ABSTRACT

INVASIVE ALIEN PLANT SPECIES OF THE BAHAMAS AND BIODIVERSITY MANAGEMENT

RESTORING THE BAHAMAS BIODIVERSITY: STRATEGY FOR MANAGING INVASIVE PLANT SPECIES (PART I) AND NON NATIVE INVASIVE PLANTS OF THE BAHAMAS (PART II)

By Ross L. Smith

The nation of The Bahamas is an archipelago vulnerable to plant invasion. Small island nations share characteristics such as isolation and high endemism, which make them the most susceptible to loss of biodiversity resulting from invasions of non-native plants. Biological invasion is particularly prominent on islands because of reduced numbers of, and in some cases, extinction of, native plants. Because The Bahamas is overrun by alien invasive plants, it is critically important to address this problem. The implementation of innovative and dynamic management practices is key to controlling invasive plants and establishing stable ecosystems. This report examines existing laws, best management practices, regulations and protocols of the Bahamas as a background for establishing a management model. A model is proposed that may be useful to The Bahamas, and issues related to effectuating this management model are discussed. This paper also examines several invasive plant species in the Bahamas archipelago. Using the Bahamas Environment Science and Technology Commission categories (species recommended for eradication, species recommended for control, and other potentially invasive plants), this writer provides relevant information and pictorial images to make identification of plants easier for persons engaging in ridding the country of invasive weeds.

INVASIVE ALIEN PLANT SPECIES OF THE BAHAMAS AND BIODIVERSITY MANAGEMENT

PART I

RESTORING THE BAHAMAS BIODIVERSITY: STRATEGY FOR MANAGING INVASIVE PLANT SPECIES

PART II

NON NATIVE INVASIVE PLANTS OF THE BAHAMAS

A Practicum Report

Submitted to the

Faculty of Miami University

in partial fulfillment of

the requirement for the degree of

Master of Environmental Science

Institute of Environmental Sciences

by

Ross L. Smith

Miami University

Oxford, Ohio

2010

Part I: Table of Content

Tables

Figures

Appendices

Part II: Table of Contents

Acknowledgement

I am grateful to Dr. Mark Boardman, faculty in the Department of Geology, and Dr. Jerry Green, faculty in the Department of Geography of Miami University for your valuable suggestions and for reading the report. Also, Dr. Michael A. Vincent, Curator, W. S. Turrell Herbarium, Miami University, whose extensive scientific knowledge about the Bahamas flora and fauna provided valuable information to complete this study. Dr. Vincent's recommended readings, suggested lists of plants to be included and his assistance with identifying specific plants were reasons for me completing this report that will hopefully change the Bahamian landscape as the country matures. In addition, I am grateful to my daughter Jerusha and a friend Nakera for contributing several photographs for this project.

Part I: Introduction

A drive around the island of New Providence in the Bahamas would perhaps lead one, who is knowledgeable about the natural vegetation of the island, to deem it an exotic plant paradise. *Casuarina equisetifolia* (Casuarina), *Albizia lebbec* (Woman's Tongue), *Delonix regia* (Poinciana), *Leucaena leucocephala* (Jumbey), *Terminalia catappa* (Almond Tree) and *Ipomoea indica* (Morning Glory) are among several exotic invasive plants that dominate the landscape. Throughout many of the subtropical islands of the archipelago the presence of invasive plants is repeated. Many citizens and residents use these plants and probably do not know they are not native to the islands. Residents, in addition, hardly understand their impact on the ecosystems.

Invasive plant species are considered a threat to biodiversity and ecosystem functioning (Underwood et al. 2002). It is widely accepted by scientists that the introduction of native plants especially on small islands is the reason for biodiversity loss. In addition, many native plants are threatened or have become extinct as a result of alien invasive plants (Davis 2003; Gurevitch and Padilla 2004; Pimentel et al. 2004). The major challenge, therefore, for land managers and ecologists is how to effectively manage invasive plants that seem to be spiraling out of control in places like the Bahamas.

The Bahamas is an archipelago, made up of 700 islands and about 2,400 cays, covering an area of 5,358 square miles (13,878 sq. km) (Bahamas Government 2009). The islands are low lying with some rolling hills and ridges. The highest point is 206 feet, Mount Alvernia, on Cat Island. There are no rivers but brackish (somewhat salty) lakes are found on several of the islands. The natural terrestrial vegetation consists of Caribbean pine forest found on Abaco, Grand Bahama, Andros and New Providence and broadleaf evergreen forest locally called coppice forest (BEST Commission 2005; Sealey 1994). Correll and Correll (1982) described the broadleaf evergreen forest as coastal coppice, whiteland communities and blackland communities. However, the Bahamas coppice forests are usually described as two types: blackland coppice and whiteland coppice (Bahamas National Trust 2008). This writer subscribes to the former classification of Correll and Correll (1982). The coastal coppice is made up primarily of shrubs nearest the shoreline where the soil is a combination of pure sand and fragmented limestone. Whiteland coppice is also near the shore and soils are comprised of packed, light grey, sterile coral sand soil. Areas of whiteland coppice further inland have loamy (sand, silt and organic matter) to black type soils. The blackland coppice forests are near the interior of the islands and the plant community is found in black to red loam soil which has the greatest plant diversity of the three sub groups (Correll and Correll 1982). Each of the forest types are habitats for a variety of animal life forms, and are important in preserving the biodiversity of the islands (Bahamas National Trust 2008). The wetland areas and mangrove forest are also important plant communities in the Bahamas.

As an archipelago, the Bahama Islands are most vulnerable to plant invasion. Islands are isolated therefore vulnerable and extremely susceptible to invasion of alien species

(Commonwealth Science Council 1996). This vulnerability leads to damage and biodiversity loss which is greater than that of the mainland. Small island nations, shares characteristics such as isolation, vulnerability and extreme susceptibility which make it the most threatened to biodiversity loss because of invasive plant species. Native species are also highly threatened because indigenous plants are unable to compete with these exotic alien plants (Wade 2005). A small percentage of native plants are endemic (Correll and Correll 1982) therefore creates a greater threat to biodiversity loss. Norton (2009) stated that biological invasion is particularly prominent on islands because of reduced numbers of, and in some cases extinction of, native plants. Is it possible that the Bahamas are overrun by alien invasive plants because of such factors? Many of the non-native plants such as *Casuarina equisetifolia* have altered the landscape of the coast, creating monoculture stands and have completely replaced native coastal plants (BEST Commission 2005). The Bahamas Environmental Science and Technology (BEST) Commission was established by the Bahamas Government in 1994. It coordinates all national efforts associated with the management and the implementation of multilateral environment agreements. It also reviews environmental impact assessments and environmental management plans for development projects within The Bahamas. The BEST Commission also develops national strategies and proposes environmental legislation for the protection of the environment.

The complex nature of an archipelagic country makes managing invasive plants more problematic. The fact that the most islands of the archipelago are not close to each other, and are only accessible by boat or airplane makes managing any program difficult. Historically in the Bahamas, a centralized approach to managing resources compounds the problem. Usually many projects are designed and initiation deadlines agreed to but very few of them every get started. The high cost for travel to various islands also complicates any management initiative (BEST Commission 2005). The need to implement innovative and dynamic management practices (US Department of the Interior Bureau of Land Management 2009) is essential in controlling and eradicating invasive plants and establishing stable ecosystems. Such a plan should be diverse in nature and responsive to current scientific knowledge on alien species invasion. The emphasis should be on preventing alien species from entering the islands and controlling (Wade 2005) and eradicating those alien species that have become invasive. According to the Invasive Plant Council of British Columbia, Canada (2009) several agencies have developed best management practices (BMP'S) to deal with invasive plants. BMP's were developed through multi-agency consensus as a guide to managing invasive plants. A guide was developed in order to identify and manage various invasive plant species throughout the Province. While there are specific management techniques for the management of individual plant species, a coordinated approach to managing all such species is essential. It is the opinion of this writer that the type of management model would probably depend on existing laws, resources, complexity of the country and degree of training.

This paper will examine existing laws, regulations and protocols of the Bahamas as a background for establishing a management model. A proposed model that may be useful to the

Bahamas, as well as issues related to planning for the introduction of a management mode will also be examined.

Section I: Existing Laws, Regulations and Protocols

The Bahamas is an independent democratic country with almost 300 years of parliamentary democracy. As a member of the Commonwealth (previously known as the British Commonwealth), United Nations and several other international affiliates, it has signed a number of environmental agreements such as the UN convention on biodiversity and the UN convention on biodiversity protocol. As a party to the convention and protocol, the Bahamas have committed itself to reducing the rate of biodiversity loss in the islands. Examining existing laws, regulations and protocols will help to realize the Bahamas' goal of reducing biodiversity loss. Such examination provides valuable information to determine whether existing laws are sufficient, need strengthening or enacting additional laws is necessary.

1.1 National Legislation

Legislation is the formal enactment of public policy into law. The process of how a bill becomes law is important in understanding and using this process to advance environmental issues in the Bahamas. Parliament, which consists of an elected body called the House of Assembly, and an appointed body named the Senate, along with the Governor General, is commanded by the constitution to make laws in order to promote a peaceful and orderly society (Bahamas Government 2009). A bill can be introduced in draft form by a member of parliament in the House of Assembly. The usual procedure, however, is for a member of the governing party to introduce a bill. The bill then goes through four stages in the house of Assembly for passage. It is sent to the Senate for debate and passage, then on to the Governor General who signs it into law. Laws passed in this manner are termed *acts* (Figure 1). While there are no specific laws dealing with invasive species, the following major environmental laws which allude to it.

1.1.1 The Bahamas National Trust Act (1959)

The Bahamas National Trust Act passed in (1959) was probably the most important legislation passed by the Bahamas parliament, which allowed for the protection of native plants. The legislation established the Bahamas National Trust as a legal entity to protect land and sea areas for the sole reason of preserving the natural beauty for the enjoyment of residents and citizens. The act does specify in generalities the powers of the trust and allows it to make provisions and regulations to protect flora and fauna in protected areas (Bahamas Government 1959).

1.1.2 The Physical Landscape of the Bahamas Act (1997)

A portion of this act provides for the protection of plants in the Bahamas. It requires that a permit be obtained in order for specific trees and rare plants to be removed from natural areas. However, such a request for a permit may be accepted or rejected by the relevant authority (Bahamas Government 1997).

1.1.3 The Wildlife Conservation and Trade Act (2004)

The wildlife conservation and trade act of 2004 was passed in response to the convention on international trade in endangered wildlife and fauna. The reason for the legislation was for the protection of endangered plants from unsustainable exploitation. This legislation, while addressing all wildlife types, gives specific guidelines for the import and export of non-native and native plants and animals. Plants in each of the categories are specified according to scientific names in schedule I, II and III of the act. The act provides for controlling trade of fauna as specified in the act. The issuing of specific certificates for the purpose of import and export as well as guidelines for inspection of imported plants is also delineated. The provisions for exceptions such as seeds and cut flowers for use by florists (Bahamas Government 2004) do raise some concerns for possible escape of these plants and their establishment in the fragile ecosystems of the Bahamas. Some florists and residents carelessly discard plants in their yards or undeveloped lots. Many of the plants have seeds that may grow and become so abundant that they escape into nearby property. Even if planted under controlled conditions there is the possibly of plants escaping and becoming established.

1.2 Regulations and Protocol

In the absence of legislation, several regulations and protocols have been initiated by the Bahamas Environment Science and Technology (BEST) Commission. A part of the duties of the commission is to provide guideline and draft legislation for consideration by the government of the Bahamas. The BEST Commission recognizes the inadequacy of present legislation as it relates to protection of native plants. It has, therefore, proposed national strategies and suggested specific laws be enacted to address the same.

1.2.1 The National Invasive Species Strategy (2003)

This strategy is a broad overview of the national focus on invasive, alien species. It suggested that prevention, early detection and response, eradication and control were most important in managing alien species. The strategy recommended training of customs officers, agriculture and fisheries officers and enforcement officers as essential to the success of the strategy. Areas proposed for regular monitoring were public places, protected areas and national parks. The committee working on the invasive species document advised that an inventory of all alien species be performed. In addition, it categorized species and recommended them for eradication and others for control (BEST Commission 2003).

The Bahamas government policy for managing invasive species includes the commitment to enact legislation, prepare and implement management plans for the control of invasive species, and the reestablishment of native species. The government also promised to encourage research into best management practices and foster regional and international cooperation to assist in the

control and eradication of alien species. Voluntary codes of conduct for government and non-government agencies were also included in this document (BEST Commission 2003).

1.2.2 The National Action Plan to Combat Land Degradation in the Bahamas (2006)

This plan cited invasive alien plant species as one of the main causes for land degradation in The Bahamas. It was suggested that the implementation of improved stakeholder participation, innovative projects to restore degraded land, funding, collaborative research, coordinated activities and added participation from a more informed public could assist in the process of reducing land degradation (BEST Commission 2006). This plan also opined that these steps could indirectly contribute to controlling and eradicating invasive plant species.

1.2.3 The Bahamas National Biodiversity Strategy and Action Plan (1999)

The national biodiversity strategy and action plan focused on the generalities of biodiversity in the Bahamas. However, it recognized that alien species are a serious threat to biodiversity loss, therefore the need to control or eradicate these species are critical to ecosystems health. The plan further suggested that risk assessment be done on each alien species, implementation of a public education program and interregional corporation be utilized to reduce biodiversity loss. This dual strategy and action plan also recommended an integrated ecosystems approach to biodiversity conservation because of the fact of interdependence of these systems. An action for the "protection or rehabilitation of threatened or degraded ecosystems and of threatened species" was central to the management process (Ray 1999).

1.2.4 Other Legislation

Several other legislations have been prepared in draft forms but have not yet been presented to parliament. The information contained in these documents will be useful to address some of the concerns relating to invasive plants control in The Bahamas. However, writers are prohibited from citing these documents at this time because they are in final draft form before being presented to parliament.

1.3 International Agreements and Protocols

The Bahamas, after obtaining its independence from Britain in 1973, became a part of the international community with the same rights and privileges as the 'parent' country. As a result, it signed on to several international agreements relevant to its sustainability as a nation. Among the agreements were the UN Convention on Biodiversity, the UN Convention on Biodiversity Cartagena Protocol and the Convention on International Trade on Endangered Species and wild Flora and Fauna (Table 1). These conventions provide the framework for individual member states to develop plans to address the concerns outlined in the documents. In most instances, The Bahamas have complied with the various agreements and have produced its national action plans to address issues in the UN documents on biodiversity and invasive species.

Table 1: Relevant International Environmental Conventions and Protocol of Which the Bahamas is a Party

Conventions/Agreements/Protocols	Objective	Concluded	In Force
Convention on Biological Diversity	To develop national strategies for the conservation and sustainable use of biological diversity.	5 June, 1992	29 December, 1993
Cartagena Protocol on Biosafety	To protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. It establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory.	29 January 2000	29 January 2000
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)	To protect certain endangered species from over-exploitation via a system of import/export permits.	3 March, 9173	1 July, 1975

Source: Bahamas Environment Science and Technology (BEST) Commission 2005

1.3.1 The U N Convention on Biodiversity (UNCBD)

The need to encourage conservation efforts through the sustainable use of resources in order to ensure biodiversity is a critical aspect of the convention. The establishment of protected areas within national jurisdictions was encouraged as a means of attaining this goal of sustainability and biodiversity. The development of national plans and policies which incorporated the ethical components of biological control measures and modern research is encouraged. Private sector involvement is also advised to ensure a policy is a reflection of the entire country (United Nations 1993).

1.3.2. UN Convention on Biological Diversity Cartagena Protocol

This convention deals with safety issues as it relates to the handling, transportation, use, transfer and release of any living modified organism. It mandates that signatories to the protocols initiate measures to insure safe movement or prohibit movement of living modified organisms. Such measures are important to reduce the risk to biological diversity. To further strengthen the protocol, an advanced informed agreement procedure is provided so that each participating country can make informed decisions before importing genetically modified organisms into their country (United Nations 2000).

1.3.3 The Convention on International Trade on Endangered Species and wild Flora and Fauna (CITES)

This international agreement sought to regulate the import and export of endangered plants within member states of the United Nations. The agreement focused on species threatened by extinction and possibly affected by trade. Parties to the convention agreed not to participate in trade except under special circumstances as specified in the agreement (United Nations Environment Programme 1973).

Section II: Planning for Invasive Plant Species Management

Most non-native plant species are legally imported or smuggled into The Bahamas as food sources or ornamentals. While some of the alien plants such as mangoes and pigeon peas are beneficial as food crops, many are economically or environmentally damaging or pose health problems to humans. The Bahamas have begun to address the issues of invasive species threat by developing a national strategy document (BEST Commission 2003). Regional cooperation has also allowed for sharing of relevant information to pilot projects in some island states of the Caribbean (CAB International 2009). The Bahamas government contributed $500,000 of the $2M it pledged to contribute to the Caribbean challenge. This is part of the Bahamas contribution as party to the United Nations Convention on Biological Diversity to conserve at least 10 per cent of the terrestrial and marine habitat by 2010 and 2012 respectively (Bahamas Government 2008). The Bahamas National Trust has also embarked on removing invasive plants from all of its properties and the protected land parks. The Nature Conservancy has provided regional leadership to coordinated biodiversity efforts within protected areas. The Ministry of the Environment has formed partnership with these environmental bodies to promote efficient management of the environment. The Bahamas government, through the Ministry of the Environment, has also increased funding to the Bahamas National Trust to assist with improving the management of protected areas and national parks (Bahamas Government 2009). However, despite the efforts by the Bahamas government and environmental agencies, a coordinated approach to the management of invasive plant species has not yet been put into effect.

2.1 Management Techniques

The BEST Commission (2003) in its national invasive strategy document outlined several measures that can be used to manage invasive plants. These include prevention, early detection, eradication and control. Each technique depends on whether a plant species has been prevented from entering the country, smuggled into the country and identified at an early stage of introduction, is abundant but not widely established or is established. In order to employ a suitable management strategy it is essential to know where alien invasive plant species are found and the potential for additional invasion.

2.1.1 Models for Predicting

An important aspect of managing alien invasive species is being able to predict locations favorable to the invasion of specific plants. A study of alien invasive plants conducted by San Luis Obispo County Agricultural Commission Office used CLIMEX, a software data model to determine the effects of climate on specific plant species. The software model was also able to predict species that had not yet infested the area. The model is dynamic in nature because it is an objective tool which takes into consideration the multidimensional nature of ecological systems (Period 2001).

The San Luis County Agricultural Commission Office also used Global Positioning Systems (GPS) and Geographic Information Systems (GIS) to collect data of major species in the county. An invasive species database was developed which specified site characteristics and areas where alien invasive plant species were successful. The study found that this model allowed for improved predictive accuracy of biotic and abiotic information. Population size could also be traced over time, thus contributing to more effective management strategies. The information provided helped with better understanding of ecological and biological ecosystems and what constitutes successful invasion as well as the strength and weaknesses of a site (Period 2001).

2.1.2 Prevention Model

Prevention is considered the first line of defense against alien invasive plants entering a country or a region. It is considered the most cost effective means of managing alien invasive species (Moncrieff 2006). It simply entails preventing entry of such plants at the borders. Prevention requires that there is legislation and regulations in place to prevent the entry of such plants in the country. This is an area in which the Bahamas is rather weak because, while a plan exists as the bases for addressing the issue of invasive plant species, it is not enforceable. It is imperative that laws be enacted specifically to deal with individuals who attempt to import alien plant species that are known to threaten the biological diversity of the islands of The Bahamas. The laws should list those species that are recommended for control and eradication by the Best Commission as well as other species that may pose possible risk to the country's ecosystems (Appendix A). Additionally, the legislation should include an import risk analysis such as pathways for introduction and quarantine and boarder control. Custom officers should be trained to detect such plants that are detrimental to the stability of the country's natural resources. As part of the detection process a booklet or manual should be provided for the purpose of identification and quarantine of such plant species. As new information becomes available, additional training should be provided along with identification materials. The Department of Agriculture may be an essential part of the training process.

2.1.3 Early Detection Rapid Response (EDRR)

Despite the best effort to prevent alien invasive plants entering a country, many will enter an area undetected. It is important that there is a plan in place to manage such conditions as well. Early detection and rapid response must be the next step in helping to arrest the problem. It is the second most cost effective method for managing alien invasive plant species. For this program to be successful there must be a direct and clear protocol in place. Such protocol should have a specific agency or group responsible for this aspect of the process. The Department of Agriculture is better suited to carry out this task, since trained personnel are already in place in several of the islands of The Bahamas. In addition, botanists working in the country may also be used to assist with the training

Key components of an early detection, rapid response system may vary from one country to another; however, most agree that it should include surveillance, reporting, identification, collection, risk assessment and response to ensure a timely implementation of effective, management of the environment (Moncrieff 2006; Welch 2007). If this approach is to be effective it requires that one pay attention to detail. This should involve initial reporting and a quick response protocol. If the Bahamas is to adopt a strategy for early detection and rapid response, each aspect of the strategy should be adhered to. However, such strategy, according to Moncrieff (2006), should be part of an ecosystem wide approach rather than a focus on individual alien invasive plants. As a result the response should not focus on the area where the alien invasive plant was initially found but areas beyond that border. Because of the dynamic nature of such plants, they spread rapidly and may affect other areas near the infested locality.

An early detection program is not easy; the components suggest it is multifaceted. It therefore requires that planning must be an integral part of this process. It must start at pre-implementation and carried through to implementation and beyond. Both Moncrieff (2006) and Welch (2007) agree that early detection requires that one pay attention to details specific to the process. Usually one of the problematic areas of the process may be the reporting mechanism. It is therefore imperative that all individuals are fully informed of the reporting protocol to be used. If the goal of early detection is to arrest the problem before it spreads, then it is essential that the protocol is followed. It is then essential that all stakeholders be trained and provided with the necessary tools to ensure success of the early detection process.

Farmers, game wardens, gardeners and other individuals involved with plant protection should also be trained and provided with an identification manual of known alien invasive plant species. They should also be trained to identify plants with invasive characteristics in order to be able to respond and eradicate them quickly before establishment. Welch (2007) suggested that rapid assessment, data management techniques and reporting are essential parts of the early detection process. As a result attention should be paid to the key stages of the process (Figure 1). This is a cyclic process and as such requires that all parties involved be familiar with it. A more detailed system (Figure 2) provides relevant information that ensures the success of the process.

