have some private land holdings, while Little Bay and Shoal Bay / Island Harbour both have private land on their borders.

► Extend analysis of impacts on marine resources, clarifying specific locations and extent of impacts.

► Develop and insert map of major point sources of impacts from coastal pollution, including population centres, runoff points etc.

2.5 Status of Anguilla's Marine Resources

2.5.1 Habitats

The status of Anguilla's marine resources was investigated by Oxenford and Hunte in 1990, five years before Hurricane Luis. Oxenford and Hunte (1990) sampled three broad habitat types – patch reefs, hard coral reefs and seagrass beds – at eight sites, as listed in Table 2 (see also Section 5.5). Oxenford and Hunte did not investigate the offshore cay sites studied by the Cambridge-Anguilla 1989 Expedition at Shoal Bay, Sandy Island and Prickly Pear / Seal Island (no report on these investigations has ever been received by the DFMR). Oxenford and Hunte, however, reported that these popular recreational areas were also showing signs of human impact in 1990.

Summaries of the status indicators recorded by Oxenford and Hunte in 1990 are given in Table 5 to Table 7. The original data producing these results is held at the DFMR, enabling statistical testing of differences against current values.

Oxenford and Hunte (1990) reported Anguillan reefs generally to be in good condition. As summarised in Table 2, relatively healthy hard coral, soft coral and seagrass sites were found on both sides of the island in 1990. Seagrass sites included mainly *Syringodium filiforme* (manatee grass) at deeper water sites on the south coast and mainly *Thalassia testudinium* (turtle grass) in the shallower north coast waters e.g. off Little Bay. The size structure of sea urchins with mean test diameters of 10-11cm suggested an unexploited population.

Table 2. Relative health of marine habitats in 1990, at sites sampled by Oxenford & Hunte (1990), based on the detailed data given in Table 5.

Location	Hard corals	Patch reefs	Seagrass
Dog Island	● ●		NS
Crocus / Little Bay		● ●	● ● (Thalassia)
Black Garden Bay	● ●	● ●	NS
Little Harbour			● ● (Syringodium)
Corito Bay			NS
Forest Bay	● ●	● ●	(Syringodium)
Sandy Hill Bay		● ●	NS
Scrub Island			NS

● ● = Sites with half or more of their 'community descriptors' (abundance and diversity of hard corals, soft corals, sponges, fish, urchins) at above median values
NS = Not sampled

Some signs of human impacts were however noticed, including indications of low levels of land based pollutants, fishing and boating, notably at the more accessible sites: Crocus/Little Bay and Little Harbour inlet, and the oil terminal site at Corito Bay. Oxenford and Hunte found high macroalgal abundance at all coral reef sites except at Dog Island (Table 5) and at all patch reef sites (Table 6). Macroalgae cover was highest in the four patch reef sites studied on the south coast. The high algae abundances at this time may have been due to the absence or very low abundance of the previously common grazing sea urchin *D. antillarum*.

Oxenford and Hunte compared their 1990 results with those recorded by Salm (1980, not seen) for Crocus/Little Bay, Little Harbour, Corito Bay, Forest Bay, Sandy Hill Bay, Dog Island and Scrub Island. The comparison revealed few qualitative changes, except at Little Harbour inlet, where Salm observed abundant juvenile lobsters and fish in the nearshore algal beds, not found

in 1990. One of the adjacent red mangrove stands had been removed between the two surveys and kept clear by the use of herbicide poisons in the area. In Crocus Bay, Salm (1980) also reported abundant *Diadema antillarum* along the eastern rocks, not seen in 1990. This drop in numbers reflects the Caribbean-wide mass mortality of this species in 1982-84, with no real recovery since this time in Anguilla.

As noted earlier, no quantitative data are available on the current status of Anguilla's habitat distribution or condition. Some anecdotal information was provided by divers, for example that the badly damaged Little Bay seagrass beds have now much recovered, with fish abundances also close to their previous levels.

- ► Insert habitat status data from 1989 Cambridge-Anguilla expedition for Prickly Pear, Sandy Island and Shoal Bay; and 1996 post-Luis assessment, if/when reports located.
- ► Append list of marine fauna and flora found in Anguilla, e.g. based on Oxenford and Hunte, 1990.
- ► Reassess status of marine habitats annually, using the methodologies given in Section 5, and provide latest results here, providing comparisons with previous years.

2.5.2 Fish stocks

The very limited available knowledge on the status of Anguilla's fish stocks was included in the 1998 Draft Fisheries Management Plan (OECS-NRMU, 1998), as summarised in Table 3.

Table 3. The status of Anguilla's fish stocks, as reported in the 1998 Draft Fisheries Management Plan.

Stock	Status
Shallow shelf and reef fish	Largely unknown. A decline is reported for stocks on near-shore reefs, with fishermen having to lay pots further offshore to maintain catch rates. High value species such as grouper are largely found on the offshore reefs.
Deep slope and bank fish	Unknown. Likely to vary considerably between banks.
Coastal pelagics	No data available
Large pelagics	No data available
Lobster.	Unknown, however, anecdotal information suggests that spiny lobster *P. argus* stocks may be at or near full exploitation. Nearshore lobster stocks are observed to be in decline. The fishery for the smaller crayfish *P. guttatus* is relatively new and is considered developing or 'not fully exploited'. There are no size limits for crayfish, but mature animals are believed able to escape through the legal minimum mesh of 38mm used in spiny lobster traps. Fishermen assert that all lobster recruitment was lost in the year of Hurricane Luis due to the destruction of sea grass and juveniles. Recruitment was minimal in the following year also as the seagrass had still not recovered. Recruitment levels are now thought to be fully recovered to their pre-Luis levels.
Conch.	Stocks are thought to be plentiful in certain areas. Demand is limited in Anguilla, both by local consumers and hotels.
Turtles.	Considered to be severely overexploited throughout their ranges in the western Atlantic, and in some cases threatened with extinction.

► DFMR to assess status of different fish and invertebrate stocks, and to insert up-to-date statement on relative positions, e.g. relative to target and limit reference points.

Table 4. Occurrence of different habitat types in localities (i.e. in each map box) around Anguilla, as identified and mapped by Blair-Myers et al (1995).

Zone	Locality	Map	Red Mang-roves	White / Black Mang-roves	Algae	Sea Grass	Algae / Sea Grass Traces	Shal-low Reef	Brown Algal Reefs	Soft Cor-als	Montos -traea Reefs	Pori-tes Reefs	Crest / Mille-pora Reefs	Mixed Reefs	Bare Sand	Subm-erged Rock
			MR	MW	AG	SG	AT	AD	AB	SC	MO	PO	CR	CX	SA	RO
Offshore Cays (W to E)	Dog Island	1				○	●		●	●●			○		●	●
	Prickly Pear	2			○	○	●	●	●	●●	●	○		●	●	●
	Seal Island	3			●	○	●	●	●	●●	●	●	○	●	●	
North Shore (W to E)	West Point (N)	12 (N)				●	●	●	●●						●	●
	Sandy Island	8			○	●	●●	●	○	●●	●				●	
	Little Bay	9			●	●●	●●	●	●	●					●●	●
	North Channel	4			○		●	●	●	●●	●		○	●	●	
	Shoal Bay	5			●	○	●	●	●	●●	●	●		○	●	○
	Snake Point (N)	6 (N)			●	○	●	●	●	●●		○		○	●●	○
	Scrub Island (N)	7 (N)	○				○	○	●	●●					●●	○
South Shore (W to E)	Shoal Bay	12 (S)			●	●●	●●	●	●	●	●				●	●
	Rendezvous Bay	13	●	○	●	●●	●●	●	●	●	●				●	
	Forest Bay	14	●	○	●	●	●●	●	●	●	●			○	○	○
	Forest Point	10	○	○	●	●	●	●	●●	●	●	○	●	○	●	●
	Sile Bay	11			●	○	●	●	●	●●	○	○	●		●●	●
	Snake Point (S)	6 (S)			●	○	●	●	●	●●					●●	
	Scrub Island (S)	7 (S)	○				●	○	●	●●					●	○

○ = Rare (<0.5% cover); ● = Common; ●● = Dominant, allocated 'by eye'.

Table 5. Abundance and diversity indices for major species groups recorded in 1990 at hard coral reef sites around Anguilla (source: Oxenford and Hunte, 1990). Above-median sites for each indicator marked in bold text.

Site code	Site Name	Hard corals		Soft corals		Sponges		Macroalgae		Fish		Sea Urchins	
		% Cover	Div-ersity (d_c)	Num-ber $10m^{-2}$	Div-ersity (d_n)	% Cover	Div-ersity (d_c)	% Cover	Div-ersity (d_c)	Num-ber $10m^{-2}$	Div-ersity (d_n)	No. D. ant. $25m^{-2}$	No. T. vent. $25m^{-2}$
1Hi	Black Garden Bay (inshore)	10.1	2.05	4.6	3.18	**2.77**	**2.04**	7.5	1.89	24.9	5.79	**0.3**	0
1Ho	Black Garden Bay (offshore)	**14.0**	**3.53**	**15.6**	1.92	2.23	**1.55**	**26.3**	1.24	**47.3**	5.28	**0.5**	0
2H	Crocus/Little Bay	10.6	**3.33**	8.0	3.34	2.64	**3.71**	12.0	2.08	15.7	**10.51**	0	0
3H	Little Harbour (out-side barrier reef)	6.3	2.31	11.3	1.06	**2.75**	1.00	10.1	**2.24**	18.5	6.30	0	0
4H	Corito Bay (30m off fuel pipe mooring)	7.3	2.63	**22.9**	**3.92**	0.05	1.00	**28.4**	**4.33**	10.0	**12.62**	0	0
5H	Forest Bay (outside barrier reef)	**12.7**	**3.14**	**15.7**	**3.50**	1.64	**2.19**	10.3	**2.19**	**42.8**	**7.71**	**0.2**	**0.1**
6H	Sandy Hill Bay (in channel to bay)	6.4	**2.94**	8.0	**7.13**	0.03	1.00	**19.4**	**3.05**	12.2	**7.57**	0	0
7H	Dog Island (West Cay)	**23.1**	2.15	**16.8**	**4.05**	**11.63**	1.54	0.2	1.00	**81.5**	2.03	**0.1**	0
8H	Little Scrub Island	**15.5**	2.54	2.6	3.07	**3.00**	1.18	**13.1**	1.08	**30.7**	6.05	0	0

Diversity measured as Simpson's Diversity Index based on cover (d_c) or abundance (d_n) data:
$d_c = C(C-1) / \Sigma c_i (c_i-1)$ where c_i is the cover by the ith species and C is the total cover by all species;
$d_n = N(N-1) / \Sigma n_i (n_i-1)$ where n_i is the number of colonies (or individuals) of the ith species and N is the total number of all species.
Sea urchins: D. ant. = *Diadema antillarum* (Black, long-spined); T. vent. = *Tripneustes ventricosus* (white, edible)

Table 6. Abundance and diversity indices for major species groups recorded in 1990 at patch reef sites around Anguilla (source: Oxenford and Hunte, 1990). Above-median sites for each indicator marked in bold text.

Site code	Site Name	Hard corals		Soft corals		Sponges		Macroalgae		Fish		Sea Urchins	
		% Cover	Div-ersity (d_c)	Num-ber $10m^{-2}$	Div-ersity (d_n)	% Cover	Div-ersity (d_c)	% Cover	Div-ersity (d_c)	Num-ber $10m^{-2}$	Div-ersity (d_n)	No. D. ant. $25m^{-2}$	No. T. vent. $25m^{-2}$
1P	Black Garden Bay	**5.51**	2.12	**21.2**	**7.73**	**2.60**	2.78	20.8	1.25	**107.6**	4.21	0.1	0
2P	Crocus/Little Bay	**5.57**	**3.50**	16.5	5.76	**4.91**	**4.50**	14.5	1.21	10.3	**4.67**	0	0
3P	Little Harbour	**5.52**	2.70	15.0	6.11	1.14	2.05	**26.2**	1.27	**27.1**	4.47	**1.0**	0
4P	Corito Bay	3.96	**3.79**	**20.7**	5.78	1.72	2.28	**45.5**	**1.39**	14.7	**4.94**	**0.8**	0
5P	Forest Bay	3.77	**3.53**	**20.2**	**8.53**	**2.41**	**3.52**	**32.2**	**2.84**	17.1	**7.09**	0.1	0
6P	Sandy Hill Bay	**6.15**	**3.73**	**27.4**	**9.34**	1.59	2.74	**27.3**	1.32	**30.0**	**5.70**	**0.2**	0
7P	Dog Island (N side)	4.48	3.26	13.6	**7.16**	**3.88**	**3.31**	22.6	**1.40**	14.2	3.38	0	0
8P	Scrub Island (W side)	1.88	2.32	7.0	6.43	1.33	**3.31**	21.7	**1.62**	**30.4**	3.43	0	0

Table 7. Abundance and diversity indices for major species groups recorded in 1990 at patch reef sites around Anguilla (source: Oxenford and Hunte, 1990). Above-median sites for positive indicators marked in bold text.

Site code	Site Name	Seagrass			Macroalgae		Fish			Sea Urchins	
		No. shoots $625cm^{-2}$	% Thal-assia	% Sand cover	% Cover	Div-ersity (d_c)	Num-ber	No. Spe-cies	% Juv-enile	No. D. ant. $25m^{-2}$	No. T. vent. $25m^{-2}$
2S	Crocus/Little Bay	13.3	100.0	17.7	11.6	**3.12**	**25.7**	**8.0**	**86.5**	0	0
3S	Little Harbour (inside lagoon)	72.8	4.3	21.8	**28.8**	2.72	1.5	1.0	30.6	0	**5.9**
5S	Forest Bay (inside lagoon)	**81.4**	5.5	0.0	22.2	2.16	0.5	0.5	50.0	0	1.6

3 The Marine Parks System

3.1 Background

This management plan was written at a time of increasing global commitment to sustainable environmental management, coupled with high uncertainty over the future management roles and responsibilities for Anguilla's marine parks. Anguilla signed the OECS St Georges Declaration of Principles for Environmental Sustainability on 10 April 2001, and also the UK Overseas Territories Environmental Charter in September 2001. Supporting these commitments, a National Environmental Management Strategy and Action Plan for Anguilla has been drafted (October 2000) providing guidance on environmental education; development planning; public participation; and legislation. Objective #5 of this draft strategy requires the development of 'a policy for, and a system of, aquatic and terrestrial protected areas for biodiversity conservation'. A draft 'National Parks and Protected Areas Ordinance' has also recently been prepared, and is currently awaiting consideration at the Attorney General's chambers (see Section 3.5). The management of marine parks is clearly at an evolving stage, and needs to be integrated with these broader initiatives for the environment.

This section describes the current marine parks system of Anguilla, including the latest proposals for legislation and management. As mentioned earlier, the details of the institutional, monitoring and financial arrangements are described in later sections.

3.2 Goals and Objectives

No clear statement has been defined outlining the goals and objectives of Anguilla's marine parks system. The five current marine parks were all originally enacted to protect against anchor damage in sensitive habitats, while allowing continued access to tourists, fishers and other users. The system was initially managed by the customs division, with fees collected for access to the marine parks and for daily mooring. In the March 1993, responsibility for the 'marine parks' was passed from Customs to the new Department of Fisheries and Marine Resources.

