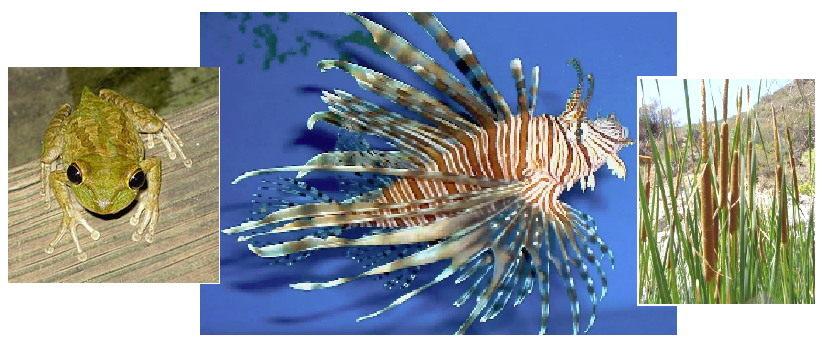


**GOVERNMENT OF ANTIGUA AND BARBUDA**

**DEPARTMENT OF ENVIRONMENT**

**Critical Situation Analysis**

**Invasive Alien Species Profiles**



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in collaboration with the National IAS Steering Committee

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# INTRODUCTION

Invasive alien species (IAS) are plants, animals, insects and other invertebrates, pathogens and parasites that expand and thrive in an area where they are not welcome. They can cause significant harm to the natural environment, to human health, to communities and to the economy. They are usually introduced as non-native species. However, in some circumstances native species can become invasive in nature after changes occur in the local environment. For example, one environmental change that favours some weed species to become invasive is deforestation, as they are suited to colonizing a site rapidly after disturbance. Environmental disturbance can also be caused by the use of a slash and burn agricultural technique or after a natural disaster such as a hurricane. Nevertheless, most invasive alien species are introduced from foreign countries into a region by people, either intentionally or accidentally. For example, cargo entering Antigua by ship may accidentally carry small amounts of foreign plant seeds, which then make their way into the local environment. There are also examples where governments deliberately introduce a foreign species into the country in an effort to control an existing invasive species (biological control agents). Not all species introduced into an environment become invasive. With the world’s connectivity, many new species are regularly introduced into Antigua. Some species proliferate, expand, and damage the environment, while others do not. Whether or not this happens depends on the individual species’ requirements and the environmental conditions into which they have been introduced. This report is concerned about particular invasive alien species that have proliferated and are causing damage within Antigua and Barbuda’s environment.

## Context, Scope and Objectives

This Critical Situation Analysis (CSA) provides a comprehensive view of the occurrence, trends, and distribution of Invasive Alien Species (IAS) in Antigua and Barbuda. It evaluates gaps in existing institutional, legislative and policy frameworks. A total of 22 IAS have been identified for Antigua and Barbuda. They include terrestrial and aquatic species, including plants, birds, and microorganisms. Two (2) plant and animal species have been targeted for eradication and 20 recommended for control. A management strategy has already been completed for the Giant African Snail. There is no management strategy for the other species.

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This document is a critical situation analysis intended to:

1. Provide an overview of occurrence, distribution and trends in distribution of the most problematic IAS, in Antigua and Barbuda, including an assessment of pathways and vectors for IAS.
2. Review efforts to prevent, eradicate, and control/mitigate IAS in the country to date. The success or failure of the efforts and cost estimates will be highlighted as far as possible.
3. Re-assess gaps in existing institutional, legislative and policy frameworks, including Multilateral Environmental Agreement (MEA) obligations and their fulfilment, to prevent IAS introduction to (and where appropriate, dissemination from) the country as baseline for strategic review under the Full Size Project (FSP) in line with Global Invasive Species Programme (GISP), Convention in Biological Diversity (CBD) and Food and Agriculture Organization (FAO) guidance, *inter alia*.

This Critical Situation Analysis (CSA) concentrates on species that are both invasive and alien. The impact of native species that turn invasive, e.g. as a result of habitat modification, is, however, acknowledged. Conversely, non-invasive aliens ae not the centre of attention, except where potential invasiveness was viewed as a risk. Living Modified Organisms (LMOs) may be a sub-set of IAS, but are not discussed in their own right here. The main emphasis will be on managing species that negatively impact native biodiversity, but this does not categorically disqualify introduced biodiversity from being conserved.

Invasive Alien Species (IAS) are organisms whose introduction and/or spread impacts human health and well-being, disrupts trade and threatens biological diversity (Caribbean Invasive Alien Species Network (CIASNET, 2010). IAS are recognised as one of the leading threats to biodiversity and also impose enormous costs on agriculture, forestry, fisheries, and other enterprises, on human and animal health as well as ecosystem services. Rapidly accelerating trade, tourism, transport, and travel – the infamous “four T’s” - over the past century have dramatically enhanced the spread of IAS, allowing them to surmount natural geographic barriers.

If a species‟ new habitat is similar enough to its native range, it may survive and reproduce. For a species to become invasive, it must successfully out-compete native organisms, spread through its new environment, increase in population density and harm ecosystems in its introduced range. Ecosystems that have been invaded by an alien species may not have the ~~natural~~ predators and competitors present among its native populations that would adapt to the novel species quickly enough to control population levels. To summarize, for an alien species to become invasive, it must arrive, survive and thrive. Not all non-indigenous species are harmful. In fact the majority of species used in agriculture, forestry and fisheries are alien species. Thus, the initial step in a national IAS management programme must be to distinguish the harmful from the harmless alien species and identify the impacts of the former on native biodiversity. This decision is not always straightforward, and conflicts of interest may arise – and therefore, need to be considered in management plans. For the purpose of this treatise, only species introduced into Antigua and Barbuda after colonization by Europeans (after *ca* 1500), will be regarded as “alien”.

Native ecosystems that have undergone human-induced disturbance are often more prone to alien invasions because there is less competition from native species. For example, imported red fire ants (*Solenopsisinvicta*) are more successful in establishing themselves in disturbed areas such as roadsides and agricultural fields and rarely colonize intact closed forests. Not all invasive species are aliens. Habitat disturbance can give the competitive edge to an indigenous organism that subsequently becomes invasive.

A species introduction is usually vectored by human activity, such as the “four T’s” however, it is not always clear to which extent human action is involved and to which extent natural range expansion occurs. For example, Iguanas may drift onto another island on a fallen local forest tree after a hurricane, thereby naturally expanding their range. The arriving Iguanas may negatively impact the previously present ones, as has happened in Anguilla. The availability of many broken up wooden houses after the hurricane, maybe combined with faster stream flow due to watershed modifications - may significantly increase their number and thus represent indirect human involvement. Thus, deciding whether or not the new arrivals should be managed to protect the original inhabitant or whether this is interference in a natural range expansion (and thus evolution)’ is a delicate matter that requires balanced decisions based on good judgement, especially in cases where solid scientific or economic data may be scarce – which, unfortunately, is frequently the case for IAS in the Caribbean. (Natural) evolution is dynamic and involves also the replacement (and sometimes extinction) of species.

By the same token, there may be situations where we wish to manage an invasive species, whether alien or not, if it threatens a particular sensitive site of high conservation value. If, for example, a new strain of influenza virus emerges (habitually originating from animal influenza viruses) among human populations, mortality rates can be much higher than usual (generally from severe respiratory disease); spread can be nearly universal, sometimes within a matter of months, and disrupt all sectors of the society. Such a situation is called a “pandemic.” Major influenza pandemics have occurred three times during the last century: the 1918 Spanish flu, 1957 Asian flu and 1968 Hong Kong flu, respectively. The 1918 pandemic was especially dramatic, causing at least 20 million deaths worldwide. Clearly, in the face of such tragedy and devastation, urgent interventions are required and any delay due to debates on the origin of the pathogen would be tactless.

IAS occur in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. Common characteristics of IAS include rapid reproduction and growth, high dispersal ability, phenotypic plasticity (ability to adapt physiologically to new conditions), and ability to survive on various food types and in a wide range of environmental conditions. A good predictor of invasiveness is whether a species has successfully or unsuccessfully invaded elsewhere. Nevertheless, IAS pose a particular risk to Small Island Developing States (SIDS) by threatening the ecosystems, livelihoods, economies, and public health of inhabitants. Islands are especially vulnerable to IAS because of the lack of competitors and predators that control populations in the aliens‟ native ecosystems. The geographic isolation of islands limits immigration of new species, with two main consequences. Firstly, islands often have ecological niches that have not been filled because of the distance from colonizing populations; secondly, the isolation allowed established species to evolve with few strong competitors and predators. IAS introduced by human activity have a dramatic effect on such isolated ecosystems and are a leading cause of species extinctions.

# STATUTORY AND CONSTITUTIONAL FRAMEWORK

### General

Antigua and Barbuda is a unitary State. It is a constitutional monarchy in which executive power is vested in the British sovereign, as Head of State, and exercised by the Governor-General of Antigua and Barbuda, Her Majesty’s local representative. Legislative power is vested in Parliament, which consists of Her Majesty’s Legal Opposition, a nominated Senate and an elected House of Representatives.

The 17 members of the Senate are appointed by the Governor-General. Ten are appointed on the advice of the Prime Minister, four on the advice of the Leader of the Opposition, and one is chosen at the discretion of the Governor-General. This person may be chosen from outstanding persons in the society as he deems reputable. The other two Senators from Barbuda would be chosen on the advice of the Prime Minister.

The House of Representatives consists of 17 elected members, the Speaker of the House and the Attorney General. It is not a requirement for the Speaker of the House or the Attorney General to be elected members of Parliament. The Governor-General appoints the Prime Minister from the political party which commands the majority of votes in the general election, held every five years. The Governor-General on the advice of the Prime Minister, appoints the Ministers of Government to the various portfolios. On 9th March 2018, the Antigua Labour Party (ALP) led by the Honourable Gaston Browne, secured15 of the 17 elected seats in the last general election. Her Majesty’s Legal Opposition, the United Progressive Party (UPP) won one seat, while the Barbuda People’s Movement won the other seat.

Subject to the provisions of the Constitution- for instance those relating to the protection fundamental rights and freedom of the individual, the Parliament of Antigua and Barbuda has plenary power to make laws for the peace, order and good governance of Antigua and Barbuda.

The Constitution contains a general supremacy clause giving it precedence over laws that are inconsistent with its provisions. While parliament may amend the Constitution, constitutional amendments are subject to both stringent procedural requirements and qualified majorities. For instance, in the case of a bill proposing to amend the provisions of the Barbuda Local Government Act that are entrenched by section 123 of the Constitution, it has already been mentioned that it requires the assent of the Barbuda Council.

### The Powers of the Barbuda Council

The Barbuda Council has the powers in the Barbuda Local Government 1976 Act and the 1904 Ordinance, now entitled the Barbuda Act, under the 1976 Act, the Council is given the responsibility and duty to administer agriculture and forestry; to administer public health, medical and sanitary facilities and services; to administer and regulate the provision of electricity and water services; and other public utilities; to construct, improve and maintain roads; and to raise and collect revenue to enable the Council to meet the expenses to be incurred in the performance of its power and functions in respect of these subject-matters.

The 1976 Act provides that, save in respect of the list of matters just quoted, Cabinet may give general or special direction to the Council as to the policy the Council should follow in the exercise of its powers and functions under the 1976 Act or any other law. These powers and functions include: to improve and maintain public buildings, wharves and harbour facilities; to promote hotel and tourist development "in accordance with and subject to any law relating to the alienation of land, foreign investment or tax incentives"; to administer fisheries; to arrange for the protection and care of public buildings; to apply monies collected by or transferred by the Council in payment of expenses incurred by the Council; to keep accounts of monies collected and disbursements made by the Council; to deliver copies of all such accounts, at least once a year, to the Director of Adult; and to make detailed lists of houses and lots of lands in Barbuda and of the owners and occupants thereof.

As already mentioned, the Council also enjoys the power to make by-laws over a wide range of subject matters. The Council is also empowered, notwithstanding the provision of the Public Utilities Act, to make by-laws in respect of the following: regulating the supply and distribution of water for sanitary, domestic and business purposes to any premises in the island, preventing the waste and pollution of such water; regulating the supply and distribution of electricity to any premises in the island, the imposition of rates for the supply of water and electricity to any premises, and the collection of such rates.

The 1976 Act provides that before the Council makes a by-law, it must cause a copy if the by-law to be published in three (3) successive issues of the Gazette. The Act provides that a by -law duty published in the Gazette: shall have full force and effect within Barbuda, but except where specifically or by necessary implication provided under this Act or any other law from time to time in force in Antigua and Barbuda shall only operate in addition to and not in derogation of any other law of Antigua and Barbuda or of any power conferred by any other law or any other person or authority and exercisable with respect to Antigua and Barbuda.

The same Act also provides the by-laws adopted by the Council have the force and effect of the law provided they are consistent with the provisions of the 1976 Act and are not repugnant to any law in force in Antigua and Barbuda.

Under the Barbuda Act, the Council is permitted, with the section and approval of Cabinet, inter alia, to allot, distribute and divide land within the village amongst villagers for residential purpose ; to set apart for public purposes such portions of land, either inside or outside the village, as shall appeared desirable; to stop up and divert any highway or path within the island ,whether in the village or not, and to open up and make other highways and paths throughout the island; to set apart portions of land to be used by the villagers as provision grounds, and to impose a rent in respect of every such plot.

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**3. GENDER PERSPECTIVE**

3.1 Why is a gender perspective on invasive species important?

The third Millennium Development Goal (MDG) is to Promote Gender Equality and empower women. Although the targets and indicators under MDG3 refer specifically to education, non-agricultural employment and parliamentary representation, it is recognized that promoting gender equality is important to achieving MDG1 on poverty and hunger and MDG7 on environmental sustainability. Invasive species have a direct impact on food production and the environment, so a gendered perspective is highly appropriate in addressing development needs.

Invasive species have significant negative and sometimes positive impacts, and so how they are managed is a matter of some consequence. Gender affects people’s experiences, concerns and capabilities in natural resource management, and gender relations influence how environments are managed and used over time (Masika and Joekes, 1997). Invasive species has impacts on the sustainable use of natural resources. In this area taking a gender perspective has been shown to be important when assessing problems, designing and implementing interventions and monitoring and evaluating the outcomes. Thus, in common with other issues in natural resource management, taking a gender perspective on invasive species can:

* Improve understanding of the impacts
* Increase the effectiveness of invasive species prevention and management.
* Contribute to social equality.
  1. Gender roles

Prior to the last two to three decades, the role of women in natural resource management was often overlooked, perhaps because the onlookers were viewing communities through the lens of their own developed country experience and perspective. Thus, the role of women was seen as that of ‘housewife’, and in that context the concern of environmentalists was with limiting environmental degradation through population control. The UN decade of women, which ended in 1985, contributed to the recognition of women as the main producers of food, as well as collectors of natural resources such as fuel wood, water and medicinal plants. The recognition of women as users and therefore managers of natural resources meant they must also be recognized as important players in sustainable development and environmental protection (Dankelman, 2002). Thus, women are now seen as part of the solution to environmental degradation, rather than part of the problem (Mikkelsen, 2005), and this is the view that should be taken in regard to invasive species prevention and management. Some authors contend that women are actually ‘closer to the environment’ than men, and so are more likely to nurture it in a more sustainable manner. This is also an unhelpful generalization as it not only overlooks the fact that in some circumstances women may be as exploitative of natural resources as men, but also runs the risk of making environmental management a role primarily for women. Agarwal (2000) asserts that there is little evidence that women are inherently more conservationist than men, although their social networks allow greater opportunities for collective action in environmental management. In highly diverse ecosystems which provide a wide variety of useful species, any one species might not be common. When invasive plants are established in natural ecosystems, the diversity of plant species generally falls, often dramatically so, and this would affect those who gather and harvest from that diversity.

The different roles that women and men perform are also apparent in agricultural labour. Women tend to be responsible for subsistence or food crops, and men for the cash crops, although this is not always the case. Women may also be required to work as labourers in male-managed cash crops, as well as farming their own food crops. Women often have a much higher demand on their time than men, meaning the factors that affect labour, such as species invasions or prevention and control methods, may have greater impact on women.

* 1. Decision making and conflict.

Coupled with issues of roles, responsibilities and asset ownership is that of decision – making and associated structures. Again, while there are differences between and within societies, women generally have less decision-making authority than men. This extends to many aspects of life, including management of natural resources and the decisions that the presence of invasive species create. The differences may manifest in subtle ways, such as community meetings being held at times or places that suit men more than women, but it may also be more formal and part of customary law. Lack of education or access to information also restricts the ability of women to play a part in decision making. Where decision making processes are imposed rather than agreed, outcomes may be difficult to accept for some parties, leading to conflict at household or community level. While conflict is not necessarily physical, violence against women is a major concern in many countries, and conflict over invasive species issues and decisions could aggravate existing problems. Westermann *et al*. (2005) found that natural resource management groups are more effective when they are mixed or women-only. Collaboration, solidarity, collective action and conflict resolution all improve with women in the group, emphasizing that a gendered approach to natural resource management problems increases efficiency.

3.4 Ownership and access to resources

A major difference between men and women in natural resource management including agriculture is their ownership and access to resources. Chief amongst these resources

is land, and while there are local variations, in general there is a marked bias in favour

of men being in the control of land as a means of production (Fontana and Paciello,

2009), women being less likely than men to own the land they farm. The lack of land ownership can affect access to other resources, such as credit, water and grazing rights, limiting livelihood options for women – for example in Antiguan women are excluded from contract farming as they lack statutory land rights, and have limited access to irrigation and infrastructure.

Lack of access to resources also increases vulnerability. When times are difficult, such

as caused by unfavourable climate, those with fewer resources find it harder to cope.

3.5 Water

Gender differences in the use and management of water have long been recognized (Khosla and Pearl, 2003). Women are often responsible for domestic use of water in drinking, cooking, washing and hygiene; men are more often responsible for crop irrigation, large livestock production and industries. Thus, if invasive species affect the

availability or use of water, there are likely to be gender differences in their impacts.

One of the ecological impacts of invasive species can be to reduce the availability of water. Reduced availability of water means women and girls spend more time collecting it, with significant opportunity costs. In the case of girls this may be lost time for schooling, and for women less time for other productive or social activities. Increased time spent collecting water can also mean increased exposure to assault. Reduced availability of water for men means their productive or income generating activities are likely to be affected. As with women, this can result in longer working hours, reduced income, and the social impacts that can follow such changes.

3.6 Gender and climate change

Climate change is now one of, if not the foremost environmental concerns, with profound implications for sustainable development and natural resource management. Recently attention has been turned to the relationship and linkages between climate change and gender (Brody et al., 2008), and consideration of how mitigation and adaptation responses can be made gender sensitive. This is relevant to the current study for two reasons. First, like invasive species, climate change will cause changes to natural resources and the way in which they are managed, which can affect and be affected by gender differences. Even though some of the changes caused by and in response to climate change may be on a different scale to those associated with invasive species, there are perhaps lessons to be learned from climate change work on gender. Secondly, climate change will have direct effects on invasive species, and so interact with gender differences in natural resource management. Climate change will result in new invasions, modify the impact of existing invasions, and modify the capacity of men and women to cope with their impacts. While this is true for anything that changes or impacts on ecosystems, the strong interaction between invasive species and climate change makes the invasive species/climate change/gender nexus one of particular significance, which to date has not been explored at all. An additional observation in the context of climate change is that it is creating an upsurge of interest in biofuels. There is much to debate on the potential costs and benefits of biofuels, but here we note that some biofuel species are considered invasive, and Buddenhagen et al. (2009) show that in general, biofuel species are more likely to be invasive than other plant species. Depending on the complex interplay of social, environmental and economic factors in a particular context, there could be very marked differences in the gender related impacts of biofuels, which invasiveness could confound further.

# PHYSICAL PROFILE: ANTIGUA – BARBUDA – REDONDA

### 4.1 Geography

The tropical island of Antigua and Barbuda is located in the heart of the Caribbean about a thousand miles to the east of Jamaica and half that distance from Trinidad on the coast of South America. The country lies at 17° N latitude and 61° W longitude. Although Antigua – Barbuda – Redonda are only three of a chain of islands comprising the Lesser Antilles, it forms an interesting link between the volcanic islands of the main arc (stretching from St Kitts, through western Guadeloupe, to Grenada) and the purely sedimentary outliers (Anguilla, St Martin, St Barts, Barbuda, Deserada, and Grand Terre of eastern Guadeloupe). Whereas the volcanic islands are all mountainous with steep slopes descending into the sea, the limestone outliers are all relatively low lying. The physiographical affinities of the northern and western parts of Antigua are clearly with the outliers, while the south – western region has many features in common with the volcanic islands.