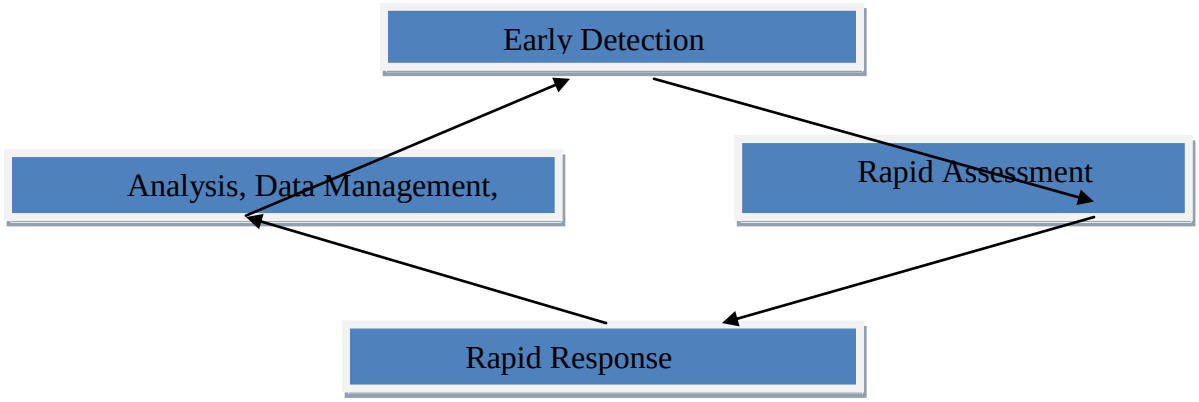


Figure 1: Key stages of Early Detection, Rap

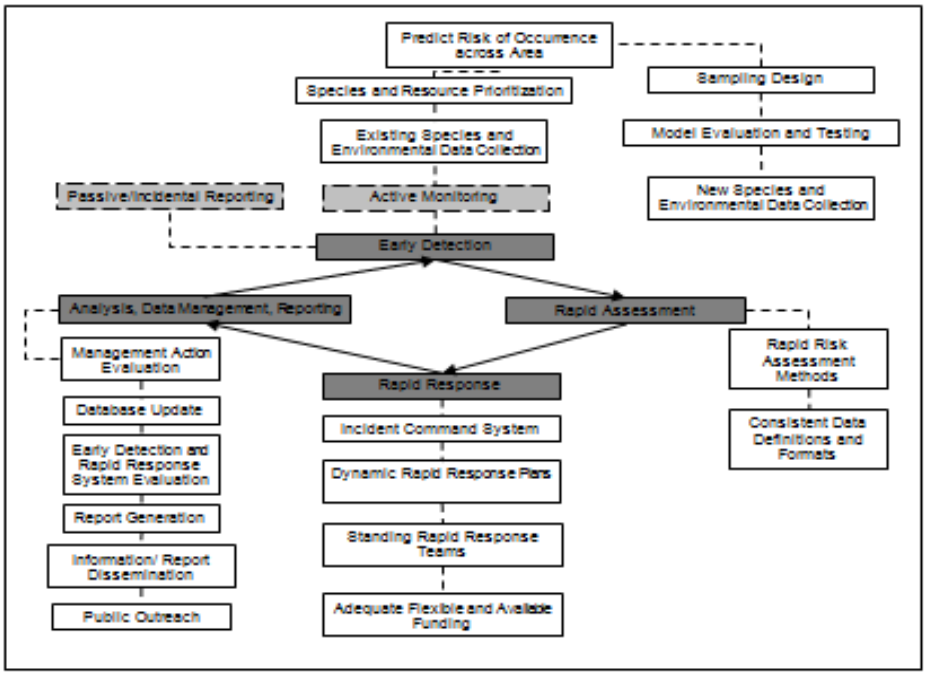


Figure 2: Key Stages of Early Detection, Rapid Response Assessment (Welch 2007)

Furthermore, an interactive page on the council's website should be established for reporting potential invasive plants. A rapid response team should then be dispatched to the site to conduct a species survey. Once the plant is identified and quarantined, the team should move swiftly to employ the most suitable technique to eradicate it. Verification is essential and should be done by a reputable source (Welch 2007). The Department of Agriculture may have trained botanists who would be able to carry out his task. In the event this is not possible then local botanists from the Bahamas National Trust, The Nature Conservancy or the College of the Bahamas may be used in this process. The process also requires an incident command system which is important to communication and ensuring that quick action is taken to eradicate the noxious plant species. A person dedicated to this task will help to improve response time.

The actual management at this stage may be different depending on the severity of the problem. The process may require one respondent, or a response team depending on the degree of invasion (Welch 2007). Moncrieff (2006) suggested that three response types may be necessary when dealing with alien invasive plants. These include low, medium and high level incursion responses. Low level incursion response should be employed using one or few persons at the local or national level when the risk involved is very low. It may be a plant that is in the early stage of invasion and can be hand pulled and treated with an application of pesticides. Usually little or no funding is required with this method. Medium level incursion response would require a more specialized "multi stakeholder invasive plant rapid response team" (Moncrieff 2006) specifically with a newly identified potential invasive that must be positively identified, by specialists. Eradication techniques may or may not be known; therefore specialists are necessary

to the process. The high incursion level requires the establishment of a special team and may require special funding. Quarantine measures and declaration under special laws may be needed before action can be taken.

A national alien invasive species monitoring and rapid response process requires a systemic approach to eradicating such plant species. It is essential that approaches to monitoring and responding are specific for national parks, botanical gardens, local parks, agricultural areas, public parks and recreation, tourist resort areas and local home gardens are clearly defined. This will ensure success at all levels. Attempts to address this aspect by the BEST Commission in its national strategy document are a starting point to this process. The National Invasive Species Strategy for The Bahamas outlined a voluntary code of conduct for the government, botanical gardens, landscape architecture, nursery professionals, zoos, aquaria, agriculturalists, aquacultures and the gardening public. Monitoring can be done but individuals and organizations are not required to follow any strict enforceable guidelines.

2.1.4 Control

By the time invasive plant species become established or naturalized in an area they are usually in numerous places. Their large numbers and wide distribution make them difficult to eradicate because the cost for such operations is huge and the rate of failure is high (Tu et al. 2001). The goal of controlling alien invasive species is the long term reduction of the species below a given threshold. This would eventually lead to weaker invasive weed populations, resulting in an increase in native species populations (Welch 2007). Several species of alien invasive plants are established and naturalized in The Bahamas. The country does not have the resources to handle an eradication program. How then should the country proceed?

Developing a coordinated control program is the best way to deal with this problem. Planning for control efforts is the first and most important aspect of the process. This involves goal setting, mapping or surveying, and utilizing the most effective method for control (Tu et al. 2001); setting realistic and attainable goals is essential to the success of any control process. Second, mapping the invasive species is also important to the process. One would think that if one knows where invasive plant species are, it would be made easier to implement a control method. Third, providing the most suitable method is also necessary to succeed. The schematic guide for control of alien species (Figure 3; Randall 1997) is a helpful tool to use with the control technique.

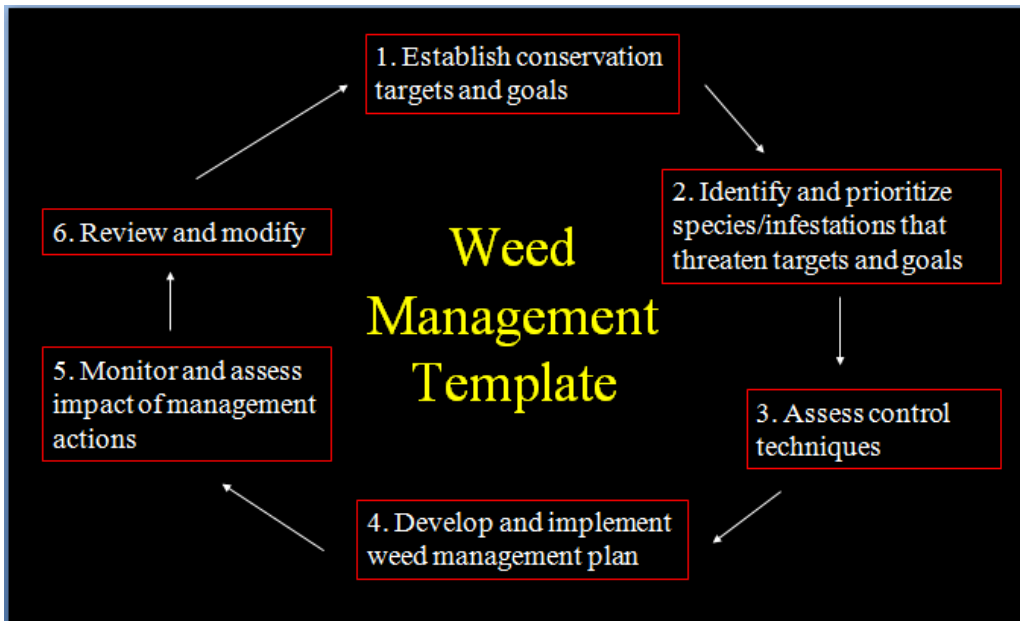


Figure 3: Management and Control of Alien Invasive Plant Species (Randall 1997)

This cyclic process explains the dynamic nature of control of plants such as *Casuarina equisetifolia* (Australian pine), which is found throughout the Bahamas. Essential to this process is developing an invasive plant management plan for systemic control of these plants that cannot be fully eradicated. Such a plan should include general information (Table 2), measurable objectives, control options (Table 3), monitoring and assessment of the species to be controlled and review and modification.

Table 2: General Information About *Casuarina equisetifolia*

Priority

High priority is assigned to the control along beaches on major islands and removal from botanical gardens and protected areas. Casuarina invades the entire shoreline, taking over sand dunes and displacing native plant species. This plant shallow root system makes it easy to tumble over with strong winds and during hurricanes. This tree accelerates beach erosion and beach loss and disrupts the nesting areas of sea turtles. The next step is to eradicate casuarinas from small islands and cays.

Description

Australian pine is an evergreen tree that resembles conifers and grows to about 150 feet (42 m). Casuarina has a single trunk with an irregular crown. The bark is reddish brown to gray, rough, brittle and peeling. The leaves are grayish green branchlets, jointed and thin. The flower is unisexual, inconspicuous, and brown. Fruit is cone-like, with one winged nutlet type seed

Current Distribution in the Country

The Australian pine is also found in mangroves and wet land areas and along the sandy shores. Casuarina is established extensively throughout The Bahamas.

Monitoring and assessment is necessary to determine if progress is being made based on the objectives and whether intensification of the control process is necessary. If during this stage there appears to be little or no progress, then a review needs to be done and where necessary modification of the process to ensure success.

It is essential to emphasize that the most effective way to coordinate a control effort is at the local level. This would mean that local invasive species councils must coordinate the effort through a subcommittee of individuals trained in different control techniques. The subcommittee should not do the work by itself but must train all stakeholders in various techniques that can be used. These techniques may involve mechanical, chemical and biological control or a combination of these methods. Individuals who are trained and understand methods of control are usually closer to a problem and can be most valuable to the process. Mechanical control is achieved through manual removal of plants from a site such as hand pulling of weeds. Other forms may involve the use of non-electrical tools such as saws, axes, shovels, machetes and hoes. A more advanced form of mechanical control is the use of power equipment such as chain saws. Other heavy equipment, like harvesting machines which are used in Florida to clear water hyacinth, and bulldozers for other large trees, are also employed in the mechanical control method. This method is very labor intensive and may require special skills and training in

operation of machines and proper disposal of invasive weeds. In addition, only specific species could be removed mechanically; therefore special training may be needed in order to identify such species before removal could begin (Wittenberg and Cock 2001).
Chemical control includes the use of herbicides developed to assist with the management of weeds. They are types of pesticides manufactured for the purpose of killing plants. Most of the herbicides used today are harmless to animals. It is usually applied to the above ground portion of a tree or plant. Application methods consist of "foliar spray or wicking, cut stump application and basal bark application to standing shrubs and thin bark trees" (Windus and Kromer 2001; Tu et al. 2001). The condition of the site must be considered before any herbicide is used. Consideration must be given to seasonal conditions, non target species, and ground water contamination (Windus and Kromer 2001). A summary of the how herbicides are applied (Table 4) should be helpful to the process. The use of a technique depends on the species to be treated. Herbicides should be used which present minimal risk to other plants and animals and the environment (Hillmer and Liedtke 2003).

Florida geography is similar to that of the Bahamas. Many of the invasive alien plant species found in Florida are present in The Bahamas. The University of Florida Institute of Food and Agricultural Science has done extensive research on various herbicides in Florida. In a publication "Control of nonnative plants in Florida natural areas," Langeland et al. (2009) suggested several herbicide applications that have proven effective in controlling various plant species. The book also outlined the behavior of various herbicides in soils and their effects on wildlife populations. The Bahamas invasive plant species program may find this useful when implementing an invasive alien plant species control protocol. However, consideration must be given to the differences in environmental conditions. In Florida it was found that treatment varied from site to site as wells as on the same site (Langeland et al. 2009).

Biological control is the introduction of a species from one environment into another to control pest species such as invasive plants. Usually such species are insects and are chosen because they are host specific. They are used to reduce the alien invasive plant population and not eradicate it. This is termed classical biological control and is said to be cost effective and self sustaining and is ecologically safe because of the specificity of the host to the plant. The biological control organism lives in balance with its host but reduces the plant population to a level that allows native plants to thrive. This method is said to be suited to nature preserves where the use of chemicals could result in damage to native plants (Wittenberg and Cock 2001).

Table 4.2 Sample objectives and control options for *Casuarinas equisetifolia*

Objectives

Casuarina equisetifolia is extensive along the sea shore of many islands in The Bahamas archipelago and cannot be eradicated completely with available technology. The following objectives will help to guide the control process.

- Determine the extent of this alien invasive plant throughout The Bahamas.
- Eradicate this plant species from uninhabitated small islands and cays.
- Eradicate stands along isolated beaches on major islands of The Bahamas.
- Reduce stands by 60% to 80% along beaches on major islands.
- Eradicate form botanical gardens and protected areas.
- Provide incentives for local gardeners to eradicate trees from their property.

Control Options

- Pull young saplings and discard them in an appropriate place and burn
- Remove small stands manually
- Remove large stands by cutting trees and applying herbicides
- Employ basal bark treatment
- Hatch and squirt tree, then inject with herbicides

Table 4: Methods of Herbicide Applications (Tu et al. 2001)

Foliar - to intact, green leaves

Spot spray - backpack applicator, spray or squeeze bottle

Wick - wipe onto leaves

Boom spray - mechanized equipment, seldom used in natural areas

Basal bark - circling the base of the trunk on the intact bark

Frill, or hack and squirt - to cuts in the trunk

Inner-bark injection - requires special equipment and herbicide products

Cut stump - to freshly-cut stems or stumps

Pellet - at plant base; rarely used in natural areas)

Pre-emergent soil treatment (before the target species emerge; rarely used in natural areas).

2.1.5 Remote Sensing, Aerial Photography and Geographic Information Systems (GIS)

Alien invasive plants continuously contribute to a decrease in native biodiversity and ecological destruction such as erosion, and species extinction. Various technology can be used with the identification and mapping of alien species. These methods include the use of Aeriel photography, remote sensing and Geographic Information Systems (GIS). While each of these techniques can be used separately, research scientists and other individuals and groups working with invasive plants use a combination of these techniques.

Mullerova et al. (2005) used aerial photographs to effectively examine the behavior of *Heracleum mantegazzianum*, which led to the discovery of an effective control method in the Slavkousky les Protected Landscape Area of west Bohemia. Underwood et al. (2002) studied iceplant (*Carpobrotus edulis*) and Jubata Grass (*Cortaderia jubata*) for identification and to compare three techniques for processing images of particular species. The researchers used Airborne Visual/Infrared Imaging spectrometer (AVIRI) to determine which of three techniques,

(1) Minimum Noise Fraction, (2) Continuum Removal and (3) Band Ratio Indices, were most effective in identifying the plant species. The technique resulted in identifying Continuum Removal as the most effective method.

GIS techniques are considered to be a superior process for gathering data. They are more efficient at locating and mapping invasive plant species and assisting in developing a program for eradicating and controlling them and replacing them with native plant species (Ricciardi et al. 2000). Combining local knowledge with GIS techniques used for identifying, mapping and managing such species is seen as critical to improving biodiversity (Robbins 2003). Other techniques are also used. In a California study (Underwood et al. 2002), topographic maps, historical data and vegetative maps were georeferenced to aid in the mapping of invasive plants. This technique led to successful and accurate identification of invasive plants as well as highest density areas and proximity to the coast line. Such accurate knowledge of spatial distribution of invasive plant species allowed for better control, eradication and management techniques (Underwood et al. 2002). A similar study combining field data, airborne imagery spectrometry and GIS found that invasive plants can be successfully managed (Ustin et al. 2002). However, having these techniques to better identify alien invasive plants is not sufficient. What happens after is more important. Methods used to manage invasive plant species must follow.

Section III: A Proposed Plan for the Bahamas

The BEST Commission has done the preliminary work for the establishment of a national program for The Bahamas (BEST Commission 2003). Attempts have been made to get public support through the planting of Bahamian trees; these attempts, however, have not affected any change nationally. The Bahamas National Trust (BNT) has established a botanical garden on the island of Eleuthera and has begun the refurbishment of the botanical garden on the island of New Providence. However, there seems to be no concerted effort to move forward in a systematic way to rid the country of noxious invasive alien plant species. The establishment of a national invasive alien plant council as suggested earlier by this writer can be the impetus for moving the national strategy forward. Once the council is established, a national plan designed for better management of noxious weeds can be properly addressed.

3.1 Bahamas National Invasive Plant Council

The Bahamas National Invasive Plant Council (BNIPC) should be the body to oversee the overall program (Figure 4). It is imperative that a national council on invasive plant species is established to coordinate the management of alien species. The council should comprise representatives from government agencies with specific responsibilities for environmental concerns, non-government agencies, scientists and environmental concern groups. This body should have responsibility to provide a national database of invasive plants by islands in the Bahamas. This would mean employing Geographic Information System (GIS) and remote sensing techniques in mapping these plants so as to ensure organized and proper management practices are employed to specific plant species. An inventory could help with planning for which plant species should be controlled or eradicated on individual islands. The national council should also be responsible for training, promoting research and monitoring and evaluation of invasive alien species projects as they are launched periodically. Minchau (2009), a researcher who worked with the Cariboo Regional District of British Columbia, outlined additional duties the council may adopt. These include coordinating the cooperation among public and private agencies and organizations, public education, dispensing of information and materials (herbicides) to general public and employing biological control methods. The national council should be the lead agency in regional collaboration and information sharing on invasive plant species. The council should also have responsibility to appoint island council with similar responsibilities in consultation with local authorities on each island of the archipelago.

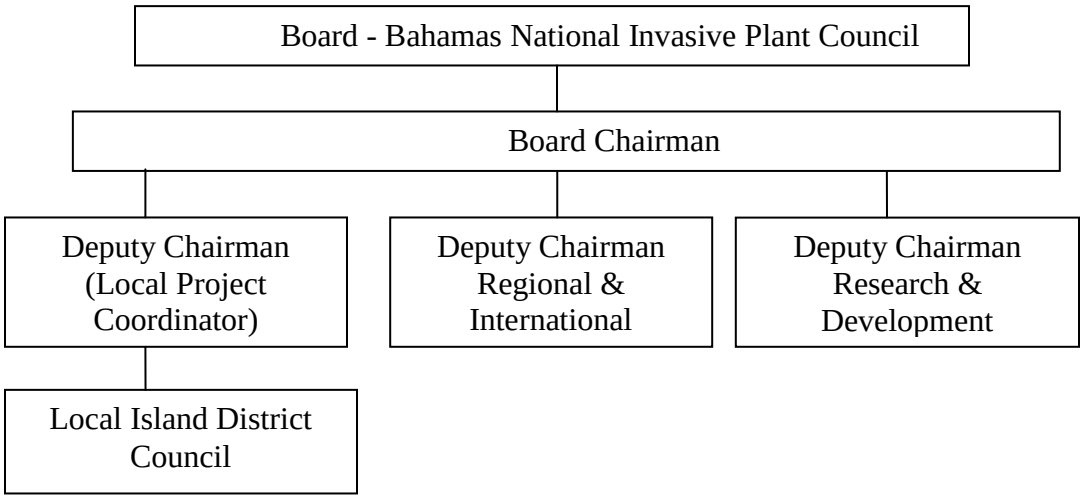


Figure4: Bahamas National Invasive Plant Council (BNIPC)

3.2 Structural Changes and the Family Islands: Island Councils

As was mentioned earlier, the establishment of island invasive alien species councils under a national council would provide a more effective means of managing alien plant species. The island councils should have similar powers to those of the national council, with the ability to generate the necessary financial resources need for funding projects, training locals and encouraging research on invasive plants to help further the work of the councils. Liaising with the national council in order to maintain open dialogue and reporting frequently on successes and failure should assist greatly in improving the management of invasive plants throughout the archipelago.

3.3 National Inventory

According to the BEST Commission report, no data is available on the extent of alien plant species in The Bahamas. While we know some species, the commission stated that the data base will be updated as information becomes available (BEST Commission 2003). This is but a beginning of acknowledging the existence of invasive plants but no serious survey or study has been done to reveal the extent of the invasion and, the invasive species threat to the country's biological diversity and security. The desire to clear the land for the development of major tourist resort hotels, condominiums, and luxury homes has resulted in a reduction of forest and other wooded areas, contributing to a threat to wildlife sustainability. It is documented that alien species are some of the most destructive threats to natural ecosystem, resulting in environmental and socio-economic impacts that affect the lives of millions of people around the world (Wittenberg and Cock 2001). It is therefore a matter of urgency that a national inventory is conducted to determine the extent of the problem.

It is important to conduct a national inventory so as to establish the legitimacy of claims by scientists and environmentalists. Napompeth Banpot (2004) of the National Biological Control Research Center, Kasetsart University, Thailand reported on invasive alien insects, and made several recommendations that this writer suggests may be important for conducting a national inventory (Banpot 2004). These suggestions are altered to suit the context of The Bahamas. The inventory can:

- Assist in establishment of a national coordination mechanism and information exchange system
- Provide the bases for refining and strengthening policy and legislation and a better national enforcement system of invasive alien species
- Better assist with determining the problems associated with invasive alien plant species and establishment of an early detection program
- Encourage appropriate and relevant research
- Assist with building a sustainable invasive alien plant program
- Improve capacity building in terms of human and financial resources needed for the program

In addition to these suggestions, this writer suggests that a national inventory will serve as the basis for a national education and training program that will truly reflect the nation's goals, objectives and priorities of a more sustainable Bahamas. Clearly defined goals and objectives can be developed and a phased management program could be adopted to address the invasive alien species concerns. The phased management program may want to first implement quick successful projects that will help to drive public involvement before moving to the more difficult eradication and control methods.