The objectives of a marine parks system should directly determine the rules and regulations applied. In broad terms, protected areas may serve two main objectives: (1) conservation of biodiversity (both for nature in its own right, and for its potential use to humankind), and (2) for increasing productivity. If fishery productivity is the main objective, a marine park may be best set in the most highly degraded area or in a spawning site. If biodiversity is to be maintained, the most pristine and diverse habitats may be best protected.

The International Union for the Conservation of Nature (IUCN, 1994) has adopted a system for categorising protected areas based on their objectives. These range from areas managed strictly for scientific research or wilderness protection (Category I) to areas managed for recreation and the sustainable use of both man-made landscapes and natural ecosystems (Categories V and VI). At one end, biodiversity is the priority, and no human access or resource use may be permitted. At the other end, people's interaction with nature is prioritised, and a wide range of *sustainable* activities may be allowed.

The goal of marine protected areas as seen by IUCN is to conserve both the biological diversity and productivity of the oceans (Kelleher, 1999). Most government statements in this area focus on the joint needs of the environment and people, and the concept of sustainable long-term use.

Beyond this general goal for the marine parks systems, explicit objectives need to be set for each of the different parks and any use zones that are defined. Each marine park may serve more than one objective, and not all need be the same. The objectives for each area will determine which rules and regulations are appropriate. Some areas may be established to protect spawning stocks of lobsters or fish, to increase the productivity of the fishery. Such areas clearly need to include spawning grounds, and to be closed at least over the spawning season. Other protected areas may be used to reduce the overall levels of fishing pressure or to prevent the damage to habitats caused by fishing gear or anchoring yachts. Specific management objectives for each of IUCN's protected area categories are given by IUCN (1994).

► Stakeholders to discuss and agree the overall goal of Anguilla's marine parks system and the various objectives for each park that contribute to the achievement of this goal. Summarise decisions in this plan. Regulations for the different parks are directly related to their objectives and should be defined at the same time (see below). A suitable goal may be '*to conserve the biological diversity and productivity of Anguilla's marine resources, and provide for their sustainable use, understanding and enjoyment, for the benefit of the people of Anguilla'.*

Though no specific objectives have yet been formally agreed, the objectives of the marine parks were briefly discussed at the public consultation meeting. The following objectives and restrictions were proposed by different stakeholders:

- divers proposed restrictions on snorkelling in Little Bay, both to protect fish stocks and to prevent damage to corals caused by spears that miss their target;
- some divers suggested to prohibit fishing completely in marine parks;
- Anguilla's chief minister reportedly promoted a fish sanctuary (no fishing permitted) in the Sandy Island area, enabling tourists to see healthy fish stocks in an easily accessible location;
- fishers suggested the protection of limited areas around Little Scrub Island and Seal island, believed to be spawning grounds for red hinds.

In deciding marine park objectives and permitted uses, it is clear that different stakeholders will have different priorities and proposals, often linked to the protection of their livelihood. While some self-interest is inevitable, win-win solutions may still be found. Fishers, for example, may accept restrictions on potting in sensitive habitats, if they can continue access for non-destructive uses such as bait fishing using surface seines. Differences in opinion may best be reconciled by a participatory process in which different users come to appreciate the needs of others. It is essential that a fair compromise position is reached, that has widespread support from the majority of users.

3.3 Existing Marine Parks and other Protected Areas

3.3.1 Marine parks

Anguilla currently has five marine parks, all of them on the north/west side of the island (see Table 8 and Figure 1). Three of the parks surround the offshore islands, sandbanks and reefs of Dog Island, Prickly Pear and Sandy Island. The other two parks lie adjacent to Anguilla's mainland in the areas of Little Bay and Shoal Bay / Island Harbour. Each of the marine parks is

managed under the same set of regulations (see Section 3.5) with no specific sub-zones yet defined apart from anchoring areas.

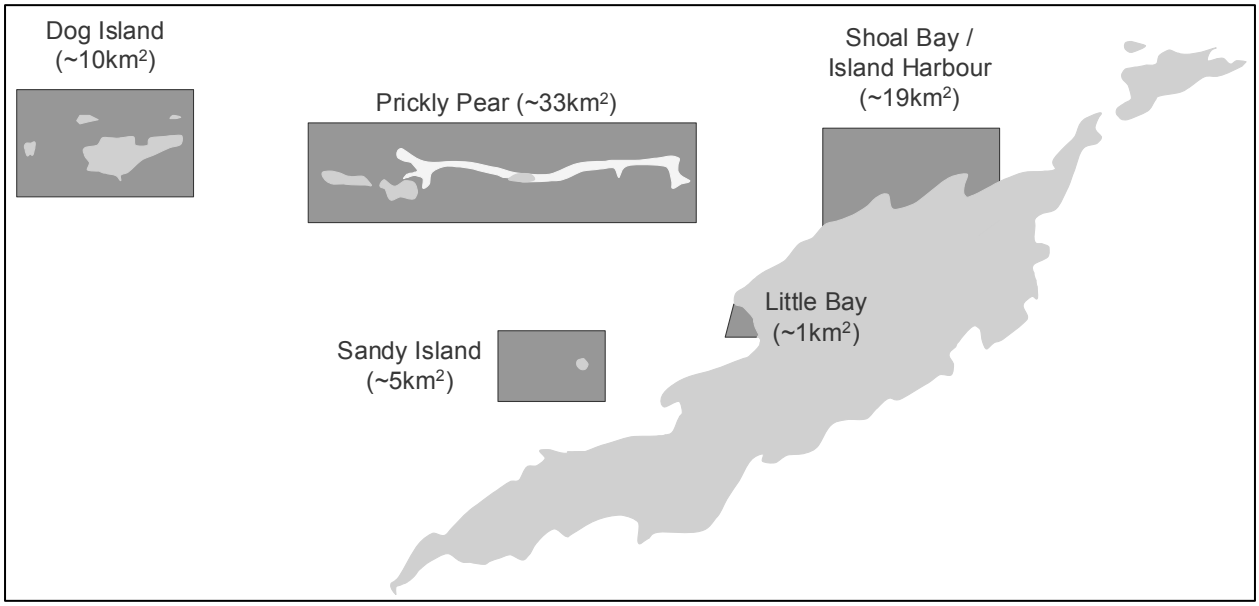

Figure 1. Anguilla's five current marine parks (not to scale, park areas estimated from park boundary latitudes and longitudes, assuming 1 minute = 1.853km, as at the equator).

Table 8. Names, broad habitat types and positions of Anguilla's current marine parks.

Marine Park	Type	Northern boundary	Southern boundary	Western boundary	Eastern boundary
Dog Island	Offshore islands	18° 17' 17" N	18° 16' 07" N	63° 16' 32" W	63° 14' 00" W
Prickly Pear	Islands + barrier reef	18° 16' 46" N	18° 15' 24" N	63° 12' 07" W	63° 05' 05" W
Sandy Island	Sand banks + reefs	18° 13' 00" N	18° 12' 06" N	63° 08' 25" W	63° 06' 49" W
Shoal Bay / Island Harbour	Coast + reef system	18° 16' 45" N	18° 14' 48" N - 18° 15' 42" N *	63° 03' 12" W	62° 59' 20" W
Little Bay	Coast + seagrass	18° 13' 54" N *	18° 13' 20" N	63° 04' 38" W *	63° 04' 09" W *

* Non-rectangular boundary

Dog Island comprises 207 ha of limestone, 15km northwest of Anguilla. The land is dominated by scrub and cacti. The island has been uninhabited since the early 1980s and is visited mainly by small numbers of recreational yachts. In 1999, the Island was identified by BirdLife International as an 'Important Bird Area' (IBA), for holding more than 1% of the biogeographic populations of bridled terns and sooty terms. Though visited by yachts and tourist boats, Dog Island is considered the most pristine of Anguilla's nearshore islands (excluding Sombrero).

The **Prickly Pear** marine park includes two islands, Prickly Pear East and Prickly Pear West, and a chain of barrier reefs, stretching more than 10km to the east. Prickly Pear East is located 9km north west of Anguilla, and comprises 31 ha of dense scrub. Like Dog Island, Prickly Pear qualifies as an 'IBA' for its 180 pairs of nesting bridled terms. A lagoon and reef provide some of the best snorkelling in Anguilla. The island includes two beach restaurants on privately owned land, that attract hundreds of visitors each week. The marine park regulations currently pose no restrictions on these restaurants, which may expand in future.

Little Bay marine park is an attractive, secluded bay, much visited by yachts both from Anguilla and St Martin. The bay has extensive seagrass beds, believed to be important spawning grounds for yellow-tail snapper, though much of these lie outside the marine park boundary. At approximately 1km^2, Little Bay is by far the smallest of the five parks (Figure 1). Due to its small size, Little Bay is reported to have the highest levels of user conflicts, especially when several yachts are moored in the area simultaneously. The ANT's concerns about Little Bay were reported in writing to the Parliamentary Secretary (Environment) in November 2001.

► Add summary information about Sandy Island and Shoal Bay / Island Harbour parks.

Anguilla's most remote territory, the 38km^2 Sombrero Island lies 60km north west of the main island. Sombrero has an endemic ground lizard, *Ameiva corvina*, and supports colonies of several bird species. Plans to build a satellite launching station on Sombrero were withdrawn in 2000. Sombrero is not protected as a marine park at present. It is only rarely visited by tourists, but could become important in the development of an offshore fishing industry in the near future. Though it is not included in the proposals for monitoring marine habitats, Sombrero should at least be included within the scope of Anguilla's marine parks system, and attention given to any threats that arise.

3.3.2 Areas of historic interest

In addition to the five marine parks, two wreck sites were given protection under the 1982 Antiquities Ordinance as 'Areas of Historic Interest'. Of these, the 1772 wreck of the 990 ton Spanish warship El Buon Consejo is now managed as a dive/research site by Anguilla Maritime Research (AMR) Ltd.

Three of Anguilla's wrecks are located in the existing protected areas and thus receive nominal protection under the marine parks legislation. Four wrecks are outside all marine parks and under no specific regulations. All wrecks have mooring buoys for diving purposes.

3.3.3 Fish nursery reserves and tourism management areas

Subsequent to the field visit, the following sites were identified by the Anguilla National Trust (ANT) as being under the management of the DFMR as 'fish nursery reserves':

- Anguillita Island;
- Blowing Point;
- Corito Bay;
- Little Bay (also a marine park).

Scrub Island was also identified by ANT as a 'tourism management area'.

► No information on the status of these fish nursery areas or the regulations applied in them was collected during the consultant's field visit. DFMR to add information as available.

3.4 Future Development of the Marine Parks System

As noted earlier, Anguilla's current marine parks were originally selected for their value as recreation sites and to protect fragile habitats from damage. It is not known whether these sites

represent the most ecologically valuable parts of Anguilla's marine waters, or include the best dive sites, or spawning or nursery grounds for fish stocks etc. This sub-section describes a series of criteria by which marine parks and any use zones may be selected to maximise biodiversity conservation and social benefits. It is not expected that the existing parks will be dropped on the basis of such an analysis, since there is some virtue in maintaining already-accepted areas. It is hoped instead that the values and relative advantages of the different areas (and others outside) may become better appreciated by comparison with a specified list of selection criteria, and that new sites or zones may be gradually added in future, as needed, and as new information becomes available.

3.4.1 Marine park selection criteria

Assuming that the marine parks system of Anguilla will be required to deliver a broad range of sustainable development objectives, the selection criteria for protected areas may be equally broad. A range of possible selection criteria are given by Kelleher (1999) and Salm, Clark and Siirila (2000), including:

- biogeographic criteria (unusual or unique qualities or features);
- ecological criteria (e.g. high habitat or species diversity, or existence of special habitats used as spawning grounds for endangered or prioritised species);
- naturalness (the extent to which the area has been protected from man-induced change);
- economic importance (either for fisheries-important species or for tourism)
- social importance (heritage, historical, cultural, traditional, aesthetic, educational or recreational qualities);
- scientific importance (value for research and monitoring, or for detecting impacts);
- international or national significance (e.g. potential for listing as a Ramsar or World Heritage site);
- practicality and feasibility (degree of insulation from possible threats; accessibility for education, tourism etc; compatibility with existing uses);
- duality or replication (selecting more than one protected area in any given category, protects against risks of human-induced or natural losses).

In working towards a 'protected area systems plan' as required by Article 8(a) of the Biodiversity Convention, consideration may also be given as to whether the current combination of marine parks achieve the following desirable system characteristics (Davey, 1998):

- representativeness, comprehensiveness and balance (including the highest quality examples of the full range of environmental types within a country; and the extent to which the protected areas provide a balanced sample of the available habitats);
- adequacy (to support the viability of environmental processes, species and communities comprising the biodiversity of the country);
- coherence and complementarity (ensuring that each protected area gives an additional benefit at least in proportion to its management costs);
- consistency (in the application of management objectives in standard ways, ensuring that purposes are clear to users); and
- cost effectiveness, efficiency and equity (achieving a balance between costs and benefits, equity in the distribution of benefits; and using the minimum number of protected areas to achieve system objectives).

► Undertake scientific studies and stakeholder consultations to score existing marine parks and other candidate sites and zones against the above criteria, demonstrating their relative contributions to different objectives. Tabulate results in this management plan and agree on the initial selection of existing and new protected areas.

3.4.2 Zoning

Zoning offers an effective way of achieving the multiple objectives required of protected areas, by defining discrete areas for specific uses. Zoning may achieve the following purposes (Kelleher, 1999):

- providing protection for critical or representative habitats;
- separating conflicting human activities;
- protecting the natural and/or cultural qualities of the area, while allowing a spectrum of reasonable human uses;
- preserving suitable areas for particular human uses, while minimising the effects of those uses on the protected area; and
- preserving some areas in their natural state undisturbed by humans except for the purpose of scientific research or education.

Detailed guidelines for the development of a zoning plan are given by Kelleher (1999). A phased participatory process should include public participation both in the initial stages of plan preparation, and again in reviewing the draft zoning plan produced. The zoning plan should be as simple as practicable, consistent with the management objectives and avoid any unnecessary restrictions on human activity. The planning team should first develop a draft zoning plan explaining which activities may be either freely permitted, limited in some way or banned outright in each zone. These proposals should be based on the management objectives and on a series of maps of resources and their uses. The zones should maximise conservation benefits and minimise negative user impacts. Good examples of marine park zoning plans are given by Kelleher (1999).

► Linked to the identification of objectives for the different marine parks, develop a zoning plan indicating the activities permitted and restricted in any defined zones of each park. This will require an up-to-date map of marine resources (see Section 5.4), and inputs from stakeholders on their uses of the different areas. Multi-stakeholder scoping visits to different marine sites (as used in zoning the Soufriere Marine Management Area in St Lucia) may enable users to better understand the needs of others in each park area.