The island of Antigua lies at latitude 17° 05' north and longitude 61° 50' west. It is roughly pentagonal in shape and has an estimated area of 279 square kilometres (108 square miles).The greatest distance from east to west is 20.9 kilometres (13 miles), and from north to south 16.1 kilometres (10 miles). The coastline is very much indented, especially on the eastern windward side and is over 96.6 kilometres (60 miles) in length. There are 51 small Islands / islets around the coast, chiefly on the northeast side, ranging in size from Guiana Island (0.8 square kilometres or 200 acres) and Long Island (0.5 kilometres or 120 acres) to tiny rocky islets which are no more than the tops of submerged coral reefs.

The mainland of Antigua is divided naturally into three distinct physiographical regions: a volcanic region in the southwest, a central plain and a limestone region in the north and east. The volcanic region, southwest of a line joining Ferris Point and Falmouth, is mountainous with summits averaging 300 metres (1000 feet), the highest being Boggy Peak, (405.1 metres or 1330 feet). It is bounded on the south by a narrow coastal plain and is intersected by a number of small alluvial valleys. The first zone is the mountainous southwest region washed by the Caribbean Sea. This area contains moist evergreen vegetation along with dry scrubland. In this zone are a number of brackish fresh and saline ponds, most of which are landlocked, though some have narrow sea islets. Martin-Kaye (1959); Loveless (1960) and Charter (1937) posits that the volcanic region contains igneous rocks such as andesite, ash beds and agglomerates of the Eocene date. Exposed rocks abound throughout the region, and most of the higher hills have precipitous slopes facing the sea. The surface of the hills is characteristically boulder, with many outcrops of the matrix. Charter places the soils of this region in the ‘Montero Suite’ and recognized five soil series, which are on the mountain slopes, on the narrow coastal plain, and in the small mainly neutral to slightly acid region, though seams of a loose form of calcium carbonate occur sporadically to varying depths from the surface. The volcanic region is comparatively well wooded, and in the upper parts of some of the remote valleys the forest show characteristics approaching those of tropical rain forest.

The Central plain is a diagonal belt almost uniformly 4.8 kilometres (3 miles) wide between the volcanic and the limestone regions. It extends from between Ferris Point and Corbinson Point in the Northwest, across the centre of the island, to between Shirley Heights and Willoughby Bay in the Southeast. The region consists of gently undulating country which occasionally rises to heights of 152 metres (500 feet) or more. It is separated from the limestone regions to the northeast by a narrow, low lying diagonal trough, about 1.6 kilometres (1 mile) wide and mostly less than 15.2 metres (50 feet) above sea level, and from the volcanic region to the southwest by the flood plain of Bendals river.

The Central Plains (the second zone) is a broad belt of low-lying land, from between Dickenson Bay and St. John’s in the northwest, extends south-eastwards across the island through Buckley’s and All Saints to the southeast coast between Falmouth and Bethesda. This is an area of coastal flats, lagoons, and shallow offshore deltas (Martin-Kaye 1959; Loveless 1960).Loveless (1960, p. 502) notes that “the central plain has been cleared entirely of forest and woods”. He continues that the “the central uplands, which were one under sugar cane, are now covered with coarse grassland, which is annually burnt together with small, scattered patches of scrub. Within the diagonal trough are considerable areas of saline swamps and marshy ground”.

Charter (1937, p. 5) writes that the rocks “comprise a series of water deposited tuffs of Oligocene age, and include indurated clays, soft shales and conglomerates containing pebbles of andesite and porphyry. Interstratified with these are beds of freshwater chart, and sporadic deposits of marine chert and limestone”. Throughout this region may be found fragments of fossil silicified wood, scattered among the surface layers. Charter classifies soil in this region into the ‘Otto suite, occupying on the whole the higher land and the ‘Gunthorpes Suite’ occupying the diagonal trough. Nine soil series are recognized in the Otto Suite as well as a ‘Boundary Phase’ of the central uplands, they consist of medium to heavy clays varying in their reaction from slightly acid to definitely alkaline, but neutral to alkaline sol appear to predominate. Charter recognizes three series which are not confined to the central region, but also occur over large areas in the central east of the limestone region. They are essentially alkaline in reaction and consist of ‘calcareous clays of Pleistocene age’. These soils are generally exceedingly heavy and hard to work.

The limestone region includes the whole of the northern and eastern third of the island together with numerous outlying islands and islets, such as, Guiana Island, Long Island and many others. On the north it consists mostly of relatively flat country of low elevation from which rises numerous, more or less, isolated, conical hills, between 90 metres (300 feet) and 120 metres (400 feet) in height. To the east the country gradually rises to form two almost level plateaus averaging about 45 metres (150 feet) high, to the north and south respectively of Nonsuch Bay, which are penetrated by narrow valleys.

The coast beyond the eastern plateau is deeply indented and extremely rugged. The limestone region is bounded to the south by an abrupt, but discontinuous escarpment, rising in places to over 107 metres (350 feet) in height. The third geological region is the rolling impure limestone hills and valleys in the north and east. The north-eastern (Atlantic) coasts are rocky or sandy beaches with substantial wave action. A band of xerophytic scrub on low limestone hills and valleys is evident (Martin-Kaye 1959; Loveless 1960). The rocks of the limestone region according to Charter (1937,p 5) consist “of Oligocene deposit of hard white limestone and compacted marls, these beds being noted for their abundant fossil fauna …The rock formation of both the central and limestone region are covered with a superficial deposit of clays and marls of about the Pleistocene age”. Charter classifies the soils of the limestone region into the ‘Fitches Suite’ with four series. The essential character is their alkalinity, over large areas of surface soil may consist of up to 75% pure calcium carbonate. These soils are easily waterlogged after heavy rainfall and in the process of drying out they develop frequent deep cracks.

Although Antigua has no permanent rivers there are about a dozen water courses (locally called “ghauts”) originating in the hilly parts of the central plain and in the volcanic region. The most important of these, Bendals river, is semi-permanent but even this is said to dry out in times of excessive prolonged drought. The other watercourses, although they become swiftly flowing streams and even raging torrents during the rainy season, are for the greater part of the year quite dry. Natural drainage is mostly poor and during periods of very heavy rain, wide areas of the adjacent low-lying land are flooded and become seriously waterlogged in consequence. The 51 offshore islands of Antigua and Barbuda include Rabbit, Redhead, Lobster and Great Bird islands in the North Sound area, Green and York in the East, Five-Islands in the West and Redonda to the West Southwest of Antigua. The majority of the islets are characterized by limestone cliffs covered by dry scrub vegetation and surrounded by mangrove and coral reef systems which provide valuable resources to the avifauna.

The island Redonda is the sole islet to retain its secluded character. The other islands are relatively isolated, and thus act as havens for nesting seabirds, both migratory and resident.

The offshore cays are relicts of coral reefs; individual or joined by a sand bar in the case of Great Bird Island or artificially formed (e.g., Maiden Island) by dredge spoil by the US Navy. Redonda is the active cone of a volcano, approximately one mile long by one third of a mile wide with cliffs of 971 feet (398 meters) in altitude. The island is completely bounded by steep cliffs and has a sole beach and a plateau that are only accessible by boat and air.

Except for Long Island and Sandy Island, Antigua and Barbuda’s offshore islands are all near pristine –they show minimal evidence of human impact. This can be seen in the form of litter left behind by fisherman and day trippers, and the occasional poachers (bird eggs, turtle eggs, etc.). Long Island is dominated by the tasteful and well laid out Jumby Bay Resort, and the resort must be commended for its environmental awareness, particularly its assistance with a turtle monitoring and conservation project. Sandy Island is the second most popular diving site in Antigua and Barbuda, being visited by an estimated average of 107 divers/snorkelers a week, not to mention a number of local fishermen who spearfish and/or set fish traps around the island (Bunce 1994). There is a lot of litter left behind on the island by day-trippers and fishermen, and the island shows the imprint of heavy human visitation.

Most of Antigua and Barbuda’s offshore islands need some kind of protected status since there are several potential developers waiting in the wings. Crump Island is also slated for development, and currently there is a private effort underway to establish a marine park there. There are also some concerns that because there two offshore islands so close to Antigua and Barbuda, that they may someday be connected by causeways rather than ferry. Bird Island is also being considered as a site for a proposed marine park (to be managed by the National Parks Authority). The preliminary plan for this has been funded by the Organization of American States (OAS).

### 4.2 Climate

The Position of Antigua and Barbuda between latitudes 17 degrees and 19 degrees north and with Open Ocean stretching uninterruptedly to the east accounts for the main features of the climate. Like the rest of the Lesser Antilles Antigua and Barbuda lies between the permanent low-pressure zone of the Intertropical Convergence and the semi-permanent, subtropical high-pressure cell of the middle North Atlantic. Consequently, the country is under the influence of easterly trade winds throughout the year. The seasonal rhythm of climate is caused by the alternating dominance of these high- and low-pressure zones, which themselves migrate in response to the annual shift of the sun to north and south; but day-to-day weather is complicated by smaller scale atmospheric disturbances such as waves in the upper trades, upper cold fronts moving both from the east and the west, and tropical revolving storms. The relief and orientation of the island is responsible for other local variations of weather.

Normally the “dry” seasons lasts from January to April and the “wet” seasons from August to November, with May, June, July, and December as transitional months: but this sequence is liable to wide variation from year to year. During the dry season both the subtropical high and the Inter tropical Convergence zone attain their most southerly positions. Atmospheric conditions over the islands are dominated by stable, dry air; the trades are strong and constant and only occasional cold front, usually from the west where they are associated with outbursts of polar air over North America, disturb the succession of hot, dry days. These fronts from the west usually travel southeast towards Trinidad, but occasionally they bring west winds, clouds, and rain as far north as the leeward Island (Twist, 1953:303). During May, the Intertropical Convergence zone begins to move north and by June it has usually reached about 10 degrees N, through waves along its boundary occur occasionally and can cause it to reach temporarily as far as 15 degrees N, almost to the Leeward. It is such times that small lows developing on the wave sometimes grow into tropical revolving storms which may reach hurricane force. The disturbed weather and heavy rainfall of the wet season is, however, attributable mainly to waves in the upper trades and to the proximity of the high-level western Atlantic polar trough. These waves move over the islands at intervals of about five days and give rise to troughs of low pressure and much active convection. Fairly frequently these troughs take the form of minor tropical storms with violent winds and thunderstorms and sometimes they develop into hurricanes. The frequency of storms increases as the wet season advances, until it reaches a peak in August and September, after which it declines: “June too soon, July stand by, August is worst, September remember, October all over” sums up the local expectation of hurricanes.

Orientation and relief in the outer Leeward do not cause such marked variations in local climate as in the mountainous, volcanic islands. The available relief of Barbuda is not too slight to bring about any significant reduction of temperature or increase of rainfall with altitude, nor is there any appreciable contract between the windward and leeward coast. The hills of Antigua, on the other hand, do receive higher rainfall and experience slightly lower temperatures than the low-lying areas, although they seldom display the plume of cloud that so often trails to leeward from the high peaks of the of the volcanic island and Antigua’s highest slopes do not support the tangle of cloud-saturated vegetation that mantles their summits.

A mean annual temperature of approximately 80 degrees F is maintained in the outer Leeward, with a range of about 10-degree F, from a maximum in August to a minimum in January. The mean annual temperature of St. John’s, capital of Antigua, is 81.8 degrees F and temperature as high as 93 degrees F and as low as 60.1 degrees F have been recorded. The growing season is thus never curtailed by low temperature. Both the amount and incidence of rainfall, however, closely influence plant growth and can be analyzed in some detail from available records. In Antigua records have been kept by the Antigua and Barbuda Meteorological Services since 1960 but from 1874 until 1908, the Department of Agriculture kept the rainfall data and in that time the number of stations has varied widely, up to a maximum of seventy. Single stations have recorded rainfall in Barbuda since 1908. From these observations it is clear that great variability from year to year is the outstanding characteristic of the rainfall regime. The mean annual rainfall of Antigua as a whole, derived from all stations over a period of 87 years (1874-1960) is 43.37 inches, but values for particular years vary from maximum of 73.59 in 1889 to a minimum of 25.51 in 1930. Comparable figures given for Barbuda a mean over 53 years (1908- 1960) of 38.82 inches, a maximum of 62.19 inches in 1942 and a minimum of 21.96, also in 1930. These extremes represent variation in Antigua from 41 percent less than, to 70 percent more than the mean; in Barbuda from 43 percent less than, to 60 percent more than the mean. Departures of over 25 percent above or below the mean occurred on between one-fourth and one third of the years recorded in each island.

The distribution of rainfall in Antigua is relatively well known as recording stations are numerous enough to afford fairly complete cover of all the south-western, mountainous district. The driest area, with less than 40 inches mean annual rainfall, includes the peninsulas and offshore islands of the east coast north of Willoughby Bay. Rainfall increases westward across the island until in the southwestern district it exceeds 50 inches. On the higher slopes and summits in the southwestern mountains it probably exceeds 60 inches, though in the area it has not been measured. As there is only one station in Barbuda the distribution of rainfall cannot be mapped, but as already suggested, it probably varies little, though the higher areas may receive slightly more than the lower land where the rain-gauges are located. The seasonal distribution of rainfall is very similar in the two islands. Almost half the year’s rain falls in the 4-month wet season from August to November and less than one-fifth in the 4-month dry season from January to April. In the two islands rainfall increases rapidly from April to May and then declines temporarily through June and July before the wet season proper sets in August. This secondary rainfall minimum of mid-summer is a pronounced feature of precipitation profiles in the Greater Antilles, but it also appears in the Leeward’s. It is probably due to a slight increase in pressure in June and July associated with the north-westward movement into the Gulf of Mexico of the high-level western Atlantic polar through. The peaks of rainfall in May and August-November are correlated with the more easterly position of the trough in those months (Trewartha, 1961: 67; Riehl, 1954: 83). The pattern of seasonal distribution is, however, liable to extreme variation, as occurred in 1957 in Barbuda when 51 percent of the year’s rain fell in the normal dry season and only 19 percent in the wet season, causing the usual sequence of planting and harvest to be completely dislocated.

It is uncertain what degree of variation there is in seasonal distribution of rainfall within the islands. In Barbuda, with their small size and simple relief, it is unlikely that more complete records would indicate any significant variation from one area to another. The erratic incidence of rainfall from year to year and the severity of the dry season find expression in the predominant life-forms of the vegetation. Their most conspicuous effect is on leaf physiognomy. Trees and shrubs with evergreen, leathery (sclerophyllous) leaves are abundant in all forms an important element in flora of Antigua. By contrast, evergreen board-leaved (macrophyllous) trees and shrubs are restricted in Antigua where they are common only in the higher, wetter, southwestern district. Other widely found physiognomic features that show adaptation to irregular rainfall and seasonal drought are nanism (reduction in size of certain parts of a plan, especially the leaves), thorniness, succulence, the presence of laticifers and essential oils, and trunks developed as organs of water storage.

### 4.3 Geology and Soils

The mainland of Antigua is divided naturally into three distinct physiographical regions: a volcanic region in the southwest, a central plain and a limestone region in the north and east. The volcanic region, southwest of a line joining Ferris Point and Falmouth, is mountainous with summits averaging 300 metres (1000 feet), the highest being Mount Obama, formerly Boggy Peak, (405.1 metres or 1330 feet). It is bounded on the south by a narrow coastal plain and is intersected by a number of small alluvial valleys. The Central plain is a diagonal belt almost uniformly 4.8 kilometres (3 miles) wide between the volcanic and the limestone regions. It extends from between Ferris Point and Corbinson Point in the Northwest, across the centre of the island, to between Shirley Heights and Willoughby Bay in the southeast.

The region consists of gently undulating country which occasionally rises to heights of 152 metres (500 feet) or more. It is separated from the limestone regions to the northeast by a narrow, low lying diagonal trough, about 1.6 kilometres (1 mile) wide and mostly less than 15.2 metres (50 feet) above sea level, and from the volcanic region to the southwest by the flood plain of Bendals river. The limestone region includes the whole of the northern and eastern third of the island together with numerous outlying islands and islets, such as, Guiana Island, Long Bay and many others. On the north it consists mostly of relatively flat country of low elevation from which rises numerous, more or less, isolated, conical hills, between 90 metres (300 feet) and 120 metres (400 feet) in height. To the east the country gradually rises to form two almost level plateaus averaging about 45 metres (150 feet) high, to the north and south respectively of Nonsuch Bay, which are penetrated by a narrow valley. The coast beyond the eastern plateau is deeply indented and extremely rugged. The limestone region is bounded to the south by an abrupt, but discontinuous escarpment, rising in places to over 107 metres (350 feet) in height.

Barbuda’s geology is described as two Pleistocene limestones and recent superficial deposits. Five parent materials have been distinguished from these by the soil survey.

Recent (1) Saline alluviums both sand and clay (low permeability).

* 1. Pleistocene Codrington Limestone

(2) Calcareous coral shell sands of various ages (highly permeability).

(3) Soft rubbly shelly limestone (permeability).

(4) Moderately hard shelly limestone; massive surface calcreted (impermeable).

(5) Jointed, semi crystalline limestone (permeable).

Volcanic rocks are not exposed in Barbuda although they are believed to be present at a depth of 60 to 100 feet the level of the Barbuda bank. Evidence of ash showers from volcanoes in neighbouring islands has not been found in the soil profiles examined although some fine shot (magnetic) in various soil profiles suggests some contamination. Soil formation has been influenced primarily by the different parent materials, land slope and the relatively dry climate. Soils have been mapped (1:25000) and described in detail by Hill (1955). In Antigua the 33-soil series described by Hill may be conveniently grouped into five broad groups according to depth and texture. These comprise:

1. Deep alluvial / colluvial soils in the valley system of the volcanic region. These soils are primarily sandy loams or loams with near neutral pH. Some of the best tree growth is found in these soils.
2. Deep Kaolinitic soils of the Central Plain. These are hard to work heavy clays with impeded drainage and near neutral pH. Some are saline at various depths below the topsoil. Some calcareous clays are found in parts of this region.
3. Generally shallow calcareous clay soils o the limestone areas in the north. These are productive in the deeper phases over the softer marls. Despite the high clay content, they possess good structure and have high base saturation. Soil pH is around 8.2.
4. Complex of shallow and deep calcareous soils, mostly in the eastern part of the limestone regions. Similar to Group 3 but with greater areas of deeper soils. Drier climate restricts productivity.
5. Shallow soils of the mountainous volcanic region. These are thin to very thin stony soils formed over andesite and basalic rocks. They are clay loams and clays of reddish-brown colour with slightly acid pH. Steep slopes, erosion hazard and shallowness preclude use for other than watersheds and forest cover.

The deeper marl soils and the alluvial soils of the volcanic regions are the most productive soils for agriculture and will support production of a range of vegetables and tree crops. Water remains the biggest limitation to agriculture production. In Barbuda, of the five major soil forming factors, vegetation and climate are almost uniform for the whole island. Topography is important only in the Highlands where it governs the distribution of eroding or accumulating phases. Two limestones of different ages are the most widespread parent material and differences in permeability and whether the rock is massive or rubbly may affect the soils. Time may be important because the Highlands represent the oldest area of land on Barbuda.

The three major soil series are corresponding to the three geological regions.

1. The Codrington Series occurs over a rubbly limestone on the more recent terraces with the lowest rainfall. Drying out during the dry season causes a black alkaline soil to form.
2. The Barbuda Series occurs over permeable limestone on the oldest terraces with the highest rainfall; leaching is moderate. A red soil with predominately kaolinitic clay is produced.
3. An intermediate soil known as the Blackmere Series is found on the hard limestone with moderately rapid through drainage. It lies on terraces older than the Codrington Series. Rainfall is moderate and a brown soil is formed.

Whether the differences between these soils are due principally to rainfall drainage or time is impossible to say, but in Barbuda all three factors are involved.

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# SOCIO – ECONOMIC SETTINGS

### 5.1 Demography

According to the 2011 Antigua and Barbuda Population and Housing Census, 85,567 persons were residing on Antigua and Barbuda on Census Day -27th May 2011. Among these persons, 84,816 were living in private households and 751 in institutional households. In addition to the resident (de jure) population, the non-resident population was also enumerated in the Census. These included persons who were visiting the island and crews on board of ships in port. At the census moment, 2,999 non-resident persons were staying in the country. This put the defacto population in the country at 88,566 on 27thMay 2011. At the time of the 2001 census (29 May 2001) 76,886 persons were living in Antigua and Barbuda. The population increased with 8,681 persons during the 10-year intercensal period. This implies an overall growth of the population of 11.3 percent for the whole period and an average annual increase of slightly more than 1 percent (1.07). In the period 6 months before and 6 months after the census, 480deathsand 1,252 births were registered in Antigua and Barbuda. With a population size of 85,567 this implies a death rate of 5.6 per thousand and a birth rate of 14.6 per thousand. As natural growth is simply the difference between the birth and the death rates, in the period December 2010 to November 2011, the population in the country grew by 0.9 percent, solely due to fertility and mortality. As the average yearly population growth rate between 2001 and 2011 was 1.07 percent, it is clear that net migration only played a limited role in Antigua and Barbuda's demographic development during the intercensal period.