However, it is important to know that part of the inventory has already started because of the National Invasive Strategy (NIS). The NIS categorized invasive plants into two groups: species to be eradicated and species to be controlled (BEST Commission 2003). This can be used as the beginning to develop an inventory of invasive alien plants. A model developed by the European Community (Table 5) may be helpful in designing a similar one for the Bahamas. However, employing the Bahamas National Geographic Information Systems (BNGIS) to conduct surveys in each of the islands is essential to the establishment of a national management program. Once a national inventory is established and available to all stakeholders then ongoing research and monitoring can occur. A serious national program could then be established for education, and mitigation of invasive plant species in The Bahamas.

Table 5: Possible Steps to Develop a National Inventory and Set Priorities

Mobilise existing expertise for species inventory and review, based on a partnership approach (universities, research institutes, botanic gardens, NGOs, other stakeholders)

Start with known IAS and species for which information is already available. Link and integrate existing databases.

Based on existing information and experience, make a preliminary assessment to identify priority species and areas for action.

Include potentially invasive alien species, which are not yet introduced but have a high likelihood of introduction or spontaneous spreads from neighbouring countries.

Where available, include information on:

– species taxonomy and biology
– date and place of introduction
– means of arrival and spread
– range and spread dynamics
– risk of expansion to neighbouring countries
– invaded ecosystems
– population size and trends
– impacts recorded and level of threat
– other data relevant for risk analysis and early warning systems
– prevention, mitigation and restoration methods and their efficiency
– references and contact details.

- (Genovesi and Shine 2004)

–

3.4 Research and Monitoring

An essential part of the process is training researchers and monitors as to the importance of these processes to the overall goals of alien invasive species management. This aspect of the program could be done through a collaborative effort of the College of the Bahamas, BEST Commission, the Ministry of Environment, Department of Agriculture, Land and Survey, and external universities and foreign individuals that engage in research in The Bahamas. This would mean establishing a core team that could be considered part of a clearing-house for collecting and dissemination of information to national and local invasive species councils to aid in the management effort. Because The Bahamas has a large number of invasive plants it may be easy to find individuals who may wish to work on specific species or several related species.

The core team should convene a national symposium once per year to provide updated information on scientific research on various plant species. Researchers working in specific islands may be considered as consultants to local invasive councils to provide support for ongoing management of invasive plants. Additionally, the core team should provide available research information on invasive plant research from areas with similar ecological make-up as The Bahamas. This may assist with the management effort.

3.5 Need for Additional Laws and Enforcement Guidelines

A national strategy was developed but implementation of the plan has not been done as expected. One of the challenges is the lack of real legislation on invasive plant control in the Bahamas. The present laws are inadequate, as they do not fully address the magnitude of the problem in the Bahamas today. Plant nurseries and individuals continue to import many of the plants considered to be harmful to the environment. Penalties for persons engaged in the transport of the various plant species must be perceived as necessary if there is to be a change. A lack of legislation is contributing to a proliferation of invasive plants into the islands of the Bahamas. Only legislation can provide the framework to begin serious work on the many challenges presented by invasive plants. The Bahamas can only be seen to be serious about the issues related to biological diversity when it moves forward to provide the necessary legislation to protect the native flora and fauna.

Existing legislation and international conventions must also be enforced if there is to be a change in attitude of the Bahamian populace. When individuals and companies engage in importing invasive plants that are presently prohibited they should be given the maximum penalties. Such actions will send a clear message to others that the country is serious about its biological diversity mandate and is intolerant of those who are willing to thwart their efforts.

3.6 Institutional Support

In the Bahamas, several government ministries, departments and agencies are responsible for environmental laws and their enforcements. The Ministry of Agriculture is responsible for enforcing legislations and regulations related to the agricultural sector; the Ministry of the Environment is responsible for forestry, crown land, subdivision development and other related areas. In each of these ministries, departments have specific responsibilities for the enforcement of various environmental laws. Non-government agencies such as the Bahamas National Trust oversee national parks and protected areas and employ wardens to enforce the laws as they relate to these areas.

During the Bahamas 2009/2010 Budget Debate in the House of Assembly June 8, 2009, the environment minister, Dr. Earl Deveaux alluded to several projects the ministry, other government agencies and non government environmental agencies worked on during the course of the year (Bahamas Government 2009). Such cooperation is necessary if there is to be a level

of success in the quest to manage the environment. However, the attention to invasive plant control and eradication was only briefly mentioned when the minister cited the work of the Bahamas National Trust to increase the number of native plants in botanical gardens (Bahamas Government 2009). Since invasive plant species pose a significant threat to biodiversity loss due to the replacement of species and land degradation, a more coordinated effort is needed to better manage this program.

3.7 Human and Financial Resources

Human and financial resources are critical to the success of any program. The need for human capital is basically to manage the invasive alien species process and to help with the physical eradication and control measures. However, it is intertwined with the financial resources because without the latter it is not possible to engage human capital. While human resources may be engaged on a voluntary basis, financial resources are needed for tools, supplies and research to carry out control and eradication measures.

It is important to note that control and eradication methods are expensive. The impact on agriculture, biodiversity and the economy as a result of accidental or intentional introduction of invasive alien species is difficult to determine but in the USA, the impact of six invasive species is estimated at $74 billion dollars per year (National Invasive Species Council 2009). Information about such impact in the Bahamas is unknown, but having examined the extent of invasive plants throughout the Bahamas archipelago, it could be estimated into hundreds of millions of dollars. The Bahamas is a small developing nation, which is faced with challenges such as financing a project that is seemingly growing out of control. This is due to the fact that more emphasis is placed on generating economic activity at the expense of conservation efforts. However, despite the challenges, the Bahamas must invest financial resources to manage this critical area of concern, which is reaping havoc on ecosystems throughout the country. In addition, acquiring international funding to assist in this process must be a national goal in order to better manage invasive alien species.

3.8 Training

Critical to the management process is a well-designed and suitable training program for leaders of the invasive alien species program, trainers, and the general public. Training is essential because establishes legitimacy for the program, therefore, provides a means of realizing the program's goals and objectives, provides general information about invasive alien plant species, provides specific information about each plant species and ensures that correct information is provided on the management of specific plant species.

The degree of training should depend on the level of participation. Leaders both at the national and local levels should be provided with extensive training program divided into six to seven sessions: overview and invasive species to be eradicated, invasive species to be controlled, other

non-native species, eradication and control case studies, alternatives (native plants) and reporting mechanisms. A booklet of invasive plant species should be provided as a reference guide for each participant. A second group of individuals from the private and public sectors should be trained as well. These individuals should include agriculture and fisheries officers, land management personnel, environmental health officers, customs, police and defense force officers, plant nursery owners and operators, botanical garden personnel, environmental agencies and organizations and science teachers.

Public education and training should be an integral part of this process. Several environmental reports have supported such training (BEST Commission 2003; BEST Commission 2005; Pinder 1995). It is important to provide training to this sector of society because members of the public, in their gardens, community parks and local farms, will do most of the actual work. The training should be a well designed, informative, and instructive media based public service program (Pinder 1995) available on radio stations throughout the country. In addition, face-to-face instruction should also be available to the general public in each island district for individuals who would prefer such a program. Training at this level should be designed based on goals to be achieved; however, a general overview of invasive alien species should be part of the program.

A web site should also be maintained by the national invasive alien species council which accomplishes the following:

- keeps everyone informed about the program
- informs the public of island projects and successes
- shares regional and international information and local research and
- provides ongoing training for leaders

Leaders of the program should ensure that this site is regularly updated because new information is available almost daily on invasive plant species. Persons should also ensure that it is interactive, with a page or section of news and an information section allocated for comments from the general public.

3.9 A Community Based Approach

Local communities can play an important role in the prevention, early detection and control of alien invasive plant species. Residents of a community are the most important stakeholders and as such should be part of any program that affects their community. Another reason for community involvement is that efforts to control or eradicate an invasive species may be expensive, but involving residents would result in lower cost. Many individuals in The Bahamas also know the landscape very well and can identify many plants by common names. They may have some knowledge of the plants but are ignorant of the environment and economic impact. Some plants may be problematic on many local farms as well, but the lack of knowledge on effective control and eradication methods has compounded the invasive species problem. By

providing the necessary training to local residents more could be done to arrest the invasive plant species problem quickly and more successfully.

Community based management is an approach that involves local residents to participate in organizing programs, planning, implementing, monitoring and reporting strategies to ensure success. This program should be headed by the national council and coordinated by local invasive plant councils. The local invasive plant councils should be the legal body for providing training for local residents and any materials that must be used in the invasive plant management program. Such a program is necessary because The Bahamas, an archipelagic nation would be better served by local management rather than by centralized agencies. Examples given below of successful control and management using a community-based approach on several islands supports the thesis that it is a useful strategy for The Bahamas.

Papua New Guinea used the community based approach very successfully with the residents in the north-eastern part of the island (Wittenberg and Cock 2001). *Salvinia molesta*, an aquatic floating fern, had completely taken over the Sepick River which was the main source of food and only transportation corridor for the people of the region. With help from the United Nations Development CSIRO, the government was able to acquire the biological control agent *Cyrtobagous salviniae* (Salvinia beetle), which it distributed to the local residents in the area. The beetles were released into the water bodies. The use of the local residents allowed for quicker distribution and release of the agents which in turn contributed to rapid control of the noxious invasive weed. This is reported as one of the most successful biological control program to date. Similar programs use volunteers, such as the restoration of the nature reserve on the island of Rodrigues east of Mauritius and the community-based Aboriginal management program in Northern Australia (Wittenberg and Cock 2001).

One example of a local problem that can be eradicated through community effort is *Schinus terebinthifolius* (Brazilian pepper tree) in North Andros and on other islands of The Bahamas where they have not been established. What is needed is a coordinated approach to organizing and educating the local communities so that efforts could be initiated to rid the islands of these noxious weeds. Such a project must first engage volunteers in a planned education program on the Brazilian pepper tree and methods for eradication. In addition to workshops and seminars posters and broachers could be developed to educate the public about invasive plants (Appendix B, C and D). Second, the planting of native plant species (Appendix E) and monitoring to prevent recovery of the Brazilian pepper tree. This can serve as a pilot for future eradication projects.

Conclusion

This study's focus is restoring the ecology of The Bahamas, not to prehistoric conditions or to pre European exploration but to a functional state that will bring balance to the existing biosphere that has become unsustainable due in part to the over population of invasive alien plant species. Because of this, the islands of the Bahamas are under threat of losing their native biodiversity. It is therefore imperative that urgent action is taken to begin the restoration process.

A revision of environmental laws will provide for regulations to properly manage the imports, smuggling and accidental introduction of invasive plants in the county. Strengthening the laws should require that existing and new subdivisions use only native plants in landscaping. Large commercial and tourist developments should have similar requirements. Those businesses with invasive plants as part of the landscape must be encouraged to replace them in the shortest possible time.

The establishment of a national invasive plant council to lead the task of restoring the county's ecosystem is most important. It cannot be done by any single government agency because various aspects of land management are the responsibility of several agencies. This writer has therefore proposed a plan that can work and will definitely impact the restoration in a positive way. It recognizes the importance of a national invasive plant council but underlines the need for local involvement to ensure success over the long term. This paper does not propose that the country strive for an ideal that does not exist or never existed. It seeks to bring attention to a problem that is spiraling out of control that must be addressed. Careful consideration of this plan will provide insight into the important ingredients required for restoration. These factors include establishing a national body, activating the national plan, educating individuals, strengthening of laws and engaging the inhabitants in the process as essential to the desired outcome.

The Bahamas is a relatively small country with limited resources; however, it has a rich tradition of involving its people in the self-help projects that benefit both them, as well as the country as a whole. Funding is always a challenge, but volunteers, along with creative fundraising, will help to move the program forward. The need to seek international grants and aid to help with the program is necessary; however, corporations wishing to do business in the Bahamas must be invited to help fund this program as well. It is a challenging, time consuming and in some cases labor intensive program, but with leadership, support and the necessary resources, this project can be an example for many other countries struggling with similar challenges.

It is this writer's opinion that the Bahamas focus on creating an enforceable early detection, rapid response program based on the information provided. The country's resources and level of expertise must also be considered if it expects to successfully eradicate specific alien invasive plant species. It is necessary that urgent action be taken because the native fauna and flora of the Bahamas is threatened; therefore, steps must be taken to save native plants from becoming extinct. The action of removing invasive plants form the Bahamas archipelago will benefit other

native species, restore our wetlands and mangroves and the fast eroding shoreline. Many native plants have been removed from many of the islands, and replaced with alien species. Many of the alien species have become naturalized on those islands. The action of removing native plants has affected the balance in nature, because animals that have used them as food sources are affected. Finding a way to re No island country can remain sustainable if it is stripped of its native forest; trees and shrub for alien invaders that are not adapted to the natural land and aquatic systems. The country's response will determine the future of the native plant community.

The task is a mammoth undertaking but with a well-organized system in place much can be done to help control and eradicate the many noxious weeds found in the archipelago. Organizing resources with a steady flow of local and international funding can help to address the issues related to invasive species. This would mean rethinking traditional management practices and implementing those that may be more effective and responsive to the process of controlling and eradicating invasive alien species. The Bahamas must follow the example of South Africa and declare war on alien invasive species and utilize an aggressive program to eradicate such species. Koenig (2009) reported that South Africa at the initial stages of its eradication program employed 7500 part time workers paying them $6 per hour. Today, because of its aggressive approach, South Africa's native vegetation is flourishing. It is important for The Bahamas to follow South Africa's and adapt a development plan in order to reverse the negative effects of non-native invasive plant species. A non responsive attitude will result in further damage to ecosystems and human enterprises such as fisheries, farming and forestry, costing the country millions of dollars.

Bibliography

Bahamas Government. 1959. *The Bahamas National Trust Act*. Trans. Bahamas Parliament. Vol. 391. Nassau, Bahamas.

Bahamas Government. 1997. *Conservation and protection of the physical landscape of the Bahamas act.* Trans. The Bahamas Parliament. Environmental ed. Vol. 260. Nassau, Bahamas.

Bahamas Government. 2004. *Wildlife conservation and trade act, 2004.* Trans. The Bahamas Parliament. Environmental ed. Vol. 26 of 2004. Nassau, Bahamas.

Bahamas Government. 2008. Government increases allocation for environmental sustainability. Nassau, Bahamas. Available from http://www.bahamas.gov.bs/bahamasweb2/home.nsf/a2adf3d1baf5cc6e06256f03005ed59c/04fcca0548b543518525745800 51f184!OpenDocument (accessed January 15, 2010).

Bahamas Government. 2009. About The Bahamas. Nassau, Bahamas. Available from http://www.bahamas.gov.bs/bahamasweb2/home.nsf/vContentW/F1D7AA0803E7FFEF06256F02007F5607 (accessed July 7, 2009).

Bahamas National Trust. 2008. Ecosystems of the Bahamas. Nassau, Bahamas. Available from http://www.bahamas.gov.bs/BahamasWeb/VisitingTheBahamas.nsf/Subjects/Ecosystems+Of+The+Bahamas (accessed August 22, 2009).

Banpot, N. 2004. Management of invasive alien species in Thailand. Food & Fertilizer Technology Center for the Asian and Pacific Region. Taipei, Taiwan. Available from http://www.agnet.org/library/eb/544/ (accessed February 10, 2010).

Bata, S. W. T. 1981. Biological control of weeds: Principles and prospects. Pp. 45-59. *In Biological Control in Crop Production* (BARC Symposium 5) P, Allanheld, Osmun, Totowa, NJ.

BEST Commission. 2003. *The national invasive species strategy for The Bahamas.* Nassau, Bahamas.

BEST Commission. 2005. *National environmental action plan (NEAP) for The Bahamas.* SENES Consultants Limited, Ontario, Canada.

BEST Commission. 2006. *The national action plan to combat land degradation in The Bahamas.* Nassau, Bahamas.

CAB International. 2009. *Mitigating the threats of invasive alien species in the insular Caribbean*, Port of Spain, Trinidad. Available from http://www.cabi.org/Default.aspx?site=170&page=1017&pid=2916 (accessed January 5, 2010).

Correll, D. S. and H. B. Correll. 1982. *Flora of The Bahama archipelago (including the Turks and Caicos Islands)*. Vaduz, Liechtenstine.

Davis, M. A. 2003. Biotic globalization: Does competition from introduced species threaten biodiversity? *BioScience* 53: 481-489.

Genovesi, P. and C. Shine. 2004. *European strategy on alien invasive species.* Council of Europe. Strasbourg, France. Available from https://69.90.183.227/doc/external/cop-09/bern-01-en.pdf (accessed December 17, 2009).

Gurevitch, J. and D. K. Padilla. 2004. Are invasive species a major cause of extinction? *Trends in Ecology and Evolution* 19: 471-474.

Hillmer, J. and D. Liedtke. 2003. Upkeep and maintenance of herbicide equipment: a guide for natural areas stewards. Ohio Chapter, The Nature Conservancy, Dublin, OH.19 pp.

Invasive Plant Council of British Columbia. 2009. Best management practices for invasive plants. Invasive Plant Council of British Columbia. Williams Lake, British Columbia. Available from http://www.invasiveplantcouncilbc.ca/publications/IPC%20InfoNote2.pdf (accessed December 27, 2009).

Koenig, R. 2009. Unleashing an army to repair alien-ravaged ecosystems. Science 325: 562-563.

Langeland, K. A., J. A. Ferrell, B. Sellers, G. E. Macdonald and R. K. Stocke. 2009. *Control of nonnative plants in natural areas of Florida*, The University of Florida IFAS Communication Services. Gainesville, FL. Available from http://edis.ifas.ufl.edu/pdffiles/wg/wg20900.pdf (accessed November 19, 2009)

Minchau, M. J. 2009. *Cariboo Regional District 2009 business plan: Invasive plant management.* British Columbia: Cariboo Regional District, 1010.

Moncrieff, A. 2006. *Invasive plants, early detection and rapid response in British Columbia.* Invasive Plant Council of British Columbia, British Columbia, Canada. Available from http://www.invasiveplantcouncilbc.ca/publications/EDRR%20for%20Review.pdf (accessed November 19, 2009)

Mullerova, J., P. Pysek, V. Jarosik and J. Pergl. 2005. Aerial photography for assessing the regional dynamics of the invasive plant *Heracleum mantegazzianum*. Journal of Applied Ecology, 42: 1042-1053.

National Invasive Species Council. 2009. What do species cost the economy? In National Invasive Species Council. Washington, D C. Available from http://www.invasivespecies.gov/main_nav/mn_faq.html#economic_cost (accessed November 19, 2009).

Period, R. 2001. *Invasive plant management project.* San Luis Obispo, CA: ARI, 46910. Available from http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1076&context=bio_fac (accessed November 21, 2009)

Pimentel, D., R. Zuniga, and D. Morrison. 2004. Update on the environmental and economic cost of associated with alien-invasive species in the United States. *Ecological Economics* 20: 1-16.

Pinder, S. 2005. *Bahamas: Country report to the FAO international technical conference on plant genetic resources.* Food and Agricultural Organization, Leipzig, Germany.

Randall, J.M. 1997. Defining weeds of natural areas. Pp. 18-25. In J. Luken and J. Theiret (eds.). *Assessment and management of plant invasions*. Springer, New York, NY.

Ray, G. C. 1999. *The commonwealth of The Bahamas biodiversity and action plan.* The Best Commission. Nassau, Bahamas.

Ricciardi, A., W. W. M. Steiner, R. N. Mack and D. Simberloff. 2000. Towards a global information system for invasive plants. BioScience, 50: 239-244

Robbins, P. 2003. Beyond ground truth: GIS and the environmental knowledge of herders, professional foresters, and other traditional communities. *Human Ecology* 31: 233-252.

Sealey, N. E. 1994. *Bahamian landscapes: An introduction to the geography of The Bahamas*, 2nd ed. Media Publishing, Nassau, Bahamas.

Tu, M., C. Hurd and J.M. Randall. 2001. Weed control methods handbook: tools and techniques for use in natural areas. Wildland Invasive Species Program, The Nature Conservancy, Davis, CA. 195 pp. Available from http://tncweeds.ucdavis.edu. (accessed November 20, 2009).

Underwood, E., S. Ustin. and D. Dipietro, 2002. Mapping non-native plants using hyperspectral. In Center for Spatial and Remote Sensing (CASTARS), Dept. of Land, Air & Water, University of California, Davis, CA. Available from ftp://popo.jpl.nasa.gov/pub/docs/workshops/02_docs/2002_Underwood_web.pdf. (accessed November 17, 2009)

United Nations Environment Programme. 1973. *Convention on international trade on endangered species and wild flora and fauna.* United Nations. New York NY. Available from http://www.cites.org/eng/disc/text.shtml (accessed October 24, 2009).

United Nations. 1993. *Convention on biological diversity.* United Nations. Rio de Janeiro, Brazil. Available from http://untreaty.un.org/cod/avl/ha/cpbcbd/cpbcbd.html (accessed November 19, 2009).

United Nations. 2000. *Cartagena protocol on biosafety to the convention on biological diversity.* United Nations, Montreal, Canada.

US Department of the Interior, Bureau of Land Management. 2009. Invasive species. 2009. Washington DC, Available from http://www.blm.gov/education/LearningLandscapes/explorers/lifetime/invasive.html (accessed November 19, 2009).

Ustin, S. L., D. DiPietro, K. Olmstead, E. Underwood and G. S. Scheer. 2002. Hyperspectral remote sensing for invasive species detection and mapping. California, U.S.A. Center for Spatial and Remote sensing (CASTARS), Dept. of Land, Air & Water, University of California, Davis.

Wade, M. 2005. Priorities for the control and management of alien invasive plants on islands. *Biology and Environment: Proceedings of the Royal Irish Academy* 105B: 167-171.

Welch, B. A. 2007. Introduction, Pp. 1-7. In Strategic approach to early detection. In: *Early detection of invasive plant species handbook*. USGS/NPS. Available from http://www.pwrc.usgs.gov/brd/invasiveHandbook.cfm (accessed November 21, 2009).