3.4.3 Previous proposals for marine parks in Anguilla

Initial proposals for marine parks in Anguilla were made by the Anguilla Resources Development Project, sponsored by the Government of Anguilla and the Eastern Caribbean Natural Area Management Programme (ECNAMP). Jackson's 1981 report on marine park management (not seen, cited in Oxenford and Hunte, 1990) suggested the creation of a large 'multiple use reserve' including all Anguilla's north coast and the offshore cays from Dog Island to Scrub Island. Jackson recommended the allocation of Anguilla's remaining coastal areas and certain parts of the multiple use area into management sub zones with the following specific purposes:

1	Dog Island	Tourism management
2	West Prickly Pear Island	Tourism management

3	Prickly Pear East - Seal Island	Coral reef reserve
4	Sandy Island	National marine park
5	Shoal Bay	National marine park
6	Scrub Island	Tourism management
7	Crocus/Little Bay	Underwater trail
8	Remaining reserve	Fishery management
A	Junk's Hole / Blowing Point	Fishery management
B	Road Bay	Commercial harbour
C	Blowing Point	Commercial harbour
D	Rendezvous Bay – Meads Bay	Tourism management
E	Anguillita Island	Species management
F	Remaining shelf	Fishery management

Commenting on these proposals, Oxenford and Hunte (1990) recommended either the inclusion of the whole island shelf in the multiple use area (avoiding discrimination against north coast fishers) or the abandonment of the principle. Since the non-park areas of Anguilla's waters are already protected by the fisheries legislation, it may be better to develop zoning plans based simply on the existing discrete park areas and any additional parks and sub-zones.

Though Jackson's management 'purposes' given above do not clarify either the management objectives or the associated restrictions recommended for the different areas, Jackson's full report may give some useful inputs for the proposed objective-setting and zoning process.

Oxenford and Hunte (1990) also noted that Dog Island had high numbers of hard coral reef fish, including high percentages of juveniles, and suggested its adoption as a nursery area. Scrub Island was also identified as a possible fish spawning and nursery site, particularly due to its upcurrent position relative to Anguilla and its potential contribution to re-seeding downstream fishing grounds.

Oxenford and Hunte agreed with Jackson's (1981) proposal for a snorkelling trail in the area between Pelican point and Flat Cap Point near Little Bay, and recommended the addition of a complimentary spearfishing ban and permanent moorings to prevent anchor damage to the seagrass beds.

On the south shore, Jackson recommended the adoption of Little Harbour inlet and Forest Bay as protected nursery sites. Oxenford and Hunte, however promoted instead the recognition of the massive reef barriers that extended across all their south coast study sites (Little Harbour, Corito Bay, Forest Bay and Sandy Hill Bay). Each of these proposals could be given consideration for the new zoning plan.

3.5 Legislation

Current legislation for Anguilla's marine parks is based on the following acts:

- Marine Parks Ordinance 1982
- Marine Parks (Amendment) Ordinance 1993
- Marine Parks Regulations 1993
- Marine Parks (Amendment) Regulations 1994

Anguilla's five marine parks were enacted by the 1982 Ordinance. The activities currently controlled in the parks were set in 1993 as described in the following section.

A 'revised draft' National Parks and Protected Areas Ordinance has recently been prepared by the 1999-2001 Darwin Initiative project 'Capacity Building for Biodiversity Conservation in Anguilla'. This was based on standard legislation from St Kitts and Nevis, Bermuda and the Turks and Caicos Islands, and is currently awaiting consideration at the Attorney General's chambers. When this first draft is approved (along with any modifications), it will be published in the official gazette for public comment.

In its current draft (dated 16 February 2001), the new Ordinance provides for the following significant extensions to the existing marine parks legislation:

- the designation of protected areas as (a) national parks; (b) nature reserves; (c) sanctuaries; or (d) areas of historical interest;
- the requirement for a full environmental impact assessment for any development proposed either within, or adjacent to any protected area;
- the establishment of a National Parks Service responsible for the enforcement of regulations and the management and administration of protected areas;
- the establishment of a National Parks Commission to set policy for the operations of the National Parks Service, and to advise government on matters affecting the long-term conservation of biological resources and the management of protected areas;
- increasing the penalties for offences to a fine of up to EC$ 50,000 and/or 12 months imprisonment, covering the removal of corals, anchor damage, dumping/pollution etc, or the use of spear guns or other weapons in all areas; for the removal of artefacts from historical sites; and for any offences committed in sanctuaries (the original penalty of EC$ 5,000 and/or six months imprisonment was retained for any other offence);
- the prohibition of spear fishing in all protected areas (Section 3(5));
- the identification of exclusive use zones within national parks or nature reserves (Section 6 of the Regulations), for (a) swimming;(b) access of vessels and vehicles to and from the shore; (c) aquatic sports, sailing, windsurfing, canoeing, kayaking, swimming / snorkelling / SCUBA from a vessel; (d) water-skiing; (e) *point missing from Draft Ordinance*; (f) anchoring; (g) camping; (h) parking; (i) entry to the area; (j) non-commercial, recreational fishing; and (k) habitat protection – where extractive uses are prohibited and public entry is restricted; and
- the preparation and implementation 'within five years' of a management plan for each protected area, including the definition of exclusive-use zones.

This legislation would provide the legal authority for developing a new objective-based, zoned system of protected areas. The National Parks and Protected Areas *Order* appended to the Ordinance provides for the identification of different areas as national parks, nature reserves, sanctuaries and areas of historical interest. Such sites have not yet been identified, and should be determined by the participatory processes described in the above sub-sections.

Section 4 of the draft Ordinance outlines the objectives and usage of the different types of protected areas, as summarised in Table 9. The draft National Parks and Protected Area *Regulations* appended to the draft Ordinance provide further clarification of the activities prohibited and permitted in the different areas (Table 10). While sanctuaries are clearly intended to conserve nature, Table 10 suggests that the only real differences between a nature

reserve and a national park are that the nature reserve has stronger development restrictions and does not allow water skiing. The implicit objective of the nature reserve, however is that biodiversity conservation is the primary objective, while public recreation is the main objective in the national parks. These underlying objectives would determine the specific activities allowed in each park in each category, and the numbers and sizes of any use zones. More and larger habitat protection zones may thus be established within the nature reserve, while larger swimming and aquatic sports zones may be set in the national parks.

Table 9. Objectives and usage of proposed protected area categories, as summarised from Section 4 of the draft National Parks and Protected Areas Ordinance.

Area Category	Proposed objectives and usage
National park	Open to members of the public for recreational and tourism use, including potential minimal development of buildings, roads, marinas etc as desirable.
Nature reserve	Available for public enjoyment through recreation and tourism, as limited by a need to maintain the ecological processes of the area; or for activities that maintain the diversity of landscape, habitat and diversity of associated species and ecosystems. Development of buildings etc to be limited to uses appropriate to a nature reserve.
Sanctuary	Intended to protect the natural ecology of the area, and to avoid any disturbance by human beings, either permanently or in defined seasons. No developments to be permitted.
Areas of Historical interest	Intended to protect areas of specific historical interest, or objects therein. Such an area may form part of a national park, nature reserve or sanctuary.

Table 10. Activities prohibited in different protected area types, as proposed in the draft National Parks and Protected Area Regulations.

Activities prohibited	National parks	Nature reserves	Sanctu-aries	Areas of historical interest
Public access, except with written prior approval			X	
Introduction of any domestic or other animal or plant not indigenous to the site			X	
Taking of any animal or plant by any method, on land or at sea	Only as permitted in any fishing zones		X	X
Taking of any artifact	X	X	X	X
Destruction of, or damage or injury to any animal or plant	X		X	
Removal of sand, rock, coral, coral-rag or any calcareous substance	X	X	X	X
Anchor damage to coral reef structures, living or dead, and associated marine life	X	X	X	X
Anchoring of vessels greater than 60ft, other than in an anchoring zone	X	X	X	X
Jet skis and hovercraft	X	X	X	X
Water-skiing	Only in a water-ski zone	X	X	X
Dumping of refuse, wastes or pollutants etc	X	X	X	X
Driving vehicles except on public roads	X	X		
Car parking, except in a parking zone	X	X		
Fires, except portable stoves or grills	X	X		
Camping, except in a camping zone	X	X		
Erecting any structures, unless authorised	X	X	X	X

Altering the outward appearance of any protected structure				X
Offensive activities, which cause discomfort to others	X	X		
Operating a vessel in excess of 25mph unless in a zone approved for such activities	X			

► Consult with stakeholders to agree on defined categories of protected areas to be used in Anguilla, to provide a flexible system by which protected areas may serve a variety of objectives and contribute to the overall adopted goal. Proposed categories are given in the draft Protected Areas Regulations (summarised in Table 9 and Table 10, and see comment in following paragraph). Consideration should also be given to the alternative adoption of the standard and globally-adopted IUCN system of six protected area categories (see IUCN, 1994).

Some possible errors or omissions in the proposed regulations are revealed by Table 10. The regulations against 'destruction of or damage or injury to any animal or plant' and against the 'introduction of non-indigenous animals' should presumably be relevant to *all* sites, not only those specified in the current draft regulations. To clarify the differences, some re-wording of the legislation may be worthwhile, listing first those restrictions applicable to *all* areas, and then any specific additional restrictions relevant to the different area types, e.g. on access in sanctuaries, water-skiing etc.

Anguilla's legislation on *fisheries* management is based on the following acts:

- Statutory Rules and Orders 1981 No. 28;
- The Fisheries Protection Ordinance, 1986 (entered into force 29 July 1988);
- The Fisheries Protection Regulations, 1988 (including the Fisheries Protection (Amendment) Regulations, 1990).

These fisheries acts restrict many fishing activities both inside and outside any marine parks, as described in Box 1, in the following sub section.

3.6 Rules and Regulations

Anguilla's marine parks are all currently controlled by the Marine Parks Regulations 1993, under the following restrictions:

- no mooring or anchoring without a permit (obtainable on payment of a fee, as described in Section 6);
- no mooring or anchoring between 7pm and 6am;
- no filming, camping, business activities etc without a permit;
- no fishing except by Anguillans;
- no scuba diving without a permit;
- no damaging or removing flora, fauna or coral; and
- no speeding, water skiing, littering, polluting, building fires or other dangerous activities.

Any person committing an offence against these regulations is liable to a fine not exceeding EC$ 5,000 and/or six months imprisonment.

At the present time, anchoring in Anguilla's marine parks is permitted only within specified use zones. These zones are marked by dashed lines on the current Marine Park Mooring System leaflet, though the purpose of these zones is not specified. Mooring in marine parks is permitted only on buoys installed by the DFMR. Red buoys provide moorings for dive and wreck sites, available for a maximum of 90 minutes. White buoys provide moorings in other areas for vessels up to 55ft in length. Divers have complained of paying for access to mooring buoys which then turn out to be in use by other boats, or broken or missing.

- ► Consult stakeholders to agree specific regulations (use restrictions) for Anguilla's different marine parks, as part of the participatory process used to identify goals, objectives and zoning.
- ► Maintain mooring facilities, ensuring that buoys are in place and available whenever fees are being charged for their use.
- ► Develop new publicity materials for marine park areas, including clear leaflets to hand out to users, and signs indicating the boundaries of any defined zones, e.g. for boat mooring, anchoring, or swimming, or restricted access. Kelleher (1999) gives good examples of zone maps.

Anguilla's fisheries regulations are applicable both in marine parks and in Anguilla's other waters, as summarised in Box 1. No specific regulations apply to crayfish, though its small size prevents the capture of immature individuals in the 1.5" mesh traps permitted.

3.7 Surveillance and Enforcement

Anguilla's marine parks are currently monitored by the two DFMR Fisheries Officers, with assistance provided by the Director of Fisheries for enforcement when required (see Section 4.3.1). Many vessels are known to operate without the required permits, and there are unresolved problems with repeat offenders. Enforcement of the Marine Parks Regulations is currently limited by several factors:

- a desire to avoid negative effects on the tourist trade;
- the impracticality of impounding vessels and charging captains in court while passengers wait unsupervised;
- the short hours normally worked by public servants including the Fisheries Officers (divers reported the frequent arrival of rule-breaking vessels after 4pm when enforcement staff go off duty); and
- the currently vacant position of the Fisheries Assistant responsible for collecting mooring permit fees at Road Bay.

Enforcement of the Fisheries Regulations is reported to be more effective, especially in the nearshore coastal waters (OECS-NRMU, 1998). The DFMR has actively publicised these regulations, particularly the lobster minimum sizes. Fishers, hoteliers and restaurants may each be penalised if found in possession of undersized specimens, but these rules are mostly accepted by the industry as an effective way of sustaining the lobster stocks.

- ► Reinstate and enforce the mooring permit fee collection system, possibly in collaboration with the customs division (see Section 4). Fisheries Officers and any new Park Wardens should have authority to collect fees at sea, when appropriate.
- ► After a fair warning period, penalise persistent rule-breakers severely to demonstrate that enforcement has been reactivated.
- ► Discuss with stakeholders the development of a system of standard fines, equivalent to traffic fines, enabling on-the-spot penalties for minor offences such as permit violations. Penalties should be higher for repeat offenders.
- ► Recruit collaborative fishermen and divers as honorary/volunteer/assistant wardens to report infringements to enforcement officers and to give out educational leaflets etc to unaware offenders. Issue such wardens with an official identification card or badge.
- ► Develop a simple permit database system to record the payments of access fees and to enable the rapid identification of non-licensed boats or those with expired licenses observed in marine parks by wardens.

3.8 Environmental Education

The goals of marine parks may be far more easily achieved when resource users and the public support the system, than when unpopular rules need to be strictly enforced. Public support may be developed both by environmental education and by community involvement in planning and management.

- ► Develop educational programmes for schools, resource users and the public, promoting resource protection, wise use, public understanding and enjoyment of the marine parks. Collaborate as appropriate with ANT, the Education Department and community groups.

Box 1. Summary of Fisheries Legislation (Source: MacAlister, Elliot and Partners, 1997)

Statutory Rules and Orders 1981 No. 28

- Established a 200nm fisheries zone contiguous to the territorial sea of Anguilla

The Fisheries Protection Ordinance, 1986 (entered into force 29 July 1988)

- Empowered fisheries officers, police and armed forces to search, seize and arrest upon suspicion of an offence (Sec. 5)
- Authorised the Governor to make regulations for the protection and management of fisheries resources (Sec. 8), including species bans, closed seasons, closed areas, licensing and fee collection, gear restrictions, marketing and processing methods.

The Fisheries Protection Regulations, 1988 (including the Fisheries Protection (Amendment) Regulations, 1990)

- Authorised the Minister to issue licenses in the following categories (Part II, fees given in Second Schedule)
  (a) Commercial Fisherman's License ($20)
  (b) Sports Fishing Licence ($50/day; $1,000/month; $5,000/year)
  (c) Fishing Vessel Licence (<20ft - $10; 20-30ft - $20; 30-60ft - $30; >60ft - $100)
  (d) Sport Fishing Vessel Licence ($500)
  (e) Process or Export Licence ($20)
- Prohibited harmful fishing practices (Section 11), including:
  (a) the use of explosives, poisons, lime or other noxious substance;
  (b) except for residents, the use of SCUBA equipment, for taking marine products;
  (c) the use of any artificial breathing apparatus, except SCUBA or snorkelling;
  (d) except for residents, the use of spear guns.
- Set minimum legal harvest sizes (Section 14):
  (a) for Lobster (*Panulirus argus*) at 95mm carapace length (3.74"), or 200g (7.05oz) minimum talk weight;
  (b) for Conch (*Strombas gigas*) at 18cm shell length (7.08"), or 225g (7.94oz) minimum meat weight (excluding digestive gland).
- Set specific regulations for crayfish and lobster (Section 15), prohibiting:
  (a) the use of any harmful capture method, preventing live return of undersized specimens (e.g. hook, spear);
  (b) the taking or possession of egg bearing crayfish or lobsters;
  (c) the removal of eggs; and
  (d) the taking or possession of moulting or soft-shelled lobsters.
- Set regulations for fishpots and traps (Section 16):
  (a) requiring all pots and traps to be clearly marked with the fisherman's license number;
  (b) preventing the interference with pots and traps; and
  (c) requiring a minimum mesh size of 1.5" (38cm).
- Prohibited the taking, killing, or selling of any turtle or turtle eggs (Section 18).
- Prohibited the use of gill nets in any form (Section 18A).
- Controlled the placing, design, marking and use of fish aggregating devices (Part IV).
- Requires the Chief Fisheries Officer to prepare and keep under review a plan for the management and development of fisheries (Part V):
  (a) identifying each fishery and assessing its present state of exploitation;
  (b) specifying the objectives of management;
  (c) specifying management and development measures;
  (d) specifying licensing programmes, and any limitations to be applied to the amount of fishing; and
  (e) consulting with Anguillan fishermen, wholesalers, retailers and exporters of marine products, other bodies or persons affected by the plan, and the Fishery Advisory Committee, in preparing the plan.
- Authorised the establishment of a Fishery Advisory Committee, comprising the Chief Fisheries Officer, and up to five other members appointed by the Governor, to advise the Governor or the Minister on the execution of the fisheries legislation (Section 23).
- Empowered the Governor to enter into access agreements with other states and with associations representing foreign fishing vessel owners or charterers (Section 25).