It is interesting that during the nineties, the female population grew more rapidly than the male population, while during 2001 -2011 the male population grew at a higher pace. As a result, the sex ratio dropped from 93.1 in 1991to 88.6 percent in 2001, but climbed again to its current level of 91.9%. Antigua is divided into 6 parishes: St. John, St. George, St. Peter, St. Phillip, St. Paul and St. Mary. A large part of the population is concentrated in the parish of St. John: 51,737 persons, i.e., just over 60 percent of the population, lives in or around the capital. Barbuda remains very sparsely populated with only 1,634 people. After St. John, the parish of St. George, adjacent to St. John and close to the international airport, has the highest population with 8,055 persons.

The age distribution of the Antigua and Barbuda population went through some notable changes. After an initial growth from 19,454 to 21,726 between 1991 and 2001, the group of persons below age 15 has decreased to 20,444. Over the last twenty years, the group of elderly citizens (60+ years) has increased at a steady pace, from 7,061in 1991 to 7,172 in 2001 to 9,543 in 2011. The population in the 15 to 60 years age group also increased significantly during the last 20 years. In 1991, there were 37,363 persons in the age group15 to 59. By 2011, this number had increased to 55,580.

Population changes in Antigua and Barbuda are to a large extent driven by in and out migration. While mortality and fertility have remained fairly constant since the census of 1991, migration has followed a more erratic pattern. As was the case for other islands in the region (Anguilla, British Virgin Islands, Cayman Islands, Curacao, and Aruba), migration was triggered by the expansion of the tourism industry. According to the Country Strategy Paper for the period 2008 -2013, from the government and the European Community, Antigua and Barbuda had the third largest concentration of immigrants in the Caribbean region. It can be expected that the further integration of the Organisation of Eastern Caribbean States (OECS) together with continued economic recovery will have an effect on the levels of migration in the coming years. Immigrants contribute through their labour to the economy of the country. Over the years an important contribution to the country's economy was also made by persons who left Antigua and Barbuda and who sent remittances from overseas. For instance, Gammeltoft indicates that during the period 1995 -1999, remittances from abroad to Antigua and Barbuda constituted 6.9 percent of GDP. It is interesting to note that globally, among countries for which remittance data were available, Antigua and Barbuda received the highest per capita inflow of remittances totaling US$3,9974.

Migration flows from and to Antigua and Barbuda have created a diverse society. At the moment of the Census 2011, 25,411persons, i.e., 30.4 percent of the total population residing in the country, were foreign-born. Most migrants originate from surrounding Latin American and Caribbean countries. As a whole, people living in Antigua and Barbuda share 108 countries of birth. Over the years, people from all over the world have settled on the islands. For instance, one would not expect that in a small country as Antigua and Barbuda persons from17 African countries are present. Compared to 2001, the proportion of the population born abroad has remained more or less the same. At that time, 53,284 persons were born in Antigua and Barbuda and 23,602 were born abroad, which was 30.7 percent of the total population. The totals for all categories do not add up to 84,816 (population in private households), as information on country of birth was missing for 1,337 persons. In Census 2011, 87.3 percent of the population living in Antigua and Barbuda is of African descent. This is slightly less than 10 years earlier, when 91.0 percent indicated they were of African descent (see Figures 1.6-1.9.). The second largest ethnic category (3.8 percent) in 2011 consists of persons who identify themselves as of mixed (other) background. Note that in 2001 other categories were used than in 2011 and therefore comparisons over time are hard to make. For instance, in 2011 there were two 'mixed' categories (Black/white and other) when there was only one in 2011. 'Hispanic' is a new category in 2011, and -2.7 percent of the population consider themselves as Hispanic. It may well be possible that this group is underreported, because there is some overlap between the various categories and people with a Latino background may favour to report themselves as Caucasian, mixed or almost any other category. Antigua and Barbuda’s population has been growing steadily for decades and is currently projected to continue this growth into the 21s t century. By 2050, the population is estimated to be around 115,000 people. The current population of Antigua and Barbuda is 97,933 based on projections of the latest United Nations data. The UN estimates the July 1, 2020, population at 97, 929. There are 71, 568 adults in Antigua and Barbuda.

### 5.2 The Economy

Antigua and Barbuda’s economic growth in 2019 was managed from two main platforms – foreign direct investment and tourism (Antigua and Barbuda 2020 Budget Statement, p 11). Several investments, including the new Royalton Hotel, Hodges Bay Club, Hammock cove, Canada Place, the Barbuda Ocean Club are obvious in their presence. There was a 13% growth in tourism in 2019. Total revenue and grants to the government amounted to $847.5 million, a decline from $859.2 million in 2018. This $11.7 million decline was because of lower tax revenues. In 2018, tax revenue was $ 679.6 million, but it declined to $672 million in 2019 (Antigua and Barbuda 2020 Budget Statement, p14). The economy and economic activity has been steady. The United Nations Economic Commission for Latin America and the Caribbean (ECLAC), states that Antigua and Barbuda’s economy grew by 6.2% in 2019 after an impressive growth of 7.4% in 2018. It is said that this growth surpassed every country in this hemisphere (Antigua and Barbuda 2020 Budget Statement, p 2).

Unemployment is down to a single digit number for the first time since 2014 to just over 8% from 25% in 2014 (Antigua and Barbuda 2020 Budget Statement, p 3 - 4). Data from the Social Security Board confirms that the total number of registered employees has increased for six successive years. In 2018, the number of registered employees was 42,682 and this climbed to 43,535 in 2019 (Antigua and Barbuda 2020 Budget Statement, p 4). According to the Human Development Report, Antigua and Barbuda boasts one of the highest per capita GDP in the Caribbean and has the second highest human development index among the ECCU countries.

The GDP per capita has risen from US$2000 in 1981 (Year of Independence) to US$20,000 in 2020. Antigua and Barbuda is now rated as a high income country in the world’s ranking and the people’s average income is among the highest in the Western hemisphere (Antigua and Barbuda 2020 Budget Statement, p 5). ECLAC has projected that Antigua and Barbuda will be the second fastest growing economy in the hemisphere in 2020 with a growth rate of 6.5% (Antigua and Barbuda 2020 Budget Statement, p 6).

In 2014 the ratio of debt to GDP was 102% and reduced to 69.1%by 2019 (Antigua and Barbuda 2020 Budget Statement, p 10). This is a reduction of 33%. The objective set for countries of the Eastern Caribbean Currency union is 60% by 2030. In 2019 debt service was $504.5 million compared to $412 million in 2018 ((Antigua and Barbuda 2020 Budget Statement, p 10). The economy has grown significantly, and new debt is funding projects such as rehabilitating roads, retrofitting street lightning, improving, and expanding education facilities, building tourism infrastructure, financing LIAT and rebuilding following the passage of Hurricane Irma. The government claims that it has been able to accomplish the above projects despite high debt overhang (Antigua and Barbuda 2020 Budget Statement, p 10).

Although Antigua and Barbuda’s economy is the second largest in the Eastern Caribbean Currency Union the tax to GDP ratio is the lowest at 16% (Antigua and Barbuda 2020 Budget Statement, p 10). The non-tax revenues, the earning from the Citizenship by Investment Programme (CIP) brought in $98.9 million in 2019 compared with $59.7 million in 2018 (Antigua and Barbuda 2020 Budget Statement, p 15). While revenues decreased, expenditure in 2019 was $1.02 billion a similar figure to 2018. Wages and salaries, statutory contribution, goods and services, pensions and transfers amounted to $819 million. Over US$150 million has been spent on the YIDA project and a further US$ 50 million to US$ 100 million will be spent in 2020 (Antigua and Barbuda 2020 Budget Statement, p 16). There are plans for the Inland Revenue Department (IRD) to launch a new user friendly and interactive IRD website in 2020. The intention is for the IRD to intensify enforcement efforts, working with the Office of the Attorney General, to take legal action for the recovery of outstanding taxes, particularly ABST, Property Tax and Corporation Tax (Antigua and Barbuda 2020 Budget Statement, p 17). Despite the challenges of de-risking and costly implementation of new regulatory measures, the banks continue to facilitate economic development by providing funds to the productive sectors of the economy. The banking sector grew by 2.5 % in 2019, following a more than 6 % expansion in 2018. Growth in this sector is supported by a 9.8% or $245 million increase in total loans and advances for the period January to September 2019, compared to the same period in 2018 (Antigua and Barbuda 2020 Budget Statement, p 24). This boost in credit is because of increased lending for land development and construction from $82.7 million in September 2018 to $177.4 million in September 2019, an increase of 114% ((Antigua and Barbuda 2020 Budget Statement, p 24). The loan to deposit ratio increased from 63% in September 2018, to 70% in September 2019 (Antigua and Barbuda 2020 Budget Statement, p 25).

# 6. ECONOMIC DEVELOPMENT

### 6.1 Tourism

Antigua and Barbuda was among the first of the Caribbean Islands to seriously and actively promote tourism in the early 1960’s. Tourism in Antigua and Barbuda is a significant industry. Tourism is a tertiary economic industry and is the world’s largest international industry, valued in 2015 at US$ 778 billion. It has proved to be capable of continuous growth and is a relatively high employer of all classes of labour. It generates income at a very high level and appears unaffected by economic recessions over a long period. The tourism industry in Antigua and Barbuda faces many challenges; one being that international tourism is competitive. Resorts within the country compete against each other and against those in other countries. The industry is influenced by climate, location factor, transport facilities, communication networks, political stability.

There are two main classes of tourist in Antigua and Barbuda: the stayover visitor and the cruise passenger. The stayover tourist is particularly important because he or she stays at least one night in rented accommodation, e.g., hotel, and brings income to the country. The length of stay of a tourist varies and may be from one day to six months, but a stay of four to ten days is the most common. The further a visitor must travel, the longer he or she is likely to stay. A visit to Antigua averages 8 days compared to 6 days for one to the Bahamas. Europeans always stay longer than North Americans, 10 – 12 days being common. Because there is a global trend towards higher incomes, more leisure time, and more travelling, it can be concluded that tourists are taking longer vacations. On the other hand, there are more flights to more destinations and more accommodations are available. This means that tourists may stay longer on vacation but may visit more destinations so that average length of stay is a difficult statistic to analyse. From a hotel a shorter stay is unprofitable, but for the airlines the extra travelling is beneficial.

### **Table 1.** The number of visitors to Antigua and Barbuda during the period 2008 – 2018

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **No. of Air Arrivals** | **No. of Sea Arrivals (Cruise)** | **No. Of Sea arrivals (yacht)** |
| 2008 | 265,844 | 582,888 | 25,913 |
| 2009 | 234,410 | 712,792 | 17,412 |
| 2010 | 229,943 | 557,635 | 25,886 |
| 2011 | 241,331 | 606,495 | 24,403 |
| 2012 | 246,926 | 572,153 | 28,117 |
| 2013 | 243,219 | 533,990 | 18,114 |
| 2014 | 249,316 | 522,342 | 17,922 |
| 2015 | 250,450 | 644,314 | 18,083 |
| 2016 | 265,187 | 608,503 | 17,737 |
| 2017 | 247,320 | 792,861 | 19,543 |
| 2018 | 268,949 | 794,604 | 18,855 |

Source: Ministry of Tourism

In 2020, investments in the tourism sector are expected top $2 billion. These tourism investments include:

1. $325 million to be spent in 2020 on the PLH Ocean Club on Barbuda.
2. $125 million renovation and expansion project at the existing Rex Halcyon Hotel by Sunwing
3. Development of a $270 million beach club at Fort James by Royal Caribbean Cruise Lines.
4. $540 million One and Only Hotel and Luxury Villas at Pearns Point
5. $100 million Armand Hotel Project in Barbuda
6. $540 million Port Oasis project at Side Hill. This project will be undertaken by the Hadeed Group of Companies in conjunction with international partners.
7. NAMCO will assume 65% ownership of the Jolly Beach Hotel and will spend $150 million to expand and refurbish the property. This will make it one of the largest hotels in the OECS sub-region.

In addition to these projects, work will continue, or commence, on several other properties, including a Best Western Hotel, a Marriott Courtyard Hotel at the Airport, the Ayre Wellness Centre, and Spa at Valley Church, Replay Halfmoon Bay project, and the YIDA projects. Many private luxury dwellings will also be constructed across Antigua and Barbuda: Pearns Point, Jumby Bay, Mill Reef Club, Galley Bay Heights, Windward Beach, and the US$50 million Baron Thyssen luxury home at Laurie Bay, which is presently under construction. Also, the new owners of Callaloo Cay will proceed with the hotel project at Morris Bay, starting construction later this year.

Another hotel project, beginning in the second quarter of this year is the Bungalows project at Devils Bridge. This is a US$100 million, Elite Island Resorts project that purportedly offers an opportunity for Antiguans and Barbudans, to acquire a stake in a hotel property. The Sunwing renovation and expansion of the Halcyon Cove Hotel will also offer a similar opportunity for people to invest in tourism accommodation. Yet another opportunity for Antiguans and Barbudans to invest and own tourism capital, is available at the Cedar Valley Golf Course. The Cedar Valley Golf Course was voted among the best in the Caribbean and is ripe for development. Government will make 10 acres of land available to locals, at $3 per square foot, for development of a 50-room Marriott Courtyard-type hotel within the golf course (source?). These investments, costing in excess of $2 billion, are projected to generate an economic boom: creating more jobs; increasing income; and enlarging demand for goods and services from which retailers, wholesalers and owners of every type of business will benefit.

The Government hasformed a partnership with Global Ports Holding (GPH) The government retains ownership of the cruise port while GPH is expected to invest US$57 million to:

* Complete a fifth pier, allowing the hosting the world’s largest cruise ships;
* Develop and construct over fifty thousand square feet of new retail, food and beverage and entertainment facilities, to be leased to local persons; and
* Renovate and enhance the Heritage Quay shopping complex.

The new pier and new commercial complex will be built by Global Ports Holdings (GPH) but owned by the Government and people of Antigua and Barbuda. As part of the partnership arrangement, GPH has already repaid a US$21 million debt, incurred by the government two decades ago, to develop the Nevis Street Pier and Antigua and Barbuda acquires the infrastructure to compete in the new cruise tourism space.

In practice, not all tourists stay in hotels, so the hotels were not as full as the calculated percentage suggests. The occupancy rate for hotel beds and for aircraft seats is a good indication of their profitability. In most case they will need about 60% occupancy to be profitable, although the price paid by tourists is also important. A winter tourist spends more than a summer package tourist. Often winter is the only profitable period. In Antigua and Barbuda, the tourist industry foreign revenue is earned through money spent by tourists on travel, accommodations, entertainment, and sightseeing and from the purchase of specialized items.

The most important statistics are the total amount spent, the average per visitor and what it is spent on. Overall, the figures are very high indeed. Antigua and Barbuda received over EC$ 187.8 million in 2004, and EC$216.73 million in 2015, which work out at about EC$ 400 – 600 per tourist. A stopover tourist is likely to spend over EC $ 360 a day, while a cruise visitor spends EC$ 130. In Antigua and Barbuda, 93% of the income is from stopover visitors, because the stopover spends more per day and stays longer. The cruise visitor does not -pay for accommodation, and usually has already paid for meals. On the other hand, he or she requires very little infrastructure and spends a lot on shopping. The amount spent that actually stays in the country is variable. Because food, transport and other facilities for tourists are often imported, and many of the hotels are foreign owned, some of the money goes abroad. This is known as leakage and can be quite high. For every dollar earned, as much as another dollar may be spent abroad on imports and services, and the net result might seem to be nothing. Jobs that are directly related to tourism in Antigua and Barbuda include chefs, hotel receptionist, housekeepers, waiters and waitresses, musicians, managers and tour operators and travel guides. The jobs indirectly related to tourism employment include chauffeurs, airline staff, shopping centres, handicraft industry, bars and cafes, singers and construction workers. A feature of the tourist industry in Antigua and Barbuda is that important part of the industry is owned and run by overseas investors. It is estimated that 40% of the income from tourism is lost or repatriated to foreign investors as a result of foreign ownership of tourist businesses. The greater part (60%) does remain in the country.

### 6.2 Agriculture

In 2019, agriculture contributed 0.7% or $23.4 million of gross domestic product.

Antigua’s agriculture is mainly confined to production of food crops mainly fruit and vegetables for the local market. Antigua currently possesses 2200 ha of crop land. A further 10,700 ha are used for grazing of cattle and small ruminants though the area is difficult to define as the grazing is mostly “unofficial” and temporary. Woodland occupies 9,600 ha. Much of the upper watershed areas not in scrub or woodland are used for rough grazing. These lands are frequently burnt to provide fresh grass for livestock to eat, but this is uncontrolled and frequently leads to further destruction of the adjoining forest and scrub vegetation.

The only significant expert crop is sea island cotton for the Japanese market. Local markets are necessarily small and easily saturated leading to cycles of gluts and scarcities. This is compounded by the lack of adequate water for irrigation, forcing many farmers to produce only when rainfall is adequate. Soils are fertile, many with good texture and gentl slopes, making mechanization quite feasible. In fact, there are a number of very competent farmers who have applied quite advanced levels of technology, including mechanized seeding, use of drip irrigation and selective herbicides. Agriculture continues to struggle with a series of constraints including high cost of labour, small size of the local market, lack of marketing structures and infrastructures, competition from imported foodstuff, inadequate water supply for irrigation, severe droughts and destructive hurricanes. Not least among agriculture’s constraints is the negative legacy of slavery and plantation agriculture which continue to exert its effects on public perception and policies towards agriculture.

In Antigua over 40% of the land area is regarded as quite well suited to intensive agriculture. The crops presently grown can be divided into a number of groups as follows:

1. Vegetable crops, the production of which has increased greatly in the last 10 years. The main crops being grown include eggplant, cucurbits, tomato, sweet peppers, okra, beans, condiments etc.
2. Food / fruit crops include bananas, sweet potato, aroids, yams, corn, pineapple, papaya, and melons.
3. Tree crops include crops such as, mango, avocado, citrus, coconut, cashew, sapodilla, sugar apple, guava, tamarind, lime, mamie apple, and dumps,
4. Antigua has a good climate for livestock production and good pasture is commonplace. The Antigua hay grass *(Dicanthiumaristatum*) and Seymour grass (*Bothriochloapertusa*) would out yield other exotic grass species under native management, and it is associated with several legumes such as *Stylosantheshamata, desmanthus spp., Clitoriaternatea, Teramnuslabialis and Rynchosia spp*. These native grasses and legumes are outstanding in their ability to withstand hard grazing and prolonged drought. The pastures are overgrown with thorny *Acacia* and this must be controlled.
5. Antigua was once a major producer of cotton. There is no reason form an agronomic aspect why this crop could not be produced in Antigua and Barbuda. It is naturally adapted to areas of lower and seasonal rainfall and on fine textured soils.
6. In Antigua ns Barbuda, there is a critical shortage of firewood since all areas which are more naturally suited for forests presently have unproductive secondary vegetation because of successive periods of shifting cultivation. The depletion of the vegetation has other repercussions such as increasing runoff and soil erosion and poor aesthetics’ in a country dependent on tourism. Re - forestation on the steeper slopes using adaptable species is a matter of great urgency. In the volcanic areas with higher rainfall, tall growing species such as Eucalyptus, mahogany and Cedar could be used. In areas of lesser slopes particularly in the limestone region on eroded and shallow soils, trees such as Leucaena, Casuarine, some Eucalyptus and neem (*Azadirachtaindica)* may be successful.

### 6.3 Forest

Antigua’s original forest cover was almost completely removed for sugar cane production and much of the original soil cover lost. Some regrowth of secondary forest has taken place especially in the wetter and least accessible areas, but Antigua remains depleted in true forest cover. There has only been one attempt at reforestation on any significant scale. This was at Wallings and involved the planting of approximately 5 hectares of trees in 1912 to protect the watersheds supplying water to the Wallings reservoir. A detailed inventory (Beard 1949) identified 47 species of trees in a half acre (2000 m2) quadrant of the Wallings Forest. Forest areas are important sources of raw materials for several industries. Charcoal making continues to use significant quantities of wood from bush and trees. Unfortunately, quality timber trees are used for charcoal making. Extraction of wattle for fish pot making is a major use of forest products. Honeybees make considerable use of flowering plants in the forest as source of pollen and nectar. Medicinal plants used in traditional medicine are found in forest areas.