Windus, J. and M. Kromer, (eds). 2001. *Invasive plants of Ohio: A series of fact sheets describing the most invasive plants in Ohio's Columbus and Franklin County Metro Parks, the Nature Conservancy, and Division of Natural Areas and Preserves*. Ohio Department of Natural Resources, Columbus, Ohio.

Wittenberg, R. and M. J. W. Cock. 2001. Invasive alien species, how to address one of the greatest threats to biodiversity: A toolkit of best prevention and management practices. CAB International, Wallingford, Oxon, U. K.

Appendix A: Early Detection Reporting Sheet

Invasive Plant Species (botanical name):				Common Name:				
Person locating infestation:				Name of property or park etc.:				
Contact Phone Number				Island				
Email:				Owner/Manager of land:				
Date of Sighting				Location features/Address of property or park and infestation location:				
Has Identification been confirmed?		By:		Specimen Number				
Type of Plant (Circle as appropriate)	Tree	Shrub	Herb	Grass/ sedge	Creeper	Vine	Floating aquatic	Emergent aquatic
Average height (in cm)	1 - 10	11 – 20	21 – 50	51 - 200	200 +			
Growth Stage	seedling	Adult (non flowering)	Adult (flowering)	Seeding	Post Seeding	Flower Color:		
Area of Infestation (in m²)	Specify or estimate if possible							
Habitat	Farm	Road Side	National Park	Public Park	Garden	Coppice	Wetland	
Specify								
Source of Introduction of Suspected Vector								
How long has it been there?								
Other Information								
Photo taken	Yes No							

Adapted from Moncrieff 2006

Appendix B: Education Poster

Invasive Plants of The Bahamas

Rise to Action!

Dig out
Pull up

Albizia lebbeck (Woman's Tongue)

Source: http://www.abettersouthflorida.org/GoNative/images/WomansTongueTree.jpg

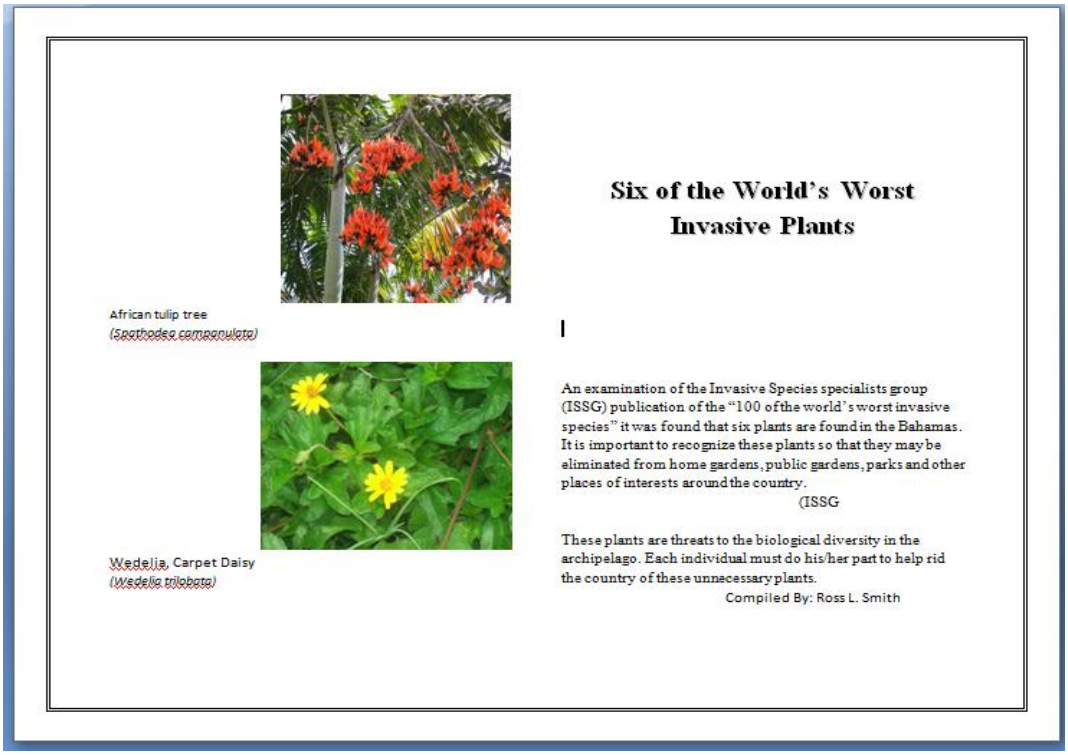
Replace with native plants

Guaiacum sanctum (Lignum vitae)
Source: Ardastra Gardens and Zoo

Protect Your Local Island

Appendix C: Wanted Invasive Poster

Appendix D: Education Pamphlet



African tulip tree
(Spathodea campanulata)

Wedelia, Carpet Daisy
(Wedelia trilobata)

Six of the World's Worst Invasive Plants

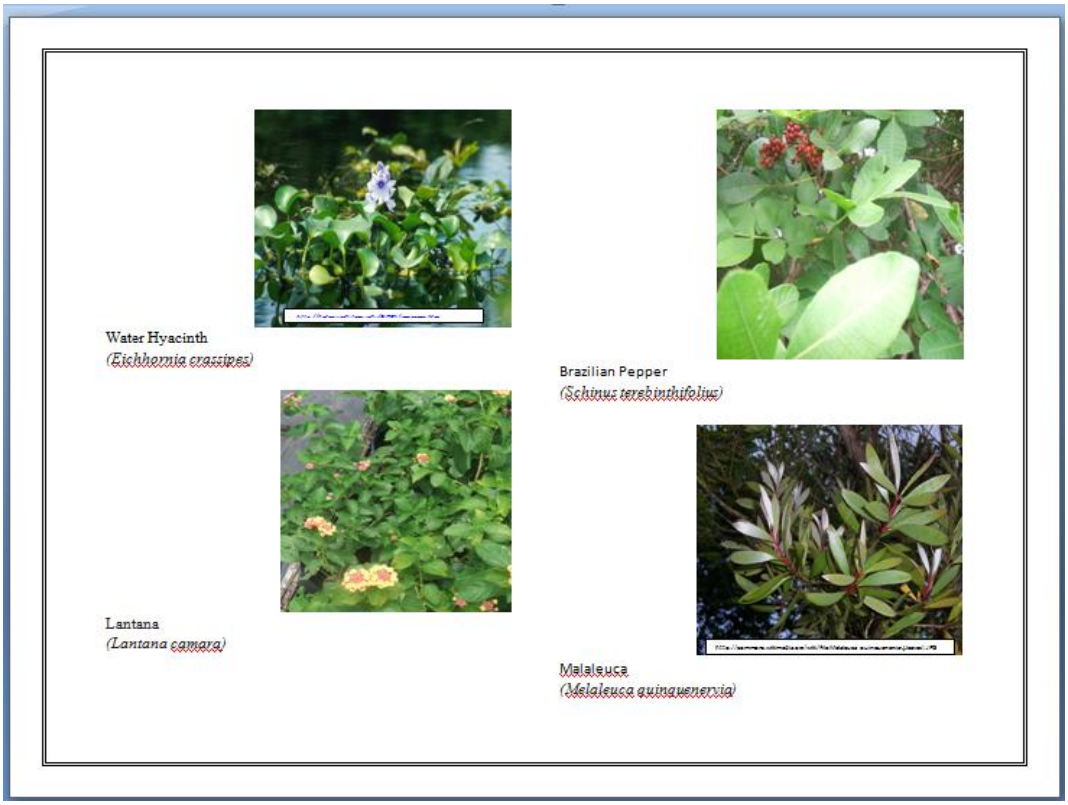
I

An examination of the Invasive Species specialists group (ISSG) publication of the "100 of the world's worst invasive species" it was found that six plants are found in the Bahamas. It is important to recognize these plants so that they may be eliminated from home gardens, public gardens, parks and other places of interests around the country.

(ISSG

These plants are threats to the biological diversity in the archipelago. Each individual must do his/her part to help rid the country of these unnecessary plants.

Compiled By: Ross L. Smith



Water Hyacinth
(Eichhornia crassipes)

Brazilian Pepper
(Schinus terebinthifoliu)

Lantana
(Lantana camara)

Melaleuca
(Melaleuca quinquenervia)

Appendix E: Native Bahamian Plants

Local Name	Scientific Name	Local Habitat	Propagation
Marlberry, Dog Berry	*Ardisia escallonioides*	Coppice scrubland	Seeds
Gumbo-limbo Gum-elemi	*Bursera simaruba*	Coppice, pineland, scrubland, open areas	Seeds, Cuttings
Brasiletto	*Caesalpinia vesicaria*	Coppice, rocky hills	Seeds
Sevenyear Apple	*Casasia clusiifolia*	Coastal coppice	
Smooth Casearia	*Casearia nitida*	Scrubland, Coppice	Seeds
Cuban Catalpa	*Catalpa punctata*	Coppice, open areas	Seeds
Coco Plum	*Chrysobalanus icaco*	Coastal swamps, sandy beaches	Seeds
Satin leaf, Saffron-tree	*Chrysophyllum oliviforme*	Woodland, coppice, scrubland	seeds
Buttonwood	*Conocarpus erectus*	Coastal mud, savannas , edge of Salinas	Seeds, cuttings
Pigeon plum, Plum bush	*Coccoloba diversifolia*	Coppice, scrubland	Seeds, seedlings, cuttings
Bahamian Pigeon plum	*Coccoloba tenuifolia*	Coppice, scrubland	Seeds, cuttings
Sea grape	*Coccoloba uvifera*	Coastal thickets, rocky areas	Seeds, seedlings, cuttings
Silver Thatched Palm	*Cocothrinax argentata*	Coppice, Pineland, Scrubland	
Anaconda, Geiger Tree, Spanish Cordia	*Cordia sebestena*	Sandy rocky coastal tickets	Seeds, cuttings
Cascarilla, Sweet Wood	*Croton eluteria*	Coppice covered ridges, rocky slopes	
Candlewood	*Gochnatia ilicifolia*	Coppice, pineline, scrubland	Seeds
Lignum Vitae, Tree of Life	*Guaiacum sanctum*	Coppice-covered rocky slopes and ridges, palm shrubs, seaside ledges	Seeds, cuttings
Beefwood	*Guapira obtusata*	Coppice, thickets	Seeds
Bay hops, Bay Winders, Railroad Vine	*Ipomoea pes-capre*	Beaches and coastal rocks	seeds
Boxwood, Cancer-tree, What-o'clock	*Jacaranda coerulea*	Coppice, scrubland	Seeds
West Indian Red cedar	*Juniperus barbadensis*	Coppice, rocky ground	Cones, seedlings

Common Name	Scientific Name	Local Habitat	Propagation
Sagebush	*Lantana demutata*	Rocky flats, coppice, scrubland	
Wild tamarind	*Lysiloma latisiliquum*	Coppice, scrubland	Seeds, cuttings
Willow Bustic	*Mastichodendron fetidissimum*	Beach coppice, pineland, flats	Seeds
Horse Bush	*Peltophorum adnatum*	Scrubland, coppice	Seeds
Black Ebony, Bull Wood	*Pera bumeliifolia*	coppice	Seeds
Black Wood	*Picrodendron baccatum*	Rocky coppice	Seeds
Dog Wood	*Piscidia piscipula*	Coppice, rocky slopes, dunes	
Bahama Cat's-claw	*Pithecellobium bahamense*	Scrubland, pineland, savannas, coppice	Seeds
	Pithecellobium glaucum	Coppice, pineland	Seeds
Bay Cedar	*Suriana maritime*	Dunes, rock shores	
Inkberry, Black Soap	*Scaevola plumier*	Coastal dunes	Seeds, cuttings
Bahama senna, Stinking pea	*Senna chapmanii*	Pineland, coastal coppice, waste land	Seeds
Sea Purslane, Sea Pickle	*Sesuvium portulacastum*	Sandy beaches, saline flats, rocky areas	seeds
Bay Cedar	*Suriana maritime*	Dunes, rock shores	
Beef-bush, Gumwood, Above-all, White-cedar, Pink-Poui	*Tabebuia bahamensis*	Scrubland, Coppice, pineland	Seeds
Yellow Elder	*Tecoma stans*	Sandy or rocky soil, coppice	Seeds, seedlings, cuttings
Small-fruited Thatch-palm, Buffalo-top	*Thrinax morrisii*	Sandy and rocky soil	Seeds
Large-fruited Thatch-palm	*Thrinax radiate*	Coastal limestone and sands	Seeds
Bahamas Buttercup	*Turnera ulmifolia*	Beach sand, coppice, scrubland	Seeds
Sea Oats	*Uniola paniculata*	Beaches and sand dunes	
Spike-grass	*Uniola virgata*	Saline	

Source: Correll and Correll, 1982

Part II: **Introduction**

The Bahamas is an archipelago of 700 islands and about 2,400 cays, covering an area of 5,358 square miles (13,878 sq. km) (Bahamas Government 2009). Like all small island developing countries it is vulnerable to invasion of noxious weeds that invade the natural landscape, threatening native plants to a point of endangerment or extinction due to human population pressures and overdevelopment of the coast (Global Environmental Facility 2005). Invasive plants are considered weeds, because they exist outside their natural range. They are also considered weeds in natural areas because they usually displace native plants and other wildlife associated with natural vegetation and can alter a natural process such as water flow (Langeland and Stocker 2009).

The Bahamas, like small island nations, shares characteristics such as isolation, vulnerability and extreme susceptibility which make it the most threatened to biodiversity loss because of invasive species of plants (Commonwealth Science Council 1996). The Global Invasive Species Programme (2009) defined invasive species as "plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause economic or environmental harm or adversely affect human health."

A number of plant species have either been intentionally introduced into the landscape of The Bahamas or brought in by mistake. In a study of *Casuarina equisetifolia* on San Salvador Island, an island in the Southeast Bahamas, it was found to be a dominant species, taking over the landscape near the shoreline and wetland areas (Rodgers 2005). A study on Eleuthera Island, an Island in the Central Bahamas reported similar findings (Vincent and Kwit 2007). Additionally, the casuarinas' aggressive mode has resulted in its removal from the Ardastra Garden and Zoo, a prominent plant conservation garden in The Bahamas (Ardastra Gardens and Zoo 2009). Another noxious weed *Schinus terebinthifolius* is rapidly invading natural areas on several islands (Hickey and Vincent 2005). Plants may have become so widespread on some islands that eradication is near impossible therefore, control measures are employed.

It is important that these invasive plants are controlled in order to maintain the native biodiversity that is critical to the archipelago's defenses to natural disasters. The *Casuarina equisetifolia*, as was mentioned earlier, is found along the coast and has a very shallow root system. It has replaced much of the coastal plant species resulting in the beach becoming more vulnerable to degradation during hurricanes. Hurricanes are very destructive storms, with very strong winds, therefore, casuarinas with its shallow root system are among the first to topple. The result is, sand dunes are flattened and sand gets blown away resulting in beach loss (Moultrie 2005). Rodgers and Gamble (2008) reported very little damage done to casuarinas and coast in San Salvador by Hurricane Francis (2004). However, this writer's experience was markedly different. In observing the same storm in Grand Bahama and Eleuthera extensive damage to the beach area was witnessed as a result of fallen casuarinas during Hurricane Francis (2004). These destructive species enter the archipelago's ecosystems and prove to be more destructive than

beneficial. It is evident from various researches that these plants possess specific identifying characteristics that make it difficult controlling or eradicating them.

The University of Arizona Office of Arid Lands Studies (2006) report that the specific traits make some plants more invasive than others. They report that many of these invasive plants grow quickly and have short life cycles; they go from seed to producing seeds very rapidly. Several are able to grow in a variety of habitats, produce large number of seeds, long seed dormancy and staggered germination and proficient seed dispersal. Some invasive plants are characterized by the ability to reproduce sexually by seeds or asexually by sending out above ground or below ground stolons and rhizomes or by growing new plants from cuttings. If the invasive weeds reproduce sexually, they are able to effectively use insects, birds, bats or other pollinators in the new environment. These plants often provide shade, which prevent the growth of native plants. Some plants may even benefit from allelopathy and release a chemical in the soil that prohibits the growth of native plants.

The Bahamas, in an attempt to address the problem of invasive plant species, ratified the United Nations Convention on Biological Diversity in 2004. Through the efforts of the Bahamas Environmental Science and Technology (BEST) Commission, a National Biodiversity Strategy and Action Plan and National Invasive Species Strategy were developed for The Bahamas. A committee on Biodiversity was formed. In addition, The Commonwealth of The Bahamas Biodiversity Clearing-House Mechanism website was launched shortly afterward in 2005 to disseminate information nationally. The Bahamas implementation of the United Nations Convention on Biodiversity is ongoing with full implementation expected by 2010 (The Commonwealth of The Bahamas Biodiversity Clearing-House Mechanism Website 2005).

Educating the public about the impact of invasive plant species is essential if controlling or eradicating them is to be successful. The Bahamas National Trust, Nature Conservancy, Bahamas Reef Environment Education Foundation (BREEF), Friends of the Environment, the Ministries of Tourism and Education and several other environmental organizations were among the leaders in educating the public on invasive plant species. A new Ministry of the Environment should be able to network with other government and non-government agencies to devise a strategy to educate the Bahamian masses about the issues of invasive plants.

The Bahamas Government leadership has also been essential to the control and eradication effort. In addition to adoption of international conventions and agreements, the establishment of the Ministry of Environment was a positive indication of a serious commitment to environmental issues. Additionally, the government supported the million tree planting program whose goal it is to plant one million native trees by December 31, 2009. This is evidence of the government's commitment to eradicate, where possible, and control invasive plant species in the Bahamas (Campbell 2009). Also, the Government's program to stem coastal erosion by removing invasive species and replacing them with native species is another indication of its commitment to eradicate invasive species from the Bahamas (Gilbert 2009).

This writer's intention is not to call attention to the government's initiatives but rather to provide an overview of its role in providing the national leadership to ensure that this program is successful. It is also important to know that while the government agencies are essential for providing the framework for the invasive species policy, it will take Bahamians and residents to help to make a real difference to fight this "war of invasion" that is threatening it's land and aquatic environments.

The initial thrust was to develop a national invasive strategy as the impetus for beginning the work to rid The Bahamas of the noxious weeds. A reference list is available as a result of extensive work by the Bahamas Environment Science and Technology (BEST) Commission. Additionally, scattered information is available on a few species. This is a first attempt to compile the local information along with that of the international researchers to effectively manage invasive plants in The Bahamas. In addition, the information contained in this booklet will serve to educate the general public and individuals, who are key stakeholders in helping with the management process, about invasive plant species in the Bahamas. It is designed with pictures and illustrations to help local residents easily identify the various species in an effort to spur active involvement in the control and eradication efforts. The booklet, further, highlights invasive plants in three categories: species recommended for eradication, species recommended for control (BEST Commission 2003) and other potentially invasive plants.

SECTION I: Invasive Plant Species Recommended for Eradication

Eradication of non-native, invasive plants is a very expensive undertaking; however, volunteer programs by citizens can help to speed up the complete removal of these species. The general public may begin by removing invasive plants from their property (BEST Commission 2003). Additionally, local area groups could be formed to assist with eradication programs within a specific locale. It is useful to employ methods that have served to successfully control invasive plants locally. However, some useful methods of control are pulling weeds when soil is wet; removing annuals and applying biodegradable herbicides during dry weather to maximize efforts. In addition, monitoring personal gardens and property nearby to detect early invasion or return of invasive species is critical to the eradication program (Simberloff 2003). Also, individuals should become involved in educational programs that will assist with physical identification of species recommended for eradication. The Bahamas Environment Science and Technology (BEST) commission has singled out five species recommended for eradication including: *Casuarina glauca* (Suckering Australian Pine), *Colubrina asiatica* (Leatherleaf), *Melaleuca quinquenervia* (Paper Bark), *Scaevola taccada* (Asian Scaevola), *Schinus terebinthfolius* (Brazilian Pepper), *Jasminum fluminense* (Azores jasmine) and *Mucuna pruriens* (Monkey Tamarind). The BEST Commission (2003) also stated that this list is fluid and may change as more information becomes available.

1.1Trees and Shrubs

Casuarina glauca
Common Name: Suckering Australian pine
Beefwood family: Casuarinaceae
Origin: Australia


Identifying Characteristics

Casuarina glauca is an evergreen tree that grows to a height of 20 meters (70 feet). It resembles the conifers with branches having green pine like needles that are jointed, long, thin and sometimes waxy. The leaves are in tiny whorls of 10 to 17, found at the joint of branchlets. Flowers are red and unisexual and bloom between April and September. Male flowers are found in small axillary clusters and females are found in small terminal spikes. Casuarinas have tiny, one seeded, winged nutlets or samaras in woody, subglobose, cone like clusters or fruiting heads (Correll and Correll 1982; Kaufman and Kaufman 2007; Langeland and Burks 1998).

Habitat

Casuarina is found only occasionally on islands of The Bahamas along the coast and inland areas, favoring sandy soil. *Casuarina glauca* is salt tolerant and is most prevalent in Andros, Berry Islands, Cat Cay, and surrounding cays (Correll and Correll 1982).

Migration Patterns

This plant produces an abundance of light, flat seeds that are easily spread by the wind. In addition, it reproduces rapidly from suckers from extensively spreading roots (Langeland and Burks 1998).

Use

Suckering Australian pine was first introduced in the Bahamas during the 1920's as an ornamental plant and is still seen in some gardens as hedges. Additionally, they are planted along roadsides as shade trees. They are also often used as firewood, for wood carving and furniture making. In some areas of the world it is used as lumber (Kaufman and Kaufman 2007).

Impact

This aggressive *Casuarina* species can take over the landscape and replace native plants. Suckering Australian pine spreads aggressively from extensively spreading roots, especially when pruned, resulting in dense stands of forests. It is extremely destructive to native plant communities as it completely takes over areas, replacing native vegetation (Langeland et al. 2008). Pollen from the flower is said to cause allergic reaction in humans (Kaufman and Kaufman 2007).

Management

Efforts to eradicate Suckering Australian pine must begin with education. In addition, preventative measures must be put in place to prevent the import of this species. For small stands, practical ways of eradication is manual removal. Young saplings should be pulled and discarded or cut until the root system is exhausted. For the larger, more extensive stands a combination of cutting and systemic herbicide application is most effective. Another effective method is to employ basal bark treatment. The tree can also be hatched and sprayed, then injected with herbicide. Burning new seedlings is also effective (Kaufman and Kaufman 2007; Langeland and Burks 1998).