4 Institutional Arrangements

4.1 Marine Parks Management

The 'institutional arrangements' for a protected areas system are the sets of rules describing what is allowed, and by whom, and who is allowed to decide or change such rules. The more technical institutional arrangements and the legislation supporting the system were described in the previous section. This section considers the *who* side of the institutional arrangements and the allocation of management responsibilities to different agencies.

The long-term adaptive management of marine parks or any other system requires three basic steps, summarised as follows:

1. *Design the system*
   In consultation with resource users and other stakeholders, and based on available scientific data, clearly define (1) marine park areas, (2) the objectives of each area and (3) the practices to be restricted in each area or zone.

2. *Implement the plan*
   Publicise the plan well, e.g. with colour maps showing zones and their permitted uses, ensure that rules are enforced, and monitor both implementation and outcomes.

3. *Adapt the plan, as required*
   Use feedback from the monitoring programme to determine if the specified objectives are being achieved, *and make changes if they are not.* Change technical regulations if implementation is good but objectives are still not being achieved. Change institutional arrangements if management or enforcement etc are ineffective.

Such a plan emphasises that institutional arrangements are never cast in stone, but are instead able to evolve over time, based on the lessons learnt and changing circumstances. Each of the components of this basic plan must be undertaken by some responsible agency or stakeholder group. There are many different roles to fill, but very limited capacity both in government and non-government bodies in Anguilla for environmental management. It is therefore assumed that relevant skills from different organisations will need to be combined to create an effective management system.

This section then initially describes the newly proposed national parks service and proceeds to discuss the possible contributions of Anguilla's other agencies towards the management of marine parks

4.2 The Proposed National Parks Service

Section 7 of the February 2001 draft National Parks and Protected Areas Ordinance proposes the establishment of:

- a National Parks Service, responsible for ' the enforcement of regulations and the management and administration of protected areas…'; and

- a National Parks Commission, to set policy for the operations of the National Parks Service, and to advise government on matters affecting the long-term conservation of biological resources and the management of protected areas.

The First Schedule of the Ordnance proposes that the National Parks Commission should comprise the following ten members:

- the Director of the National Parks Service;
- representatives of government departments responsible for (a) lands and surveys;
- (b) physical planning;
- (c) fisheries or marine resources;
- (d) environmental health; and
- (e) the environment; and
- representatives of (f) the Attorney General's Chambers;
- (g) the Anguilla National Trust;
- (h) the business community; and
- (i) the 'users of the protected areas.

Three alternative organisational structures for the National Parks Service were prepared by the Darwin project for government consideration. It is understood that the proposal for a new statutory, autonomous body (outlined in Figure 2) has been provisionally accepted by government, in preference to a body led by the ANT, or the creation of a new government division. As a statutory body, the National Parks Service (NPS) would receive some funding from government, but would act as an independent advisory body.

It is assumed in this interim management plan that some form of NPS will soon be established and that such body will assume responsibility for managing both terrestrial and marine protected areas in Anguilla.

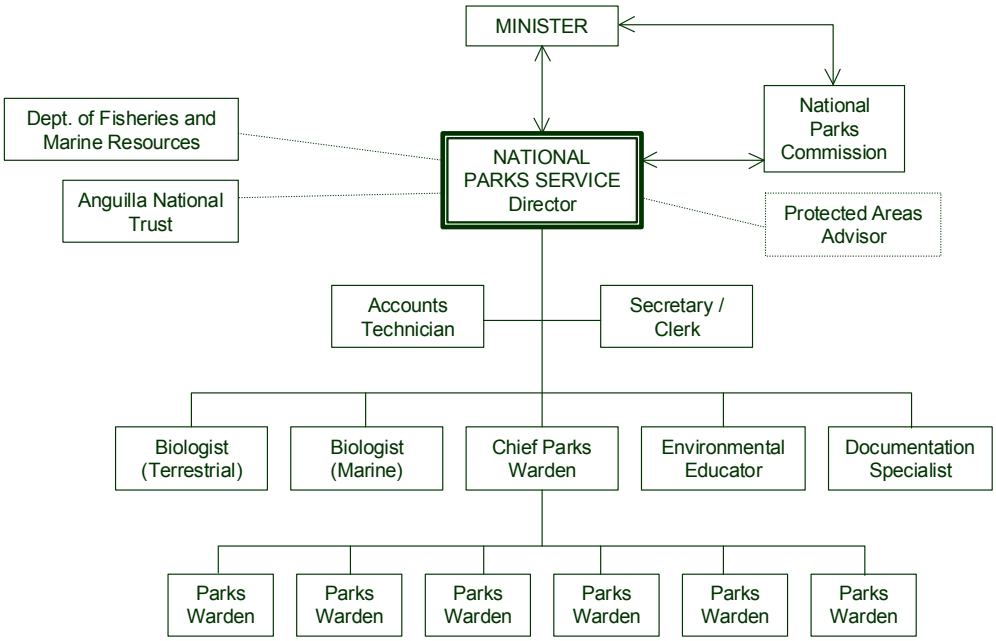

Figure 2. Organisational structure for the proposed National Parks Service, as proposed by Homer (March, 2001), and provisionally accepted by government.

- ► Arrange institutional and public consultations to discuss and confirm the organisational structures of the National Parks Service and Commission (or other bodies, as adopted), and their responsibilities for marine parks. Summarise agreed structures in this plan.
- ► Recognising the diverse and sometimes competing interests of the fishing and tourism sectors, extend the 'users' representation on the Commission (if adopted) to at least two members, with one each from these sectors.

4.3 Environmental Roles and Responsibilities

Effective environmental management requires many different roles to be fulfilled – deciding objectives and providing legislation, researching and assessing resources, raising funding, setting rules and enforcing them, communicating, educating and coordinating, and monitoring the outcomes of management. Where resources are scarce, these roles need to be allocated to appropriate stakeholders, according to their skills and capacities. The draft organisational structure prepared by Homer (March 2001) (Figure 2) implies that the new National Parks Service would have a staff of 13, and be supported by the DFMR, ANT and a temporary Protected Areas Advisor recruited to build initial capacity. While such a competent structure is attractive, it seems optimistic in comparison with the size of Anguilla's other agencies (see following sub-sections). An alternative organisational structure is offered in Figure 3, with a reduced staff complement of nine but with more collaborative support from other stakeholder agencies. For such a structure, the 'biologists' and director would need to take on some of the environmental education and documentation roles. DFMR have confirmed their support of this alternative structure; ANT have raised concerns about the 'skeleton' staffing levels.

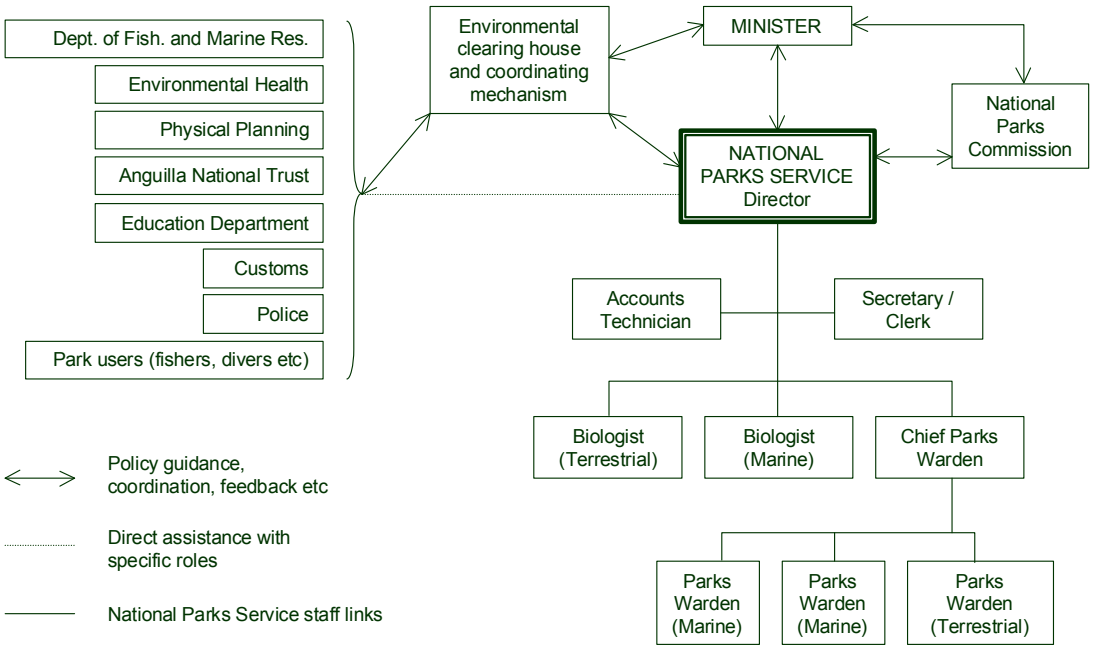

Figure 3. Alternative organisational structure for the proposed National Parks Service, recommended in this interim management plan.

Interagency coordination of the different roles both within the NPS system, and with wider environmental planning issues would be an important task. This task is recognised in the draft National Environmental Management Strategy and Action Plan (October 2000), in which Objective 3 promotes increased public participation in decision making, and 'a clearing house and coordinating mechanism to facilitate information sharing and increase access to civil society functioning'. It is understood that the UK government has also promoted the adoption of some form of national environmental advisory committee to aid in environmental management, to include government representatives, NGOs and business managers. In the proposed alternative NPS structure, it is assumed that such an environmental coordinating mechanism would be established and would promote interagency cooperation as required (Figure 3).

For such a 'collaborative' protected areas institution (managing both terrestrial and marine parks), it is proposed that the different agencies could be responsible for the various activities as listed in Table 11.

- ► In conjunction with the objective-setting sessions, hold meetings and public consultations to clearly define the roles, responsibilities and staffing requirements of the different agencies in marine park management, e.g. based on the draft proposals in Table 11.
- ► Develop and sign memoranda of understanding or other formal agreements between collaborating agencies as appropriate, and summarise the agreed arrangements in this plan.

Table 11. Proposed responsibilities of different stakeholder groups in the collaborative management arrangements for protected areas (including marine parks).

Agency / group	Responsibilities
Environmental clearing house and coordinating mechanism	- Facilitating information sharing - Promoting user participation in decision making - Coordinating activities and promoting environmental coherency
National Parks Commission	- Advising on policy for the operations of the National Parks Service - Advising government on matters affecting the long-term conservation of biological resources and the management of protected areas.
National Parks Service (NPS)	- Designing the protected area system, setting goals, objectives and restrictions, using participatory processes - Installing and maintaining mooring systems and boundary markers / signs - Issuing permits to Anguillan park users from a central office - Collecting permit fees from unlicensed vessels encountered at sea - Enforcing protected area regulations - Monitoring habitat status (see Section 5) - Environmental education (e.g. in collaboration with environmental NGOs or the Education Department for distribution to school children)
Dept. of Fisheries and Marine Resources (DFMR)	- Monitoring levels of fishing pressure and fish catches - Assessing the status of different fisheries - Enforcing fisheries regulations
Anguilla National Trust (ANT)	- Guiding environmental and socio-cultural policies for protected area management - Managing specific terrestrial protected areas and historical sites - Monitoring land-based impacts
Physical Planning Division	- Development control (in collaboration with NPS for protected areas) - Coordination of environmental impact assessments for planning applications (collaborating with NPS, ANT, Water Lab etc) - Coordination of reactive assessments of the impacts of pollution etc from land-based sources - Monitoring land-based development and likely impacts from pollution etc
Water Laboratory	- Monitoring water quality, in collaboration with NPS for offshore sites
Customs Division	- Collecting cruise / mooring permits for visiting foreign yachts at Road Bay
Police	- Assisting with enforcement of regulations, particularly in cases of expected resistance (noting that the police are responsible for enforcing *all* legislation in Anguilla, for marine parks or any other areas)
Resource Users **	- 'Self-policing' and promotion of regulation compliance among members - Monitoring and reporting of illegal practices at sea, and distribution of educational materials e.g. as honorary/volunteer/assistant wardens
Funding agencies	- Support for specific research and development projects, training etc (WWF, Darwin Initiative etc)

** Especially as organised fisherfolk and divers' organisations

The following sections provide background information on the agencies proposed for involvement in the protected areas management system, and their respective capacities, roles and needs.

4.3.1 Department of Fisheries and Marine Resources

Responsibility for the management of fisheries, marine parks and coastal zones is currently vested with the Department of Fisheries and Marine Resources (DFMR), of the Ministry of Home Affairs, Natural Resources and Tourism.

The DFMR's current draft Fisheries Management Plan reports on the objectives and status of the different species groups, and describes management options and issues related to their adoption. Management options proposed for most fisheries include effort control, closed areas and seasons; size and gear limits and the adoption of 'co-management'. The plan provides a broad framework for decision making and planning, which requires regular updating based on the progress achieved. The plan states that the DFMR will 'develop a more detailed Action Plan from this framework, prioritising the issues identified and establishing a national action strategy for fisheries management'. It is understood, however, that little progress has yet been made towards developing such an action plan, with many of the proposed options (effort control, closed areas/seasons etc) being constrained by the lack of data on stock status, socio-economic factors, current habitat status etc. Indeed, since Hurricane Luis, very little fisheries research or monitoring has been conducted.

Enforcement of fisheries regulations is the joint responsibility of the DFMR and the Royal Anguilla Police Force. Fishermen are *not* required by law to submit data on catches, effort etc. Many resist the attempts by the DFMR to collect such data, due to suspicions that the data may be used for taxation purposes etc. Catch data collection is further complicated by the practices of storing lobsters in cages before landing, and of landing direct to St Martin.

A Fisheries Advisory Committee (FAC) was established in the late 1980s, following enactment of the 1988 Fisheries Protection Regulations. This comprised six members, and was intended to advise the Governor and the Minister on the execution of the fisheries legislation. The FAC is no longer functional and needs to be re-established with a broad cross-section of stakeholders.

For its Marine resources functions, the DFMR works closely with the Department of Planning, though there is no formal framework for coordination.