Increasing attention has been paid to the forest for recreation and as an ecotourism resource. The growth in use of the Wallings Dam and Christian Valley trails by individual visitors, hikers and tour groups from cruise ships is evidence of the growing demand for such experiences and evidence that there are several levels of ecotourism not all of which are dependent on virgin rain forest to attract the casual visitor. The dry climate is well suited to livestock production and the grassland areas support aconsiderable population of cattle and small ruminants. However, production remains a part time hobby for many livestock owners who rely on waste land as pasture. Production practices are basically impossible to improve under these conditions and even for those with land, livestock production generally remains a low input / low output enterprise subject to the vagaries of the weather.

### 6.4 Fishery

Antigua and Barbuda’s commercial fishery sector is still largely artisanal, contributing 1.5% to Antigua’s GDP (CARICOM 2006) and employing 2% of the work force (Horsford 2004b). As of 2003, there were 695 fishing vessels and 1058 registered fishers, although only 245 vessels and 724 fishers were active in the fishery throughout the year (Horsford 2004b). The commercial fishery sells US$8.7 million worth of finfish, US$2.75 million of lobster, and US$0.5 million of conch (Horsford 2005), at 28 landing sites on Antigua and three on Barbuda (FAO 2002b). Largely through international donors like Japan, Antigua’s fishery has begun to receive large increases in capital investments (FAO 2002a). Four major landing sites on Antigua were built with the aid of the Japanese government, who have offered US$35 million in fisheries assistance to Antigua since 1997 (Embassy of Japan 2008). The latest complex, Point Wharf, has boat ramps, a boat haul lift, fish processing and refrigeration facilities as well as an active port for export and import (Fisheries Division 2006).

According to the Food and Agriculture Organization of the United Nations (FAO), Antigua also imports 439 MT (US$1.65 million) of seafood into the country to meet local demand (FAO 2015). What portion of their imported seafood is destined for local consumption, hotel and resort use, or other functions has not been published. Finfish landings have generally increased since 1950 for Antigua and Barbuda. This trend has continued more recently when a reporting programme was generally adopted throughout the OECS. In comparison to other OECS member states, there remains large and economically attractive stocks of conch and lobster both for local consumption and export. As of 2004, the Fisheries Division determined that both conch and lobster stocks around Antigua were ‘relatively healthy’ (Horsford 2004c 2004d). Antigua and Barbuda’s resource managers continue to monitor and manage these stocks actively. Conversely, the commercial finfish fishery on the island of Antigua is thought to be in decline (OPM 2001a; Brandt *et al.* 2005; Espeut 2006).

The lack of finfish sustainability is a consequence of insufficient regulations, outdated stock assessments, lack of compliance and ineffective enforcement, and the deterioration of critical marine habitat. Assessment efforts for finfishes are still in their infancy. Antigua and Barbuda acknowledge ongoing illegal and unsustainable fishing practices. Fishery researchers, managers and conservationists recognise that without preventative measures, active conservation programmes, and requisite education and enforcement, the common end-game scenario for exploited marine resources is exemplified, sadly, by the ‘Antigua and Barbuda path’. Antigua and Barbuda is facing the serious risk of overexploiting its marine resources, especially nearshore fisheries and associated marine and coastal habitats. Continued dependence on destination and cruise ship tourism as a major industry should encourage the development and enforcement of conservation measures that protect these resources for their tourism industry, while balancing access rights to other user groups, especially commercial fishing, which acts as an ‘important safety net economic activity [subsidising] other economic shifts, which are severe in Antigua’s seasonal tourism market’ (Jackson 2007, 16).

### 6.5 Public Utilities

The Antigua Public Utilities Authority (APUA) continues to position itself to meet the diverse and dynamic challenges ahead. More frequent and severe weather phenomena have amplified the need for more resilient infrastructure. Therefore, the utilities company has embarked on a program to increase its generation capacity by 25-30 MW. In order to keep pace with the expected water demand of 8 million gallons per day, two new Reverse Osmosis Plants will be installed –one at Fort James and the other in Bethesda. The Fort James Reverse Osmosis Plant will primarily serve Heritage Quay and the central business district. The Bethesda Reverse Osmosis Plant will replace the Delaps Water Treatment Plant during extreme drought conditions, when water is below extraction levels at the Potworks Dam Reservoir. An aging, leaky distribution network has negatively impacted APUA’s efforts to provide water consistently. To address this, the Authority will undertake a $30 million re-piping project to reduce water loss and increase supply to homes and businesses. In terms of telecommunications, the Government will proceed with its US$30 million project to significantly upgrade the telecommunications infrastructure. This will include investment in an underwater fibre optic cable, to bring more reliable and affordable broadband internet service through the fibre-to-home initiative.

### 6.6 Housing

Providing affordable housing, especially low-income social housing for the poor and vulnerable, is touted by government as one of its most important goals. Grant funding of $120 million from China will pay for the construction of 250 low-income, climate resilient homes at several locations in Antigua, with approximately 50% earmarked for Booby Alley. Fifty of the homes will also be constructed on Barbuda. The National Housing and Urban Renewal company, which built and handed over eighty-seven homes in 2019 at Paynter’s Development, will complete construction of another 73 this year at that location. At Denfields, 60 homes are completed and ready to be transferred to potential homeowners, once the necessary infrastructure is in place. Under the “Build on Your Own Land” option, National Housing also completed and transferred 63 houses to homeowners, and100 parcels of land were sold to Antiguan and Barbudan citizens in the Friars Hill Development. Ninety-four parcels of land at Donovan’s are currently being distributed under the land for youth initiative and 92 parcels at Royal Gardens are being distributed to potential homeowners. The Central Housing and Planning Authority (CHAPA) has developed approximately 20 new homes at North Sound, with a further 10 under construction at Lightfoot. Between CHAPA and the Lands Division, approximately 250 parcels of land were sold in 2019. As part of the Government’s strategy to renew and expand the housing stock rapidly, lands are being sold at the concessional rate of $3.00 per square foot, to contractors and developersto build affordable homes for sale to citizens and residents. This type of development will take place at Belmont, Paynter’s, Judges Hill, Lightfoot and Bolans. To help accelerate the supply of homes to Antiguans and Barbudans, the China Civil Engineering Construction Corporation (CCECC), will also construct a few hundred homes in Paynters, Bolans and Belmont.

The United Nations Office of Project Services (UNOPS) and Bau Panel have recently acquired funding to construct a factory in Antigua to manufacture 10,000 affordable and sustainable homes. Two thousand, five hundred of these homes will be allocated to Antiguans and Barbudans, while the others will be exported to countries in the Eastern Caribbean. The price for these homes will be under$150,000.00. CHAPA will also be constructing additional low-income homes for individuals who do not qualify under the National Housing initiative.

### 6.7 Climate Resilience

Therefore, the Government will establish a Climate Resilience and Development Fund (CRDF) in 2020.The purpose of this fund is to finance projects and programmes that will build climate resilience, provide a buffer for public finances in times of natural disasters, and support development of the country. This Fund will be financed mainly through a Tourism Accommodation Levy (TAL), which will be applicable to hotel accommodation, guest houses, apartments, Airbnb rentals, and villas. This levy will be charged at a rate of US$3 per guest per night, for room rates up to US$150 per night. For rooms with rates above US$150 per night, the levy will be charged at a rate of US$5 per guest per night. The Tourism Accommodation Levy took effect from March 1, 2020.

A successful partnership with the International Renewable Energy Agency (IRENA) and the Abu Dhabi Fund fora US$15 million renewable energy project, the Fund has approved another US$15 million for Phase 2. This brings the total investment to US$30 million. Antigua and Barbuda’s investment in renewable energy is nearly US$70 million and evidences a commitment to reducing the country’s carbon footprint, building resilience, and adapting to climate change. The Sustainable Island Resource Framework Fund (SIRFF) became operational in 2019. It will obtain almost US$8 million from the Green Climate Fund and other donor agencies in 2020. A key activity of the Fund will be to facilitate homeowners who need financing to make their homes climate resilient –that is hurricane and drought ready–through highly concessional loans.The government indicated that it would no longer waive the 10% Revenue Recovery Charge (RRC) that Customs and Excise is mandated to collect on imported items. A portion of the additional revenue that will be generated from collection of the full amount of the RRC, will be transferred to the Climate Resilience and Development Fund.

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# 7. POLICY AND LEGISLATION

None of Antigua and Barbuda’s national legislation addresses IAS management explicitly. Several Acts, however, are directly and highly relevant to prevention of IAS entry (see table 4), most foremost, the Plant Protection Act 2013 with accompanying instruments, Fisheries Act 2013, Forestry Act , Importation of Bees Acts, and the Quarantine Act. A noteworthy gap in the law is the fact that the importation of most exotic animals can essentially only be blocked on veterinary grounds. Legislation that addresses the risk of the animal itself becoming invasive is urgently needed. In contrast, the Plant Protection Act recognised the risk posed by exotic plants turning weedy. There is still a need for a Biodiversity Bill and as well as Biosafety Bill to be drafted. The same applies to the CITES Management Bill, which needs to be drafted to enable effective implementation of the CITES Convention in Antigua and Barbuda with emphasis on monitoring and regulation of importation and exportation of wild flora and fauna, this Bill could fill the above-mentioned gap, as it also restricts the importation of species that are believed to be potentially harmful to local biological diversity.

### **Table 2.** National legislation relevant to IAS Management in Antigua and Barbuda

|  |  |  |
| --- | --- | --- |
| **Year** | **Law** | **Accountable agency** |
| 2006 | Fisheries Act | Fisheries Division, Ministry of Agriculture |
| 1992 | The Importation of Live Fish (CAP 209) | Fisheries Division, Ministry of Agriculture |
| 1992 | The Forestry Act (Cap 178) and Forestry Regulations (SRO No. 13, SRO No.42 (1952) | Forestry Unit, Ministry of Agriculture |
| 1965 | Public Parks Act | Parks Commission under Minister of Lands |
| 2003 | Physical Planning Act | Development Control Authority |
| 1974 | Marine Areas (Preservation and Enhancement) Act | Fisheries Division, Ministry of Agriculture |
| 1992 | National Parks Act (CAP 290) | National Parks Authority |
| 2019 | Environment Protection and Management Act | Environment Department |
| 2013 | Plant Protection Act | Plant Protection Unit, Ministry of Agriculture |
| 1992 | Public Health Act (CAP 353) | Central Board of Health |
| 1992 | Animals (Disease and Importation) Act (CAP 18) | Veterinary and Livestock, Ministry of Agriculture |
| 1992 | Animals (International Movement and Disease) Act (CAP 19) | Veterinary and Livestock, Ministry of Agriculture |
| No. 12 of 2017 | Animal Health Act. | Veterinary and Livestock, Ministry of Agriculture |
| 1992 | Beach Control Act (CAP 45) |  |
| 1992 | Beach Protection Act (CAP 46) |  |
| No. 6 of 1993 | Beach Protection Amendment Act |  |
|  |  |  |
| 1992 | Dumping at Sea Act (CAP 141) |  |
| 1992 | The Exportation of Fruit Act (CAP 161) |  |
| 1992 | The Litter Act (CAP 250) | National Solid Waste Authority |
| No. 8 of 2004 | The Litter (Amendment) Act | National Solid Waste Authority |
| No. 3 of 2019 | Litter Control and Prevention Act | National Solid Waste Authority |
| 1992 | The Mongoose Prohibition (Barbuda) Act (CAP 284) | Barbuda Council |
| No.1 of 2006 | The Antigua and Barbuda Merchant Shipping Act | Department of Maritime and Merchant Shipping |
| No. 11 of 2004 | National Parks (Amendment) Act | National Parks Authority |
| No. 10 of 1995 | The National Solid Waste Management Authority Act | National Solid Waste Authority |
| No. 6 of 2005 | The National Solid Waste Management Authority Act | National Solid Waste Authority |
| 1992 | The Praedial Larceny (Prevention) Act (CAP 337) |  |
| 1992 | The Port Authority Act (CAP 333) | The Port Authority Act (CAP33) |
| 1992 | The Port Authority (Validation of Regulations) Act (CAP 334) | The Port Authority Act (CAP33) |
| 1992 | The Wild Birds Protection Act (CAP 472) |  |
| 2006 | Antigua and Barbuda Merchant Shipping Act | Department of Marine Services and Merchant Shipping |
| 2020 | Antigua and Barbuda Merchant Shipping (Amendment) Act | Department of Marine Services and Merchant Shipping |
| 2020 | Antigua and Barbuda Merchant Shipping (Commercially Operated Large Vessels) Regulations | Department of Marine Services and Merchant Shipping |
| 2021 | Code of safety for small commercial vessels – SCV | Department of Marine Services and Merchant Shipping |

Far few laws allow the effective management of IAS once they have entered national territory and again largely via legislation mainly focussing on other issues, such as, the Disaster Management Act 2002. A major gap here surrounds the pet and aquarium trade, which regularly gives rise to potentially invasive alien escapees. Informal breeders are currently largely beyond control measures. However, the revised version of the Animal Health Act of 2017 stipulates that a license is needed to keep any wildlife in captivity as well as to import any wildlife into or export from Antigua and Barbuda. The legal interpretation of “wildlife” is important: all vertebrates and crustaceae, whether resident or migratory, indigenous, or alien, found living beyond the control of man. It is questionable, however, if a maximum EC$5,000 fine for offences is sufficient a deterrent for commercial lawbreakers. An amendment dated 2008 foresees the licensing system to become obligatory also to operate a pet trade to sell wildlife (birds, reptiles, mammals, or exotic/alien species). This Amendment also proposes to add feral animal to non-protected species; however, it has yet to be enacted. Similarly, the disposal of faeces of pets in yachts is currently not well managed, as excrements enter the normal garbage stream after disposal in marina bins.

A principal discussion needs to be held whether Government of Antigua and Barbuda should develop an Invasive Alien Species Act or whether IAS legislation should be incorporated into existing legislation. There are pros and cons for either decision. While the former would be a compact on-stop shop, implementation and enforcement would invariably remain the responsibility of a range of agencies under different Ministries. Thus, the current problem of fragmentation would possibly not be significantly alleviated. Furthermore, enactment of an entirely new Act could take longer than amendments to existing laws. The development of IAS legislation via either avenue may require some external assistance. Local expertise in drafting environmental legislation exists but could not be contracted to contribute to the present gap analysis. Invasive alien species - specific legislative training would also be beneficial.

Legislation aimed at environmental protection has-been piecemeal and without outlined authority for responsible parties to ensure effective legislative and policy protection for environmental issues. All of these legislations formed parts of Acts administered by other government agencies such as the DCA, the CBH, the APUA as well as the NSWMA. Based on this fragmentation, in 2005, the country began its quest to develop an overarching environmental management bill for the protection of the environment.

**Table 3 (a).** Environment treaties signed by Antigua and Barbuda

|  |  |  |
| --- | --- | --- |
| **Date entered into Force** | **Date of Signature** | **Title of Environmental Treaty** |
| 16 Nov. 1994 | 7 Feb. 1983 | United Nations Convention on the Law of the Sea. |
| 11 Oct. 1986 | 11 Sept. 1986 | Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. |
|  | 18 Jan. 1990 | Protocol concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. |
| 21 Mar. 1994 | 4 Jun 1992 | Framework Convention in Climate Change |
| 29 Dec. 1993 | 5 Jun 1992 | Convention on Biodiversity |
| 3 Dec. 1981 | 3 Dec 1981 | Charter of the Organisation of American States |
| 10 Jan. 1970 | 16 Oct 1969 | Agreement establishing Caribbean Development Bank |
| 22 Sept. 1983 | 22 Sept 1983 | Agreement of the International Bank for Reconstruction and Development |
| 15 Jul. 1982 | 15 Jul.1982 | Constitution of the United Nations Educational, Scientific and Cultural Organisation |
| 25 Feb 1982 | 25 Feb 1982 | Agreement of the International Monetary Fund |
| 11 Oct 1983 | 11 Oct 1983 | Treaty for the Prohibition of Nuclear Weapons in Latin America |
|  | 8 Dec. 1984 | Third ACP EEC Convention |
|  | 15 Dec 1989 | Fourth ACP EEC Convention |
| 21 Jun. 1985 | 8 Sept. 1982 | Constitution of the United Nations Industrial Development Organisation |
| 26 Dec. 1996 | 4 Apr 1995 | International Convention to Combat Desertification in those countries Experiencing Serious Drought and / or Desertification, particularly in Africa. |

**Table 3 (b).** Environmental Treaties not signed by Antigua and Barbuda

|  |  |
| --- | --- |
| **Date Entered in Force** | **Title of Environmental Treaty** |
| 21 Jul 1982 | International Convention for the Regulation of Whaling |
| 29 Apr 1988 | International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978 |
|  | International convention for the Prevention of Pollution from Ships (MARPOL) |
| 1 Nov. 1981 | Treaty banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water |
| 5 Feb 1989 | Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter |
| 21 Jul 1982 | Protocol to the International Convention for the Regulating of Whaling |
| 1 Feb. 1984 | Convention concerning the Protection of the World Cultural and Natural Heritage |
| 5 Feb 1989 | Amendments to Annexes to the Convention on the Prevention Marine Pollution by Dumping of Wastes and other Matter concerning incinerating at Sea. |
| 11 Oct. 1986 | Protocol concerning Cooperation in Combatting Oil Spills in the Wider Caribbean Region |
| 3 Mar 1993 | Convention for the Protection of the Ozone Layer |
| 3 Mar 1993 | Protocol on Substances that depletes the Ozone layer |
| 1 Jul 1992 | International Convention for the Protection of Pollution from ships, 1973 (MARPOL) Annex 111 (Optional): Hazardous substances carried in packaged form |
|  | International Convention for the Protection of Pollution from ships, 1973 (MARPOL) Annex IV (Optional): Sewage |
| 4 Jul 1993 | Convention on the Control of Trans boundary Movement of Hazardous Wastes and their Disposal |
| 24 May 1993 | Amendment to the Montreal Protocol on Substances that deplete the Ozone layer |
| 14 Jun 1994 | Amendment to the Montreal Protocol on Substances that deplete the Ozone layer |
| 29 Jan 1988 | Convention on the International Regulations for Preventing Collisions at Sea. |
| 9 May 1987 | Protocol relating to the International Convention for the safety of Life at Sea (SOLAS prat.) |
| 25 Jan 1989 | Convention and Statue on the Regime of Navigable Waterways of International concern |
| 25 Oct. 1988 | Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques |
| 13 Dec 1988 | Convention on the Recognition of Objects launched in Outer Space |
| 2 May 1989 | Convention on the Recognition and Enforcement of Foreign Arbitral Awards |
| 1 Nov 1981 | Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare |
| 3 Sept 1993 | Convention on the Physical Protection of Nuclear Material |
| 1 Nov 1981 | Treaty n Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies |
| 1 Nov 1981 | Convention on International Liability for Damage caused by Space Objects |
| 16 Feb 1982 | Constitution of the International Labour Organisation |
| 10 Dec 1981 | Convention on International Civil Aviation Annex 16 Aircraft Noise |
| 16 Nov 1988 | Convention on world Meteorological Organisation |
| 11 Nov 1981 | Charter of the United Nations |
| 13 Jan 1986 | Convention on the International Maritime Organisation |
| 7 Nov 1983 | Constitution of the Food and Agriculture Organisation of the United Nations |
| 1 Nov 1981 | General Agreements on Tariffs and Trade |
| 5 Feb 1989 | Amendments to Annexes to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter |
| 31 Dec, 1988 | International Convention for the Protection of Pollution from ships, 1973 (MARPOL) Annex IV (Optional): Garbage |
| 6 Apr 1987 | Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victim of International Armed Conflicts (Protocol 1) |
| 6 Apr 1987 | Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victim of Non - International Armed conflicts (Protocol 11) |

# 8. BIODIVERSITY – TERRESTIAL

The Biodiversity of Antigua – Barbuda - Redonda suffered a similar fate as forest cover. Destruction of habitat during early colonial times was severe and extensive in a country where it has been estimated that 92% of the land area was eventually cleared for sugar cultivation. Threats to national biodiversity have been primarily due to human activities in pursuit of economic and social development. However, in addition to human development activities, the country is facing more emerging threats mainly in the form of invasive species and climate change associated impacts. Addressing these threats have become increasingly difficult given the country’s small size and human population of 86,656 and inherent challenges. The biodiversity challenges faced by the country are relatively similar to that of many other SIDS.

The major challenges include:

• Fragile terrestrial and marine ecosystems such as mangrove wetlands and coral reefs endangered by development projects, pollution, and misuse.

• Vulnerability to external economic and natural environmental events, such as economic recessions, hurricanes, and climate change; Droughts and hurricanes have severely impacted the bird population, as well as vegetative communities and their dependent fauna.

• Lack of human resource capacity in key biodiversity areas.

• Conflicting land use pressures, especially among housing, tourism, and agricultural activities.