Colubrina asiatica
Common Name: Leatherleaf
Buckthorn Family: Rhamnaceae
Origin: Tropical Asia

A http://commons.wikimedia.org/wiki/File:Starr_061108-9754_Colubrina_asiatica.jpg

B http://www.invasive.org/gist/photosc-f.html

Identifying Characteristics

Leatherleaf is a low shrub with climbing branches which can grow to a length of 30 ft. (9 m). Leaves are alternate, thin, shiny green, egg-shaped and long pointed. Flowers are small greenish

and bloom in clusters. Seeds are in green capsules and are small, grey then turning brown at maturity (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

Leatherleaf is found in coastal thickets on both sandy and rocky shores. It is now established in The Bahamas, Florida and the Caribbean (Correll and Correll 1982).

Migration Pattern

It is spread vegetatively by trailing stems. Climbing vines may fall back and produce roots, producing new vines. Seeds survive in soils for 3 to 5 years (Kaufman and Kaufman 2007).

Use

It is used as a ornamental plant in gardens and has escaped cultivation.

Impact

It has a sprawling habit, forming a thick mat of stems on native plants, preventing light penetration, impeding germination of plants, thus threatening native species (Kaufman and Kaufman 2007).

Management

Leatherleaf is controlled using basal bark treatment or is cut to stump and controlled by applying the herbicide triclopyr. Also, spraying glyphosate on leaves can kill the plant (Kaufman and Kaufman 2007).

Melaleuca quinquenervia
Common Name: Melaleuca, paper bark
Myrtle family: Myrtaceae
Origin: Australia, New Guinea, Solomon Islands

C
ier/imagepages/singles/starr_031108_0008_melaleuca_quinquenervia.htm

D
http://commons.wikimedia.org/wiki/File:Melaleuca_quinquenervia_(leaves).JPG

E
http://www.calflora.net/losangelesarboretum/whatsbloomi

Identifying Characteristics

This fast growing evergreen tree can reach a height of 80 feet (24 m). Its most distinctive characteristic is its whitish, multi-layered peeling bark. Leaves are short-stalked, narrow elliptic. The bottlebrush-like-spike clusters flowers are small and white with many stamens. Fruits are short, woody cylindrical capsules with many seeds (Correll and Correll 1982; Kaufman and Kaufman 2007; Mazzotti et al. 2009).

Habitat

Melaleuca grows best in wetland areas like mangrove swamps (Kaufman and Kaufman 2007). It also favors open rock flats near ponds and in scrubland. It is found on most islands of The Bahamas archipelago including Exuma, Rose Island, Cat Island, Andros, Berry Islands, Eleuthera, Harbour Island, St. Georges Cay, Paradise Island, New Providence, Andros, Bimini, Cat Cay, Abaco, Grand Bahama and surrounding cays (Correll and Correll 1982).

Migration Patterns

This aggressive, fast growing plant is propagated by seeds that are dispersed by wind and water (Kaufman and Kaufman 2007).

Use

Used extensively as an ornamental plant in gardens throughout the Bahamas, it is also used as mulch and pulpwood in Florida (Kaufman and Kaufman 2007).

Impact

Due to its fast growth, it takes over vast areas of land, invading wetlands and terrestrial areas. It prevents native species from being established by forming a dense canopy, and preventing light from penetrating. Melaleuca can change the ecology of marshes and swamps by establishing itself as the dominant tree species. Trees are adapted to fire, and threfore very hot crown fires can result. The nectar is used by honey bees. The pollen causes allergic reaction in some people (Kaufman and Kaufman 2007; Mazzotti et al. 2009).

Management

Seedlings can be pulled and disposed of properly to prevent regrowth. Large trees are usually cut or girdled and treated with the herbicide imazapyr. Biological control methods are also employed using melaleuca snout beetle or melaleuca weevil (*Oxyops vitiosa*) and melaleuca psyllid (*Boreioglycaspis melaleucae)* (Kaufman and Kaufman 2007).

Scaevola taccada
Common Names: Asian Scaevola, White Inkberry, Hawaiian Seagrape
Goodenia family: Goodeniaceae
Origin: Indian and Pacific Region
Can be confused with the native species (*Scaevola plumieir)* but leaves of the native species are not as glossy as those of *Scaevola taccada* and the fruit of *Scaevola plumieri* is black.



Identifying Characteristics

Asian Scaevola is a rounded, erect, bushy shrub that grows to 16 feet (4.8 m). Leaves are simple, evergreen glossy and thick with alternate arrangement. They are also oblong – obovate and broadly rounded at the apex. Flowers are in clusters of 2-4 and white to pinkish, flowering year round, with five petals that are arranged in a semicircle when mature. The fruit is fleshy and round, first green, then white (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

This plant thrives in sandy areas such as dunes, as well as rocks along the beach and coast (Kaufman and Kaufman 2007). It is found throughout the islands of The Bahamas, especially on Andros, Bimini, Cat Cay, Abaco, Grand Bahama and surrounding cays (Correll and Correll 1982).

Migration Pattern

New plants get established easily because the fruits of *Scaevola taccada* are eaten by pigeon and sea birds. Additionally, fruits drop into the water and float to new locations (Kaufman and Kaufman 2007).

Use

This is used as an ornamental plant by many coastal developments such as hotels, condominiums, other residential developments and as hedging by local residents (Kaufman and Kaufman 2007).

Impact

Asian Scaevola forms dense thickets along the coast and in garden areas, out-competing the native species that are better at controlling erosions. They also cover sand dunes, which threatens the habitat of plant species and other animal species like the sea turtles that use them for laying eggs (Kaufman and Kaufman 2007).

Management

Plants can be hand pulled, but one must be careful to pull all underground stems to prevent them from sprouting again. Another effective method is to cut the stems and then paint them with the herbicide triclopyr (Kaufman and Kaufman 2007).

Schinus terebinthifolius
Common Names: Brazilian Pepper, Bahamian Holly
Sumac family: Anacardiaceae
Origin: Argentina, Paraguay & Brazil



Identifying Characteristics

Brazilian Pepper spreads along the ground or grows as a shrub to about 30 feet (9 m) with arching branches. The leaves are dark green, alternate on stems, with about 3 to 12 toothed leaflets. Flowers are white and unisexual, with 5-petaled clusters. Fruits are the most distinguishing characteristic and are like round peppercorns; they begin green then turn bright red (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

Cultivated in gardens but escaped and inhabits both terrestrial (thickets and waste lands) and wetlands (Kaufman and Kaufman 2007). The plant is found on most of the islands and cays of The Bahamas with extensive stands in North Andros, New Providence, Long Island, Rum Cay, San Salvador, Exuma, Abaco, Bimini and Grand Bahama (Correll and Correll 1982).

Migration Patterns

Some birds feed on the fruit of the Brazilian Pepper and spread the seeds (Kaufman and Kaufman 2007). Many seeds also drop near standing trees and new plants grow. In addition, new plants are grown from cuttings.

Use

The Brazilian Pepper is used mainly as an ornamental plant (Kaufman and Kaufman 2007) as well as for decorating by some individuals.

Impact

This plant escapes and competes very aggressively with native plant species. It forms very dense stands, casting very heavy shade, which hampers the growth of native plants. It also produces a chemical that also stops the growth of native plants. The sap contains alkenyl phenols, chemicals that cause skin irritation in humans. It is reported that persons in proximity experience sneezing, burning eyes, and headache. Brazilian Pepper also produces nectar that is a rich source of honey (Kaufman and Kaufman 2007).

Management

A most effective method is to kill seedlings during the growing season with herbicide containing Hexazinone or picloram plus 2, 4-D. Fire is also used to prevent germination. A most practical method is to remove large stands using bulldozers, front-end loaders and other heavy equipment. The stumps and roots are then treated with herbicides. Single or scattered trees should be cut and painted with herbicides. The leaves of the Brazilian Pepper could also be sprayed with synthetic herbicide containing Triclopyr, Glyphosate, Hexazinone or imazapyr (Kaufman and Kaufman 2007).

1.2 Vines

Jasminum fluminense
Common Names: Azores jasmine, Brazilian jasmine
Olive Family: Oleaceae
Origin: Tropical Africa


Identifying Characteristics

This vine is an evergreen, climbing woody vine. Young stems are densely hairy and mature stems are glabrous. Leaves are opposite, compound, with 3 oblong leaflets. Fruits are fleshy,

black 2-lobed rounded berries. Flowers are white, tubular, and fragrant at night (Correll and Correll 1982; Langeland et al. 2008).

Habitat

Brazilian jasmine is found over vegetation in thickets, in hedgerows and in shady waste places. It is established in most of the Bahamas archipelago and naturalized in the tropical and subtropical regions of the world (Corell and Correll 1982).

Migration Pattern

Fruits are eaten and dispersed by birds and raccoon (Langeland et al. 2008).

Use

Brazilian jasmine is cultivated as an ornamental vine for hedges in gardens. Brazilian jasmine is considered to be an important plant in the Bahamian garden, but is categorized as a weed because of the invasive nature of the plant.

Impact

This vine climbs trees, completely covering the canopy, blocking sunlight to plants below and reducing native plant diversity (Langeland et al. 2008).

Management

Brazilian jasmine can be controlled by hand pulling or by cutting older vines to ground level. Cutting and treating stem with the herbicide triclopyr is effective (Kaufman and Kaufman 2007). If it is cultivated then care must be taken to prevent the plant escaping.

Mucuna pruriens
Common Name: Monkey Tamarind
Legume family: Fabaceae
Origin: India



Identifying Characteristics

Monkey Tamarind is a tropical climbing vine that can reach a length of 5 feet (15 m). Leaves are arranged alternately with three large rhomboid-ovate leaflets. The flowers are white to dark purple and several or many, found in long clusters. The pods are coriaceous, containing seeds are and are arranged in clusters covered with a reddish-brown hair (Correll and Correll 1982).

Habitat

These plants grow wild throughout The Bahamas in disturbed areas, open grassy soil on the edge of coppice forest and, on fences. They are more prevalent between April and September (Correll and Correll 1982; Oudhia 2001). It is common in the Berry Islands, Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Paradise Island and New Providence as well as southern Florida, and the Caribbean and other tropical regions of the world (Correll and Correll 1982).

Migration Pattern

Propagation is by seeds. Usually, the pods split open and seeds dropped and new plants grow (Oudhia 2001).

Use

The roots, leaves, pods and beans are used in the preparation of herbal medicines (Oudhia 2001).

Impact

The reddish-brown hair on the pods causes intense itching if it touches the skin. Monkey Tamarind also forms wood thickets and smother underlying vegetation (Oudhia 2001).

Management

Mucuna pruriens is highly resistant to insect pests because of toxic compounds found in the plant; therefore biological control by insect prey and other organisms are not likely to occur. However, physical removal of the plant by pulling seedlings until exhausted (Langeland and Stoker 2001) is the most effective means of controlling this plant.

SECTION II: Invasive Plant Species Recommended for Control

Some species of plants may have extensive stands in The Bahamas and would require major financial resources to completely eradicate them. In some cases small islands and cays in the archipelago can be completely eradicated of invasive plant species as was successfully done in Bermuda (Mack and Lonsdale 2002). However, this may not be possible for all islands; therefore, control measures must be put in place to keep invasive species at the lowest acceptable level (BEST Commission 2003). General management practices that may aid in the control of species include:

- Education and prevention strategies
- Enactment and enforcement of laws to ban imports
- Enforcement of the national policy on invasive species

The species recommended for control by the BEST Commission are *Albizia lebbeck* (Woman's Tongue), *Bauhinia variegata* (Poor Man's Orchid), *Casuarina equisetifolia* (Casuarina, Australian pine, Beefwood), *Delonix regia* (Poinciana), *Ficus benghalensis* (Banyan fig), *Haematoxylon campechianum* (Logwood), *Leucaena leucocephala* (Jumbey), *Pimenta racemosa* (Bay Rum), *Terminalia catappa* (Almond Tree), *Ricinus communis* (Castor Bean), *Spathodea campanulata* (African Tulip Tree, Flame of the Forest), *Schefflera actinophylla* (Schefflera, Queensland Umbrella Tree), *Antigonon leptopus* (Coral Vine), *Ipomoea purpurea* (Morning Glory), *Wedelia trilobata* (Wedelia, Carpet daisy) and *Eichorina crassipes* (Water Hyacinth).

2.1 Trees and Shrub

Albizia lebbeck
Common Name: Woman's Tongue
Pea family: Fabaceae
Origin: Tropical Asia, Africa



Identifying Characteristics

Woman's tongue is a deciduous tree that grows to about 65 feet (20 m) high. It has a rounded spreading crown and pale bark. The leaves are alternate, bipinnate with 2 to 5 pinnae and each pinna having 3 to 5 leaflets. Flowers are fragrant, in snowy rounded clusters at stem tip. They are cream to yellowish white and have many long, yellow stamens. The fruit is a flat, linear pod with many seeds. It is green when young, turning brown when mature (Langeland and Burks 1998).

Habitat

This plant grows best in saline and alkaline soils (Langeland and Burks 1998). It is found primarily on Long Island, Ragged Island, New Providence, Eleuthera, Harbour Island, St. Georges Cay, Paradise Island, Cat Cay and Berry Islands and is widespread throughout all tropical regions of the world (Correll and Correll 1982).

Migration Pattern

Woman's tongue produces a massive amount of seeds. Seeds are dispersed mainly by wind.

Use

Woman's tongue is cultivated as an ornamental plant, but easily escapes cultivation due to dispersal patterns.

Impact

This is a very fast growing plant that invades disturbed areas (area where native vegetation is removed because of farming or other use) throughout The Bahamas. It is a threat to all natural coppice forest species as well as pine forests (Langeland and Burks 1998).

Management

Trees should be cut and the stumps treated with herbicides. Root sprouts should also be treated with herbicides (Langeland and Stocker 2009).

Bauhinia variegata
Common Name: Poor Man's Orchid
Pea family: Fabaceae
Origin: Eastern Asia (India, China)



Identifying Characteristics

This tree is semi-deciduous and grows to 50 feet (15 m), with a spreading crown. Leaves are alternate, long petioled, and thin-leathery. Flowers are in clusters, showy, fragrant, pale lavender, indigo and white. The fruit is a flat, long, oblong pod with few seeds (Langeland and Burks 1998; Correll and Correll 1982).

Habitat

Poor Man's Orchid grows best in full sun or partial shade and can tolerate a wide range of well drained soils but is most suited to acidic soils (Langeland and Burks 1998). It is found in disturbed areas, principally on Berry islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, New Providence, Paradise Island, Rose Island, Abaco, Grand Bahama and the surrounding cays (Correll and Correll 1982).

Migration Patterns

Bauhinia variegata is easy to propagate from seeds distributed naturally and by wind The plant also grows easily from suckers (Langeland and Burks 1998).

Use

This plant is used as an ornamental plant but has escaped into natural coppice forest and is naturalized (Langeland and Burks 1998).

Impact

Poor Man's Orchid is a very fast growing plant that invades disturbed areas at the edge of natural areas. It forms thickets in open coppice forests and along roadsides. It is difficult to manage because its seeds could remain viable for more than a year (Langland and Burks 1998; Correll and Correll 2008).

Management

Individual trees should be cut and basal bark treatment applied to the tree stump (Langeland and Stocker 2009). It can also be eliminated by controlled burning.

Casuarina equisetifolia
Common Name: Australian Pine, Beefwood
Casuarina family: Casuarinaceae
Origin: Australia



Identifying Characteristics

Australian pine is an evergreen tree that resembles conifers and grows to about 150 feet (42 m). It has a single trunk with an irregular crown. The bark is reddish brown to gray, rough, brittle and peeling. The leaves are minute, on grayish green branchlets that are jointed and thin. The

flower is unisexual, inconspicuous, and brown. Fruit is cone-like, with one winged nutlet-like seeds (Kaufman and Kaufman 2007; Langeland and Burks 1998).

Habitat

This plant is the most salt tolerant of all casuarinas, and found along the shoreline and roadsides throughout The Bahamas (Correll and Correll 1982). However, it is also found in mangroves and wet land areas. It is established extensively throughout The Bahamas and is widespread throughout the tropics and subtropics (Correll and Correll 1982).

Migration Patterns

Australian pine produces a large number of seeds; as many as 300,000 seeds make up a pound. Several thousand can be produced by one tree. Casuarina reproduces by seeds that are dispersed by wind (Langeland and Burks 1998)

Use

Casuarina is cultivated as an ornamental plant and used as fire wood. It is also used in carving and furniture making. In some countries it is used for lumber (Langeland and Burks 1998).

Impact

Casuarina is a very fast growing tree and is naturalized in The Bahamas. It invades the entire shoreline, taking over sand dunes and displacing native plant species. Its shallow root system allows it to tumble over easily with strong winds and during hurricanes. This tree accelerates beach erosion and beach loss and disrupts the nesting areas of sea turtles (Kaufman and Kaufman 2007; Langeland and Burks 1998).

Management

For small stands, practical ways of eradication is manual removal. Young saplings should be pulled and discarded or cut until the root system is exhausted. For the larger, more extensive stands a combination of cutting and systemic herbicide application is most effective. The tree can also be hatched and squirted, then injected with herbicide. Burning new seedlings is also effective (Kaufman and Kaufman 2007; Langeland and Burks 1998).

Delonix regia
Common Name: Poinciana
Bean family: Fabaceae (Leguminosae)
Origin: Madagascar



Identifying Characteristics

Poinciana is a deciduous tree that reaches 30 to 40 feet (9.1 – 12. 2 m) in height. Its spreading depressed crown is about 40 to 60 feet wide, with exuberant red and orange flowers. Each flower is large and showy with 5 spoon-shaped petals, one slightly larger than the others, and 10 stamens that are shorter than the petals. Leaves are lacy, green, oblong, fernlike and twice pinnate (bipinnate); each is divided into 10 to 20 leaflets (pinules). Fruits are pods, green then dark brown, flat and woody, with many seeds (Gilman and Watson 1999; Correll and Correll 1982).

Habitat

Poinciana tolerates a wide range of soil types and is also drought tolerant. It grows best in full sun and is found on most inhabited islands and cays in The Bahamas. It is primarily found on Great and Little Exuma and Cays, Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, Paradise Island, New Providence and Rose Island and the surrounding cays and throughout most tropical regions of the world (Correll and Correll 1982).

Migration Patterns

This beautiful tree grows easily from semi-ripe tip cuttings and seeds that sprout beneath Poinciana trees (Gilman and Watson 1993).

Use

Poinciana is an ornamental tree that is cultivated in many home gardens as well as public parks and along main streets (Gilman and Watson 1993). A major thoroughfare on the island of New Providence bears the name of the Poinciana tree. The flower is also used in decorations for special celebrations.

Impact

Poinciana has a shallow root system that is visible above ground. It threatens buildings and sidewalks and does not tolerate understory vegetation. The woody pods produce many seeds. The pods also drop and break open, producing many seedlings under the tree (Gilman and Watson 1993). It easily escapes cultivation and is found in coppice forests throughout the Bahamas.

Management

Poinciana is developed by pruning. Controlling the population may involve cutting down trees, peeling the trunk and painting it with herbicide. In order to prevent damage to sidewalks and buildings, it is recommended that trees be planted 10 feet or more away from these structures. The tree is also susceptible to root fungus (Gilman and Watson 1993).

Ficus benghalensis
Common Name: Banyan tree
Mulberry family: Moraceae
Origin: India



Identifying Characteristics

This very large, fast growing, evergreen tree grows to about 90 ft. (30 m). It has spreading branches and aerial roots. The leaves are stalked and ovate-cordate. Fruits are round, downy, in axillary pairs, and about the size of cherry (Oudhia 2004).

Habitat

The Banyan tree grows best in monsoon areas of India and is drought resistant (Oudhia 2004). In The Bahamas it is cultivated but occasionally escapes to coppice forest areas and is found on New Providence, Andros, Eleuthera, San Salvador and several other islands.

Migration Patterns

Propagation is by seeds, transplanting of young trees or stem cuttings (Oudhia 2004).

Use

The bark, leaves, root-fibers, and milky juice (latex) are used in the preparation of traditional medicines. The tree is also planted for soil conservation, timber and pulp paper. The leaf is used in the preparation of fodder (Oudhia 2004).

Impact

The root system can damage buildings and sidewalks. In addition, invasion is by epiphyte on trees and epilithic on rocks and stones (Oudhia 2004).

Management

An effective treatment is with basal bark (herbicide is applied to the lower 12-15 inches of the entire bark). However, care should be taken when applying herbicides to epiphytes because some native plants are killed in the process (Langeland and Stocker 2009).

Haematoxylon campechianum
Common Name: Logwood
Pea family: Fabaceae
Origin: Central America (Mexico

F http://www.plantes-otanique.org/src/galeries/gua08/haematoxylon_campechianum_02.j

G *http://www.plantes-*

H http://caliban.mpiz-

Identifying Characteristics

Logwood is a small gnarled tree or shrub with a short and crooked trunk (Correll and Correll 1982) that grows to a height of 30 to 50 feet (9-15 m) (Encyclopedia Britannica, 2009). Leaves are alternate, evenly pinnate, with oval leaflets. Flowers are fragrant, with 5 small yellow petals

and 5 purplish-red sepals and 10 stamens. The pod is flat, with two seeds (Correll and Correll 1982).

Habitat

This tree grows in disturbed areas along hillsides, edge of marches, lakes or salt ponds and flooded places. Logwood is widely distributed on almost all islands and cays of the Bahamas except Inagua, Abaco, Grand Bahama and surrounding cays. It is also established in Central America and the Caribbean (Correll and Correll 1982).

Migration Patterns

It is propagated from seeds.

Use

The heartwood is used in the making of dyes and the bark is used in the preparation of traditional medicines.

Impact

These trees form coastal thickets (Correll and Correll 1982) replacing natural vegetation. It can also invade other natural areas as well.

Management

No known management practices are associated with this plant species. However, cutting the tree and employing basal bark treatment or herbicide may prove effective.

Leucaena leucocephala
Common Name: Jumbey
Pea Family: Fabaceae
Origin: Mexico and Central America



Identifying Characteristics

Jumbey is a small to medium sized tree or shrub that reaches a height of 26 feet (8 m). Leaves are alternate, evenly bipinnate, with each blade having 4 to 9 pinna. There are many leaflets, 11 to 17 per pinna, that are pointed or oblong. Flowers are creamy-white, in small round clusters, with 5 petals, 10 stamens, and hairy anthers. The Jumbey is self fertilized. The pods may be several or many, and are flat, with 18 to 25 glossy brown seeds (Kaufman and Kaufman 2007; Correll and Correll 1982).