The DFMR presently has the following staff:

- Director of Fisheries (Chief Fisheries Officer), currently the only member of the DFMR holding legal authority to enforce fisheries regulations (in addition to the police).
- Deputy Director of Fisheries, responsible for running the department in the absence of the Director, and for supervising other staff.
- Fisheries Officers (x2), responsible for data collection (though not operating at present); maintaining mooring buoys; educational awareness etc. Trained in SCUBA diving etc.
- Marine Biologist (as of 3 December 2001).
- Fisheries Assistant, responsible for collecting cruising and mooring permit revenues at Road Bay. This post has been vacant for the last year, partly due to the need to work weekends and bank holidays etc.
- Secretary.

► Discuss and agree contribution of DFMR to marine parks management and summarise in this plan.

► DFMR to reinstate the data collection systems for fish catches and fishing effort as a matter of priority. If a fully stratified port sampling system cannot be achieved with available manpower, cooperative (reliable) fishermen may be enlisted to provide trip-based catch-effort data. If supported by annual frame surveys (numbers of fishers, vessels etc), such data may give good catch-per-unit-effort (CPUE) indicators of the state of fish stocks and estimates of total catches.

► Provide training on the enforcement of fisheries laws, e.g. over the care required with evidence, to enable the two Fisheries Officers and the Deputy Director to enforce regulations in the absence of the Director.

4.3.2 Anguilla National Trust

The Anguilla National Trust was established by the Anguilla National Trust Ordinance 1988. The trust is required to 'promote the permanent preservation for the benefit of Anguilla of lands of beauty and buildings of historical or archaeological interest', and promote the access to and enjoyment of such lands etc by the public. The Trust undertakes ad hoc monitoring of specific issues and projects, but its role is mainly related to public awareness.

The Trust has been actively involved in the identification and recognition of the following three terrestrial protected areas, two with archeological resources and one in a wetland/salt pond habitat:

- Fountain Cavern
- Big Spring National Park (Heritage Site)
- East End Pond

The Trust is currently pressing the Attorney General's Chambers to prepare the vesting instruments necessary to assign legal responsibility for managing these sites to the ANT.

The Trust has three permanent staff, supported by government funds:

- Executive Director;
- Associate Executive Director; and
- Administration Manager

An application has been made to Government for the appointment of a Protected Areas Manager, responsible for coordinating protected area management and developing management plans etc. Approval for this post is awaited from the Executive Council.

Regarding their role in the management of a marine parks system, ANT's Executive Director has confirmed that ANT would continue their public awareness activities beyond the management planning stage and assist in monitoring as mentioned in Table 11. ANT would also offer assistance in local training re guiding and interpretation in those areas where recreational activities will be allowed.

4.3.3 Physical Planning Division

The Physical Planning Division includes a Principal Planning Officer, 2 Planners, a GIS Technician and Assistant, 2 secretaries and an Environment Officer. The Environment Officer is responsible for impact assessments for specific planning applications, and for the coordination of other agencies who may become involved in the assessment – ANT, DFMR etc. New legislation – the Land Development Control Ordinance – now awaiting approval by the Executive Council, will provide guidelines for Environmental Impact Assessments. Special

consideration is given to planning proposals submitted inside or adjacent to marine parks or other protected areas.

The Physical planning division and the DFMR have recently initiated six monthly 'Reef Check' surveys and mangrove assessments, that could provide data to compliment the marine parks monitoring system, or be replaced by that system.

► Discuss and agree contribution of Physical Planning Division to marine parks management and summarise in this plan.

4.3.4 Customs Division

All vessels entering Anguilla must comply with the legal procedures specified in Sections 11, 12 and 13 of the 1981 Customs Ordinance. Customs Division maintain a marine office at the Road Bay port for the purpose of clearing vessels, and issuing cruising permits. Cruising permits are issued to boats for periods of 1 day / 1 week / 1 month or 1 year. All sailors must also pay an embarkation tax of $5/person. These permits are separate from the charges payable to DFMR for marine park mooring permits, though the two could clearly be combined or collected together.

The Customs Division also maintains a marine patrol vessel (a hard bottom inflatable) for the purpose of checking cruise permits on the cays. Good prospects exist for collaborative surveillance by Customs and the NPS.

► Discuss and agree contribution of Customs Division to marine parks management and summarise in this plan.

4.3.5 The Water Laboratory

The Water Laboratory of the Ministry of Social Development's Primary Health Care Department is responsible for the following functions:

- to routinely monitor water quality, in order to find sources of pollution and avoid long-term problems; and
- to promote healthy water quality protection practices among the public.

The Water Laboratory has 2 technical staff, currently supported by a Technical Cooperation post funded by the UK Department for International Development (DFID). Following its establishment in late 1997, the Water Lab. began a routine Water Quality Monitoring Programme (WQMP) in September 1999. This samples water from various sources including at bathing beaches and in wastewater effluents that may affect the marine environment. Samples are taken for a range of different tests on bacteriological, physical (turbidity, pH, conductivity, dissolved oxygen, temperature, salinity) and chemical factors (nitrates, sulphates).

Coastal bathing waters are sampled every month at eleven popular tourist bathing beaches around Anguilla. For the year 2000, all beach waters showed 100% compliance with the guideline values for faecal streptococci (an indicator of domestic sewage pollution), though wide variation was observed around the island. The highest values were recorded for Crocus Bay, near to the Little Bay marine park. The WQMP provides a valuable ongoing baseline for testing

the impacts of occasional pollution incidents, or for monitoring long-term changes in seawater quality.

► Discuss and agree contribution of the Water Laboratory to marine parks management and summarise in this plan.

4.3.6 Resource Users

The need for a participatory, consensus-based plan for the management of fisheries and marine resources was recognised by the draft 1998 Fisheries Management Plan. At that time, user participation was constrained by the lack of effective channels of communication. This has been partly resolved by the creation of the Island Harbour Fishermen's Association. It is hoped that this and other similar user groups will facilitate the involvement of fishers in marine resources management.

At a meeting with the Island Harbour Fishermens Association, the committee members supported the concept of protected areas supporting their industry, especially if they were set in areas with a clear rationale for selection, e.g. in known spawning grounds. Both fishers and divers agreed to act as the 'eyes and ears' of the enforcement agency at sea, by reporting rule-breaking when observed. They also both noted the need for strong and reactive support from the agency responsible for enforcement to make such a system work.

► Discuss and agree contribution of resource users to marine parks management and summarise in this plan.

► Promote the creation of additional new user organisations, e.g. for West End / Sandy Ground fisherfolk and for diving/tourism operators, to enable these user groups to participate more effectively in the design and management of the protected areas system.

5 Monitoring

5.1 Monitoring for a Reason

As described in Section 4.1, management may comprise a cyclical process of objective setting, monitoring, feedback and adaptation. Monitoring must be seen as an integral part of such a long-term decision making process and the data to be collected must be guided by the objectives of the management system.

The monitoring programme proposed here would (1) improve the overall understanding of Anguilla's coastal systems, and their states and pressures; (2) provide regular feedback on the progress made towards agreed goals and objectives; and (3) also record any changes in factors that may affect success, such as levels of pollution, fishing pressure, and management effectiveness.

The monitoring programme is designed to enable statistical comparisons of relative changes over time between marine parks, impacted areas outside the parks and 'control' sites as available. Recognising that many different factors will determine outcomes at a given site, it is unrealistic to expect to be able to fully explain outcomes using statistical comparisons between sites. Coral abundance may be higher at marine park site X than 'control' site Y for many different reasons over its 'protected' status. Rather than assuming that differences are due to any particular factor, a long term monitoring programme instead enables comparison of *relative changes* over time between the two sites. If resource indicators are thus declining outside the park but remaining high or increasing inside, other things being equal, there is a good chance that this change is due to the park. The programme is thus designed to provide quantitative data to detect *changes* in status over time at different locations around Anguilla. At each site, replicate *transects* are included to estimate the precision (variance) of status indicators. No attempt is however made to sample several 'replicate' *sites* within any given use / protection / impact category. Though this may enable better statistical comparisons (if the sites could even be identified), such a programme is unlikely to be within available funding and/or manpower capacities.

The monitoring programme should produce indicators of both the status of resources at the different sites, and the threats and pressures being placed upon them. Such pressures may include both the impacts of destructive local human activities such as anchoring or fishing, and of natural fluctuations in environmental quality or global impacts such as coral reef bleaching due to high water temperatures. The monitoring programme should also include the effectiveness of enforcement of existing rules, such as the levels of illegal fishing or other activities inside the marine parks. Monitoring (changes in) resource status at different sites, against such multiple possible causative factors increases the chances of management detecting the real causes of problems, and taking the right corrective action.

5.2 What to Monitor?

A monitoring programme is proposed to assess both the 'outputs' of the system (the health of the marine resources) and any 'inputs' that may affect the system (i.e. explaining any changes in the outputs). Outputs include both habitat distribution (resource *quantity*) and biological status (resource *quality*). Standard procedures are outlined below for assessing biological status in three habitat types: hard corals, soft corals, and seagrass beds. Inputs include (1)

physical and chemical conditions, (2) possible direct impacts on the marine environment such as diver damage, fishing or oil spills, and (3) the implementation and effectiveness of management practices.

- **Monitoring 'outputs' – resource distribution and status**

The status of habitats may best be monitored by directly measuring the numbers and types of different animal and plant species by diving surveys. The extent (distribution) of habitats may be measured by remote sensing from aerial photographs or satellite imagery.

Underwater survey techniques are proposed to record the densities of healthy corals, the levels of algal cover, and the numbers of fish and other animals, along specified transects (see Section 5.6). Remote sensing information measures both the extent of habitats and their distribution - enabling managers to select marine park areas to include valuable habitat types. Such habitat distribution data were collected prior to Hurricane Luis, but now required updating to assist future planning and status monitoring.

It is recommended that such quantitative data are supported by underwater photographs, providing a visual record of resource status at a specific point in time. Photographs should be taken now to compare with their pre-Luis state, and after any future impacts. Rogers et al (1994) give useful guidelines on the use of photography and note that 'a picture is worth a thousand numbers', especially when produced as evidence in court!

In addition to the underwater survey data, the health of fish species dependent on protected habitats may be determined from fisheries data. Relevant information may include spatial catch-per-unit-effort records (indices of fish abundance) and the species and size composition of the catches (showing stock diversity and mortality rates).

- **Monitoring 'inputs'**

Any factor that may affect the status of a marine park or the success of management requires monitoring as an 'input' to the system. Such factors may increase gradually over time (e.g. housing, fishing levels), or occur as infrequent events (e.g. hurricanes, oil spills). Inputs include:

- land-based activities that may affect coastal waters, particularly housing development, sewage systems, construction, and land clearance (the impacts of these factors on marine parks depend on their vicinity and the directions of local water currents);
- water quality (sedimentation, sewage, pollution etc);
- levels of illegal fishing or other restricted destructive activities;
- levels of legal fishing or other permitted but extractive uses;
- levels of tourist pressure on resources, including numbers of divers and snorkellers; and
- destructive natural events such as hurricanes, high water temperatures etc.

Monitoring for some types of 'input' data may fall outside the remit of the National Parks Service (NPS), but should be collected on a regular basis by other agencies. The important point is that such factors are recognised as potentially influencial on the health of marine parks and the wider environment, and that some data are made available for analysis in suitable format.

Monitoring of occasional damaging impacts should clearly be carried out on a reactive basis, as and when incidents are reported. Indicators of the more gradual long term impacts (such as levels of fishing effort, coastal development and numbers of tourists etc) should be prepared on an annual basis.

The 'input' factors described above represent the technical issues that may affect the marine environment. Attention should also be given to the implementation and effectiveness of the institutional arrangements that are set up. If for example, mooring buoys are well maintained in one marine park, but are lost in another and not replaced, this *management failure* may affect the levels of anchor damage that occur. Such factors may be included on a common-sense basis, or a more formal 'management planning systems evaluation' may be used to determine why a particular park is succeeding or failing (see guidelines in Hocking et al, 2000).

5.3 Monitoring responsibilities

It has been proposed that the management and monitoring of Anguilla's marine parks system should involve a number of different agencies (see Section 4). As summarised in Table 12, the National Parks Service should be responsible for monitoring resource status using diving surveys and habitat mapping (see details in following sub-sections). Other agencies, particularly the Department of Fisheries and Marine Resources (DFMR), the Physical Planning Division and the Water Laboratory may contribute more to the collection of 'input' data.

Coastal zone development should thus be monitored by the Physical Planning Division and new developments or land uses reported annually, as thought to affect each marine park. Levels of fishing (e.g. the numbers of boats, both Anguillan and foreign), illegal fishing practices and fish catch rates (indicative of fish abundance) should be monitored by the DFMR.

Recoginising the support of the dive tourism operators and the Island Harbour Fishermen's Association (see Section 4.3.6), resource users should also be invited to contribute to the monitoring system, at least for the detection of impacts from pollution incidents or illegal fishing etc. Community involvement in the programme may promote acceptance of new rules arising from the monitoring programme as members are less likely to deny the validity of the research results. An example of a collaborative monitoring system is given by Salm, Clark & Siirila (2000, page 79).

Table 12. Proposed monitoring requirements and possible responsibilities for data collection.

Monitoring component	Monitoring target	Why monitor?	Who to monitor?
Physical / Chemical Monitoring	Temperature	Potential impact on coral bleaching	NPS + Water Lab
	Dissolved Oxygen	Indicator of high bacteria	NPS + Water Lab
	Salinity	Orinoco plume; Desalination plant	NPS + Water Lab
	pH	Pollution indicator	NPS + Water Lab
	Water Transparency	Indicator of sedimentation / algae	NPS + Water Lab
Marine Impacts Monitoring	Photographs of impacts	Record visual evidence e.g. to assist prosecutions	NPS
	SCUBA diving / snorkelling impacts	Physical reef damage / sediment stirring	NPS / users
	Boat / anchor damage	Physical reef damage / sediment stirring	NPS / users
	Coastal development	Siltation / pollution problems	Planning Division

	Fishing (legal / illegal)	Potential impact of overfishing	DFMR / users
	Oil spills	Impact of oil pollution	Planning Division / Water lab / NPS
	Hurricanes	Physical reef damage	NPS
Habitat mapping	Habitat distribution (from aerial scanning)	Monitor resource quantity and recovery from hurricanes etc	NPS / Planning Division / Consultants
	Participatory mapping		Fishers / divers
Habitat monitoring	Photographing habitat states	To demonstrate visual changes in aesthetic resource quality / cover / diseases etc	NPS
	Hard Corals (excluding Acropora palmata - elkhorn dominated reefs)	Reef builders; sensitive to water quality and sedimentation	NPS
	Elkhorn corals	Recovery from hurricane damage	NPS
	Soft Corals	Indicates changes in water quality	NPS
	Sponges	Reef builders; sensitive to water quality and sedimentation; food of reef fish and turtles	NPS
	Algae	Indicate eutrophication / lack of grazing	NPS
	Seagrass	Fish nursery and feeding habitat	NPS
	Fish	Reef / algal grazers; commercial value	NPS
	Sea urchins & conch	*D. antillarum* 'keystone species'; Commercial value: *T. ventricosus* and *S. gigas*	NPS
	Disease / bleaching	Ecological / commercial impact	NPS

Detailed proposals for mapping habitats and for habitat monitoring are given in the following sections. Though no specific guidance is given here, the requirement for taking photographs at monitoring sites and to demonstrate impacts of accidents etc should not be forgotten.