• Land degradation due to uncontrolled grazing; and limited institutional capacity to manage the development process due to the presence of weak and fragmented land use and development control mechanisms.

Threats are:

• The loss of habitat primarily through the sub-division of lands for housing, tourism development, agriculture and the mining and dredging of sand

. • Fragmentation of natural communities by roadways, and other man-made features that form barriers to the movement and dispersal of species.

• The introduction of non-native species, like the Giant African Snail, mongoose, lemon grass and Lionfish that have a detrimental effect on native wild species by acting as predators, parasites, or competitors.

• Overgrazing by livestock mainly goats, sheep, cattle, and donkeys that pose a serious threat, particularly in upper watershed areas.

• Pollution as a result of excessive nutrients or sewage discharge into coastal waters, as well as the unregulated and excessive use of pesticides.

### **Table 4.** Biodiversity Trends

|  |  |  |  |
| --- | --- | --- | --- |
| **Ecosystem** | **Drivers** | **Pressure** | **Status** |
| Mangroves | Economic and employment demands  Preferred investment areas  Climate change impact | Tourism, marinas and private docks development demand.  Frequent occurrence of extreme weather events | Rejuvenation after major destruction of mangroves from Tourism development and severe storm.  Mangroves filled in and blocked thereby hindering ecosystem functions |
| Coral Reefs | Land based developments to support economic and residential developments | Demand for Tourism development  Improper sewage waste disposal practices  Invasive species  Increased occurrences of soil | Majority of Coral reefs destroyed by frequent hurricanes and storms as well as land based sources of pollution |
| Beaches | Commercial and residential growth  Climate change impacts | Integrity compromised because of demand for tourism developments  Erosion related to reef loss  Sand mining | Increased rates of erosion |
| Forests | Indiscrimination land clearing for agriculture, commercial and residential developments  Climate change impacts | Invasive Species Forest Fires | Initial mass clearance during colonial era.  Modern situation is slow decline |
| Fisheries | Economic demand  Climate change impact | Habitat loss related to reef and mangrove decline.  Over exploitation of near shore species.  Lack of regulations  Illegal fishing by foreign vessels | Declining near shore fisheries  Pelagic largely untouched |

### 

### 8.1 Vegetation

There have been several attempts to classify the current vegetation on Antigua and Barbuda, the most recent by Pratt et.al. (2009).who provided a classification of the wild plants of Antigua and Barbuda. Their book excluded small herbaceous Dicotyledons, grasses, sedges, rushes and submerged aquatics. Featured in this book are trees, shrubs and climbing plants. Pratt et al. (2009) have recorded species that were introduced and are now invasive and have severely reduced the diversity of native species. The writers have documented the ‘worst offenders’ as *Antigononleptopus, Acacia tortuosa, Acacia macracantha, Haematoxyloncampechianum, Azadirachtaindica, Prosopisjuliflora, Leucaenaleucocephala,* and *Eichhorniacrassipes.*

The author from the writings of Howard (1974, 1977, 1979, 1988, 1989a, 1989b); Francis et al. (1994); Harris (1963); Loveless (1960) and Beard (1949) extrapolated 1159 species (149 families) of plants: 45 species of ferns and fern allies (5 families); 4 species of gymnosperms (3 families) and 1107 species of Angiosperms (141 families) which are known to occur in Antigua – Barbuda – Redonda. Lindsay and Horwith (1997c) listed 1156 species (149 families) of plants: 45 species of ferns and ferns – allies (5 families); 4 species of gymnosperms (3 families) and 1107 species of Angiosperms. Horwith and Lindsay (1997b) have listed 197 species of flowering plants and 24 species of ferns were considered rare, and either Endangered or Vulnerable and merit special conservation. Of importance to watershed management is the quality of vegetative cover on the upper watershed areas where slopes are steepest and rainfall erosivity highest. No specific study of this aspect of vegetation has been undertaken but qualitative observations would suggest that the protection of many upper watershed areas is of poor quality especially in areas where Citronella grass is the dominant vegetation. In Antigua the main threats to the flora result for expanding residential and coastal development (primarily commercial resorts with isolated impact from sand mining). Coastal development is a conservation threat in Barbuda as well, but sand mining is on a larger scale and represents a much wider impact. An additional factor impacting the vegetation in Barbuda is widespread uncontrolled livestock grazing.

### 8.2 Amphibians and Reptiles

Schwartz (1967) identified an amphibian known for Antigua and Barbuda as the tree frog *(Eleutherodactylusjohnstonei*) and in Antigua, the marine toad *(Bufomarinus*). Harris (1965) has made reference to the crapaud*(Leptodactylusfallax).* However, an analytical study of the crapaud *(Leptodactylusfallax)* by Lynne (1957) and Kaiser and Hardy (1994) have concluded that the historical record is weak and does not include a voucher specimen. Horwith and Lindsay (1997) have documented that twenty terrestrial species of reptiles are recorded, four being now extinct. The extinction has been attributed to the introduction of the Indian Mongoose *(Herpestes auropnctatus*). There is no mongoose in Barbuda and Redonda.

There are three species of gecko recorded on Antigua (Horwith and Lindsay, 1997). They are called the common Woodslave *(Hemidactylus mabouia*); Giant Woodslave (*Thecadactylus rapicauda*) and the Dwarf Woodslave *(Sphaerodactylus elegantulus*) which is endemic to Antigua. These authors have recorded three Anolis lizards. The green lizard (*Anolisbimaculatus leachi*) endemic to Antigua and Barbuda; A. *Wattsi wattsi*, which is an Antiguan endemic subspecies and a *Wattsi forrestia* is a Barbudan endemic subspecies. The lizard (*Anolis nubilus) and (Ameiva pluvianotata)* is recorded as endemic to Redonda. The ground lizard *(Ameiva griswoldi*) is common to Barbuda but found only in parts of Antigua. There is also a blind snake *(Typhlops sp.)* and the Antigua Racer snake *(Alsophis antiguae)* endemic to Antigua and amongst the rarest snakes in the world. The marine turtles are found in Antigua – Barbuda – Redonda’s waters. They are the Hawksbill (*Eretmochelys imbricate*), Green *(Chelonia mydas*) and Leatherback (*Dermochelys coriacea*) turtles. The Hawksbill is known to nest on several beaches and studies of population nesting at Long Island have been carried out of over 25 years.

### 8.3 Birds

Gricks et al. (1997) have recorded 182 species of birds in for Antigua – Barbuda – Redonda, of which 65% are Neotropical migratory birds (Prosper et al. 2009). Twenty of these species are sub regional endemics. Two are single island endemics – the Broad winged Hawk and the Barbuda warbler. The wetlands and offshore islands are of special importance to many species of bird as they important feeding grounds and nesting sites. Prosper et al. (2009) noted that Barbuda supports the Caribbean’s largest colony of Magnificent Frigate Birds (F*regatamagnificens*) with a population estimated at 5300 individuals (1743 occupied nests) in March 2008.

### 8.4 Mammals

Bats are the only native terrestrial mammals, and seven species of bats are found in both Antigua and Barbuda (Morton 1994; Pedersen 2006). Agouti (*Dasyprocta agouti*), Fallow deer (*Dama dama*), Indian mongoose (*Herpestes javanicus*), rabbits (*Oryctolagus cuniculus*), black rat (*Rattus rattus*) Brown rat (*Rattus norvegicus)* and the mouse (*Mus muscalus*) were all introduced.

### 8.5 Invertebrates

Knowledge of the invertebrate fauna is not well recorded. Species listings are very incomplete and largely restricted to agricultural pests and some beneficial insects. Studies of invertebrates’ fauna associated with freshwater ecosystems are notably lacking.

# 9. BIODIVERSITY – MARINE

### 9.1 Mangroves and wetlands

Antigua and Barbuda have some of the most extensive mangrove wetlands to be found in the Eastern Caribbean. Bacon (1991) identified 36 mangrove sites in Antigua and 9 sites in Barbuda. An estimated 4900ha of mangroves and salt ponds were to be found in the two islands, (World Resources Institute 1987), although not indicating the data base from which this estimate was made. According to Bacon 1991 the sites range from very small, single species, single layer, stand of trees to the large, complex swamp such as Flashes (225 ha.) at Hanson Bay. In Barbuda, there is the luxuriant 352 ha. fringe mangrove of Codrington Lagoon and the narrow scrubby borders of mangroves around some of the salt ponds (James and Jeffery 1997). The mangroves in Barbuda are known to be important for their variety of aquatic and terrestrial life. The dominant species in both islands is *Rhizophora mangle* (Rm) – red mangrove, *Laguncularia racemosa* (Lr) - white mangrove, *Avicennnnia germinans* (Ag) – black mangrove and *Conocarpus erectus* (Ce) – button mangrove fringe the ponds and xerophytic scrub mangroves in the territory are typically poorly developed, seldom exceeding 4 meters in height. The ponds are shallow – water depths very rarely exceeded 1.5 meters – with little or no emergent or submergent vegetation. Substrates are mostly silt or clay. Well-developed mangrove woodlands are present in Parham Harbour, Ayres Creek, Comfort Hall, Fitches Creek and Guiana Island.

The importance of mangroves is well known:

* Mangroves act as sediment traps, promoting the accumulation of sediments and maintaining the quality of coastal waters. They trap sediments eroded form the land, thus protecting the reef form being smothered.
* Mangroves act as natural breakwaters and buffer zones protecting the coastline from erosion during storms. They reduce the erosive power of waves and currents and limit the effects of flooding. The level of coastal protection which mangrove offer is dependent on its width. A very narrow fringe stands to offer only limited protection whereas wide stands prevent wave damage and reduce damage from flooding. However, these narrow bands, with their red mangrove are important as nursery areas for marine organisms.
* Mangroves are important nursery, breeding and feeding grounds for many commercially valuable, marine fish and crustacean species. They can also act as habitats for rare fauna.
* Mangroves add scenic beauty to the natural landscape.

Except for their function as nursery, breeding grounds and habitats for both marine and terrestrial wildlife, and hence their recreational value, very little use is made of the mangroves in Antigua and Barbuda. In the past, mangroves have been used as sewage and domestic dumps, but this practice has rapidly declined. According to James and Jeffery (1997) several major wetlands areas have been destroyed and removed (reclaimed and dredged) through tourism-based development in the last 50 years.

Water ponds are fringed with acacia trees, scrub vegetation and wooded areas. Wooded areas are composed of native vegetation as well as introduced species. Characteristic trees include royal palm (*Roystonea borinquena*). Fringing the Caribbean shores are further poorly developed patches of mangroves, in general no more than two meters in height. Hurricanes and fuel wood have contributed to the demise of the mangroves.

Salt ponds and mangrove areas in Antigua and Barbuda are being destroyed/ lost at an alarming rate, primarily due to tourism development and some of the islands unique flora and fauna are seriously endangered. What makes Antigua’s salt ponds/mangroves swamps particularly attractive for tourism development is that often associated with them is a strip of sandy beach. The land adjacent to the beach is usually too narrow to accommodate a major tourism resort complex, so when these areas are slated for development, part, or the entire, pond/swamp is filled in. Until 1988 there was little concern voiced over the development of wetlands, nor was there much awareness of how valuable mangroves, swamp/salt ponds were as nurseries for fish and crustaceans and as wildlife habitats. Indeed, these mangroves, swamps/salt ponds have long been used as garbage dumps and assumed to only have nuisance value. Both Ballast Bay and Deep Bay salt ponds have been lost because of development activities in relationship to the Royal Antiguan Hotel (now Ramada Renaissance). Some parts of the Flashes have been reclaimed, large areas of mangroves have died, and much of the grass and weeds have disappeared. It is suspected that this is due to the dumping of toxic and other waste at Cook’s dump. Other mangrove areas/salt ponds have also been destroyed at Jolly Hill, Carlisle Bay and Emerald Cove, all as a result of tourism development. The destruction of the Jolly Hill salt ponds/mangroves area and its subsequent impact is detailed in DE Albuquerque (1991). Currently the salt pond/mangrove area at Darkwood is being systematically destroyed through clearance of the adjacent area for road expansion and a yet undisclosed development. There are several other salt ponds/mangroves that require close monitoring, namely Crab Hill, Yorks, and McKinnon’s, to ensure that they do not go the way of Jolly Hill or Carlisle Bay. McKinnon’s have already experienced severe environmental pressure, first from several oil spills in the 1970’s from the now abandoned Occidental Petroleum Refinery, and most lately the discharge of raw sewage from hotels and the dredging and filling in of the northern end of the pond.

### Table 5. Qualitative Assessment of Antigua’s Costal Resources, Salt Ponds/Mangrove areas

|  |  |  |  |
| --- | --- | --- | --- |
| **Salt Pond/Mangrove Area** | **Status** | **Observations** | **Reasons** |
| **Ballast Bay (St. John’s)** | L | Reclaimed land filled in by dredged materials | Road to Deep Bay (Ramada Renaissance Hotel) |
| **Deep Bay** | S₂ D | Parts reclaimed, destruction of pollution | Tourism development (hotels) |
| **Galley Bay** | S₂D | Some filled in, destruction of some mangroves | Expansion of Galley Bay Hotel |
| **Pinching Bay** | S₁D | Some brush and tree clearance | Road to beach |
| **The Flashes**  -- Salt Pond  -- Mangrove Area | S₂D  S₂D | Parts reclaimed.  Solid waste dumping, industrial | Road to Deep Bay  Inadequate solid waste disposal system and toxic waste, clearing of mangroves |
| **Yorks**  -- Salt Pond  -- Mangrove Area | S₂D  S₂D | Extensive brush and tree clearance  Some clearing of mangroves | Grazing animals, solid waste dumping inadequate solid waste disposal system |
| **Jolly Hill**  -- Salt Pond  -- Mangrove Area | L  L | Lost to Jolly Harbour  Lost to Jolly Harbour | Tourism development (marina and condominiums) |
| **Cocks Hill** | S₂D | Extensive brush and tree clearance | Tourist related development, some dumping, some fill in |
| **Valley Church** | S₁D | Extensive brush and tree clearance | Inadequate solid waste disposal system, some solid waste dumping |
| **Dark Wood**  -- Salt Pond  -- Mangrove Area | S₃D  S₃D | Solid waste dumping, heavy siltation  Extensive destruction | Land development (bulldozing hillside), some fill in |
| **Crab Hill**  -- Salt Pond  -- Mangrove Area | S₂D  S₂D | Some fill in, some dumping.  Extensive destruction | Tourism development (hotels, apartments) |
| **Carlisle Bay**  -- Salt Pond  -- Mangrove Area | L  L | Cleared and filled in.  Cleared and filled in | Tourism development (hotel, tennis courts) |
| **Falmouth**  -- Mangrove Area | L | Cleared | Commercial, residential and tourism development |
| **Bethesda/Christian Cove**  -- Salt Pond  -- Mangrove Area | S₁D  S₁D | Some solid waste dumping.  Some clearing | Inadequate solid waste disposal system  Land development |
| **Solider Point**  -- Mangrove Area | NP |  |  |
| **Ayres Creek**  -- Mangrove Area | S₂D | Some siltation, considerable area | Land development destroyed |
| **Ledeatt Cove (Emerald Cove)**  -- Mangrove Area | L | Cleared | Tourism development (Emerald Cove Villas) |
| **McKinnon’s**  -- Salt Pond  -- Mangrove Area | S₂D | Sewage discharge, dredging channel.  Considerable cleaning and fill in | Tourism development (Marina Bay) Runway Bay, oil pollution from old refinery, very high BOD’s  Tourism development, e.g. (Marina Bay, mangroves dying in some areas, restaurants), land development (residential and commercial) |

Source: Personal Observation, Joseph Prosper, 1992 – 2020

Notes: P = Pristine – no evidence of human impacts

NP = Near Pristine – little evidence of human impacts (some litter, less than 2% shoreline vegetation destroyed, some beach erosion partially as a result of human activity, little or no siltation of beach waters)

S₁D = Slightly degraded – considerable evidence of human impacts (litter, 2-10% shoreline vegetation destroyed, some beach erosion partially as a result of human activity, some siltation of beach waters)

S₂D = Significantly degraded -- very significant evidence of human impacts (moderate amount of litter, 10-50% of shoreline vegetation destroyed, moderate beach erosion partially as a result of human activity, moderate siltation of beach waters)

S₃D = evidence of excessive human impacts (large amount of litter, greater than 50% of shoreline vegetation destroyed, severe beach erosion partially as a result of human activity, heavy siltation of beach waters)

L = Lost

### 9.2 Coral Reefs and Sea Grass Beds

The following summary of reef and sea grass conditions for Antigua and Barbuda came from a literature review of papers written by Leigh (1989), Island Resource Foundation (1996), Multer (1986) and Goreau and Goreau (1996). Antigua and Barbuda sits on a shallow rock floored platform or “shelf” which in turn is covered by sediments (sand and mud) and a wide variety of reefs. The edge of the shelf is at depths of 50 -100 fathoms (90 – 180 m) where it drops rapidly to oceanic depths. The shelf is quite narrow, however along the south coast of Antigua where it drops off to depths of over 1000 feet (305 m) within a mile (1.6 km) from the shore. Reef flourish on the shelf. It has been estimated that approximately 25.45 square kilometres of reef coverage, most of which is fringing can be found around Antigua. The reefs are better developed on the Windward coast of the Antigua, where the high wave energy provide circulation of nutrients and flushing and there is an absence of fine muddy sediments. However, the reefs are poorly developed or non-existent on the west (Leeward coast), where the lack of circulation and the abundance of fine sediments provide for a difficult reef environment.

Multer (1986) gave an extensive description of the reef systems, and it has been summarized below.

On Antigua, the windward north, east and south coasts are protected by an intermittent bank barrier complex. The bank barrier reef is the largest of the reef formation. They commonly display at least 3 subdivisions of zones. The middle subdivision or crest zone is where the wave breaks, characterized by tall seaward pointing branching pillar of *Acropora palmate* with massive thick pillars of the star coral *Montastrea annularis,* heads of brain coral *Diploria spp.,* blades of the “stinging coral” *Millipora,* and thickets of branching corals *A.Cervicornis.*

This community forms a broken ridge or crest zone, roughly parallel to the shoreline, as across Nonsuch Bay from Green Island to Indian Town Creek.

Seaward of the crest is the foreshore zone of gradually deeper water containing seaward trending, irregular, high coral encrusted ‘spurs of *A.Palmata, Diploria, Montasirea and Millipora*, between intervening broad, low sediment filled “groves”. The spurs are lower and seaward become ragged and eventually yield to a relatively flat framework of welded dead coral or sediment rubble flats at depths over 40 feet (2 m). Landward of the crest is the flat reef zone which often can be divided into two sub Zones: a scattered seaward accumulation of large mushroom shaped star corals (*Montastreaannularis)* rising to about 10 feet (3 m) above a white sand floor and also populated with some stinging corals (*Millipora),*brain coral *(Diploria spp.,)* and branching coral *(A.Cervicornis)* and further landward there is a broad well developed sub zone dominated by low mounds of finger coral *(poritesporites),* and includes some *A. Cervicornis and A. Palmata.* The calcareous algae *Halimeda incrassate and H. Opuntia*are also common members of this sub zone.

Patch reefs are common in lagoons between barrier reefs and the shore. In Antigua many occur west of Great Bird Island and in Nonsuch and Willoughby Bays. Most are made up of large masses of finger coral *Porites porites* with lesser amounts of *A Palmata, diploria spp., P.astreoided, A. prolifera and Millipora sp.* Species of the calcareous algae Halmeda are common in sandy zones within and around patch reef areas. Coral pillars act as local baffles for sediment swept up by storms to accumulate, and by this mechanism elevated the floor of the patch reef several feet above the surrounding lagoon floor. Fish and spiny black sea urchin (*Diademaantillarum*), use the niches of the patch reef as a protected home. In 1983 / 1984 most of the sea urchins died, throughout the Caribbean apparently from some disease caused by micro – organisms.

Fringing reefs are not extensive in Antigua. Goat head fringing reef along the southwestern shore of Antigua is well developed and may be divided into distinct parts: (a) central crest; (b) seaward spur and grove zone; and (c) landwards reef flat zone. This reef type vividly displays the effect of hurricanes on the system. The central crest zone is represented by denuded reef framework some 500 feet (150 m) from the shore covered with soft fleshy algae and only occasionally small live corals. Surf break on this zone and surges through pores and channels onto the higher rubble heap and reef flat behind the crest zone. This is dominated by small fringe coral and the knobby, encrusting coralline alga *Gomolithon*. Flat bladed and deep-rooted turtle grass (*Thalassia)* are abundant. This community was the last affected by Hurricane David (August 1979), with the exception of being covered locally by piles of coarse rubble. Most of the system tend to be flat and level. Landwards of this Zone in a shallow, soft bottomed muddy lagoon, stabilized locally by turtle grass and the calcareous alga *Halimeda and Penicillus*. Large soft bodied shrimp and conch inhabit these areas.