Habitat

This plant is found in coppices, waste land, and disturbed areas, as well as along the coast. It favors moist soil and full sun (Kaufman and Kaufman 2007; Correll and Correll 1982). Jumbey is common throughout the Bahamas from Grand Bahama in the north to Inagua in the south. This plant is also established in Florida, Bermuda, and throughout the Caribbean and continental tropical regions and the Old World tropics (Correll and Correll 1982).

Migration Pattern

Jumbey is propagated by seeds that are dispersed by people and wind (Kaufman and Kaufman 2007).

Use

Jumbey is used as feed for goats and sheep but becomes a laxative when eaten in large quantities. The leaves are brewed as a tea to strengthen the heart and for treatment of stress. In South Asia and Africa it is manufactured for charcoal (Kaufman and Kaufman 2007). In The Bahamas, this tree has medicinal value as it is used to treat gastric pains termed “wind in the stomach”, nervousness and heart trouble.

Impact

This tree grows rapidly in disturbed areas, and along the coast, forming dense thickets and replacing native plant species (Kaufman and Kaufman 2007).

Management

Jumbey is very difficult to manage because it re-sprouts rapidly after cutting and seeds can remain viable in the soil for 10 to 20 years. Browsing by goats will kill plants. In addition, herbicides triclopyr is sprayed on foliage or painted on stumps to kill plants (Kaufman and Kaufman 2007).

Pimenta racemosa
Common Name: Bay Rum
Myrtle family: Myrtaceae

Origin: Caribbean Islands

I *Killer Plants http://www.killerplants.com/plant-of-the-*

J www.np-d.com/images/Pimenta%20racemosa.jpg

Identifying Characteristics

Trees grow to a height of 13 to 39 feet (4 to12 m). Leaves are shiny above and dull below and obovate to oblanceolate or elliptic. Flowers are white and fruits ovoid and black at maturity (Moore 2009).

Habitat

Bay Rum grows best in full sun in moist areas (Moore 2009).

Migration Patterns

Seeds are spread by birds that feed on them (Moore 2009).

Use

Bay rum is cultivated as an ornamental plant in gardens. The oils are extracted from the leaves and used in traditional medicine (Moore 2009).

Impact

Bay rum can become naturalized and replace native species of plants (Moore 2009).

Management

There are no known management practices for this plant. However, pulling seedlings, cutting mature trees and applying herbicides may be effective in controlling this species.

Ricinus communis
Common Name: Castor Bean
Spurge family: Euphorbiaceae
Origin: Tropical Africa



Identifying Characteristics

Castor bean is a course, glabrous annual or short-lived perennial that appears to be a tree or shrub; it reaches 3 to16.4 feet (1-5 m) (Correll and Correll 1982). The young plant is herbaceous and the mature plant is somewhat woody. Bark is light brown and smooth, with rings at nodes (Francis 2009). Leaves are star-shaped, alternate, with deeply serrate palmate lobes. Flowers are in large inflorescences, and have 5 sepals. The fruit is 3-celled, rough and spherical, with ellipsoid seeds that look like ticks (Correll and Correll 1982).

Habitat

Castor beans are cultivated, but escape to disturbed areas such as abandoned farms and overgrown lots. Castor bean is found throughout The Bahamas. In Addition, it is found throughout Central and South America, the Caribbean and in other warmer regions of the world (Correll and Correll 1982).

Migration Patterns

Propagated from seeds that fall out of dried fruits or gets hooked into animal fur and dispersed (Francis 2009).

Use

The leaves are used in traditional medicines for headaches, colds and heat rashes. It is also used as an ornamental plant (Francis, 2009). The seeds are a source of castor oil that was used as machine oil and a purgative (Correll and Correll 1982). In The Bahamas it is used to treat menstrual troubles.

Impact

Castor beans invade disturbed areas and crowd out natural plants. The seeds are highly poisonous, producing a chemical, ricin, which can cause skin irritation as well as death. Pests and diseases are also associated with these plants (Francis 2009).

Management

Basal bark herbicide application is an effective treatment for each stage of the plant's development. Also, cutting the stump and treating it with the herbicide garlon 4 is effective. Pulled seedlings are treated with the herbicide Roundup (Langeland and Stocker 2009).

Schefflera actinophylla
Common Names: Schefflera, Queensland Umbrella Tree
Aralia family: Araliaceae
Origin: Australia, New Guinea and Java



Identifying Characteristic

Umbrella tree in an evergreen tree with single or multi-stemmed trunk and greenish bark (Langeland et al. 2008). Schefflera grows indoors and outdoors. Outdoors, it can grow up to 40 ft. (12 m) high. The leaves are evergreen, alternate, palm-like, and made up of 7-16 leaflets, that branch out like spokes of umbrella from the leaf stalk. Flowers are in long, dense, deep red whorls that spread out above the foliage. Fruits are round and dark purple (Kaufman and Kaufman 2007).

Habitat

Schefflera is found in a variety of habitats including coppice forest, dunes, and disturbed woodland areas. Schefflera has spread to several islands of the Bahamas but is found more extensively on Andros, Grand Bahama Island, Bimini, New Providence, Eleuthera and Abaco. Kaufman and Kaufman (2007) reported it to be naturalized in South Florida.

Migration Patterns

Seeds germinate in the soil or on other plants (cabbage palm) or rock and survive until roots reach ground. Fruits are eaten by birds and seeds are spread to new locations (Kaufman and Kaufman 2007). Careless disposal of cuttings into undeveloped property and forest areas is also contributing to the spread of this tree.

Impact

This plant escapes into forest and other natural areas and form dense thickets that shade out native plants, preventing them from being established (Gillman and Watson 1994). It is becoming a common weed in several of the islands of The Bahamas.

Use

Schefflera is used in landscapes as ornamental plants as well as house-plants (Gillman and Watson 1994). Several varieties are now common in the in the archipelago.

Management

One effective management strategy is to hand pull seedlings and saplings. Another is to cut large trees and treat stumps with Glyphosate and triclopyr herbicides. Mixing triclopyr with oil and applying it at base of tree will also kill the tree (Langeland and Stocker 2009).

Spathodea campanulata
Common Names: African TulipTree, Flame of the Forest
Family: Bignoniaceae
Origin: Tropical Africa

K
http://www.nybg.org/bsci/belize/Spathodea_campanulata_1.jpg

Identifying Characteristics

The African tulip tree is a large upright tree that grows to about 50 to 60 feet (15 – 18 m). Crown spreads 35 to 50 feet (10.7 – 15 m). Leaves are evergreen, pinnately compound, with elliptic (oval) or oblong leaflets. Flowers are showy and orange to yellow. Fruits are elongated, brown pods (Gillman and Watson 1994).

Habitat

Flame of the forest likes full sun and well-drained soil (Gillman and Watson 1994) which makes it suited to The Bahamas climatic conditions. It is found on several islands of the archipelago including Andros, Grand Bahama, New Providence and Eleuthera.

Migration Patterns

Propagation is by seeds, softwood cuttings, or root suckers (Gillman and Watson 1994).

Use

Flame of the forest is cultivated as a landscaping shade tree in gardens and along road-sides and parks (Gillman and Watson 1994). In the Bahamas it is also cultivated because of its colorful bloom.

Impact

African tulip tree has a shallow root system that can lift sidewalks and interfere with mowing.

It can produce significant litter during windy periods (Gillman and Watson 1994).

Management

African tulip tree's growth is controlled by periodic thinning (removing some plants) (Gillman and Watson 1994).

Terminalia catappa
Common Name: Almond Tree
Combretum family: Combretaceae
Origin: Tropical and subtropical India and Pacific

Identifying Characteristics

The almond tree is a deciduous tree that reaches a height of 35 to 55 feet (10.7 – 16. 8 m) with a spreading vase shape crown that flattens at the top. Leaves are glossy green, and leathery, turning red, yellow and purple before they drop. They are alternate and clustered at the end of twigs. Flowers are in terminal clusters, inconspicuous, greenish-white, with no petals and 10 stamens. Fruits are called drupes, green at first, becoming yellow or red (Gilman and Watson 1994; Correll and Correll 1982).

Habitat

This tree prefers well drained soil, full sun and is wind, salt, and drought tolerant (Gilman and Watson 1994). It is established in coppice forests, and abandoned areas. Almond trees are widely distributed throughout The Bahamas, with only a few islands and cays without this plant species (Correll and Correll, 1982).

Migration Patterns

This plant is spreads by seeds. Each tree produces large numbers of fruits that are eaten by birds and humans who are also responsible for spreading the seeds (Gilman and Watson 1994).

Use

Both the fruit and seed are eaten. In the Philippines it is used to make wine. It is also cultivated as an ornamental tree and a shade tree in gardens. In some areas of the world it is used for timber (Gilman and Watson 1994). In the Bahamas it is also cultivated as shade trees near beaches.

Impact

Almond trees produce **a** significant amount of litter, leaves and fruit which require constant removal. Trees are fast growing and produce many new seedlings. There is potential of invading large areas along coast (Gilman and Watson 1994).

Management

Fruits contain tannic acid that stains cars and other commodities. The tree is difficult to manage because of multiple trunks, requiring regular maintenance because of fallen leaves and fruit. It also requires regular pruning because of its fast growth. Exposed surface root system can also be hazardous to humans, sidewalks and buildings (Gilman and Watson 1994).

2.2: Vines

Antigonon leptopus
Common Name: Coral Vine
Buckwheat Family: Polygonaceae
Origin: Mexico


Identifying Characteristics

This is a perennial fast growing, climbing vine, with a large rootstock forming underground tubular roots. It holds on to plants and other material via tendrils. It can grow to 25 ft or more in length. Leaves are alternate, ovate, heart shaped or triangular and soft. Flowers are pink to red and occasionally white (Center for Aquatic and Invasive Species 2007; Correll and Correll 1982).

Habitat

Coral vine grows in disturbed areas, in abandoned fields and along roadsides. Coral vines are found extensively in The Bahamas, except on the island of Inagua and a few southern cays. Additionally, it is naturalized in warm temperate and tropical regions of the world (Correll and Correll 1982).

Migration Patterns

This vine is a prolific seed producer. Seeds float on water and are dispersed. Seeds are also spread when fruits and seeds are eaten by birds, raccoons and pigs. If it is cut down, it re-sprouts from underground tubers.

Use

Cultivated in landscapes as an ornamental plant and grows well on hot walls (Center for Aquatic and Invasive Species 2007).

Impact

Coral vine has many reproductive and dispersal methods which make invasion easier. Vines cover entire plants, preventing light from getting to the understory and preventing growth of native plants. It also covers other structures such as walls and buildings (Center for Aquatic and Invasive Species 2007).

Management

One way to manage this vine is to limit planting. Additionally, remove existing plants, before seed production to assist with controlling it. When the vine is cut, remove underground tubers to prevent re-growth. Treat the area where the plant is removed with glyphosate or triclopyr herbicides (Center for Aquatic and Invasive Species 2007).

Ipomoea indica
Common Name: Morning Glory
Bindweed Family: (Convolvulaceae)
Origin: Mexico, Central America



Identifying Characteristics

Morning glory is a hairy stemmed, trailing, climbing vine. Leaves are heart shaped and flowers are purple, in clusters of 3 or more. Fruits are brown capsules, with 4-6 seeds that are dark brown or black, hairy and wedged shaped (Virginia Tech Plant Identification Guide 2009)

Habitat

This plant is found along roadsides, in disturbed areas, thickets or as an ornamental in landscape. It is prevalent throughout the islands of The Bahamas and can tolerate full sun and a variety of soil types (University of Michigan Plant diversity website 2009). It is found generally throughout The Bahamas and the tropical and subtropical regions of the world (Correll, and Correll 1982)

Migration Patterns

Propagation is by seeds that are dispersed by wind, rain, gravity, and human activity (University of Michigan Plant diversity website 2009).

Use

The flower, seeds, roots and stems are used in herbal medicine for treating various diseases (University of Michigan Plant diversity website 2009).

Impact

Morning glory produces large amounts of seeds that are easily germinated. It dominates the substrate, nutrients, water and sunlight of native plants making it difficult for these plants to survive. It also releases a chemical that is poisonous to native plants (University of Michigan Plant diversity website 2009).

Management

This plant is very widespread, making it difficult to eradicate and control. However, removing plants before seed production may be effective.

Wedelia trilobata
Common Name: Wedelia, Carpet daisy
Family: Asteraceae
Origin: Caribbean, Central America, Northern South America



Identifying Characteristics

Wedelia is a perennial, creeping herb that is mat forming, with stem often rooting at nodes. Leaves are evergreen, fleshy, simple, serrated and lobed. Flowers are bright yellow, and in dense heads. Fruits are elongated, brown, dry and hard (Gilman 1999; Correll and Correll 1982).

Habitat

Grows best in part shade and part sun and is water tolerant (Gilman 1999). Found growing in coastal thickets, scrubland and open rocky hill and along road sides. It is found extensively throughout most of The Bahamas archipelago and in the tropical and subtropical regions of the world (Correll and Correll 1982).

Migration Patterns

Carpet daisy is spread by un-rooted tip cuttings (Gilman 1999).

Use

The plant is used in landscaping, as groundcover and in hanging baskets (Gilman 1999).

Impact

Wedelia creates dense mat foliage those crowds out native plants, affecting their growth rate. It is a hard to control, creeping weed that spreads rapidly in wet areas (Gilman 1999).

Management

To control this plant, trim along edges of dense mats to prevent it from escaping. In addition, in areas where it has escaped remove it completely (Gilman 1999).

2.4 Aquatic Plants

Eichhorina crassipes
Common Name: Water Hyacinth
Water hyacinth family: Pontederiaceae
Origin: Brazil

L
http://www.mobot.org/gardinghelp/plantfinder/plant.asp?code=A621

M
http://botany.ccdl.tamu.edu/FLORA/imagepop.htm

Identifying Characteristics

Water hyacinth is a floating, aquatic plant that grows to about 3 ft (1 m) high, rooting at nodes. Leaves are thick, oval or rounded with dense veins curved inward. Flowers are 15 to 18 in large spikes, lavender to pinkish, with 6 pelals, the upper of which has yellow splotches bordered in blue. Fruits are 3 segmented, with reddish seeds (Kaufman and Kaufman 2007; Correll and Correll 1982).

Habitats

Water Hyacinth prefers still and shallow water (Kaufman and Kaufman 2007) and inhabits pond, ditches lakes and canals (Correll and Correll 1982).

Migration Pattern

This weed is transported by wind, water and accidently by boats and other means (Kaufman and Kaufman 2007).

Use

This plant is an ornamental but has escaped cultivation and is established in many shallow water areas (Kaufman and Kaufman 2007).

Impact

Water Hyacinth grows rapidly and covers entire water area, preventing native plants from germinating. It also reduces habitats for native fish and other aquatic animals and increases insect production such as mosquitoes. Dead plants use up oxygen needed by other aquatic life (Kaufman and Kaufman 2007).

Management

Small populations are controlled by hand pulling and dispose of unwanted or dead plants in dry places to prevent proliferation. Large populations are mechanically harvested using a swamp devil. Herbicide is effective but it kills native plants (Kaufman and Kaufman 2007).

Section III: Potentially Invasive Non-Native Plant Species

In addition to the plant species mentioned earlier, a number of other plants have made their home in The Bahama Islands. While they are not considered invasive species as yet, studies from Florida indicate that these plants can become invasive and threaten the native species on the islands. This is by no means an exhaustive list but includes the more prominent plants in this category. The list includes *Calliandra surinamensis* (Pink powderpuff), *Cestrum diurnum* (Day Jasmine), *Eugenia uniflora* (Surinam Cheery), *Lantana camara* (Lantana, Shrub verbena, angel lips, big sage, black sage, prickly lantana), *Moringa oleifera* (Horseradish tree), *Ruellia tuberosa* (Mexican petunia), *Senna alata* (Christmas senna), *Thespesia populnea* (Seaside mahoe, cork tree, Spanish cork), *Veitchia merrillii* (Christmas Palm), *Abrus precatorius* (Rosary pea), *Cissus sicyoides* (Princess Vine), *Dioscorea alata* (Winged yam), *Dioscorea bulbifera* (Air potato), *Passiflora quadrangularis* (Giant granadilla), *Syngonium podophyllum* (Arrow head vine), *Asparagus densiflorus* (Asparagus fern), *Nephrolepis multiflora* (Asian sword fern), *Imperata cylindrica* (Congo grass), *Neyraudia reynaudiana* (Silkreed, Burmareed, Cane grass), *Panicum maximum* (Guinea Grass), *Panicum repens* (Torpedo grass), *Pennisetum purpureum* (Napier grass) and *Sorghum halepense* (Johnson grass).

3.1 Trees and Shrubs

Calliandra surinamensis
Common Name: Pink Powderpuff
Bean Family: Leguminosae
Origin: North America


Identifying Characteristics

Pink powderpuff is a large, multi-branched, evergreen tree that grows to a height of 12 to 15 ft. (3.7 – 4.6 m). Leaves are bipinnately compound, arranged alternately, glossy metallic green and are oblong in shape. Flowers are fragrant pink-white and flower year round. The fruits are dry pods and are brown with 2 to 6 seeds (Correll and Correll 1982; Gilman and Watson 1993).

Habitat

This plant is propagated in gardens and in hedges along roadsides (edge of coppices). It grows best in part shade, part sun in well-drained soil. It is also drought resistant (Correll and Correll 1982; Gilman and Watson 1993). Pink powderpuff is generally found throughout The Bahamas and Cuba (Correll, and Correll 1982).

Migration Patterns

Pink powderpuff is a fast growing tree and is propagated from seed or cuttings (Gilman and Watson 1993).

Use

Powderpuff is used as an ornamental plant in gardens and as a hedge along roadsides because of its showy, fragrant flower (Correll and Correll 1982; Gilman and Watson 1993).

Impact

The planting of the tree along roadsides near coppice forest heightens its potential for escape. However, it is not considered a highly invasive plant species (Gilman and Watson 1993).

Management

This plant requires occasional pruning to become established. Once established it does not need much care. It is, however, infected by chewing insects such as mites and caterpillars (Gilman and Watson 1993).

Cestrum diurnum
Common Name: Day Jessamine
Nightshade Family: Solanaceae
Origin: Caribbean



N

www.kingsnake.com/westindian/cestrumdiurnum1.JPG

Identifying Characteristics

Day Jessamine is an evergreen shrub that grows to 6.5 ft (2 m) tall. It has multiple trunks that are often densely branched, with arching branches. Leaves are alternate, simple and short petioled. The leaf blades are smooth, leathery, shiny green and oval to oblong. Flowers are fragrant in the day, and are creamy white and trumpet-shaped. Stamens are straight and edentate. Fruits are oval berry, ripening violet-shiny blue-black with 4 to 14 seeds (Correll and Correll 1982; Langeland et al. 2008)

Habitat

Day Jessamine is found mostly in dry soil in waste areas and along roadsides. It can be found along the coast under Australian pine, as it is shade tolerant and can tolerate the allelopathic

litter. However, it must be protected from salt spray and over-wash from storms (Correll and Correll 1982; Langeland et al. 2008). This plant is found primarily on Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, New Providence, Rose Island and surrounding cays (Correll and Correll 1982).

Migration Pattern

Propagation is by seeds, fruit dispersed by birds and by seedlings sold by nurseries. Day Jessamine has escaped cultivation (Correll and Correll 1982; Langeland et al. 2008).

Use

Day Jasamine was introduced as a landscaping plant for gardens, but has since been naturalized in many areas of the Bahamas (Langeland et al. 2009)

Impact

This plant has escaped cultivation and now considered a weed in the wild. It invades coastal and waste areas and grows along roadsides forming dense thickets. Fruits are poisonous to humans and other mammals (Langeland et al. 2008).

Management

Young plants should be hand pulled where possible. Additionally, apply basal bark or cut tree and apply herbicide to stump (Francis 2009).

Eugenia uniflora
Common Name: Surinam cherry
Myrtle Family: Myrtaceae
Origin: South America



Identifying Characteristics

Surinam cherry is a shrub or small tree that grows to 30 ft. (9 m). Leaves are opposite, shiny, dark green above and paler beneath. It has smooth edges. Flowers are fragrant white with many stamens that bloom in clusters. Fruits are red and juicy when ripe with 8 longitudal grooves and 1 to 2 brown rounded seeds (Kaufman and Kaufman 2007; Correll and Correll 1982).

Habitat

This plant favors fertile, moist soil and partial shade (Kaufman and Kaufman 2007). It is cultivated in many gardens in The Bahamas. However, it has escaped and forms thickets in low open coppice (Kaufman and Kaufman 2007; Correll and Correll 1982). While it can be found throughout the archipelago, it is primarily abundant in Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, New Providence, Paradise Island and Rose Island and throughout the tropics (Correll and Correll 1982).

Migration Pattern

Surinam cherry is propagation by seeds which is spread through birds, humans, and other mammals eating the fruit. It is also propagated by seedling and in India by layering (Kaufman and Kaufman 2007).

Use

Edible fruit is eaten by human (Kaufman and Kaufman 2007). It is also used in the making of jellies and sherbets (Correll and Correll 1982) and the plant as a hedge in gardens (Kaufman and Kaufman 2007).

Impact

Surinam cherry forms thickets in open coppice forests (Kaufman and Kaufman 2007; Correll and Correll 1982) preventing native tree growth. It may also be a host for the Mediterranean fruit fly that is destructive to citrus trees (Kaufman and Kaufman 2007).

Management

Surinam cherry can be controlled by pulling small plants. Larger plants can be cut and stumps treated with synthetic herbicides. Additionally, a basal bark treatment can be applied (Kaufman and Kaufman 2007).

Lantana camara
Common Names: Lantana, Shrub verbena, angel lips, big sage, black sage, prickly lantana
Verbena Family: Verbenaceae
Origin: Central and South America



Identifying Characteristics

Lantana is a spreading, branched shrub of about 6 to 15 feet (1.8 - 4.6 m). Leaves are opposite, pointed, oval, toothed edges and a rough surface. Stems have many prickles. Flower are tubular with 4 lobes, ranging from yellow to orange, pink, white or red, sometimes with different colors in the same compact cluster. Fruit are shiny and green with 2 seeds, turning blackish when ripe (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

Lantana grows in open, sunny, partially shady, slightly moist wastelands along roadsides, dunes and pinelands. It is also cultivated as an ornamental plant (Correll and Correll 1982; Kaufman and Kaufman 2007). Lantana is found throughout the northern and central Bahamas, Bermuda, Georgia to Florida and Texas, the Caribbean and other parts of the Americas (Correll and Correll 1982).