5.4 Habitat Mapping

Previous surveys of Anguilla's marine and coastal resources were done in two different ways. Oxenford and Hunte (1990) used a 'manta board' sampling technique, with divers recording habitats while being towed out to sea along transects to known positions. This approach is labour intensive and only records habitats under the transect lines. Oxenford and Hunte (1990) surveyed line transects at 10 locations around Anguilla, covering only a small proportion of the country's inshore habitats. Wider areas may be covered by manual grid surveys, but these may also overlook some habitats between adjacent grid points. The probability of missing habitats decreases when a finer grid is surveyed but requires much greater survey effort. A grid spacing of 25m (recommended by Green et al, 2000) would require 320,000 samples for a marine survey of say 200km^2.

In contrast, the Anguilla Marine Resource Inventory project prepared accurate 1:10,000 habitat maps from colour air photographs, taken in 1991, digitised and ground-truthed at 750 sites (see Blair-Myers et al, 1995). Both of these surveys provide valuable historical data, but now require updating due to the destruction caused by Hurricane Luis.

- ► Re-map marine habitats to provide a new baseline of resource distribution, and to support the design of the protected areas zoning plan. Commission expertise and materials to prepare map using remote sensing technology, either using aerial (i.e. taken from an aeroplane) or satellite imagery. Seek expert advice to determine the most cost-effective of the different remote sensing options available for use in Anguilla (see comments below).

- ► Monitor future changes in habitat distribution, by repeating remote sensing surveys, on a 3-5 yearly frequency, or following any future hurricanes.

Table 13 describes the image characteristics and relative costs of alternative remote sensing methods for coastal and marine habitat mapping (based on Green et al, 2000). The costs given were based on a case study of 150km^2 in the Turks and Caicos Islands; the shallower parts of the Anguilla shelf (including Dog Island, but excluding Sombrero Island) are roughly 400km^2.

Table 13. Image characteristics and relative costs of alternative remote sensing methods for coastal and marine habitat mapping (source, Green et al, 2000).

Method	Resolution	Image width	Cost (incl. set up)	Cost (excl. set up)	Time inputs (man-days)
Landsat TM satellite images	30m pixels	185km	EC$132,052	EC$42,169	98
SPOT XS satellite images	20m pixels	60km	EC$129,888	EC$40,005	97
Airborne digital scanner (e.g. CASI)	1-10m pixels (depends on altitude flown)	0.5-5km	EC$226,656	EC$136,772	117
Aerial Photograph Interpretation (API)	Depends on altitude flown and photograph quality		EC$185,353	EC$95,469	229

Note: Original costs expressed in UK£, converted to EC$ at 3.93363 rate, as of 12 November 2001

Costs, not surprisingly are related to the resolution provided by the image, with the high resolution aerial solutions being more costly than the satellite ones. Landsat and SPOT satellite images provide course resolution mapping with pixel sizes of 20-30m. Airborne scanning or photography can provide much finer resolution mapping, though more adjacent aerial images need to be merged to cover the area.

The 'true colour' aerial photographs used by Bythel et al (1996) penetrate 25m in clear water, and can generate highly accurate maps. The necessary visual interpretation of polygons, however, increases the time inputs required for this method (note the high manpower costs in Table 13). Airborne multispectral imagery (airborne digital scanning) gives direct digital images which require much less manual interpretation. Though the airborne digital scanning solution is the most expensive of the options in Table 13, it would also provide the highest resolution maps.

The relative benefits of the aerial scanning approach over photographs would also increase as the size of the area increases (as proportionally less manpower is required for image

processing). Green et al (2000) note that even for a small area of 150km^2, aerial photograph interpretation (API, as used by Blair-Myers et al, 1995) is at least twice as time consuming as digital remote sensing. For larger areas, such as in Anguilla, 'API' costs would be even higher. Image costs for CASI are higher than aerial photographs, but this additional cost may be more than compensated by the lower processing times (depending on manpower costs etc).

The choice also partly depends on the existing capacity available for remote sensing data analysis in Anguilla. The costs given in Table 13 include the set up costs (hardware and software); field survey costs for habitat identification; the time required for image processing into habitat classes, and the cost of imagery. The best choice for Anguilla will depend on the number of scenes required to cover the marine area and the hardware and software already available. If the marine waters can be covered by a single full SPOT XS scene (60x60km), this may be a highly cost effective option for medium-resolution monitoring.

5.5 Site Selection

The primary monitoring targets within the marine parks are coral reefs (hard and soft coral areas) and seagrass beds. These habitats are important as fish nursery grounds, as attractions for the dive tourism sector, and for their role in coastal protection. They are also particularly susceptible to deterioration due to overexploition of key species, declines in water quality and physical damage.

No monitoring is proposed here for Anguilla's few remaining mangrove stands. These all lie outside the current marine parks and may be better monitored under the terrestrial remit of the protected areas system. The monitoring programme also does not include measuring the physical status of beach habitats, though water quality is measured by the Water Laboratory at beach locations. Salm et al (2000) provide information on protected areas for beach habitats.

Monitoring sites, then, were selected using the following criteria:

- sites are required both inside and outside marine parks, and affected by different impacts, to compare relative changes over time, and thereby explain management outcomes;
- all existing marine parks should be monitored, as should other ecologically valuable or impacted areas that may be protected in future;
- the most valuable habitats (ecologically and economically) should be monitored: hard and soft corals and seagrass, in their main areas of distribution;
- sites should be good representative examples of surrounding habitats;
- previously studied sites (particularly those of Oxenford and Hunte illustrated in Figure 4) should be monitored to enable comparisons with pre-Luis status indicators.

To detect changes, it is proposed that sampling should be carried out at permanently established monitoring sites, rather than at new randomly selected sites each time. Though the representativeness of the sites can always be questioned, permanent sites reduce the numbers of samples required, and increase the consistency of comparisons.

▪ Site marking

Permanent sites should be marked with submerged reference markers, clearly visible from a distance to a snorkeller on the surface (see Rogers et al, 1994). 24-36" re-bar, brass or survey stakes may be used to mark sites, each of which should last several years. Such markers may be driven into the substrate with a sledge hammer in some locations, or with a pneumatic drill in

hard substrates. Site locations should be recorded as GPS coordinates (preferably using the more accurate 'differential' GPS if funds permit). For sites close to shore, triangulation landmarks and compass bearings may also assist relocation (see examples in Oxenford and Hunte, 1990).

- **Site locations**

The proposed locations for monitoring four types of habitats are given in Table 14 and illustrated in Figure 5. Each of these sites are affected by a range of different potential human impacts and included for a specific rationale (see Table 14).

The exact locations for the monitoring sites remain to be determined. Table 14 indicates only the broad areas to be sampled. At sites previously sampled before Hurricane Luis by Oxenford and Hunte (and the Cambridge-Anguilla expedition if data are available), the original sites should be relocated for comparability. Site locations in the new areas should be chosen as representative habitats identified from the new habitat maps, if or when available. If no further mapping is anticipated, the original Anguilla Coastal Resource Atlas (Blair-Myers et al, 1995) could be used. The knowledge of fishers and divers could also be sought to identify areas that survived the hurricane, or were badly damaged (if recovery is to be monitored).

► With reference to the general site selection criteria (this section), the selection rationale for individual sites (Table 14), the site maps (Figure 5), and drawing on the information in new habitat maps and the knowledge of resource users, identify exact locations of permanent habitat monitoring sites.

► Mark sites with survey stakes and submerged, but visible floats, and record GPS positions.

Table 14. Proposed sites for monitoring marine habitats. Current marine park names and site codes sampled by Oxenford and Hunte (1990) in bold text.

Habi-tat	Site code	Site Name	Rationale for inclusion (what impacts would be monitored?)	Distance offshore (km)	Depth (m)	Potential Human Impacts			Sea conditions
						Fishing	Pollution	Recrea-tional use	
Hard coral reef sites	**1Ho**	Black Garden Bay (offshore)	Fishing impacts	1.5	11-12	Traps	--	--	E-W current
	2H	**Crocus/Little Bay**	User impacts	<0.1	5	Lines, spear-guns	Silt / construction runoff	Yes	Sheltered
	4H	Corito Bay (30m off fuel pipe mooring)	Oil terminal	0.2	8	--	Oil spills, sediment from tankers	--	Choppy
	5H	Forest Bay (outside barrier reef)	Control for Corito Bay	0.4	6	Possible	Possible	--	Choppy
	6H	Sandy Hill Bay (in channel to bay)	2nd Control for Corito Bay	0.2	9	Traps	Domestic	Anchor damage	Turbid
	7H	**Dog Island (W. Cay)**	User impacts	<0.1	5-6	--	--	--	Surges
	8H	Little Scrub Island	Monitor inclusion as new park?	<0.1	3-5	--	--	--	Surges
	9H	**Prickly Pear West (S)**	Tourism impacts	?					
	10H	**Seal Island reefs**	Fishing impacts	?					
	11H	**Shoal Bay reefs**	Fishing impacts	?					
	12H	**Sandy Island**	User impacts	?					
Elk-horn sites	**1E**	Black Garden Bay (inshore)	Elkhorn recovery	?					
	9E	**Prickly Pear West (S)**	Tourism impacts	?					
	11E	**Shoal Bay**	Elkhorn recovery	?					
Patch reef sites	**1P**	Black Garden Bay	Fishing impacts	1.4	7-8	Traps	--	--	E-W current
	2P	**Crocus/Little Bay**	Pollution impacts	1.6	9	--	Silt runoff	--	Sheltered
	4P	Corito Bay	Oil terminal	0.8	11	--	Shipping	--	Surges
	5P	Forest Bay	Control for Corito Bay	0.3	11	--	Shipping	--	Surges
	6P	Sandy Hill Bay	2nd Control for Corito Bay	0.2	9-11	--	--	--	Surges
	7P	**Dog Island (N side)**	'Control' site	0.9	15	Traps	--	--	E-W current
	7Ps	**Dog Island (S side)**	User impacts						
	9P	**Prickly Pear West (S)**	Tourism impacts	?					
	10P	**Seal Island reefs**	Fishing impacts	?					
	11P	**Shoal Bay reefs**	Fishing impacts	?					
	12P	**Sandy Island**	User impacts	?					
Sea-grass sites	**2S**	**Crocus/Little Bay**	Pollution impacts	0.5	8	--	Silt runoff, domestic sewage, desalination plant	--	Sheltered
	5S	Forest Bay (inside lagoon)	Sewage impacts	0.2	4	Traps	Domestic sewage	Possible	Sheltered
	13S	Rendezvous Bay	Pollution impacts	?					

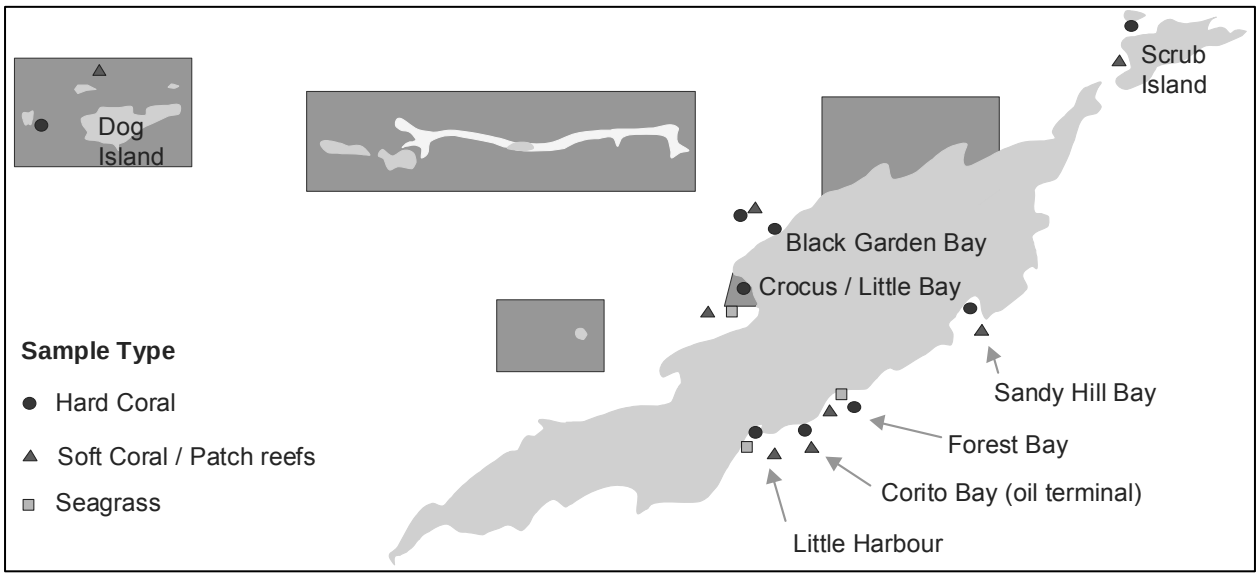

Figure 4. Habitat sites investigated by Oxenford and Hunte (1990).

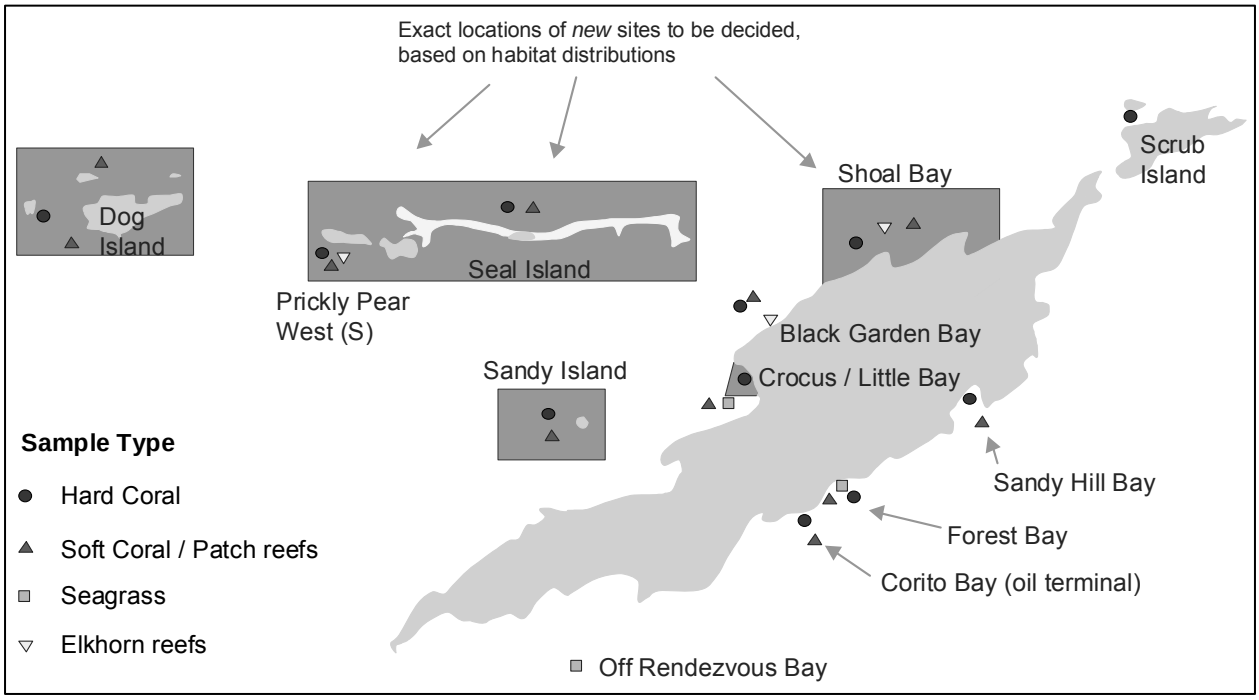

Figure 5. Proposed habitat monitoring sites.