The two major seagrasses in Antigua and Barbuda are the dominate flat bladed turtle grass (*Thalassia testudinum)* and the less common thin rod-shaped leaves of Manatee grass (*Syringodium filliforme)* which occurs commonly in association with the turtle grass. Both grasses grow best in loose sediments at relatively shallow (0.5 – 10 m) depths, and where water circulation by tides or currents is persistent. Sea grasses on Antigua’s shelf and intertidal zone are important resources. They represent:

* Food for some fish, sea urchins and turtles
* A nursery for the juveniles of conch, spiny lobsters, shrimp and many commercial and sport fishes.
* A trap to remove suspended sediment washed from the land or stirred form the bottom.
* An effective mechanism for retarding erosion of the bottom sediments during storms, for grass held sediment it is almost hurricane proof.
* A substrate for many small lime secreting organisms, such as red algae and serpulid worms, which are responsible for major quantities of tiny particles of lime mud sediments.

Coral reef and sea grasses beds are regularly damaged by a variety of natural causes. The most dramatic of these are the devastating effects of large tropical storms and hurricanes. In 1989, 1995, 1999, 2000, 2007, 2017, powerful waves generated by hurricane damaged large reef areas and sea grass beds. Sediment raised and swept violently across reefs and sea grasses by waves and currents which scoured and scrape the bases of colonies. Sediments were deposited among the living coral and buried sea grasses. Large deposits of rubble and this includes n this case any large heavily eroded dead coral heads still remain in situ in several areas around Antigua and Barbuda, as the aftereffects of hurricanes. The rubble was covered, for the most part in filamentous algae rather than encrusting forms.

Like mangroves, coral reefs and sea grass are adversely affected by sedimentation. Heavy sediments impact from road construction, buildings etc. have had lasting effect. Reefs on the west and southeast coast show a high degree of environmental impact. Barrington reef, Middle and Johnson Pont reefs are affected by a high degree of sedimentation. Barrington reef was affected by the dredging activity of the St John Harbour.Weiss (1989) notes that between 1941 and 1981, Antigua’s fringing reefs, particularly on the north and the northeast coasts, have diminished in size and in abundance of coral and sea grasses. He associates these changes to coastal and marine development, most notably, dredging, the construction of ramps and docks, tourism and residential development on beaches and cliffs and the discharge of raw sewage and other pollutants. A Reef watch study conducted by the Deep Quadrants team in 1989, concluded that for the most part Antigua’s reef are in reasonable shape, but it cautioned against the detrimental effects of uncontrolled tourism on reef ecosystem.

Bunce’s more recent study (1994) indicates that the reefs are being significantly degraded as evidenced by low coral species diversity and abundances, low fish populations, increasing sediments levels, and moderate to high algae abundance. Bunce concludes her report with the following recommendations (in addition to continued monitoring of the reef): “regulate fishing to reduce algae growth; investigate sewage outfall sites…. Investigate a user fee on divers and snorkelers…. Install mooring buoys to reduce anchor damage; limit land run-off and sewage disposal ….and increase diver’s awareness to reduce diver damage” (Bunce, 1994:31). We might also add the need to control spear fishing and indeed ban it from certain reefs, to control fish traps and mandate the use of natural material to construct them, and the monitor the discharge of sewage and all other pollutants and wastes into the coastal waters. Given the high value of reefs to Antigua and Barbuda fishing and tourism industries, the implementation of all these measures is essential.

The fringing reef in Barbuda are in significantly better condition although they do show some visible human impact—most notable from fish traps and spear fishing (see table 14). While not overfished like Antigua’s reefs, reef fish population in many of Barbuda’s reef is low to moderate. Coral species diversity is low to moderate while coral abundance is generally low. Lobster pots and fish traps ring Barbuda, and fishermen have been complaining for years about significant declines in their catches. Most of the lobsters caught in Barbuda’s water are immediately bought up and flown to St. Maarten, Martinique and the Virgin Islands, even Palaster Reef, which has protected status, was observed to have lobster pots by Deep Quadrants divers. The Reef Quality Index established for this reef by the divers “falls within the general pattern observed for Antigua reefs” (Deep Quadrant, 1989).

# 10. PROTECTED AREAS

The government of Antigua and Barbuda has established nine protected areas, 5 marine and 4 terrestrials, to achieve a range of management objectives. These include resource protection, maintenance of scenic and historical landscapes as well as for sustainable development and to meet its obligations to the CBD. However, protected areas are often poorly managed and independent of each other. The first protected areas system plan was completed with assistance from the Organization of Eastern Caribbean States (OECS). This plan has recently been placed under revision and is currently being adjusted to include more recent information on the protected areas system for the country. The review was undertaken in light of the country’s acquisition of updated and in some cases new data sets relating to the country’s natural resources and the GIS mapping of its land usage. This was also necessary as a result of the development of the SIRMZP and the EIMAS system.

### **Table 6.** Antigua and Barbuda Marine Protected Areas

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Size (hectares)** | **Date of Protection** | **Accountable agency** |
| Northeast Management Area | 10783.5 | 29 Dec. 2005 | Fisheries Division, Ministry of Agriculture |
| Palaster Reef | 382.9 | 1 June 1973 | Fisheries Division, Ministry of Agriculture |
| Diamond Reef | 1457.3 | 1 June 1973 | Fisheries Division, Ministry of Agriculture |
| Cades Bay | 1927.9 | 1 June 1999 | Fisheries Division, Ministry of Agriculture |

### **Table 7.** Antigua and Barbuda Terrestrial Protected Areas

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Size (hectares)** | **Date of Protection** | **Accountable agency** |
| Codrington Lagoon | 6680.9 | 24 March 2005 | The Barbuda Council |
| Devils’ Bridge | 98.9 | 15 Nov. 1989 | National Parks Authority |
| Green Castle Hill | 35.3 | 1 Oct. 2008 | National Parks Authority |
| Fort Barrington | 34.5 | 1 Oct. 2008 | National Parks Authority |
| Nelson’s Dockyard | 6300.1 | 15 Nov. 1989 | National Parks Authority |
|  |  |  | National Parks Authority |

# 11. WATERSHEDS

Antigua’s 86 watersheds recognized by the Halcrow study (Halcrow 1977) were grouped by McMillan (1985) into 13 larger watershed groups. The two largest watersheds, Pots Works and Big Creek, drain the northern slopes of the southwest volcanic region and the main parts of the Central Plain to the east and west respectively. Fitches Creek drains into North Sound. Christian Valley, Parham and Bethesda are important watershed groups. These six watersheds occupy 43% of the land area and contain 80% of the ground water supplies and 90% of surface water storage. Within these watersheds are found 50% of Antigua’s Forest land, 90% of its root production, 60 % of livestock production and 70% of the population (Fernandez 1990). Details of these six major watersheds are provided in Table 9.

### **Table 8.** Features of the six major watersheds in Antigua

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Watershed | No. | Area  (ha.) | Existing Storage  (acre feet) | | Groundwater Yield  (m3/yr) |
| Agriculture | Municipal |
| Creekside | 2 | 4,000 | 200.4 | 278 | 390, 000 |
| Pots Works | 1 | 3,160 | 30.6 | 4,010 | 2220,000 |
| Christian Valley | 4-11 | 1,780 | 9.2 | 166 | 610,000 |
| Parham | 63-66 | 1,472 | 33.4 |  |  |
| Fitches Creek | 3 | 1,040 | 334.5 |  |  |
| Bethesda | 47-53 | 120 | 540.0 |  |  |
| **Total** |  | **11,572** | **1,148** | **4,454** | **1,220,000** |

*Source: Fernandez et al. (1999)*

All the watersheds are quite short, the largest being less than 11 km in length. The two largest have areas of 4000 ha and 3,160 ha respectively. Considerable portions of many watersheds are close to the coast and saltwater intrusion is a factor in the quality of some surface storage and ground and water supplies in many aquifers. Vegetative coverage of these watersheds is very variable. The upper catchment may have considerable area where citronella grass (*Cymbopogan citrates*) is the dominant cover.

# 12. NATURAL HAZARDS

Today, Antigua is much more developed relative to Barbuda in terms of tourism and has a greater population density. Barbuda’s population is small, and development is limited as a result of Barbuda’s unique land tenure of common property. Still, despite their differences, both islands face similar environmental hazards including drought, hurricanes, soil erosion, flooding, and the long-term risks posed by climate change. Antigua and Barbuda have had a long history of natural disasters experience, associated with such hazards as tropical storms, floods, earthquakes, and drought. For Antigua and Barbuda, the primary risk is that they lie in the hurricane belt – these islands not being normally regarded as being in the main earthquake zone. Arguably the greatest challenge that faces Antigua and Barbuda is finding effective solutions to reduce the increasing losses from natural disasters. Despite remarkable progress in science and technology in different spheres of life and in controlling domains of the natural world today, only limited progress has been attained in preventing natural events from adversely affecting people and their habitats. In the past thirty years alone, disasters have killed about 10 Antigua and Barbudans and have caused more than XCD$ 20 million in losses. The earliest historical record to a hurricane date back to the second voyage of Christopher Columbus (Lobdell 1989). While the precise number of storms that have traversed Antigua and Barbuda in historical times is not known, Lobdell (1989) suggests that there are references to as many as 500 hurricanes between 1494 and 1938 and has estimated as many as 3,500 storms over the same period. The Caribbean Cyclone Resistant Housing Project Information Bulletin (1991) suggested over 2000 events ranging from tropical depressions to major hurricanes in the Caribbean and over 500 hurricanes between 1886 and 1990 (see table 10).

### **Table 9.** Summary of Tropical Storms and Hurricanes in the Caribbean, 1886 - 1990

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type | Total Number | Example | Date | Island affected |
| TS | 368 | Alma | Aug. 1974 | Trinidad |
| HC1 | 151 | Katrina | Nov. 1981 | Cuba |
| HC2 | 174 | Edith | Sept.1963 | St. Lucia |
| HC3 | 108 | Eloise | Sept. 1975 | Hispaniola |
| HC4 | 64 | Flora | Sept. 1963 | Tobago |
| HC5 | 24 | Gilbert | Sept.1988 | Jamaica |

*Source: Caribbean Cyclone Resistant Housing Project Information Bulletin, Issue No.1*

### **Table 10.** Hurricanes affecting Antigua and Barbuda 1989 – 2019

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Date | Name | Category |
| 1989 | Sept. 17 | Hugo | 4 |
| 1990 | Oct. 4 – 7 | Klaus | 1 |
| 1995 | Sept. 5 -6 | Luis | 4 |
| 1995 | Sept. 15 | Marilyn | 1 |
| 1996 | July 8 | Bertha | 1 |
| 1997 | Sept. 6 | Erika | 1 |
| 1998 | Sept. 21 | George | 3 |
| 1999 | Nov. 18 – 20 | Lenny | 3 |
| 1999 | Oct. 20-21 | Jose | 2 |
| 2000 | Aug. 22 | Debby | 1 |
| 2007 | Aug. 17 | Dean | 3 |
| 2008 | Oct. 16 | Omar | 4 |
| 2010 | Aug 29 – 30 | Earl | 2 |
| 2014 | Oct. 13 | Gonzalo | 1 |
| 2017 | Sept.5-6 | Irma | 5 |
| 2017 | Sept. 9 | Jose | 4 |
| 2017 | Sept. 19 | Maria | 5 |

*Source: Antigua and Barbuda Meteorological Services*

In the lesser Antilles, the most important active faults can be classified: (1) faults belonging to the first set of bound arc perpendicular graben or half graben that disrupt the fore arc reef platforms of Guadeloupe, Antigua – Barbuda – Redonda and St. Martin - St. Barthelemy; and (2) a large right stepping en echelon system that appears to accommodate a trans-tensional motion along the volcanic arc between Saba, the northernmost volcano, and Martinique. At plate scale, the arc perpendicular fore arc graben and inner arc echelon system are connected, forming a sinistral horsetail east of the tip of the left lateral Puerto Rico fault zone that takes up the trench parallel component of convergence between the North American and Caribbean plates west of the Anegada passage.

Few hundred earthquakes are recorded each year by the local seismic network in the Lesser Antilles arc and several damaging ones have occurred during the historical period. The intraplate faults are responsible for a part of the shallow seismicity in the arc implying a strong seismic hazard in addition to that related to large subduction earthquakes. Two M6 earthquakes have occurred along the en echelon system in the last 30 years, on 16th March 1985 in Redonda, close to Nevis, and on 21st November 2004 near Les Saintes in Guadeloupe. The 21stNovember 2004 earthquake ruptured a N140 E striking normal fault offshore between Dominica and Les Saintes. Several other large interpolate ad moderate intraplate earthquakes were reported in the arc during the historical period. Information (epicentre location, distribution of intensities, damage) about these events is scattered in several reports, catalogues, and papers, some in French and Spanish. The impact of the societies has consistently been depilating, often resulting in the retardation of planned development. Despite its long history of natural hazard experience, little effort has been made to adopt design and development practices which could mitigate the impact. The point is made that, though there are some limitations in present damage assessment methods, there is little doubt about the extensive economic and social impacts of natural hazards on the Antigua and Barbuda’s societies. In many instances damage could be significantly reduced through simple adjustments on our human use systems. The need, therefore, for natural hazard considerations in our human use systems. The need therefore for natural hazards considerations in our development planning is forcible emphasized.

**13. PORT OPERATIONS**

In the container storage yard, there are 180TEU bottom spaces presently available, in addition to the approximately 176 TEU bottom spaces available in the container operations area between the Port Authority office building and the transit shed. The percentage of containerization of cargo has risen from 42% in 2000 to 65% in 2019. This, combined with the increase in cargo moving through the port, resulted in an increase in the number of containers coming into Antigua from 3091 TEU’s in 2014 to 6690 TEU’s in 2019. This increase is beginning to stain the land resources of the port specifically the area available for container storage. The projected increase in the volume of cargo flowing through the port to the year 2050 are based on current trends: the economy of Antigua is heavily dependent n the tourism industry, which has been increasing steadily for the past 10 years. The percentage of containerization internationally is expected to stabilize at 75% of total cargo. This should also hold true for Antigua and will mean further increases in the number of containers passing through the port. The projection shows a total annual container import figure of 20100 by the year 2050. This is over twice the present volume and it is clear that the present facilities will be considerable overload with traffic of this magnitude.

Analysis of cargo and container statistics from the Port Authority reveals that full containers remain on the port for an average of 5.5 days, and empties for an average of 9.0 days, a total of 14.5 days per container. Analysis of the number of ro-ro and lo-lo containers arriving at the port shows that 30% of the containers are ro-ro. Calculation of the areas required for full containers is complicated somewhat by the fact that many of the full containers are stripped on the operations yard, which means that the storage pattern must be designed in such a way as to maximize the bottom spaces and allow opening of the container. Although some of the containers are stripped into the CFS, we have assumed that of the 40% of full containers stripped on the port, all 40% are stripped in the yard. This will conservatively result in the yard size planning.

It is estimated that the container operations area will require 100 TEU bottom spaces and at least 160 other spaces for FCL containers which will be moved off the port for stripping. It is estimated that the storage area will require 212 TEU bottom spaces to handle the containers estimated. This figure breaks to 150 lo-lo bottom spaces, 24 – 20 feet ro-ro and 22-40 feet ro-ro spaces. The development of 1.5 acres of land immediately to the east of the existing container park will increase the capacity of the park to 20-20 feet ro-ro and 53-40 feet ro-ro spaces, and 210 lo-lo bottom spaces (730 TEU’s when stacked 3 high).

**14. BALLAST WATER**

Many policies, rules, and management options have been developed in an attempt to reduce the introduction of species. The agreed instruments, including conventions, treaties, multilateral agreements, and codes of practice, have in common that they aim to support internationally consistent management of specific transport vectors, quarantine, or other biosecurity measures. Probably, the most important because of their global application is the 1982 UN Convention on the Law of the Sea (UNCLOS) and the 1992 Convention on Biological Diversity (CBD). The main **purpose of ISGOTT** is to provide recommendations and guidance on the safe carriage and handling of crude oil and petroleum for tankers and terminals. It does not provide a definitive description of how cargo operations should be conducted on board a tanker. The International Chamber of Shipping (ICS) and the Oil Companies International Marine Forum (OCIMF) and the International Association of Ports and Harbors (IAPH).

More regionally, measures aiming to reduce the spread and new introductions of species have been available since the mid-1970s when ICES adopted the first version of what was to become the internationally recognized “Code of Practice on the Introductions and Transfers of Marine Organisms.” This code addresses quarantine and other measures avoiding negative impacts of unintentionally imported nontarget species, such as fouling organisms, +-on oyster shells or parasites of fish, moved with living specimens around the world. It also includes a risk assessment approach to ensure that the target species being transported will not cause unexpected impacts in their new environments (ICES, 2005).

The importance of ballast water as a species-moving vector was initially recognized in the 1973 International Maritime Organization (IMO) resolution (IMO, 1973). With more and more documented the negative impacts of species transfers mediated by ballast water IMO worked toward the finalization of the BWM Convention, which was adopted in February 2004 at a diplomatic conference in London (IMO, 2004). This Convention aims to prevent, minimize, and ultimately eliminate the risks to the environment, human health, property, and resources, which may be a consequence of the transfer of harmful aquatic organisms and pathogens (HAOP) via ships’ ballast waters and related sediments. It is interesting to note that harmful aquatic organisms in this context are not limited to nonindigenous species but contain all species irrespective of their origin. (Elliott and Wiley ) As a result, the term HAOP includes all potentially harmful nonindigenous (NIS), cryptogenic, and impacting native aquatic species also including pathogens (David, 2013)

Ballast water is essential for the safe operation of ships. .However, the process of loading and unloading untreated ballast water poses a major threat to the environment and public health as ballast water impacts the transfer of organisms between ecosystems, from one part of the world to another. Ballast water is essential for the safe operation of ships. It is used to adjust the overall weight of the vessel and its internal distribution in order to keep the ship floating safely, upright and in a stable condition. Ballast water may be taken on board by ships for stability and can contain thousands of aquatic or marine microbes, plants and animals, which are then carried across the globe. Untreated ballast water released at the ship's destination could potentially introduce a new invasive marine species. Ballast water impacts the environment when the ballast water is discharged, and the organisms are released into new environments. ... In some cases, there is a high probability that the organism will become a dominant species, potentially resulting in: The extinction of native species. Ships take on and discharge ballast water to compensate for changes in the mass of cargo carried. Organisms become entrained when water is taken on and can be released far from their native range when the ballast is discharged.

Ballast water has been focused as a source of both chemical and biological pollution in ocean. Each year 10 billion tons of ballast water around the globe is released into foreign waters. How does ballast water pollute? When a large vessel such as a container ship or an oil tanker unloads cargo, seawater is pumped into compartments in the hull. Similarly, when a large vessel is being loaded, it discharges seawater from these compartments. The seawater is meant to help stabilize and balance a ship. Ballast discharges from ships are responsible for tar balls in the open oceans and seas and can cause problems in navigating tanker routes. Nevertheless, the discharge of ballast water only accounts for a small percentage of oil pollution in the marine environment. Ships are also responsible for transporting harmful organisms in their ballast water. It often contains species, such as the killer algae (Caulerpa taxifolia), zebra mussel, and comb jellyfish, that can colonize their new environment to the detriment of native species and local economies. Coastal ecosystems are frequently invaded by microorganisms from ballast water. At a meeting with the legal consultant, and the Director of Operations at the Department of Marine Services and Merchant Shipping (ADOMS), the ADOMS team introduced the researcher to Ballast Water Mangement Convention Implementation. The overall tenents underpining this implentation plan is outlined below:

**Contracting government**

* To give full and complete effect to the provisions of the BWM convention
* Right to act individually or jointly with other parties
* National policies, legislation, and institutional arrangement

**Flag State**

* Require ships to be surveyed and certified.

**Port State**

* Ensure ports and terminal have adequate reception facilities (where cleaning and repairing of ballast tanks occur)
* Port State Control; inspection (valid certificate, Ballast Water Record Book, Ballast Water Management Plan, sampling Ballast Water)

**Coastal State**

* Biological baseline surveys

**Stakeholder Agencies**

* **Marine Authority (ADOMS)**
* Coordination and control of shipping including maritime safety and environmental aspects. Flag and Port state control. Implementation of shipping-related conventions and legislation.
* **Department of Environment**
* Overall coordination and management of invasive species problems, including monitoring and response plans. Implementation of biodiversity and environmental conventions and facilities.
* **Port Authrity**
* Responsible for the elaboration and implementation of port ballast water management plans (consistent with national strategy) and provision of relevant infrastructure eg. Port reception facilities.
* **Fisheries Adminstration**
* Regulates and oversees ﬁsheries and aquaculture, both of which may provide pathways for species introductions. NBWMS may have implications for ﬁsheries.
* **Public Health Authority**
* Supervision and evaluation of sanitary control activities in ports
* **Ship owners, agencies, and other port users**
* Responsible for the procedures and activities on board ships. Must inform ship masters about the requirements of the ports to be visited, including port, maritime, health, immigration and customs authority
* **Environmental NGOs and General Public**
* Play a watchdog role and may assist in monitoring for the early detection of introduced species.