Migration Pattern

The shoots become rooted when they touch the ground and the seeds are dispersed by birds (Kaufman and Kaufman 2007).

Use

This plant is used as an ornamental plant because of its showy fragrant flowers but has escaped into natural areas (Kaufman and Kaufman 2007).

Impact

Lantana forms dense strands in natural areas, enriching the soil with nitrogen and poisonous allelochemical released from roots and stem. It can reduce the productivity of the forest and other areas it inhabits. It hybridizes with native endangered pineland lantanas and changes the gene pool. Flowers also attract insects such as bees and butterflies (Kaufman and Kaufman 2007).

Management

Small plants can be pulled by hand or herbicides can be applied to actively growing plants. Also, trunks could be cut and basal bark treatment applied. Hot fire and herbicide combination is also deemed effective (Kaufman and Kaufman, 2007).

Moringa oleifera
Other Latin name: *Moringa pterygospera*
Common Name: Horseradish tree
Horseradish tree Family: Moringaceae
Origin: India



Identifying Characteristics
Horseradish is a large shrub or small tree that grows to about 33feet (10 m) tall with a dense crown. It has a large, thick, irregular trunk with whitish, rough bark. Leaves are pale green, alternate and oddly pinnate. Leaflets are opposite with short slender petioles, entire and obovate to oblong or obtuse. This plant has many fragrant white flowers. The capsules in which broadly winged seeds are located are linear, obtusely trigonous and pendent (Correll and Correll 1982).

Habitat

This plant is found in thickets, open coppice and wetlands. Horseradish tree is found in Florida, Mexico and Central America, Caribbean and The Bahamas. In the Bahamas it is established in Inagua, Mayaguana, Crooked Island, Long Cay, Cat Island, Berry Islands, Eleuthera, Harbour

Island, St. Georges Cay, Rose Island, Paradise Island and New Providence (Correll and Correll 1982).

Use

Horseradish tree is cultivated and its roots used as horseradish; its foliage is used as greens in salads and in curried dishes. Leaves are also used as feed for livestock. Roots and leaves are considered useful in the preparation of traditional medicines. The seeds yield an oil called Ben oil that is utilized as a lubricant for watches and in the manufacturing of perfumes and hairdressings. A blue dye is made from the wood (Duke 1983)

Migration

The horseradish tree is propagated from seeds (Duke 1983).

Impact

This is a low impact invasive plant species. However, it is attacked by fruit flies that harm other plant species. It is also susceptible to fungal attack. It becomes a weed if it escapes (Duke 1983)

Management

As a result of it being a low impact invasive plant species it can be successfully managed by maintaining it within cultivated fields.

Ruellia tuberosa
Common Name: Mexican petunia
Also called *Ruellia brittoniana*
Acanthus Family: Acanthaceae
Origin: Mexico

Identifying Characteristics

Mexican petunia is a perennial shrub with erect or arching, dark purple stem to 3 ft. (1 m). Leaves are opposite, lance shaped, smooth or wavy edged. Flowers are 5 petaled, purple-blue, in small clusters at the ends of branches. Seeds are in small cylindrical capsules and are ovate or compressed (Correll and Correll 1982; Kaufman and Kaufman, 2007).

Habitat

Mexican petunia prefers sun and moist soil but is also drought tolerant and can grow in a variety of soil types (Kaufman and Kaufman 2007). It is found throughout The Bahamas as a garden plant but has escaped cultivation into scrublands, thickets and coppice forests. Generally, it is cultivated throughout the southern United States, the Caribbean, South America, and tropical Asia and Africa (Correll and Correll 1982).

Migration Pattern

This plant is spreads through roots and stem fragments and by seeds (Kaufman and Kaufman 2007).

Use

Mexican petunia used as an ornamental plant in landscaping; however, it has escaped cultivation into natural areas (Kaufman and Kaufman, 2007).

Impact

Mexican petunia forms dense mats that out shade other plants, stifling the growth of native plants (Kaufman and Kaufman 2007).

Management

This plant is hand pulled or dug up. However, roots are difficult to remove and seeds persist in soils for long periods. Large plants are sprayed with the herbicide glyphosate to kill them (Kaufman and Kaufman 2007).

Senna alata
Also called *Cassia alata*
Common Name: Christmas senna, popcorn senna, Christmas candle, ringworm shrub, seven golden candlesticks, candlestick senna
Family: Bean Family: Fabaceae/Leguminosae
Origin: Africa, South East Asia and Pacific Islands


Identifying Characteristics

This is a bushy evergreen shrub that grows to about 6ft (1.8 m). Leaves are even-pinnate, alternate and dull green. Leaflets are oblong or obovate and opposite. Flowers are bright yellow, with 5 petals on upright racemes. Fruits are winged pods, green when young, turning brown at maturity (Brown 2009).

Habitat

Christmas senna grows along roadsides, in disturbed areas as well as in pasture lands (Brown 2009). The extent of the distribution in The Bahamas in unknown at this time; however, it is observed growing on the island of New Providence.

Migration Patterns

Plants are produced by seeds. The seeds of Christmas senna ripen on the plant, drops, and produce many seedlings (Brown 2009).

Use

Christmas senna is used as an ornamental tree in gardens and along roadsides as well as a potted plant on patios (Brown 2009).

Impact

Christmas senna produces a large number of seeds and many new plants grow from them. It is fast growing and highly invasive. It also forms monoculture stands, replacing native plants.

Management

In order to limit the impact of this tree it should be pruned heavily. Pruning reduces its chances of survival. It will not survive more than three years if heavy pruning is done (Brown 2009). In addition, limiting its transportation to other islands may also be effective in controlling this plant.

Thespesia populnea
Common Names: Seaside mahoe, cork tree, Spanish cork
Mallow Family: Malvaceae

Origin: India



Identifying Characteristics

Seaside mahoe is an evergreen shrub or tree that grows to 40 ft (12 m) (Correll and Correll 1982; Kaufman and Kaufman 2007). Leaves are alternate, heart-shaped, shiny green, firm in texture and slightly fleshy (Correll and Correll 1982; Kaufman and Kaufman 2007). Flowers are hibiscus-like, yellow with red centers (Correll and Correll 1982; Kaufman and Kaufman 2007) and a purple base (Correll and Correll 1982). Fruit are leathery, ball-shaped capsules, brown when mature, with few hairy seeds (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

Seaside mahoe is salt and wind tolerant (Kaufman and Kaufman 2007). It is found on the borders of marshes, mangroves, beach areas, vacant lots and waste areas throughout the Bahamas. It is naturalized generally throughout the tropics

Migration Pattern

Fruits are dispersed by water, floating to new locations, resulting in its widespread dispersal in tropical habitats (Kaufman and Kaufman 2007)

Use

Seaside mahoe is used in the carving of small items, rope making, and making of yellow dye. It is also used in traditional medicine (Kaufman and Kaufman 2007). In the Bahamas, it is planted near beaches and in park areas.

Impact

This plant usually forms dense thickets on dunes and in mangrove areas, displacing native plants as well as altering these habitats for animals such as sea turtles and fish (Kaufman and Kaufman 2007).

Management

An effective control method is by pulling and digging seedlings and saplings. Large trees are cut and stumps treated with herbicides (Kaufman and Kaufman, 2007). It may also be useful to utilize basal bark treatment with this plant species.

Veitchia merrillii
Common Name: Christmas Palm
Palm family: Arecaeae
Origin: Philippines



Identifying Characteristics

This is a stocky single trunked palm that grows to about 25 feet (7.6 m) tall. Leaves are green, alternate, spiral and odd pinnately compound. Fruits are glossy, bright red and oval. Flowers are white and yellow and inconspicuous (Gilman and Watson 1994).

Habitat

Christmas palm prefers full sun or part shade as well as well drained, clay, sandy or loam soils. It is moderately salt tolerant (Gilman and Watson 1994) and can be found throughout the Bahamas, especially New Providence, Exuma, Grand Bahama, Bimini, Eleuthera, Andros, Paradise Island, Harbour Island and St. Georges Cay. Christmas palm has escaped cultivation into natural areas of The Bahamas.

Migration Patterns

Propagation of Christmas palm is from seeds that germinate quickly, in about 1 to 3 months (Gilman and Watson 1994).

Use

This plant is used as both an indoor and outdoor ornamental plant in gardens, along sidewalks and road sides (Gilman and Watson 1994).

Impact

Christmas palm is susceptible to lethal yellowing disease which affects other native species. Recently, it was discovered to escape cultivation and is competing with other native plant species (Gilman and Watson 1994).

Management

This plant is said to carry the disease found in palm trees call lethal yellowing, for which there is no cure. The lethal yellowing disease demands that it is controlled or banned and replaced with native species (Gilman and Watson 1994). Christmas palm should be placed on the eradication list and a plan implemented for the same so as to protect native palm species.

3.2: Vines

Abrus precatorius
Common Name: Rosary pea
Pea Family: Fabaceae
Origin: India



Identifying Characteristics

Rosary pea is a high twining, trailing, perennial vine with a woody stem. Leaves are alternate, delicate, and feathery with 5-15 pairs of leaflets that are oblong in shape with smooth edges. Flowers are in clusters and are small pale violet to pink. They are pea like flowers hanging from the leaf axils. Pods contain 6-8 bright red seeds with black dots at the base (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

This plant favors full sun and well drained soil (Kaufman and Kaufman 2007). It grows on the edge and in coppice forest, scrubland and waste places. It can be found on most of the islands of The Bahamas except Great Inagua and several cays in the southern and northern Bahamas. It is established in Southern Mexico and Central America, the Caribbean, South America, and Tropical Asia and Africa (Correll and Correll 1982). In the United States it is distributed in Florida (Langeland et al. 2008; Kaufman and Kaufman 2007), Alabama, Arkansas and Georgia (Kaufman and Kaufman 2007).

Migration Pattern

The seeds are eaten and dispersed by birds (Kaufman and Kaufman 2007).

Use

Rosary pea is used in the local craft industry in the making of several items including jewelry and other ornaments.

Impact

The Rosary pea climbs over trees and shrubs and blocks light to vegetation below. It fixes large quantities of nitrogen in soil which increasing levels of nitrogen. Seeds are eaten by birds, but have no nutritional value. In addition, seeds contain a toxic chemical, abrin, when ingested by people, cattle and horses causes blindness or death (Kaufman and Kaufman 2007).

Management

Young plants should be hand pulled, but deep-rooted vines are difficult to eradicate. Large stands should be sprayed with herbicides to kill them. Heavy grazing also helps to kill rosary pea (Kaufman and Kaufman 2007). Another method that may prove effective is to cut the vine to the base and apply herbicide.

Asparagus densiflorus
Common Name: Asparagus fern
Lily Family: Liliaceae
Also called *Asparagus aethiopicus*
Origin: South Africa


Identifying Characteristics

Asparagus fern is an evergreen perennial herb that grows from crown of tuberous roots. Stems are2- 9.8 feet (0.6 - 3m) or longer, having large branches with axillary spines. Leaves are tiny and scale-like, at the bases flat, needle-like, light bright green branchlets (cladophylls). Fruits are bright red berries with 3 seeds (Correll and Correll 1982; Langeland et al. 2008).

Habitat

This plant grows best in low to high light, is drought tolerant and grows in well drained soil. It escapes cultivation and grows in coppices and woodland areas (Correll and Correll 1982; Langeland et al. 2008). In the Bahamas it is established in several islands including Berry Islands, Eleuthera, Rose Island, Harbour Island, St. Georges Cay, Rose Island and New Providence. Asparagus fern is widely established in warmer areas of the world (Correll and Correll 1982).

Migration Pattern

The plant is spread by division of tuberous crowns and by birds that eat the seeds (Langeland et al. 2008).

Use

This vine is cultivated as an indoor and outdoor potted plant, and as an ornamental in gardens.

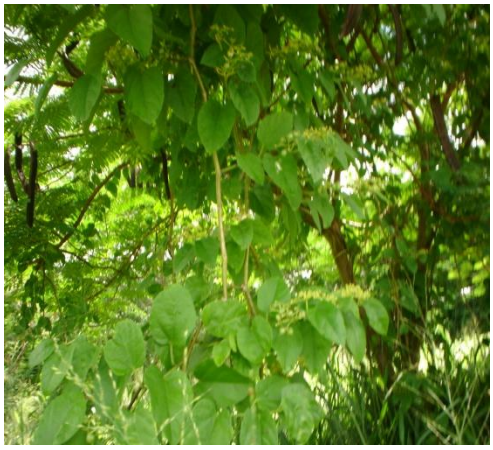
Impact

Asparagus fern escapes cultivation and replaces native ground cover and understory shrub (Langeland et al. 2008).

Management

Preventative control measures such as restricting imports can be employed. Limiting planting and monitoring to prevent escape is also effective. Another effective measure is removing existing plants; completely remove all roots, then cut and spray with the herbicide glyphosate solution with surfactant (Center for Aquatic and Invasive Plants 2007).

Cissus sicyoides
Common Name: Princess vine, Common Cissus
Grape Family: Vitaceae
Origin: northern South America




Identifying Characteristics

This is a woody, perennial vine. It climbs tall trees, fences and over debris on the ground. The stem is flexible, tough and wiry growing to about 65.6 ft (20 m). Leaves are alternate with simple blades, suborbiculate-ovate to ovate-oblong and usually symmetric. Flowers are in cymes (flower clusters where the first flower is terminal on the main axis), green or yellow. Fruits are spherical or round, speckled (deep green) turning bluish-black at maturity (Correll and Correll 1982).

Habitat

Common cissus is found climbing over ledges, shrubs, trees, fences and over dead material on the ground. It is established on several Bahamian islands including Long Island, Rum Cay, San Salvador, Berry Islands, Eleuthera, Harbour Island, St. Georges Cay, Paradise Island, Rose Island, New Providence, Bimini, Andros and surrounding cays. It is also established in Florida, Central and South America and throughout the Caribbean (Correll and Correll 1982).

Migration Patterns

Propagation occurs when fruits are eaten by migratory birds and seeds dispersed in their droppings. Seeds are also disbursed when mature fruits drop into water ways such as canals and invade new areas. Broken offshoots of vines may also spread from one area to another (French et al. 2003)

Use

This vine was introduced as an ornamental vine in the Bahamas. It is probably used as a herbal medicine as well.

Impact

During the early growth stage it is indistinguishable from other vegetation like citrus because of the dark green foliage. Mature vines completely cover shrubs and trees, forming a thick canopy, blocking sunlight to the understory native plants. It also affects agricultural trees such as citrus (grapefruits and oranges) by completely covering them (French et al. 2003).

Management

There are no known biological herbicides available for eradication or control; therefore plants are manually removed (French et al. 2003).

Dioscorea alata
Common Name: Winged yam
Yam Family: Dioscoreaceae
Origin: Southeast Asia



O http://www.hear.org/starr/plants/images/image/?q=031108-3193

Identifying Characteristics

Winged yam is a twining, stout, herbaceous vine that twines to the right and has massive underground tubers. Stems may reach 30 ft. (10 m), and are free branching, with square internodes with corners compressed into "wings" that are red or purple. Leaves are long petioled, opposite, narrowly heart-shaped, with angular basal. Aerial tubers (bulbils) form in leaf axils, and are rough and bumpy (Correll and Correll 1982; Kaufman and Kaufman 2007). Flowers are small; staminate flowers are in whorls, with 6 stamens, and pistillate flowers are in

simple spikes (Correll and Correll 1982). Fruits are 3 parted winged capsules (Langeland et al. 2008).

Habitat

This vine is cultivated throughout the tropics but has escaped cultivation in scrubland, coppice, sand dunes, and pine forest (Langeland et al. 2008). It is found primarily in Exuma, Rose Island, Andros, Bimini, Abaco, Grand Bahama and the surrounding cays.

Migration Pattern

Winged yam is spread by aerial tubers and underground tubers (Langeland et al. 2008).

Use

This vine is cultivated as an ornamental and as an edible tuber throughout the tropics including The Bahamas (Correll and Correll 1982).

Impact

Winged yam climbs vegetation and disrupts natural area plant communities. It also invades coastal dunes, coppice, pine forest and cultivated areas (Langeland et al. 2008).

Management

Winged yam can be controlled by cutting vines high in trees, cutting bulbils and removing them from site and burning to destroy them. Where possible, dig up underground tubers, cut them and treat with herbicides (Langeland et al. 2001).

Dioscorea bulbifera
Common Name: Air potato
Yam Family: Dioscoreaceae
Origin: Africa and Asia

Identifying Characteristics

Air potato is a twining, herbaceous perennial vine, 60 feet (18 m) long that twines to left. It has a square stem that grows from underground tubers and produce aerial tubers (bulbils). Leaves are heart-shaped and alternate. Flowers are rare, fragrant green to white, with about 6 stamens (Correll and Correll 1982; Kaufman and Kaufman 2007; Langeland et al. 2008).

Habitat

Air potato invades hardwood trees, woodland edges and waste places (Kaufman and Kaufman 2007). Air potato is found primarily in the Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Paradise Island and New Providence and throughout the tropics (Correll and Correll 1982).

Migration Pattern

This vine grows rapidly from aerial tubers (bulbils) that are moved by animals or may drop in water, float and colonize new places (Kaufman and Kaufman 2007).

Use

Air potato is cultivated as an ornamental vine but has escaped cultivation (Langeland et al. 2008).

Impact

Air potato climbs over small trees and shrubs, completely covering them, blocking sunlight to vegetation below and preventing growth. It is considered to be very aggressive in full sun and is rampant in undeveloped areas (Kaufman and Kaufman 2007; Langeland et al. 2008).

Management

For small invasions, rake or pick bulbils and burn to kill plant. Also, frequently cut vines to ground level during growing season and spray with the herbicide glyphosate (Kaufman and Kaufman 2007).

Passiflora quadrangularis
Common Name: Granadilla
Passion Vine Family: Passifloraceae
Origin: Tropical America

P http://www.fmnh.helsinki.fi/nayttelyt/ktp/sisalto/kasvihuoneet/03.htm

Identifying Characteristics

Granadilla is a glabrous, fast growing vine that grows to about 50 feet (15 m) or longer. The stem is four angled and stout and prominently winged at the angles. Leaves are alternate, broad-ovate or oblong-ovate and rounded or cordate at the base. The flowers are greenish to greenish-red without, and violet to pinkish within. Fruits are oblong-ovoid, greenish-white to yellowish with blushes of purple at maturity, with a thin, delicate skin (Correll and Correll 1982; Morton 1987).

Habitat

This vine grows best in full sun to partial shade. It is usually cultivated, but can escape. Granddilla is found throughout the Bahamas especially in Abaco, Grand Bahama and surrounding cays as well as throughout the tropics (Correll and Correll 1982; Morton 1987).

Migration Patterns

Granadilla is propagated from cuttings and seeds.

Use

Grandillia is used as an ornamental plant, but mostly cultivated for its fruit which is used in the preparation of fruit salads, and juices. The green fruit is cooked and served as a vegetable. The root is also cooked and eaten in the place of yam in Jamaica. Additionally, it is used in the preparation of traditional medicines in many areas of the tropics (Morton 1987).

Impact

Parts of this plant are poisonous if eaten. The leaves, skin of the fruit and immature seeds contain a cyanide compound, cyanogenic glycoside. The pulp contains passiflorin and if eaten in large amounts can cause lethargy (unconsciousness) and somnolence (sleepiness). Uncooked roots are emetic, narcotic and poisonous (Morton 1987).

Management

Granadilla is not overly invasive; however, to prevent its escape it may be necessary to prune it occasionally.

Syngonium podophyllum
Common Name: Arrow head vine
Family: Araceae
Origin: Central America (Mexico to Panama)

Q http://commons.wikimedia.org/wiki/File:Starr_080610-

R http://www.kingsnake.com/westindian/manexotics1.html

Identifying Characteristics

This is a fast growing epiphytic vine. Seedlings have one to several arrowhead-shaped leaves. Older vines have variable compound leaves, long petioles (leaf stalks) with 3 to12 leaflets of different sizes, are dark green above and pale green below. Flowers are pink and hidden inside a spathe; the fruiting spathe eventually turns bright red (Correll and Correll 1982; Morgan et al. 2004).

Habitat

Arrow head vine is found in natural areas like pond apple swamps and low swales. This vine is most common in the Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Paradise Island and New Providence (Correll and Correll 1982).

Migration Pattern

This vine is spread through stem cuttings, escaping abandoned garden areas (Morgan et al. 2004).

Use

Arrow head vine is cultivated as an ornamental ground cover plant (Morgan et al. 2004). In the Bahamas, it is also used as an indoor and outdoor plant in hanging baskets.

Impact

This is a strong climber, making canopy top heavy and toppling trees. It also has extensive root systems that are difficult to remove. It forms thick impenetrable ground cover (Morgan et al. 2004).

Management

This plant can be hand pulled, but must be dug to remove it. Next, it should be sprayed with the herbicides glyphosate or triclopyr to kill it (Morgan et al. 2004).

3.3: Ferns

Nephrolepis multiflora
Common Name: Asian sword fern
Wood Fern Family: Dryopteridaceae
Origin: Tropical Asia


Identifying Characteristics

Fronds which reach 3 feet in length are evergreen, with 40 to100 pairs of pinnae (leaflets) that are oblong, triangular pointed and narrow at the base, with edges that are smooth and slightly toothed. It produces above-ground stolons (stems) that are covered with tan scales, and underground stems (rhizomes), that are also covered with scales and produce small tubers at the tips. Spores are produced in sori located on fertile fronds on the underside of pinnae (Correll and Correll 1998; Kaufman and Kaufman 2007).

Habitat

This fern is found in the ground, shady moist areas on rocks, and on other plants in coppices, along roadsides and waste areas (Correll and Correll 1998; Kaufman and Kaufman 2007). Asian sward fern is widely distributed throughout the Bahamas, Florida and the Caribbean (Correll and Correll 1982).

Migration Pattern

Asian sword fern is spread by spores or dispersed by rhizomes or above ground stolons (Kaufman and Kaufman 2007).

Use

Like most invasive plants, it is cultivated as an ornamental plant in gardens (Kaufman and Kaufman 2007).

Impact

This fern escaped cultivation and grows in dense stands, displacing native plants (Kaufman and Kaufman 2007).

Management

One of the best ways to control this fern is to hand pull or dig up to remove all rhizomes, tubers, stolons and spray with the herbicide glyphosate (Kaufman and Kaufman 2007).