5.6 Quantitative monitoring methodologies

For the quantitative habitat monitoring sites, it is proposed that transect and quadrat methodologies are used to monitor seven species groups at the three habitat types, as indicated in Table 15. These species groups were also sampled by Oxenford and Hunte (1990), enabling comparisons to be made. They were selected for their sessile nature, sensitivity to water quality (corals) or undergrazing (algae), their roles as reef builders (corals and sponges) and their commercial importance (either to diving or fishing). The collected data would enable standard indicators to be calculated, such as percentage cover, species diversity and relative abundance. Due to the different sizes and characteristics of the species groups, each transect at each site would require three separate recording steps. Methodologies for each step are given below.

Table 15. Species groups to be monitored at each sampling step at the coral and seagrass sampling sites.

Species Groups	Hard coral and soft coral / patch reef sites			Seagrass sites		
	Step 1. Belt transect (20x2m)	Step 2. Belt transect (10x1m)	Step 3. Chain transect (10m)	Step 1. Belt transect (20x2m)	Step 2. Chain transect (10m)	Step 3. Quadrats (25x25cm; 5 in 20m)
Hard corals			●			
Soft corals		●				
Sponges			●			
Algae			●		●	
Seagrass					●	●
Fish	●			●		
Sea urchin / conch	●			●		

In addition to these standard sites, it is proposed that additional monitoring is carried out for elkhorn corals, and for coral bleaching and diseases (see below).

5.6.1 Sampling considerations

- **Numbers of replicate transects required at each site?**

Pilot studies should be used to determine the number of replicate transects and/or quadrats that should be monitored at each study site, to obtain a reasonable level of accuracy. Plotting the numbers of species detected against the number of samples taken can easily show the number of samples at which the species numbers start to level off (i.e. the asymptote) (see e.g. Green et al, 2000, p171).

Oxenford and Hunte used ten 10m transects for corals and twenty 25m transects for seagrass sites. High numbers of transects such as these will increase precision, and statistical power, but probably not in proportion to the time and effort required to collect the data. Experience elsewhere suggests that about 3-5 transects at each sampling sites, would enable parameters to be reasonably estimated, and allow some statistical comparisons to be made, without requiring excessive sampling effort.

► Carry out pilot studies to determine the number of transects required to achieve desired statistical power and identify most species present at each site.

- **Transect placement**

Oxenford and Hunte (1990) sampled coral reef transects in a 10x10m square grid, with ten 10m transects[1] running parallel to each other. Seagrass sites were sampled with four 25m transects on each of five 'spokes' radiating out from a central metal stake. Clustering the transects together in this way reduces the numbers of stakes required, but increases the chances that the survey divers will disturb or damage the habitats in adjacent transects.

Since the exact locations of Oxenford and Hunte's sites are likely to have been destroyed by Hurricane Luis, it is advised that transect positions for the future monitoring programme should be laid out separately from each other, either down a long single line, or in roughly parallel lines at least 5m apart. Transects should be marked with survey stakes at each end, and, for each sampling occasion, a line should be stretched between the two end markers to clearly re-identify the transect location.

- **Sampling frequencies**

Sampling should be conducted often enough to detect changes shortly after they occur, but infrequently enough to keep down monitoring costs and to reduce the chances of serious damage to habitats during the surveys. Monitoring frequency should also be limited to ensure that staff have time to maintain equipment, manage and analyse data and perform their other functions.

► Conduct each of the main biological and physical/chemical monitoring procedures (at hard coral, patch reef and seagrass sites) every 6 months. Consider any likely variability between sampling seasons, and adopt timing to capture such differences (e.g. summer/winter; dry season/wet season). Once seasons are selected, conduct long-term sampling at the same times of day, months etc in each year to ensure valid comparison.

- **Time requirements**

Depending on the methods adopted after the pilot studies, and the numbers of transects required, it is hoped that each study site could be fully sampled during a single visit, once every 6 months. It should be possible to achieve all three steps for three full transects in a single day, though five might be more difficult to achieve.

5.6.2 Monitoring procedures

Monitoring procedures need to be used that are standardised, clearly documented, easily repeated by new staff after minimal training and able to produce standard indicators of resource health. The following procedures are recommended for use in Anguilla. More detailed guidelines and backgrounds to the procedures are given by Rogers et al (1994).

► Agree procedures for monitoring different resource indicators after pilot testing; and revise following sections as needed.

► Develop standard data recording forms to be used for each sampling procedure.

[1] A linear transect is a line of specified length laid out within a study site.

- **Physical and chemical monitoring**

Temperature, dissolved oxygen, salinity, pH, and water turbidity should be recorded using hand-held meters at each field site on a 6-monthly basis, with the assistance of the Water Laboratory. Such data would be supplemented by the existing monthly programme monitoring bathing water quality at 11 beaches around the island.

► Water Laboratory to provide further detailed instructions as needed, to be summarised here.

- **Belt transects for fish, sea urchins and conch**

For each of the hard coral, patch reef and seagrass sites, a permanent 20m transect should first be swum to record information on the numbers of fish, sea urchins and conch of each species within a 2m wide 'belt'. A 2m wide belt transect should enable more large fish to be identified than the 1m transects used by Oxenford and Hunte. A width of 2m is the approximate upper limit that a single diver can record reliable information. To compare results with the 10x1m transects used by Oxenford and Hunte and the 20x5m transects used by ReefCheck (see http://www.reefcheck.org/), abundance estimates would need to be converted to a standard m^2 unit.

► Provide training as required to ensure reliable identification of different species of fish, and also for corals etc, as monitored below. Check species identification keys with Hazel Oxenford, UWI, Barbados to ensure valid comparisons with the historical data of Oxenford and Hunte, 1990.

- **Belt transects for soft corals**

At the soft coral / patch reef sites, a smaller 10x1m belt transect should be swum to record the numbers of soft corals of each species whose holdfasts are anchored within the belt. If soft coral 'quality' data are required in addition to abundance and diversity, the height of each colony could be measured. The shorter 10x1m transect is recommended for the soft corals to ensure full comparability with the Oxenford and Hunte data sets. The 10m belt should always be started from the same end to ensure consistency between samples. A belt transect is used for soft corals (rather than the chain transect used below for hard corals) due to their relatively small attachment points, many of which may be missed by a chain transect.

- **Chain transects at hard corals and patch reef sites**

In the third step at coral reef sites, a 10m chain transect should be swum, recording the numbers of each species of hard corals, sponges and algae touched by the chain. In this transect, a chain is used to measure along the contours of the substrate directly under the transect line. The distance along the chain touched by each coral, sponge or algae may be recorded to give a total percentage cover of each species within the transect. To save time, a point-chain transect may be used to record the species lying at say each 10 or 20cm under the chain. Each specimen encountered should be recorded to species, or genus where unknown. The width and height of each colony touching the chain may also be recorded to the nearest cm. Alternatively, an overall 'spatial index' could be calculated as the ratio of the reef surface contour (chain) distance to the transect distance (10m). Such a spatial index effectively measures the topographical complexity of the reef.

Chain transects are used in hard coral sites, where coral cover is fairly high and colonies are evenly spaced and dominated by head corals rather than branching varieties. They are not so

useful in elkhorn zones or soft coral sites or where hard coral colonies are small and widely spaced. Rogers et al (1994) compare methods and provide further details.

- **Chain transects at seagrass sites**

At the seagrass sites, seagrass and algae cover should be recorded under a 10m chain transect. Again, either a measurement or point system could be adopted, depending on the time available and the accuracy required. Both seagrass and macroalgae should be identified to species level where possible. The size of each patch of algae touching the chain may be measured to the nearest cm.

- **Quadrat samples at seagrass sites**

Since seagrass abundance or 'quality' can not easily be measured for all of the blades along a transect line, a quadrat sampling system is proposed as Step 3 at the seagrass sites. Approximately five quadrats of 25x25cm should be used to supplement the % cover data produced by the chain transects. The locations of the quadrats should be randomly selected along each transect. In each quadrat, Oxenford and Hunte recorded the mean length of blades and the number of shoots. This system could be maintained for future samples or a simpler low-medium-high density category system could be developed to reduce sampling time. Rogers et al (1994) recommend harvesting the segrass to count and/or weigh the blades back in the laboratory. Such destructive sampling, however, would over time cause significant damage at the permanent sites proposed.

- **Belt transects at elkhorn coral sites**

Since chain transects are hard to use for branching corals such as elkhorn, and since elkhorn corals were reported to be very badly affected by Hurricane Luis, it is proposed that three special elkhorn sites should be sampled to monitor recovery of this important species (see Table 14 for proposed locations). At these sites, 10m x 2m belt transects could be swum to record the abundance and sizes of live and dead elkhorn coral heads. To save time, no data on other species would be recorded at these sites.

- **Coral diseases / bleaching**

Monitoring of coral bleaching and diseases is not included in the other sampling steps due to the low expected frequency of occurrence. If relatively common, consideration could be given to including counts of specific diseases on different corals during the belt and chain transects.

As an easier alternative, it is suggested that a watch is kept for coral diseases and bleaching during the routine monitoring. If and when diseases are observed at the different study sites, records should then be kept of the numbers of corals affected, e.g. within the whole dive, or within each transect, depending on abundance. Permanent markers may then be attached to a sample of affected coral colonies, and their status monitored in future visits. Rogers et al (1994) give guidelines for monitoring individual hard coral colonies in this way, and for recognising different diseases and conditions.

5.7 Data Analysis and Reporting

► Define and insert here formulae for calculating % cover, abundance and diversity indices etc, when sampling procedures agreed.

6 Financial and Physical Requirements

6.1 Introduction

The following sub-sections describe approximate manpower requirements, and capital and recurrent costs for the proposed *habitat monitoring programme*. Comments on the roles and responsibilities, and the staffing needs of the proposed National Parks Service for monitoring and other management programmes were given in Section 4.3.

► Further develop this section to also describe the financial, logistical and manpower requirements of the non-monitoring aspects of the marine parks system as components of the proposed National Parks Service. Section 6.5 also requires development on the fundraising strategy of the marine parks / National Parks Service.

6.2 Staff Requirements

- **Habitat monitoring programme**

Of the nine staff proposed for the reduced National Parks Service (NPS), (Section 4.3, Figure 3) a minimum of three would be required to safely run the habitat monitoring programme: two to carry out the underwater surveys, and one to remain as a watchman on the boat. These roles should normally be carried out by the Marine Biologist and the two Marine Parks Wardens (see Figure 3). Other staff (e.g. the Chief Parks Warden and terrestrial officers) could stand in occasionally given the necessary training and experience.

Dive survey staff would need to be trained in boat handling and safety, in SCUBA diving, e.g. to PADI Open Water Diver level, and in the use of underwater drilling tools. At least the Marine Biologist would need to be able to identify corals, fish, algae etc to common species and family levels (e.g. as recognised by Oxenford and Hunte, 1990). The Marine Biologist should also be competent to design and maintain a computer database of monitoring programme records and be able to make statistical analyses of differences between sites and of any changes over time.

The proposed monitoring programme currently has the following numbers of sites:

Hard coral reef sites:	11
Elkhorm sites:	3
Patch reef / soft coral sites:	11
Seagrass sites:	3

As described in Section 5.6.1, each of these sites should be sampled once every six months. At least three replicate transects should be sampled at each site; five or more transects may be required to achieve the necessary precision (see Section 5.6.1). For each transect at the hard coral, patch reef and seagrass sites, separate procedures are required to collect data for corals, fish, algae etc (see Table 15). For the elkhorn sites, only data for elkhorn would be collected, making for a much quicker procedure. If all of the coral and seagrass sites can be fully sampled in a single day (i.e. all three or more transects), and all three elkhorn sites can be sampled in a single day, then a total of 26 days would be required for each of the habitat monitoring programme field work surveys. With two surveys per year (every six months), a minimum total of 52 field days would be required, i.e. 156 man-days for a three-person team.

Additional lab.-time should be allocated for data entry and analysis by the Marine Biologist. Additional *field* time *may* be required if more transects are needed at each site, and if coral diseases and bleaching become prevalent and need to be monitored also. Further additional field time may be needed if more monitoring sites are selected when the zonation and objectives of the marine parks system are decided.

Each of the surveys could be accomplished within a single, intense, six week sampling period. Alternatively, the diving days could be more spread out over the year to run alongside other essential activities. In the latter case, comparison/control sites should at least be sampled on dates close to each other to minimise differences due to seasonal factors.

Most of the sites are less than 10m deep, so dive times should not be a constraint to achieving three transects per day. For some of the deeper sites (e.g. Dog Island, Black Garden Bay, see Table 14), expert consideration would need to be given to decompression requirements.

- **Habitat re-mapping**

As described in Sections 5.3 and 5.4, Anguilla's marine habitats also need to be re-mapped following the devastating impact of Hurricane Luis. Such an exercise would probably best be undertaken, not by NPS staff, but by a specialist team of consultants, with remote sensing and GIS skills. As far as possible, such skills should be transferred to the Marine Biologist during the re-mapping project, to facilitate future mapping every few years.

6.3 Physical Requirements

Some of the sampling sites recommended in Table 14 could be sampled by diving from the beach (e.g. Forest Bay, Corito Bay, Little Bay). For most of the sites, however, a boat will be required to access the sites and to provide support during diving operations. To access the offshore sites (e.g. Dog Island), such a vessel would need to be at least 20ft (6m) in length with a bimini top or permanent cover or cabin. Twin outboard engines (at least 40hp each) or a single 60hp engine with a smaller backup engine would be required.

Two full sets of diving gear would be required, with a spare set as a backup and six air tanks to cover each day's diving. Other equipment requirements are described in the following section. Suppliers of marine survey equipment are given by Rogers et al (1994).

6.4 Budget requirements

- **Habitat monitoring programme**

Table 16 provides the approximate minimum costs for running the habitat monitoring programme as described above, every six months, at 28 sites, with three transects per site.

The staff costs given below are for the full annual salaries of the proposed NPS Marine Biologist and the two Marine Park Wardens. While the monitoring programme would not occupy these staff full-time, it is assumed that any remaining time would be taken up with their other responsibilities for surveillance, fee collection, enforcement, public education, data analysis and reporting etc. As noted in Section 5.6.1, additional transects may be required to achieve higher precision. More monitoring sites may also be needed if additional marine parks are identified, or specific zones are identified for restricted uses, and need to monitored. In these cases, the annual/survey costs and staff *time inputs* would increase (though not the staff *costs* up to a point).

Capital and recurrent costs below include the items directly related to the habitat monitoring programme. Additional funding would be required for land-based costs (such as a vehicle, office space etc) that would be shared between programmes (monitoring, enforcement, education etc).

Table 16. Capital and recurrent costs of the proposed habitat monitoring programme.