**Next Steps**

* **Consideration by National Ocean Governance Committee**
* Lead Agency to be determined (ADOMS/Port Authority/Environment are key institutions)
* **National Task Force to be established**
* Guidelines available:
  + Templates for economic assessment
  + Legal, policy and institutional reform at the national level
  + Development of a national ballast water management strategy
* **National Workplan to be developed**

In addition to introducing non-native species into new environments, ballast and bilge discharge from ships can spread human pathogens and other harmful diseases and toxins, causing potential health risks for humans and marine life alike. Vibrio cholera is a useful model to represent the possible significance of ballast water-mediated dispersal in the transmission of pathogens. Discharges into coastal waters along with other sources of marine pollution are toxic to marine plants, animals, and microorganisms, causing alterations such as changes in growth patterns, disruption of hormone cycles, birth defects, suppression of the immune system, and disorders resulting in cancer, genetic abnormalities, or even death. They may also have the opposite effect on certain marine life, stimulating growth and providing a source of food. Hence, seafood can become contaminated and unhealthy for consumption. Not surprisingly, cholera outbreaks have been attributed to ship operations. Shellfish and drinking water can then be contaminated when the ship discharges its ballast water.

To prevent marine bioinvasions, biosecurity strategies have been developed. Biosecurity management allows countries to meet a number of international obligations and provides some protection from potential degradation of environmental, economic, social, and cultural values. Ocean governance relies on the precepts of ecologically sustainable development to manage the multiple uses in the coastal zone. The increasing reliance on aquaculture to provide food security and economic development has led to an increase in the use of nonnative target species grown as food sources. Increased economic activity has led to shifting trade patterns and increased efficiencies in vessels with a resulting increase in the number of introduced marine species via ballast water and hull fouling. Thus, typical tools being used include quarantine, import health standards, voluntary cleaning guidelines, and risk assessment, all of which aim to prevent introductions. For example, Antigua and Barbuda there is no comprehensive prevention and management of nonindigenous species. Hence there is a need for a biosecurity Act and possibly a Hazardous Substances and New Organisms Act. A Biosecurity Act could be oriented toward the management of unintentional introductions of species and sets out the standards for creating pre - border quarantine systems as well as the post - border incursion response and continued management.

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# 15. STATE INSTITUTIONS

There are several governmental agencies in Antigua that are responsible for the management of coastal resources. The National Parks Authority is responsible for the management of the Dockyard under development. The Public Works Department has the responsibility for enforcing the Beach Protection Act 1957 (see table 2), which prevents removal of sand and aggregate from beaches and foreshore. The Central Board of Health (**CBH)** is responsible for the collection and disposal of solid and liquid waste and for enforcing sanitation laws. The Port Authority is charged with managing the ports/harbours. The main responsibility for managing the coastal resources, however, belongs to the Ministry of Agriculture, Fisheries, Lands and Housings. Within this Ministry, the Fisheries Department is charged with protecting the marine resources, the Lands Division with the management and control of crown (Government) lands, and the Development Control Authority with the overall monitoring and control of all development and construction. In fact, from statutory standpoint, Antigua has all the necessary laws (see table 2) and institutional framework to effectively manage and monitor its coastal resources (for more detailed description see CEP, 1991).

While Barbuda comes under the ambit of various Government agencies and is subject to the same laws and statutes, technically the island is through the **Barbuda Council**, internally self-governing. While the **Council** in theory is entitled to make by-laws and in general control development in Barbuda, in practice it has been able to exercise very little control over its resources. The Antigua Government (GOAB), and specifically the Cabinet, has routinely made decisions affecting Barbuda without input of the Council, to wit, leasing the rights to mine sand or to develop land. The GOAB’s justification is the claim that much of Barbuda is Crown Land. Barbuda’s relationship vis-à-vis the national Barbuda government is the subject of a protracted legal dispute.

The operation of these various agencies and regulations in managing A/B’s coastal resources has been largely ineffective. Take the Department of Public Works which is responsible for protecting beaches from illegal sand mining. This Department has no real enforcement arm and no personnel willing to enforce the Beach Protection Act of 1957. Only the remotest beaches in Antigua have escaped illegal sand mining. In fact, sand mining continues at Dry Hill (Runaway Bay), Ffryes Bay, Pearns Bay, Hermitage Bay and elsewhere, in broad daylight and often within view of DPW trucks and GOAB officials. The reason why GOAB turns a blind eye to illegal sand mining operations are explored elsewhere in the report.

The **CBH** does an equally poor job in terms of enforcement of various sanitation laws, and an inadequate job in terms of solid and liquid waste collection and disposal. The latter is largely due to an inadequate budget and an antiquated waste disposal system which is attempting to deal with a problem of major dimensions since the modernization of the Antiguan economy has resulted in a quantum increase in garbage, construction waste, industrial waste, junked cars, car tires, batteries, etc. strewn all over the island, sometimes right in front of **DPH** signs prohibiting the dumping of rubbish. Gone are the litter wardens of earlier times or the community awareness and pride that were so much in evidence.

Perhaps the most important agency in terms of protecting A/B coastal resources, and the agency that has had the least authority, is the **Development Control Authority (DCA)**. This agency has been and is routinely bypassed by developers and even regular citizens, who simply take their construction/development plans directly to Cabinet. The **DCA** has also been hampered by an inadequate and poorly trained staff. Through much of the construction boom period in the late 1980’s there were only two building inspectors in Antigua. It has also tried to operate without a National Development Plan. A draft plan was prepared in 1976 but no plan as yet has been approved by Government. The problems of development control in A/B are reviewed in detail in the CEP (1991).

While many GOAB Agencies tend to have overblown staffs, they invariably lack persons with appropriate technical skills, who are quickly lured to the private sector. Those that stay on in Government say in the **Fisheries Department** or **Forestry Division** are terribly overburdened with routine matters and consequently underutilized. There are a number of highly trained persons in the area resource conservation frustrated by the lack of equipment, support staff and so on. Thus, the institutional framework that exists with respect to managing coastal resources is essentially non-functional, and likely to remain so because of the Government’s consistent preference for quick short-run economic payoffs over long-run environmental stability and slower-paced growth.

In 1989, the GOAB bowing to pressure from the Historical and Archaeological Society (**HAS**) and the newly formed Environmental Awareness Group (**EAG**), and especially to radio and television interviews given by E.T. Henry the driving force behind this group, established the **Historical, Conservation and Environmental Commission** (**HCEC**). Th **HCEC** has no statutory authority and has no clear mandate , other than to demonstrate the Government’s concern for environmental issues and to represent the Antigua Government in environmental forums regionally an internationally In the minds of many environmentalists in Antigua and Barbuda, the commission is simply window dressing, given increasing environmental awareness in the region, by a Government with a very poor record of protecting the environment.

The **St. John’s Development Corporation** was established by an Act of Parliament on 1986 on the recommendation of the **OAS.** Their primary objective is to promote the revitalization of St. John’s. The corporation has been involved in a number of ventures/projects—the Heritage Quay Projects (Duty Free Shopping), the Marina Bay Project, a Heritage/Historic preservation project which through the help of **OAS** architect Eduardo Rojas, has identified buildings of historical and architectural significance, and proposed the Market Esplanade project to revitalize the Heritage Quay area and East Bus Station. Except for the Heritage Quay project and the Marina Bay project at Runaway Bay, both of which have been fraught with problems (Italian contractors, equipment, materials, imported workers, inappropriate technology), the corporation has been able to do very little to revitalize St. John’s. Despite several **OAS** studies for street improvements and the reorganization of traffic patterns, the city is inhospitable to pedestrians and has a major traffic and parking problem.

The city also has a major liquid and solid waste disposal problem. Open sewers flow directly into St. John’s harbour. Solid waste lines the streets and is dumped in gutters, around the harbour shoreline and everywhere possible. Street sweeping and washing is often impossible.

# 16. NON – GOVERNMENTAL ORGANISATIONS

The earliest NGO to have a decided impact on the management of Antigua’s resources, in this case historical/cultural, was The Friends of English Harbour. An eclectic organization of mostly expatriates who had settled in Antigua, this organization must be recognized for its work in protecting and preserving Nelson’s Dockyard and Shirley Heights, for eventually convincing the GOAB of this important national treasure, and for widely publicizing the tourism potential of English Harbour. Much of the credit must go to the Nicholsons, especially Desmond and Lisa Nicholson, because it was through their efforts to promote park status for the Dockyard that the National Parks Act of 1984 was enacted, and subsequently a Park Development Plan and Park Management Plan drawn up with assistance from CIDA. Having accomplished its goal, The Friends of English Harbour disbanded, although many of its former members continue their participation in the Nelson’s Dockyard Foundation and the Historical and Archaeological Society (HAS).

The Antigua Archaeological Society (AAS) was the predecessor of HAS, which was established in 1965. Credit again must go to Desmond Nicholson for keeping HAS together and for all his research into A/B’s early history. Nicholson’s work and research achieved national recognition when GOAB provided support to the Museum of Antigua and Barbuda in 1986 with help from UNESCO and CIDA. HAS has about 100 members, both local and foreign. It publishes a quarterly Newsletter, sponsors numerous field trips and lectures, helps mount exhibitions at the Museum, and is actively involved in the preservation and conservation of historical sites and objects. However, since Antigua lacks a National Trust, the responsibility of protecting historical/cultural resources has fallen to several agencies who have different mandates and who lack the necessary interest and technical expertise.

Consequently, residential, industrial, infrastructural and tourism development has and continues to destroy A/B’s prehistoric and historic sites, despite the fact that HAS has made a very comprehensive inventory of sites available to the DCA, the HCEC, and the National Parks Authority. As an NGO all HAS can do is to publicize destruction when it occurs and engage in highly visible archaeological salvage operations as they did at the Emerald Cove development in Muddy Bay or at Coconut Hall. This does serve a useful purpose since it alerts regional and international organizations to the problem. The Organization of American States for example, has undertaking several studies in Antigua, particularly related to preserving historical sites in St. John’s and now more recently Parham. Unfortunately, the recommendations from these studies have all been shelved and St. John’s continues to lose properties of historic significance to commercial development.

It is because HAS has not been able to significantly influence GOAB’s development policy, that its sponsorship of the Betty’s Hope project becomes all that more important. When completed the project will have restored several windmills and will have installed mill machinery to create a replica of what the estate looked like in its heyday. Betty’s Hope has already become an important site for tourists and local visitors, a clear example of the economic, socio-cultural and educational benefits that would accrue of such heritage sites were emphasized by GOAB policy and appropriate resources made available for their protection. However, private efforts pressing for public support to save sites like Montpelier Estates and Fort James remain unheeded. Currently, erosion produced by dredging and other activities in St. John’s harbour has produced a huge crack in the Fort James’ Sea wall. The wall and other areas of the Fort need to be shored up.

Two organizations in the private sector require special mention—the Antigua Hotel and Tourism Association (AHTA) and the Chamber of Commerce and Industry (CAIC). The AHTA is an organization governed by an Executive Board and the day-to-day operations are entrusted to a manager. Member hotels pay graduated fees based on the number of rooms. In return they are provided with listing in the AHTA directory, cooperative media advertising, displays at the airport, bargaining with unions etc. Some of the AHTA’s major concerns are the tourism infrastructure (particularly the airport), /Continental Europe, the high cost and unreliability of electricity and water, and the Government’s apparent lack of a tourism master plan.

The AHTA has been a very vocal critic of the various GOAB tourism ventures, particularly the Royal Antiguan, which was built almost entirely by Italian workers and benefitted few local contractors and suppliers. In 1989, in reaction to Cabinet’s policy of making beach lands available to the highest bidder, the AHTA commissioned a “Strategic Plan” envisioning who the likely loser and winners would be in 1995-98 in the competitive Caribbean tourism market. Antigua was projected to be a likely loser because of overbuilding of accommodations, the trend towards mass tourism, deep rooted environmental and infrastructure problems, excessive pricing to meet costs, all of which were projected to cause a decline in the visitor experience. The AHTA because of its interest in maintaining a quality product is very much aware that protecting and properly managing Antigua’s coastal resources is the key to the industry’s long-term success. In fact, the AHTA is on record in opposing the kind of tourism development that has taken place in Barbados where massive concrete structures along the coastline have blocked visual as well as physical access to beaches/coasts. On several occasions AHTA President has called for an official investigation into the misappropriation of public funds by GOAB ministers.

The CAIC has also opposed the current tourism development policy GOAB is pursuing and has decried the numerous “sweetheart” deals with Italian and other developers. The CAIC has issued press releases critical of the GOAB’s local and foreign debt, the number of business licenses being issued to foreigners and the extent of corruption, mismanagement, and poor public accountability. Even the Private Sector Organization (PSO), which represents a number of different business organizations and has maintained a low profile, was finally driven to request a meeting with Cabinet in 1992 to address the issue of widespread corruption in the country. All of these organizations have powerful members, and they cannot be ignored when attempts are made to pressure GOAB to adopt a national development plan that will promote sustainable tourism.

The Churches, particularly through the Antigua Council of Churches, have also played an active role in mobilizing citizenry against Governmental corruption and the destruction of the environment. While the Churches and Ministers have focussed most of their attention on corruption, particularly Governmental involvement with they have also preached against the ongoing ecosystem destruction and have helped promote environmental education among youth. As a very significant force in the life of many Antiguans, the Churches have been able to bring out thousands of people to protest corruption. There are several other NGO’s that have played some role in promoting coastal conservation, such as the Humane Society (protecting wildlife, particularly on the Off-shore islands) and local community groups, such as the Fitches Creek Community Association, which generally mobilize to deal with specific problems impacting their respective communities. However, it is the Environmental Awareness Group (EAG) that has had the most success in bringing environmental issues to the forefront.

Environmental Awareness Group (EAG)

The life history of the EAG provides a useful case study of the environmental movement in A/B. In 1988, a number of HAS members concerned with the continuing destruction of A/B’s coastal resources through tourism and related infrastructural and residential development, organized the EAG to raise public concerns about the environment. Among this group were E.T. Henry, the Curator of the Museum, Desmond Nicholson, and the Museum’s Director, Winston Derrick a businessman, Brian Cooper of CARDI, John Jorgensen who was overseeing a restoration project in Rat Island, and some retired expatriates. While the group operated out of the Museum, and continues to do so, it was loosely organized and had no formalized membership or funds. However, in January of 1989, a constitution was accepted and the election of officers took place.

The first monthly meetings were sparsely attended but a series of environmental disasters later in the year, including the fish kill at McKinnon’s swamp (de Albuquerque, 1991), brought environmental issues into the public’s consciousness and provided a wider forum (newspaper, radio and television) for the group to publicize its concerns. These included a long litany of environmental abuses—the pumping of raw sewage into McKinnon’s and the sea by hotels, beach sand and minding, coral harvesting, destruction of mangroves, the filling of salt ponds, the clearing of hillsides, the destruction of shoreline vegetation, solid waste dumping and so on. With the help of one of the authors of this report, proposals for funding the activities of the EAG were drawn up and submitted to a number of regional organizations. Island Resources Foundation (IRF) provided a preliminary grant to help organize the EAG and provide a consultant to help develop an “Institutional Development Plan”. Within short order the EAG was up and running.

One of the EAG’s first activities was to sponsor the Antigua Clean as a Whistle Campaign. This was followed by an environmental education program, exhibits in the museum, a membership drive, lectures, preliminary planning for Earth Day and for publishing a Newsletter. By the beginning of 1990 the EAG had become firmly established, and EAG members had begun making contacts to local businesses and with senators who they knew were sympathetic to environment causes. Two EAG members were appointed to the HCEC. The EAG was also designated the host NGO to oversee and assist with the development of the IRF/CCA Country Environmental Profile.

The EAG has been fairly successful in its environmental education program. School children have come to view environmental exhibits at the museum, students have attended EAG field trips, and much energy has gone into impressing upon teachers the importance of introducing an environmental component (required by the CXC) into the syllabus of some subjects. At Antigua State College future teachers are being exposed to environmental studies. The EAG also maintains an adequate library that is open to students doing school projects and to the general public. The organization has frequently provided in-kind support to a number of researchers working on environmental issues in the country.

Since 1990 the EAG has obtained contributions and grants from a number of local individuals and businesses, the Caribbean Conference of Churches (CCC), the Caribbean Conservation Association (CCA), IRF, the Nature Conservancy, the Pan American Development Foundation, the Atlantic Centre for the Environment, and so on. It has expanded its activities into many areas—agroforestry projects, environmental education (in the schools, public lectures, media programs etc.), a youth agenda, a biodiversity project and a coastal and marine resources project (plant specimen collection, biological monitoring, wetlands monitoring, coral reef monitoring). All this is in addition to sponsoring Earth Day, World Environment Day, plant sales, poster competitions organizing recycling efforts etc. By all measures, the EAG has been remarkably successful. It has operating programs and projects, has a functioning office, support from members and some local businesses, an informative newsletter, fund-raising activities, a successful record managing grants, wider recognition in the region and elsewhere, and yet it has failed to impress upon the political directorate that environmental concerns must weigh heavily in all development decisions.

“Our country is in a terrible crisis. Our very lives are at stake. The degradation of our environment, lack of consultation, poor commutation and information transfer all add up to a growing mountain of environmental and social problems…”

# 17. INVASIVE ALIEN SPECIES IN ANTIGUA AND BARBUDA

# 

Twenty-three (23) invasive species are listed in Table 11 and 12 – seven plants and fifteen animals. The Global Register of Introduced and Invasive Species (GRIIS, 2017) identifies thirteen (13) verified invasive alien species (IAS) in Antigua and Barbuda; Ten (10) verified IAS of the plant kingdom, and Three (3) verified animal kingdom species. Antigua and Barbuda’s Fifth National Report to the Convention on Biological Diversity indicates that there are approximately twenty (20) invasive species with known impacts to the country’s islands.

### **Table 11.** Invasive Species – Antigua and Barbuda – Kingdom: PLANTAE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **KINGDOM: PLANTAE** | | | | |
| **Scientific Name** | **Common Name (s)** | **Environment** | **Native To** | **Sources** |
| *Acacia nilotica* | Gum Arabic Tree | Terrestrial | Africa, Middle East, India | GRIIS |
| *Calotropisprocera* | Sodom’s Apple Milkweed | Terrestrial | North and tropical Africa, West and South Asia, Indochina. | GRIIS |
| *Cosmos caudatus* | Ulam Raja | Terrestrial | Latin America | GRIIS |
| *Cymbopogonspp* | Lemon Grass | Terrestrial |  | 5NR |
| *Mangiferaindica* | Mango | Terrestrial | India | GRIIS |
| *Mynduscrudus* | Lethal Yellowing Disease | Terrestrial |  | 5NR |
| *Ricinuscommunis* | Castor Bean | Terrestrial | Eastern Africa, India, SE MEditerranean | GRIIS |
| *Halophila Stipulacea* | Broad-Leaf Sea Grass | Aquatic |  | DoE |

***Sources****: GRIIS database, Antigua and Barbuda; Antigua and Barbuda Fifth National Report to the Convention on Biological Diversity, 2014; Invasive Species Compendium, Centre for Agriculture and Biosciences International (CABI), Department of Environment (DoE), Plant Protection – Department of Agriculture. .*

### **Table 12.** Invasive Species – Antigua and Barbuda – Kingdom: ANIMALIA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **KINGDOM: ANIMALIA** | | | | |
| **Scientific Name** | **Common Name (s)** | **Environment** | **Native To** | **Sources** |
| *Achatina fulica* | Giant African Snail | Terrestrial | East Africa | 5NR |
| *Anastrepha obliqua* | West Indian Fruit Fly | Terrestrial | South America and Caribbean | GRIIS, CABI |
| *Cactoblastiscactorum* | Cactus Moth | Terrestrial | South America | GRIIS, CABI |
| *Canis lupus* | Dog (feral) | Terrestrial |  | GRIIS |
| *Capra hircus* | Goat (domestic) | Terrestrial |  | GRIIS |
| *Feliscatus* | Cat (domestic) | Terrestrial |  | GRIIS |
| *Helogateparvula* | Mongoose | Terrestrial |  | 5NR |
| *Iceryapurchasi* | Cottony Cushion Scale | Host | Australia | GRIIS |
| *Maconellicoccushirsutus* | Pink Hibiscus Mealybug | Host | SouthernAsia | GRIIS |
| *Osteopilusseptentrionalis* | Cuban Tree Frog | Terrestrial |  | 5NR |
| *Pteroisvolitans* | Lionfish | Aquatic | Indo-Pacific Ocean | 5NR, CABI |
| *Rattusnorvegicus* | Brown Rat | Terrestrial | Northeast China | 5NR, CABI |
| *Rattusrattus* | Black Rat | Terrestrial | Indian subcontinent | GRIIS, 5NR, CABI |
| *Solenopsisinvicta* | Red Imported Fire Ant | Terrestrial | Central South America | GRIIS |
| *Zachrysiaprovisoria* | CubanGarden Snail | Terrestrial | Cuba | GRIIS |

***Sources****: GRIIS database, Antigua and Barbuda; Antigua and Barbuda Fifth National Report to the Convention on Biological Diversity, 2014; Invasive Species Compendium, Centre for Agriculture and Biosciences International (CABI), Department of Environment (DoE), Plant Protection – Department of Agriculture.*

Other Introduced and Invasive Species

One hundred and twenty-six (126) unverified introduced species have also been identified through the GRIIS database for Antigua and Barbuda, summarized below in Table 13.