Capital Costs (Equipment)	**EC$**
Boat, minimum 20ft, including twin 40hp outboard engines, tanks, safety gear, depth sounder, radio etc	$60,000
Diving gear (2 sets: bottles, regulators, bouyancy aids, guages, masks, fins etc)	$8,000
Survey stakes and marker floats (28 sites * 2 stakes for each of 3 transects @ $30)	$5,040
Survey equipment (transect chains, tape measures, writing slates etc)	$800
Underwater drilling equipment	(*already owned by DFMR*)
Differential GPS meter (or regular GPS meter at EC$ 600, if sites can be relocated easily)	$8,000
Nikonos V camera with flash and 28mm lens etc	$4,000
Field identification guides / keys etc	$750
Computer and printer for storing / analysing data	(*already provided by DFID/NRMU project*)
Subtotal	$86,590

Annual Survey Costs	**EC$**
Boat fuel (52 days @ EC$90 per day)	$4,680
Boat maintenance, insurance, servicing etc	$3,000
Annual contribution to boat / equipment depreciation fund (assuming ~5 year life)	$16,000
Diving air (156 fills / year @ EC$20 / tank, assuming 1 tank / diver / transect)	$3,120
Physical / chemical sampling costs (5 meter readings per site @ EC$10 / site [2])	$2,800
Subtotal	$29,600

Annual Staff Costs	**EC$**
Marine Biologist (annual salary)	$50,000
Marine Park Wardens (2 @ $29,500 annual salaries)	$59,000
Insurance (3 insured at EC$3169.80 per person per year [3])	$9,509
Social security, pensions etc (5% of salaries)	$5,450
Training costs (dependent on staff skills; diving, boat safety, biological, computer…)	$4,000
Subtotal	$127,959
Total Annual Recurrent Costs	$157,559

Grand Total (Capital Costs plus First Year Annual Recurrent Costs)	$244,149

[2] The Water Laboratory charge a standard rate of EC$ 10 per direct measurement or meter/electrode reading, e.g. for pH, temperature, salinity, dissolved oxygen and turbidity. This rate could be discounted for a regular government job such as this monitoring programme.

[3] Quoted premiums of US$562.50 to provide US$100,000 coverage for loss of sight, speech, hearing, accidental death or total dismemberment; plus US$611.50 to provide US$15,000 coverage for accident and medical expenses reimbursement.

- **Habitat re-mapping**

Habitat mapping costs would depend on the remote sensing option adopted (see Table 13) and the manpower costs (see Section 5.4). Including the hardware and software setup costs (assuming that suitable facilities are *not* available e.g. at the Planning Division), and assuming daily consultant fees (including per diems etc) of EC$1,500 per day, a medium resolution SPOT XS map would cost at least EC$275,000, while a high resolution airborne scanning image would cost at least EC$400,000. Expert advice is required to improve habitat mapping cost estimates.

6.5 Revenue Generation

► Discuss and agree short term and long-term revenue generation mechanisms, and summarise here.

Current user fees for Anguilla's marine parks are summarised in Table 17.

Table 17. User fees for marine parks, as set by the 1993 and 1994 Regulations

Mooring or anchoring:	Per Day	Week	Month	3 Months
Charter Boat Local	EC$ 10	EC$ 50	EC$ 210	EC$ 540
Charter Boat Foreign	EC$ 60	EC$ 210	EC$ 480	EC$ 1200
Foreign Owned Boat	EC$ 40	EC$ 198.75	EC$ 795	
Diving				
Locally Operated Dive Vessel	US$ 1 per tank used			
Foreign Owned Dive Vessel	EC$ 10 per tank used			
Filming	EC$ 2,700 per day			
Erecting Structures	5% of the cost or value of the development permitted			
Camping	EC$ 28 per tent per week			
Carrying on Business	5% of the gross income relating to the operation			
Issue of any duplicate permit	EC$ 5			

User fees and charging systems need to be agreed as a component of the draft National Parks and Protected Areas Ordinance. Fee rates are not given in the February 2001 draft. The Ordinance proposes that dive vessels and charter vessels obtain permits for access to park areas using application form NP2 for permit NP3. Vessels may also be able to lease pre-defined single user buoys within marine parks using form NP4. There is no requirement in the draft Ordinance to pay daily non-specific mooring fees as before for mooring etc; though some system must be required for visiting yachts.

For divers, the draft Ordinance proposes the payment in arrears of a per-person fee against the number of persons diving (form NP5A) or snorkelling (form NP5B) at each specified dive site in each month. Dive operators indicated that they would prefer to pay a standard fee of say EC$ 1-200 per year, rather than levy a user fee on each visiting tourist.

If enacted as a statutory body, it is assumed that the National Parks Service would receive some seed money from government at least covering staff salaries and running costs for the first years. With a clear signal sent by the enactment of the new Protected Areas legislation, grant funding may be available from DFID or the FCO for supplementary funds, e.g. for training,

habitat re-mapping, and capital equipment costs. In the long-term, it is assumed that the NPS would increase its own fund raising capacity and over time become more independent. It is emphasised here that monitoring and research programmes providing feedback to managers are *necessary, long-term requirements* and should be supported under the core funding of the protected area management system.

Useful simple guidance on financial planning for marine protected areas is provided by Kelleher (1999). More detailed guidelines, including the advantages and disadvantages of alternative revenue generating mechanisms, and prospects of support from different international donors, are given by WCPA and IUCN (2000), and The Nature Conservancy (2001a). Detailed financial planning guidance and worksheets are given by The Nature Conservancy (2001b). Protected area visitor fees and fee systems for different countries have recently been reviewed by The International Ecotourism Society and Programme for Belize (documents downloadable from http://www.ecotourism.org/retiesselfr.html).

7 Summary of Action Plan

This management plan document provides a summary statement of the various factors affecting the development and management of a marine parks system for Anguilla. The following recommended action points are drawn from the preceding sections (as indicated by the parentheses) and repeated here in an ordered sequence of events.

This interim plan should be upgraded to a **first full management plan** upon completion of the preparatory and participatory planning processes described in Sections 7.1, 7.2 and 7.4.1 below. Anguilla's marine resource stakeholders (government, NGO and public) need to agree the goals and institutional arrangements for the marine parks system, and the objectives, zonation, and regulations specific to existing parks and any new parks.

After the marine parks system is established and the first full management plan is published, **the management plan should be updated and revised every three years**.

7.1 Evaluation of relevant background information

7.1.1 Technical factors

- ► **Re-map marine habitats** to provide a new (post Luis) baseline of resource distribution, and to support the design of the protected areas zoning plan. Commission expertise and materials to prepare map using remote sensing technology, either using aerial or satellite imagery. Seek expert advice to determine the most cost-effective of the different remote sensing options available for use in Anguilla. (see Section 5.4)

- ► Prepare and insert summary **map** of Anguilla's marine and coastal systems, indicating major habitat distributions, bathymetry and water currents. (insert in Section 2.2)

- ► Extend analysis of **impacts** on marine resources, clarifying specific locations and extent of impacts. (Section 2.4)

- ► Develop and insert map of major **point sources of impacts** from coastal pollution, including population centres, runoff points etc. (Section 2.4)

- ► Insert **habitat status data** from 1989 Cambridge-Anguilla expedition for Prickly Pear, Sandy Island and Shoal Bay; and 1996 post-Luis assessment, if/when reports located. (Section 2.5.1)

- ► Append list of **marine fauna and flora** found in Anguilla, e.g. based on Oxenford and Hunte, 1990. (Section 2.5.1)

- ► DFMR to assess **status of different fish and invertebrate stocks**, and to insert up-to-date statement on relative positions, e.g. relative to target and limit reference points. (Section 2.5.2)

- ► Insert summary information about existing **Sandy Island** and **Shoal Bay / Island Harbour** parks. (Section 3.3.1)

7.1.2 Socio-economic evaluation

► Research and insert information on numbers of **fishers and vessels** operating from different ports and in different fishing grounds, indicating the dependence of livelihoods on different marine parks and other areas. (Section 2.3.1)

► Research and insert information on numbers of **tourism operators** working from different ports (including St Martin) and in different waters, marine parks etc. (Section 2.3.2)

7.1.3 Management issues

► DFMR to add information as available on existing **fish nursery areas** and the regulations used therein. (Section 3.3.3)

7.2 Management system planning

7.2.1 Goals and objectives

► Stakeholders to discuss and agree the overall **goal** of Anguilla's marine parks system and the various **objectives** for each park that contribute to the achievement of this goal. Decisions to be summarised in this plan. Regulations for the different parks are directly related to their objectives and should be defined at the same time (see below). (Section 3.2)

► Consult with stakeholders to agree on defined **categories of protected areas** to be used in Anguilla, to provide a flexible system by which protected areas may serve a variety of objectives and contribute to the overall adopted goal, as above. Proposed categories are given in the draft Protected Areas Regulations (summarised in Table 9 and Table 10). Consideration should also be given to the alternative adoption of the standard and globally-adopted IUCN system of six protected area categories (see IUCN, 1994). (Section 3.5)

► Undertake scientific studies and stakeholder consultations to score existing marine parks and other candidate sites and zones against the selection criteria in Section 3.4.1, demonstrating their relative contributions to different objectives. Tabulate results in this management plan and agree on the **initial selection of existing and new protected areas** as required to achieve the objectives. (Section 3.4.1)

► Linked to the identification of objectives for the different marine parks, develop a **zoning plan** indicating the activities permitted and restricted in any defined zones of each park. This will require an up-to-date map of marine resources (see Section 5.4), and inputs from stakeholders on their uses of the different areas. Multi-stakeholder scoping visits to different marine sites (as used in zoning the Soufriere Marine Management Area in St Lucia) may enable users to better understand the needs of others in each park area. (Section 3.4.2)

► Consult stakeholders to agree specific **regulations** (use restrictions) for Anguilla's different marine parks, as part of the participatory process used to identify goals, objectives and zoning. (Section 3.6)

► Discuss with stakeholders the development of a system of standard **fines**, equivalent to traffic fines, enabling on-the-spot penalties for minor offences such as permit violations. Penalties should be higher for repeat offenders. (Section 3.7)

► Incorporate the above decisions into the draft Protected Areas Regulations and legislate as required.

7.2.2 Institutional arrangements

► Promote the creation of additional new **user organisations**, e.g. for West End / Sandy Ground fisherfolk and for diving/tourism operators, to enable these user groups to participate more effectively in the design and management of the protected areas system. (Section 4.3.6)

► In conjunction with the objective-setting sessions, hold meetings and public consultations to clearly define the **roles, responsibilities** and **staffing requirements** of the different agencies in marine park management, e.g. based on the draft proposals in Table 11. (Section 4.3)

► Arrange institutional and public consultations to discuss and confirm the organisational structures of the **National Parks Service** and **Commission** (or other bodies, as adopted), and their responsibilities for marine parks. Legislate as required. Summarise agreed structures in this plan. (Section 4.2)

► Develop and sign **memoranda of understanding** or other formal agreements between collaborating agencies as appropriate (see Figure 3), and summarise the agreed arrangements in this plan. (Section 4.3)

► Recognising the diverse and sometimes competing interests of the fishing and tourism sectors, extend the **'users' representation on the Commission** (if adopted) to at least two members, with one each from these sectors. (Section 4.2)

► Recruit collaborative fishermen and divers as **honorary/volunteer/assistant wardens** to report infringements to enforcement officers and to give out educational leaflets etc to unaware offenders. Issue such wardens with an official identification card or badge. (Section 3.7)

7.2.3 Financial planning

► Develop Section 6 of this plan to include the **financial, logistical and manpower requirements** of the *non*-monitoring aspects of the marine parks system as components of the proposed National Parks Service (or other body as adopted). (Section 6.1)

► Discuss and agree short term and long-term **revenue generation mechanisms** of the marine parks / National Parks Service (or other body as adopted), and summarise in this plan. (Section 6.5)

7.3 Management Implementation

► **Maintain mooring facilities**, ensuring that buoys are in place and available whenever fees are being charged for their use. (Section 3.6)

► DFMR to provide **training on the enforcement of fisheries laws**, e.g. over the care required with evidence, to enable the two Fisheries Officers and the Deputy Director to enforce regulations in the absence of the Director. (Section 4.3.1)

► Reinstate and enforce the **mooring permit fee collection** system, possibly in collaboration with the customs division (see Section 4). Fisheries Officers and any new Park Wardens should have authority to collect fees at sea, when appropriate. (Section 3.7)

► Develop new **publicity materials** for marine park areas, including clear leaflets to hand out to users, and signs indicating the boundaries of any defined zones, e.g. for boat mooring, anchoring, or swimming, or restricted access. Kelleher (1999) gives good examples of zone maps. (Section 3.6)

► Develop **educational programmes** for schools, resource users and the public, promoting resource protection, wise use, public understanding and enjoyment of the marine parks. Collaborate as appropriate with ANT, the Education Department and community groups. (Section 3.8)

► Develop a simple **permit database system** to record the payments of access fees and to enable the rapid identification of non-licensed boats or those with expired licenses observed in marine parks by wardens. (Section 3.7)

► After a fair warning period, **penalise persistent rule-breakers** severely to demonstrate that enforcement has been reactivated. (Section 3.7)

7.4 Monitoring

7.4.1 Programme Planning

► Carry out **pilot studies** to determine the number of transects required to achieve desired statistical power and identify most species present at each site. (Section 5.6.1)

► With reference to the general site selection criteria (Section 5.5), the selection rationale for individual sites (Table 14), the site maps (Figure 5), and drawing on the information in the new remote sensing habitat maps and the knowledge of the resource users, identify exact **locations of permanent habitat monitoring sites**. (Section 5.5)

► **Mark sites** with survey stakes and submerged, but visible floats, and record GPS positions. (Section 5.5)

► **Agree procedures** for monitoring different resource indicators after pilot testing; and revise management plan as needed. (Section 5.6.2)

► Provide **training** as required to ensure reliable identification of different species of fish, and also for corals etc, as monitored. Check species identification keys with Hazel Oxenford, UWI, Barbados to ensure valid comparisons with the historical data of Oxenford and Hunte, 1990. (Section 5.6.2)

► Develop standard **data recording forms** to be used for each sampling procedure. (Section 5.6.2)

► Define **formulae** for calculating % cover, abundance and diversity indices etc, when sampling procedures agreed. Summarise in management plan. (Section 5.7)

► Water Laboratory to provide further detailed instructions as required about **physical / chemical monitoring requirements**, to be summarised in plan. (Section 5.6.2)

7.4.2 Monitoring programme implementation

► **Monitor future changes in habitat *distribution***, by repeating remote sensing surveys, on a 3-5 yearly frequency, or following any future hurricanes. (Section 5.4)

► Conduct each of the main **biological and physical/chemical monitoring** procedures (at hard coral, patch reef and seagrass sites) every 6 months. Consider any likely variability between sampling seasons, and adopt timing to capture such differences (e.g. summer/winter; dry season/wet season). Once seasons are selected, conduct long-term sampling at the same times of day, months etc in each year to ensure valid comparison. (Section 5.6.1)

► **Reassess status of marine habitats annually**, using the methodologies given in Section 5, and provide latest results in the management plan, making comparisons with previous years. (Section 2.5.1)

► DFMR to reinstate the **data collection systems for fish catches and fishing effort** as a matter of priority. If a fully stratified port sampling system cannot be achieved with available manpower, cooperative (reliable) fishermen may be enlisted to provide trip-based catch-effort data. If supported by annual frame surveys (numbers of fishers, vessels etc), such data may give good catch-per-unit-effort (CPUE) indicators of the state of fish stocks and estimates of total catches. (Section 4.3.1)

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