### **Table 13.** Other Invasive Species – Antigua and Barbuda

|  |  |
| --- | --- |
| **Category** | **Total** |
| Plant species | 88 |
| Animal Species | 38 |
| Other | -- |

***Source****: GRIIS database, Antigua & Barbuda.*

Since 2000, thirteen (13) invasive alien species are known to have been introduced into Antigua. Table 14 summarizes the species and their impact on the country.

### **Table 14.** Antigua and Barbuda: Invasive Alien Species – habitat, impact, and spread

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Species name** | **Common Name** | **Type** | **Habitat** | **Introduction** | **Impact** | **Spread** |
| |  | | --- | | *Achatina fulica* | | |  | | --- | | Giant African Snail | | Snail | Farming and Residential areas | Accidental through the agro - industry | Very destructive for local agricultural farms. There is also the health risk of Meningitis and can vector other human and plant disease. Occurs in high numbers in infested areas. | Natural dispersal; hitchhiking on vehicles out of infested areas; movement of conveyances (e.g., s intentional spread by man.oil, garbage); |
| *Pterois Volitans* | Lionfish | Fish | Sea | Accidental Introduction | Causing damage to the fishing industry as it has no natural predators here | The remarkable speed with which lionfishes have invaded Antiguan waters is unprecedented and alarming. At this time it is unclear what effects this new addition will have on native communities, and because the invasion is so recent there are few ecological studies of its impact. |
| |  | | --- | | *Cymbopogon spp.* | | Lemon Grass | Grass | Body Ponds, Mount McNish, Wallings Forest, Christian Valley and other hilly areas exposed to the sun | Unintentional introduction | Top Soil and water loss (NBSAP).   |  | | --- | | Inhibits the natural growth of native species and is highly flammable during periods of drought. | | Average daytime temperatures of 23-30°C without extremely low night temperatures are optimum for growth and yield. It performs best below 500 m altitude. |
| |  | | --- | | *Osteopilus septentrionalis* | | Cuban Tree Frog | Frog | Moist areas in residential and other areas | Unintentional introduction | Displaces native frog species due to high fecundity rate which competes for resources in the environment.   |  | | --- | |  | | Natural movement of the frog from one location to another & the laying of eggs which mature quickly, even in puddles of water after heavy rains (observation). |
| |  | | --- | | *Helogateparvula* | | Indian Mongoose | Small carnivorous mammal | Urban, Suburban and rural areas | Intentional introduction for pest control in the plantation era | Attacks and eats native species. Was responsible for the near annihilation of the Antiguan Racer Snake population | Natural movement of the Mongoose from one location to another. The litter is small (3) but mature under a year. Breeds three times in a year. |
| Plant Hopper (*Mynduscrudus*) | Lethal Yellowing | |  | | --- | | Plant Disease spread by bacteria known as the Plant Hopper (MyndusCrudus). | | Wherever coconut and other palm trees are found | Accidental introduction | Destruction of palms and coconut trees. | Spread of the disease occurs when the vector (*Mynduscrudus*) feeds on the sap of an infested palm and then goes on to feed on another susceptible palm species. |
| |  | | --- | | *Rattus rattus* | | Black Rat | Small omnivorous mammals | Urban, suburban, rural areas especially human habitation | Accidental Introduction | Carry disease.  Prey on local wildlife. | Natural movement of the Black Rat from one location to another. Females can produces five litter per year. A litter range from 6-12. These rats are able to reproduce 3 months of their birth. |
| *Rattus Norwegian* | Brown Rat | Small omnivorous mammals | Urban, suburban, rural areas especially human habitation | Accidental Introductions | Carry disease.  Prey on local wildlife. | Natural movement of the Brown rat from one location to another. These rats are able to reproduce four months of their birth. Females can produce five litter per year. A litter range from 8 -12. |
| *Scyphophorus acupunctutus* | *Agave* Snout Weevil | Insect | Dry habitats where Agave grows | Accidental Introduction | Infestation occurs wherever the agave plant, a national symbol of Antigua and Barbuda occurs. The plant grows wild and occurs mainly in the limestone areas of Antigua. Plants eventually die from infestation with this pest but the percentage of plants lost has not been quantified | Spread through movement of infested plant material or natural movement of the weevil. |
| *Typhadomingensis* | Southern Cattail | Grass | Fresh and brackish water ponds, and waterways | Accidental Introduction | Clogs water catchment areas such as ponds, road drainage, natural waterways, etc. by growing from the shallow edges and gradually overgrowing the area. | Wind dispersal of seeds |
| *Varroa spp. (Varroa mite)* | Varroa mite | Arachnid | Any habitat where the bee is found | Accidental Introduction | Parasitize bees, resulting in the death of hives if left untreated; severely impacts pollination of dependent crops, significantly reducing production in the agricultural sector. | Movement of mite-infested materials and lack of application of proper hive hygiene |
| *Huanglongbing* | Citrus Greening Disease. | Bacteria | Anywhere citrus trees are grown | Accidental Introduction | Most citrus plants in Antigua and Barbuda have succumbed to the disease. The rough lemon variety is the only citrus species that has shown some tolerance to the disease. The magnitude of the impact has not been quantified. | The causative agent – a bacterium, *Candidatusliberibacterspp*. – is insect-vectored through the feeding habits of the Asian Citrus Psyllid, *Diaphorinacitri.* |
| *Phytophthora palmivora* | Budrot of palms | Fungus | Anywhere host palm trees are found | Accidental Introduction | The disease generally manifests itself when the spear leaf dies. At this stage, it is too late to treat or save the plant. The impact is yet to be quantified. | The fungal pathogen is spread through rain splash which facilitates movement of the spores from plant to plant. The disease is highly infectious |

*Source: Antigua and Barbuda National Strategic Biodiversity Action Plan 2014; Daltry 2007; Plant protection 2019 (per. comm.); Veterinary and livestock 2019 (per comm.); Fisheries 2019 (per comm,)*

### 17.1 Invasive Alien Species (IAS) Impacts

Antigua and Barbuda reports that measures are in place to monitor and assess the spread of some IAS, but they are generally weak. Antigua and Barbuda depend on fisher folk/farmers/general public to report IAS. The problem lies in the fact that there are insufficient numbers of trained staff to carry out surveillance activities. Additionally, there is no coordination mechanism or strategy to address IAS’s which do not fall within the mandate of the Ministry of Agriculture (Plant/Vet/Fisheries). One of the outcomes of the upcoming project (Preventing COSTS of IAS in Barbados and the OECS Countries) is assessing the effectiveness of monitoring measures. The Plant Protection Unit (PPU) is about to launch an impact assessment on Giant African Snail (GAS) management effectiveness. The Environmental Awareness Group (EAG), a non-governmental organization, carries out biosecurity protocols for offshore islands.The Fifth National Report (2014) indicates that invasive species such as the Lionfish and Giant African Snail have placed pressure on coral reefs and vegetation, respectively, in Antigua and Barbuda, and some amount of investigative and/or continuous manual removal from the environment for IAS control has been done.

The Antigua and Barbuda 2017 Dossier on Invasive Alien Species (IAS) produced for the Caribbean Regional Workshop on Invasive Alien Species and progress towards Aichi Target 9 posit that, “eight (8) introduced and invasive alien species have been earmarked as national priority concerns for Antigua and Barbuda”. Priority IAS affecting “plants were so designated based on the level of impact being experienced in affected areas as well as giving consideration to the level of invasiveness and potential impact on the agriculture and tourism sectors if no actions were taken to control them”.

There is a current trend in the loss and extinction of biodiversity in Antigua by the clearing of its original vegetation for the cultivation of sugar cane and cotton as well other financially viable developments. However, the primary role of development is to improve the quality of human life through utilization of and access to the resources. From observation, the trend shows that although almost all of Antigua’s development has been based on the utilization of our environmental resources, the pathway to development has failed to find an environmentally sustainable course. If invasive alien species are not controlled or eliminated from the Antiguan landscape, the quality of human life both in the present and the future is being compromised.

Threats to national biodiversity have been primarily due “to human activities in pursuit of economic and social development. However, in addition to “human development activities, the country is facing more emerging threats mainly in the form of invasive species and climate change associated impacts” (ABNSBAP, p12).

The challenges are:

1. Fragile terrestrial and marine ecosystems such as mangrove wetlands and coral reefs endangered by development projects, pollution and misuse.
2. Vulnerability to external economic and natural environmental shocks, such as economic recessions, hurricanes, and climate change. Droughts and hurricanes have severely impacted the bird population, as well as vegetative communities and their dependent fauna.
3. Lack of human resource capacity in key biodiversity areas and other related fields.
4. Conflicting land use pressures, especially among housing, tourism and agricultural activities.
5. Land degradation: and limited institutional capacity to manage the development process because the presence of weak and fragmented land use and development control mechanisms.

The threats include:

1. The loss of habitat primarily through the sub-division of lands for housing, tourism development, agriculture and the mining and dredging of sand.
2. Fragmentation of natural communities by roadways, and other man-made features that form a barrier to the movement and dispersal of species.
3. The introduction of non-native species, like the Giant African Snail, mongoose, lemon grass and Lionfish that have a detrimental effect on native wild species by acting as predators, parasites, or competitors.
4. Overgrazing by livestock mainly goats, sheep, cattle, and donkeys that pose a serious threat, particularly in upper watershed areas.
5. Pollution as a result of excessive nutrients or sewage discharge into coastal waters, as well as the unregulated and excessive use of pesticides.
6. Natural and anthropogenic activities that stress coral reefs (directly and indirectly including through overfishing).

Invasive alien species seem to be dominant in habitats that have been modified, destroyed, overcrowded, over-exploited, and in cases where destructive fishing methods are used. Mangroves that function as nurseries, breeding grounds, and habitats for both marine and terrestrial wildlife are being destroyed for coastal development, especially associated with the tourist sector. The sea turtle populations are being impacted by the destruction of critical nesting and foraging habitats through coastal construction, sand mining, pollution, and over-fishing. Furthermore, the regulatory mechanisms, though effectively enhanced with the enactment of the new Fisheries Act and its accompanying regulations, is undermined as the necessary capacity to enforce these laws to protect nesting and foraging turtles and their habitats is inadequate. Sea grass beds that provide food for fish and turtles and function as nurseries for young conch, spiny lobsters, shrimp and a variety of fish are being destroyed. Coral reefs are in very poor condition, stressed by high sedimentation, and activities like over-fishing, destruction by the anchoring of boats, improper placement of fish traps, garbage, breakage by recreational diving, and the release of partly treated sewage from coastal holiday developments directly into the sea.Today, with an increased awareness of the impact of climate change and the importance of the country’s natural resources to its economic survival, renewed efforts have been undertaken to prioritize the protection of such natural resources in the country. This has had significant successes as the government, in partnership with a number of international and regional organizations, has begun the necessary steps to establish and implement a system of protected areas, and develop other policies for natural resource protection and management.

### 17.2 Management Measures

Measures to manage IAS currently are listed in Table 16 below.

**Table 15.** Management Measures

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Measures to Regulate / Control Entry** | **Measure to Control / Eradicate Populations** | **Effectiveness of Control** |
| *Achatina fulica*  (Giant African Snail) | Plant Protection Act No. 18 of 2012 | Eradication program: approved application of molluscicide at infested sites; physical removal and destruction of snails. Cabinet Decision on policy of eradication. Multi-Sectoral Task Force in place  Routine voluntary community collection encouraged in infested areas | Sub-optimal effectivity levels due to decreasing resources to deal with a rapidly escalating level of infestation |
| Lethal Yellowing Disease Phytoplasma (vectored by *Myndus crudus*) | Plant Protection Act  No. 18 of 2012    Import Ban on live plants to Prevent Entry. | Prophylactic Prevention/Management Treatment regime of Ox tetracycline Hydrochloride (OTC) injection of eligible palms. | Generally, plants treated correctly continue to thrive. |
| *Pterois volitans*  (Lionfish) | Fisheries Act 2013 & Fisheries Regulations 2013 | Lionfish Derby; Culinary display of Lionfish; Tournaments with Hawaiian Sling |  |
| *Rattus norvegicus*  (Brown Rat) | Public Health Act (CAP 353) | OICP Rat eradication program: commercial bait stations.  Biosecurity measures to be developed and enhanced on offshore islands including Redonda | Rats eradicated from Great Bird Island. Significant success in preserving the endangered Racer Snake; improving island vegetation, bird species populations, native snail populations, turtle nesting activities.  Eradication efforts successful on Redonda and several offshore islands |
| *Rattus rattus*  (Black Rat) |  | OICP Rat eradication program: commercial bait stations.  Biosecurity measures to be developed and enhanced on offshore islands including Redonda | Rats eradicated from Great Bird Island. Significant success in preserving the endangered Racer Snake; improving island vegetation, bird species populations, native snail populations,  turtle nesting activities  Eradication efforts successful on Redonda and several offshore islands |

***Sources****: Antigua & Barbuda Fifth National Report to the Convention on Biological Diversity, 2014; CARICOM/CBD IAS Survey, 2017.*

Antigua’s National Strategic Biodiversity Action Plan (2014) (ANBSAP) reports that some invasive alien species first occurred in the country through accidental introductions, such as the Lionfish, Cuban tree frog, and the Giant African Snail. The small Asian mongoose reportedly was intentionally introduced for pest control during the sugar plantation era. The ANSBAP reports that offshore islands were accessed by rats through swimming, floating across on storm debris, and as boat stowaways.

### **Table 16.** Introduction Pathways – Antigua and Barbuda

|  |  |  |  |
| --- | --- | --- | --- |
| **IAS Introductory Pathways** | | **Species** | **Suggested Measures to Manage Pathway 1** |
| **Category** | **Sub-category** |
| Release in nature | Biological Control | *Herpestes javanicus (Small Asian Mongoose)* | Risk analysis prior to release, monitoring, and rapid response. |
| Erosion Control/Dune Stabilization | *Cymbopogon citratus (Lemon Grass)* |
| Escape from Confinement | Ornamental Purpose | *Pteroisvolitans (Lionfish)* | Physical confinement, alert labelling as hazard to biodiversity, education of stakeholders |
| Pet/Aquarium/Terrarium Species |
| Corridors | Interconnected Waterways/ Seas | *Pterois volitans (Lionfish)*  *Achatina fulica*(Giant African Snail) | Impact risk assessment prior to construction of corridors; monitoring and rapid response |
| Transport Contaminant | Food Contaminant | *Achatina fulica* (Giant African Snail)  *Myndus crudus*  (Lethal Yellowing) | Management of Transport Vectors: Border Inspection and Quarantine |
| Transport Stowaway | Ship/Boat Ballast Water | *Pterois volitans (Lionfish)*  *Rattus norvegicus*  *(Brown Rat)*  *Rattus rattus* (Black Rat) | Management of Transport Vectors: Border Inspection and Quarantine |
| Container/Bulk | *Achatina fulica* (Giant African Snail)  *Rattus norvegicus*  *(Brown Rat)*  *Rattus rattus* (Black Rat) |
| Hitchhikers in or on Plane | *Achatina fulica* (Giant African Snail) |
| Hitchhikers on Ship/Boat | *Pterois volitans (Lionfish)*  *Rattus norvegicus*  *(Brown Rat)*  *Rattus rattus* (Black Rat) |
| Machinery/Equipment | *Achatina fulica* (Giant African Snail) |
| People and Luggage | *Achatina fulica* (Giant African Snail) |
| Vehicles | *Achatina fulica* (Giant African Snail)  *Rattus norvegicus*  *(Brown Rat)*  *Rattus rattus* (Black Rat) |

*Source: IUCN Pathway Management Resource.*

1 *Items under this column were based on Paragraph 29 of UNEP/CBD/SBSTTA/20/9 Add.1, with slight modification.*

Port of entry controls were reported as the primary measure to reduce the incidence of IAS pathways into Antigua and Barbuda (CBD, 2014). Additionally, the eradication of rats from offshore islands and the subsequent recovery of the ecosystems are distributed through public media sources and the education system in an effort to raise awareness. Pest Risk Analyses are generally conducted to determine the most appropriate phytosanitary measures to be applied to reduce risk of IAS entry to acceptably low levels.

### **Table 17.** Pathway Management Measures – Antigua and Barbuda

|  |  |  |  |
| --- | --- | --- | --- |
|  | Introduction Pathway | Measures to Manage Pathway | Management Effectiveness *\*(To be filled by Parties)* |
| *1* | Ports | Training of Border Control officers and inspectors;  Inclusion of all Border Control Agencies in policy and decision-making;  Greater fines for breaking laws;  Improved inspection protocols;  Inspections;  Continued collaboration between border control agencies;  Requirement for import permission and phytosanitary certification for regulated articles. | Unapproved and/or prohibited items are generally intercepted and the relevant actions taken in the case of commercial consignments.  Passenger baggage and the passage into the country of prohibited articles occur from time to time and this poses the greatest anthropogenic-facilitated threat of IAS entry. |

*Source: CARICOM/CBD IAS Survey, 2017.*

There is currently no formal National Policy/Strategy on IAS, but this will be developed in the project: “Preventing COSTS of IAS in Barbados and the OECS”. However, Antigua and Barbuda could be considered to have an indirect IAS policy/strategy, in terms of its Animal and Plant Protection Acts and the quarantine officer border surveillance regimes.

### **Table 18.** For Aichi Target 9, Antigua and Barbuda’s NBSAP outlines the following strategies:

|  |  |
| --- | --- |
| **Indicator** | **Activities** |
| Reports on the identification of the invasive species and the pathways identified. | Collate existing information on the programs currently underway on IAS management for use as a baseline for effective management of invasive species. |
| Border Control Officers (and other agencies responsible for monitoring species) trained in identifying alien species. | Initiate training programs for Border Control Officers on invasive species identification and management. |
| Monthly monitoring reports from relevant agencies within the Ministry of Agriculture and all other relevant ministries and NGOs. | * Establish reporting links between the Environment Division and relevant NGOs on work being undertaken regarding invasive alien species; * Utilize the EIMAS to initiate alien invasive species monitoring and management; * Source regional and international information to strengthen work at the national level. |
| Completed protocol document on managing relevant invasive species. | Develop a legally enforceable invasive species policy document. |

***Source****: Antigua and Barbuda National Strategic Biodiversity Action Plan, 2014.*

Other documented targets include the following:

* Develop regulations to curb the importation of potentially invasive species that pose a danger to biodiversity (Antigua and Barbuda Fifth National Report to the CBD, 2014);
* Successful eradication of known Invasive Alien species predators – Identify known invasive predators of the protected species and identify measures to ensure eradication (National Strategic Biodiversity Action Plan, 2014).

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# 18. COUNTRY NEEDS

Antigua and Barbuda has indicated the following national needs for IAS management:

## Priority Actions to Improve Identification and Prioritization of IAS

1. Training of inspectors and border control agencies in identification of priority IAS;
2. Specialist training in various disciplines (nematology, virology, parasitology, entomology etc.);
3. Adequate facilities to conduct lab confirmation, sample preparation and storage, incineration, fumigation, quarantine;
4. Strengthening the capacity of the Pest Risk Analysis (PRA) Committee members to conduct PRAs.

## Priority Actions to Improve Control and Eradication of IAS

1. Emergency funds/facility to provide for immediate funding to manage IAS;
2. Emergency plan for each IAS in country as well as procedure for regional or other IAS of high priority;
3. Training of Inspectors for the surveillance phase.
4. *Priority Actions to Improve Management of IAS Pathways*
5. Public Awareness on dangers of IAS, especially on in-flight messages, airport signage and general public information.
6. Acquiring non-human screening for IAS e.g. dogs, machines;
7. Strict legislation and enforcement.
8. Creation of an IAS national group and coordinating mechanism to facilitate IAS issues.

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