3.4: Grasses

Imperata cylindrica
Common Name: Cogon grass
Grass Family; Poaceae
Origin: Southeastern Asia

S http://commons.wikimedia.org/wiki/File:Imperata_cylindrica.jpg

T http://home.vicnet.net.au/~sbea/html/plants/vegbycommon.html

Identifying Characteristics

Cogon grass grows in loose bunches or turfs of 1 to 4 feet (0.3 – 1.2 m) from stout, creeping rhizomes. Leaf blades are stiff, light green, with off-centered midribs and serrated edges. Flowers are in long, fluffy, white heads (panicles) with long silky hair. Seeds are attached to plumes of the long silky hair (Langeland et al. 2008; Kaufman and Kaufman 2007).

Habitat

This grass has invaded sand dunes, roadsides, marshes and other wetland areas. Cogon grass is established in parts of Alabama, Georgia, Louisiana, Mississippi, South Carolina and Florida (Langeland et al. 2008). In the Bahamas, it is commonly found in Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Andros, New Providence, Paradise Island and Bimini.

Migration Pattern

The plant spreads mainly by seeds, which are spread by animals and wind (Kaufman and Kaufman 2007). It also has aggressive, branching rhizomes that allow it to form extensive colonies.

Use

This grass is frequently cultivated as forage in pasture areas and as an ornamental plant (Kaufman and Kaufman 2007).

Impact

Cogon grass is among the top 10 invasive plants in the world. It establishes easily because it has strong spreading rhizomes. Leaves form dense mats that prevent native plants from establishing and can cause severe fires when established. Leaves also reduce nesting of ground nesting birds because of its thick mat (Kaufman and Kaufman 2007).

Management

An effective management method is combined mowing and burning followed by plowing or disking. In addition, applying herbicides imazapyr or glyphosate can also help control this grass species (Kaufman and Kaufman 2007). Cogon grass is not harmed by fire, which makes it particularly bad for The Bahamas.

Neyraudia reynaudiana
Common Names: Silkreed, Burmareed, Cane grass
Grass Family: Poaceae (Gramineae)
Origin: South Asia

U http://aquat1.ifas.ufl.edu/node/287

V http://www.coralsprings.org/environment/sandyridge/Vegetation%20Survey/BurmaReed.cfm

Identifying Characteristics

Silkreed grass is a vigorous, reed-like perennial that grows to10 feet (3 m) high. It forms clumps from rhizomes. The stem is branched with soft pith and leaf sheaths are long, smooth and shiny, with clasping woody at the areas at the top. Leaf blades are linear, flat, wide, with smooth margins, and are frequently deciduous. Flowers are in large terminal panicles, and are covered with long feathery hair (Correll and Correll 1982; Langeland et al. 2008).

Habitat

Silkreed grows in a wide variety of habitats, preferring sunny, dry areas in depressions in disturbed sites (Langeland et al. 2008). This grass is found primarily in Andros, Abaco, Bimini, and surrounding cays in The Bahamas, and in the United States from Massachusetts south to Florida and eastern Texas as well as eastern Mexico and the Caribbean (Correll and Correll 1982).

Migration Pattern

Plants are moved by people who grow them as ornamentals. The seeds are easily dispersed by the wind (Langeland et al. 2008).

Use

The flower plumes are used in flower arrangements. It is also cultivated as wind breaks around crops in Southeast Asia (Langeland et al. 2008).

Impact

Silkreed frequently escapes cultivation and colonizes marginal and undisturbed areas. It threatens native plant species. It is also highly flammable, promotes frequent fires, enhancing its spread (Langeland et al. 2008).

Management

This grass establishes deep roots, which makes mechanical removal difficult. Some effective management approaches include a combination of cutting or prescribed burning. In addition, herbicide could be applied to stems and the remaining plants hand pulled. The site should be monitored for two years to ensue all plants are killed (Invasive Species Specialist Group 2005).

Panicum maximum
Common Name: Guinea Grass
Grass Family: Poaceae
Origin: Africa


Identifying Characteristics

Guinea grass is a perennial with strong, extensive rhizomes reaching 9.8feet (3 m). Stems are stout, erect, reaching 4 feet in height, and glabrous to hairy, with thick patches of hair at the leaf blade. Blades are flat, linear, long and wide. Flowers on branchlets are green to purplish, with white seed (Correll and Correll; 1982 Langeland et al. 2008).

Habitat

Guinea grass favors coastal areas, especially behind dunes, but is found in disturbed areas as well. In The Bahamas it forms dense monoculture stands. It is found primarily in Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Paradise Island, New Providence, Abaco, Grand Bahama and surrounding cays. This grass is also extensively distributed in warmer regions of the world (Correll and Correll 1982).

Migration Pattern

Guinea grass is spread mainly by seeds, and also from underground rhizomes after fires (Langeland et al. 2008).

Use

Guinea grass is cultivated as a forge grass in part of the U. S. A. (Langeland et al. 2008). However, it has no special use in The Bahamas.

Impact

This grass usually establishes monoculture stands, replacing native grasses. It also changes the nitrogen cycle in soils, has allelopathic activity, causes pollen allergies and is a source of dermatitis in humans (Langeland et al. 2008).

Management

Guinea grass should be removed in small patches, including rhizomes. Also, it is controlled with herbicides. As the depth of seeds increase in soils so do their viability. Also, seeds are not water tolerant so germination is easily controlled in flooded conditions (Langeland et al. 2008).

Panicum repens
Common Name: Torpedo grass
Grass Family: Poaceae
Origin: southern Europe, tropical/sub-tropical Africa, Asia Australia

W http://www.virtualherbarium.org/lf/

X http://commons.wikimedia.org/wiki/File:Starr_050902-4373_Panicum_repens.jpg

Identifying Characteristics

Torpedo grass is a perennial with strong, extensive rhizomes reaching18 feet (5.6 m) or longer. Rhizomes are pointed at the torpedo-shaped tip, with overlapping white scales, and knotty. Stems are stiff and stout, reaching 3 ft (1 m). Blades are flat, firm, broad, upper surface are hairy or whitish bloom with edge rolled under. Flowers and seeds in branched inflorescence, whitish seed (Correll and Correll 1982; Kaufman and Kaufman 2007; Langeland et al. 2008).

Habitat

This grass favors damp areas near swamps, canals and along coasts on sandy dunes (Kaufman and Kaufman 2007). In The Bahamas it is an extensively creeping grass on beach sand and in wasteland. It is found primarily in Berry Islands, Cat Cay, Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Paradise Island, New Providence, Abaco, Grand Bahama and surrounding cays. It is also established from the southern United States to Brazil and in tropical regions of the Old World (Correll and Correll 1982).

Migration Pattern

The plant is spread by fragmentation of rhizomes as well as seeds (Kaufman and Kaufman 2007).

Use

Torpedo grass is cultivated as a forge grass in part of the U. S. A. (Kaufman and Kaufman 2007). However, it has no special use in The Bahamas.

Impact

This aggressive grass species usually establishes monoculture stands, and replacing native grasses. It is also weedy in lawns and farm lands (Kaufman and Kaufman 2007).

Management

Torpedo grass should be removed in small patches, including rhizomes. Also, it can be controlled with the herbicides imazapyr and glyphosate. It may be drowned out by flooding depending on the duration and depth of the flood (Kaufman and Kaufman 2007).

Pennisetum purpureum
Common Name: Napier grass
Grass Family: Poaceae
Origin: Africa

Y http://www.hear.org/starr/plants/images/image/?q=031108-0231

Z
http://t1.gstatic.com/images?q=tbn:PvTNn5BEPtxc8M:http://www.kingsnake.com/westindian/pennisetumpurpureum1.JPG

Identifying Characteristics

Napier grass is a vigorous perennial reaching 13 feet (4 m) tall. It forms thick clumps, from basal offshoots and short rhizomes. Stems are branched and internodes are bluish glaucous. Leaf sheaths are glabrous and leaf blades are linear, tapering, flat, bluish green, with rough margins. Inflorescences are dense terminal panicles that are spike-like, bristly and tawny purple-tinged. Spikelets are solitary, in clusters, on hairy axes with sparse yellowish bristles (Correll and Correll 1982; Langeland et al 2008).

Habitat

This grass grows in a wide variety of soils in disturbed areas. It is found throughout The Bahamas and tropical America (Correll and Correll 1982).

Migration Pattern

Napier grass is a trailing grass that is spread by root crown division or rhizomes stem fragments (Langeland et al. 2008).

Use

This grass was cultivated as forage and silage but has escaped cultivation (Langeland et al. 2008). In the Bahamas it was cultivated as a forage grass but has escaped cultivation.

Impact

Napier is a weed that forms dense stands, crowding out native species. It survives drought once established (Langeland et al. 2009).

Management

Napier grass is controlled by cutting stems to ground level, allow sprout to reach 12 inches then remove seedling's head and treat it with herbicides (Langeland et al. 2008).

Sorghum halepense
Common Name: Johnson grass
Grass Family: Poaceae
Origin: Mediterranean region of Europe and Africa

Identifying Characteristics

Johnson grass is a perennial that grows to 8 feet (2.4 m) with roots about half inch thick. It has extensive rhizomes that are whitish to pinkish when young and beige when mature. The leaf blade is flat with a white rib. The panicles or seed head is hairy (Correll and Correll 1982; Kaufman and Kaufman 2007).

Habitat

This aggressive grass escapes and grows in old fields, pastures, along forest edges, cleared road sides and stream banks (Kaufman and Kaufman 2007). In the Bahamas Johnson grass is found

mainly in the Berry Islands, Eleuthera, Harbour Island, St. Georges Cay, Rose Island, Paradise Island, New Providence, Andros, Bimini, Abaco, Grand Bahama and the surrounding cays. It is also widely distributed in the southern United States and in temperate and tropical regions of the world (Correll and Correll 1982).

Migration Patterns

This grass grows from rhizomes and copious (large amount of) seeds (Kaufman and Kaufman 2007).

Use

This grass species is cultivated for forage but escapes easily because of extensive rhizomes and seed production (Kaufman and Kaufman 2007).

Impact

When this plant escapes cultivation, it becomes a weed, taking over extensive areas. It is considered to be the worst weed in the world. It produces large amounts of biomass, thus becoming a fire hazard. Johnson grass can also be toxic to animals if it is wilted, frost damaged, or injured in any other way (Kaufman and Kaufman 2007).

Management

Johnson grass can be killed by heavy grazing from hogs and goats. Also, preventing seeding and not allowing nutrients to roots can also control this grass. Additionally, tilling or plowing to expose roots and applying herbicides will also help control this plant. Hand pulling young plants is also possible when the ground is wet (Kaufman and Kaufman 2007).

Bibliography

Ardastra Garden, Zoo and Conservation Centre. 2009. Education resources plant information. Ardastra Garden, Zoo and Conservation Centre, Nassau. Bahamas. Available from http://ardastra.com/exoticplantinfo.html (accessed May 15, 2009).

Bahamas Government. 2009. About the Bahamas. In The Bahamas Government. Nassau, Bahamas. Available from http://www.bahamas.gov.bs/bahamasweb2/home.nsf/vContentW/F1D7AA0803E7FFEF06256F02007F5607

BEST Commission. 2003. *The national invasive species strategy for The Bahamas.* Nassau, Bahamas.

Best Commission. 2005. *National environmental action plan (NEAP) for The Bahamas.* SENES Consultants Limited. Ontario, Canada.

Brown S. H. 2009. Senna alata Candlebush, *Candlestick Senna*, Christmas Candle, Ringworm Bush, Mocoté. University of Florida IFAS Extension. Gainesville, FL. Available from http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/FactSheet/SennaAlataCassiaAlataCandlebush.pdf (accessed May 15, 2009)

Campbell K. 2009. Environment minister continues million tree campaign. Government of The Bahamas Information Services. Nassau, Bahamas. Available from http://www.bahamas.gov.bs/bahamasweb2/home.nsf/a2adf3d1baf5cc6e06256f03005ed59c/6aa9d858cbd7ee83852575010056b3b4!OpenDocument (access June 3, 2009).

Center for Aquatic and Invasive Plants. 2007. Coral vine *Antigonon leptopus***.** University of Florida IFAS Extension. Gainesville, FL. Available from http://plants.ifas.ufl.edu/node/40 (accessed June 4, 2009).

Commonwealth of The Bahamas Clearing-House Mechanism. Bahamas Environmental Science and Technology Commission. Nassau, Bahamas. Available from http://www.bahamaschm.org/ (accessed June 27, 2009)

Commonwealth Science Council. 1996. *Biodiversity in small island states: A methodology for identifying and monitoring biodiversity and its use in small island developing states*. Commonwealth Secretariat, London, England

Correll D. S. and H. B. Correll. 1982. *Flora of the Bahamas archipelago (including the Turks and Caicos Islands*. Vaduz, Liechtenstine

Duke J. A. 1983. *Moringa oleifera*. Center for New Crops and Plant Products, Purdue University. West Lafayette, IN. Available from http://www.hort.purdue.edu/newcrop/duke_energy/Moringa_oleifera.html (accessed May 10, 2009)

Encyclopedia Britannica. 2009. Logwood *Haematoxylon campechianum*. Encyclopedia Britannica. Available from http://www.britannica.com/EBchecked/topic/346505/logwood (accessed May 10, 2009)

Francis J. K. 2009. *Cestrum diurnum* L. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry. Rio Piedras, PR. Available from http://www.fs.fed.us/global/iitf/pdf/shrubs/Cestrum%20diurnum.pdf (accessed May 9, 2009).

Francis K. J. 2009. *Ricinus communis* L. castor bean. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry. Rio Piedras, PR. Available from http://74.125.47.132/search?q=cache:eMI0t8TSISAJ:www.fs.fed.us/global/iitf/pdf/shrubs/Ricinus%2520communis.pdf+http://www.fs.fed.us/global/iitf/pdf/shrubs/Ricinus%2520communis.pdf&cd=1&hl=en&ct=clnk&gl=us (accessed May 9, 2009).

French J. A., R. I. Lonard, and J. H. Everitt. 2003. *Cissus sicyoides* C. Linnaeus (Vitaceae), a potential exotic pest in the lower Rio Grande Valley, Texas. Subtropical Plant Science 55: 72–74.

Gilbert L. 2009. Environment ministry launches programme to stem coastal zone erosion. Government of The Bahamas Information Services. Nassau, Bahamas. Available from http://www.bahamas.gov.bs/bahamasweb2/home.nsf/a2adf3d1baf5cc6e06256f03005ed59c/34fb2acc8ef95ffd85257599006752cc!OpenDocument (accessed May 9, 2009)

Gilman E. F. 1999. *Trachelospermum asiaticum*. University of Florida Corporative Extension services, Institute of Food and Agricultural Science. Gainesville, FL. Available from http://hort.ifas.ufl.edu/shrubs/TRASSIA.PDF (accessed June 4, 2009)

———. 1999. *Wedelia trilobata*. University of Florida Corporative Extension services. Institute of Food and Agricultural Science. Gainesville, FL. Available from http://hort.ufl.edu/shrubs/WEDTRIA.PDF (accessed June 4, 2009)

Gilman E. F. and D. G. Watson. 1993. *Calliandra surinamensis*, Pink Powderpuff. University of Florida IFAS Extension. Gainesville, FL. Available from http://hort.ufl.edu/trees/CALSURA.pdf

———. 1993. *Delonix regia:* Royal Poinciana. University of Florida IFAS Extension. Gainesville, FL. Available from http://hort.ufl.edu/trees/DELREGA.pdf (accessed June 1, 2009)

Gilman E. F. and D. G. Watson 1994. *Cercis canadensis*. University of Florida IFAS Extension. Gainesville, FL. Available from http://edis.ifas.ufl.edu/st146 (accessed May 10, 2009)

———. 1994. *Schefflera actinophylla*. University of Florida IFAS Extension. Gainesville, FL. 1994]. Available from http://hort.ufl.edu/trees/SCHACTA.pdf (accessed May 10, 2009)

———. 1994. *Terminalia catappa*: Tropical-almond. University of Florida IFAS Extension. Gainesville, FL. Available from http://hort.ufl.edu/trees/tercata.pdf (accessed May 10, 2009)

———. 1994. *Veitchia merrillii*: Christmas palm. University of Florida IFAS Extension. Gainesville, FL. Available from http://hort.ufl.edu/trees/VEIMERA.pdf (accessed May 10, 2009)

Global Environmental Facility. 2005. GEF and Small Island Developing States. Global Environmental Facility. Washington, DC. Available from http://www.gefweb.org/outreach-PUblications/GEF_sids_END.pdf (accessed May 15, 2009)

Global Invasive Species Programme. 2009. What are invasive alien species. Convention on Biological Diversity. Montreal, Canada. Available from https://www.cbd.int/idb/2009/about/what/ (accessed May 15, 2009)

Hickey R.J. and M. A. Vincent. 2005. Nearing a point of no return with *Schinus terebinthifolius* in the Bahamas. Pp. 55-63. In Fried, E.H. and L. Wiedman (eds.). Proceedings of the Conference on the Natural History of Andros Island, Bahamas, 4-5 February, 2005, Love at First Sight Resort, Andros Island, Bahamas. Pp. 55-63.

Invasive Species Specialist Group (ISSG). 2005. *Neyraudia reynaudiana* (grass). Global Invasive Species Database. Available from http://www.issg.org/database/species/ecology.asp?si=303&fr=1&sts= (accessed May 16, 2009)

Kaufman S. R. and W. Kaufman. 2007. *Invasive plants: A guide to identification, impacts, and control of common North American species*. Stackpole Books. Mechanicsburg, PA.

Langeland K. A. and K. C. Burks. 1998. *Identification and biology of non-native plants in Florida's areas*. University of Florida. Gainesville, FL.

Langeland K. A., H. M. Cherry, C. M. McCormic and K. A. Craddock-Burks. 2008. *Identification and biology of non-native plants in Florida's natural areas*. University of Florida, Gainesville, Florida.

Langeland K. A. 2009. Help protects Florida's natural areas from non-native invasive plants. University of Florida IFAS Extension Gainesville. FL. Available from http://edis.ifas.ufl.edu/pdffiles/AG/AG10800.pdf (accessed May 16, 2010)

Langeland K. A. and R. K. Stocker. 2009. Control of non-native plants in natural areas of Florida. University of Florida IFAS Extension. Gainesville, FL. Available from http://edis.ifas.ufl.edu/WG209 (accessed May 16, 2009)

Mack R. N. and Lonsdale W. M. 2002. Eradicating invasive plants: Hard-won lessons for islands. Pp. 164–172. In: Vertch, C. R. and M. N. Clout (eds.). *Turning the tide: The eradication of invasive species, proceedings of the international conference on eradication of island invasives.* IUCN, Gland and IUCN/SSC Invasive Species Specialists Group. Auckland, New Zealand.

Mazzotti F. J., T. D. Center, F. A. Dray and D. Thayer. 2009. Ecological consequences of invasion by *Melaleuca quinquenervia* in South Florida wetlands: Paradise damaged not lost. University of Florida IFAS Extension. Gainesville, FL. Available from http://edis.ifas.ufl.edu/UW123 (accessed May 17, 2009)

Moore J. W. 2009. *Pimenta racemosa*. Pier Species. Available from http://www.hear.org/pier/species/pimenta_racemosa.htm

Morgan E. C., W. A. Overholt and K. A. Langeland. Wildland weeds: Arrowhead vine *Syngonium podophyllum*. University of Florida IFAS Extension, Gainesville, FL. Available from http://edis.ifas.ufl.edu/IN530 (accessed May 19, 2009)

Morton J. F. 1987. *Giant granadilla*. In *Fruits of warm climates*, Pp. 328-330. In: Morton, J. F. (ed.). *Fruits of warm climates*, Miami, Florida.

Moultrie S. 2005. Hurricanes and invasives: A deadly duo. The Commonwealth of The Bahamas Biodiversity Clearing-House Mechanism. Nassau, Bahamas, 2005. Available from http://www.bahamaschm.org/article_of_month.htm (accessed May 19, 2009)

Oudhia P. 2001. Kapikachu or cowhage (*Mucuna pruriens*). Purdue University. West Lafayette, IN. Available from http://www.hort.purdue.edu/newcrop/cropfactsheets/mucuna.html (accessed May 21, 2009)

Oudhia P. 2004. Kapikachu or cowhage (*Mucuna pruriens*). Purdue University. West Lafayette IN. Available from http://www.hort.purdue.edu/newcrop/cropfactsheets/mucuna.html (accessed May 19, 2009).

Rodgers J. C. 2005. The distribution of casuarinas on San Salvador Island, The Bahamas. *Southern Geographer* 45: 222-238.

Rodgers J. C. and Gamble D. 2008. Impact of hurricane Frances (2004) on the invasive Australian pine (*Casuarina equisetifolia L.*) on San Salvador Island, The Bahamas. *Journal of the Torrey Botanical Society* 135: 367-376

Sealey N. E. 1994. Bahamian landscapes: An introduction to the geography of The Bahamas, ed. 2. Media Publishing, Nassau, Bahamas.

Simberloff D. 2003. How much information on population biology in needed to manage introduced species? *Conservation Biology* 17: 83-92

U. S. Army Corps of Engineers.2004. Water resources assessment of the Bahamas. In U. S. Army Corp of Mobile District & Topographic Engineering Center. Washington, DC. Available from www.sam.usace.army.mil/en/wra/Bahamas/BAHAMASWRA.pdf (accessed June 15, 2009)

University of Arizona Office of Arid Land Studies. 2009. Common invasive plant characteristics. In The National Invasive Species Information Center. Tucson, AZ. Available from http://alic.arid.arizona.edu/invasive/sub3/p2.shtml (accessed June 24, 2009).

University of Michigan. 2009. *Ipomoea purpurea*. In University of Michigan Plant Diversity Website. Ann Arbor. MI. Available from http://www-personal.umich.edu/~rburnham/SpeciesAccountspdfs/IpompurpCONVFINAL.pdf (accessed June 20, 2009)

Vincent M. A. and C. Kwit. 2007. Additions to the vascular plants and flora of Eleuthera. *Bahamas Naturalist and Journal of Science* 2: 52-54.

Virginia Tech Plant Identification Guide. 2009. Tall morning glory *Ipomoea purpurea*. In Virginia Tech. Blacksburg, VA. Available from http://www.ppws.vt.edu/scott/weed_id/ipopu.htm (accessed June 20, 2009)

Glossary

Alkaline. Relating to or containing an alkali; having a pH greater than 7; "alkaline soils derived from chalk or limestone"

Allelopathy. Ability to suppress growth of nearby plants by secretion of toxic substance

Allelochemical. A chemical produced by one plant that is toxic to another

Aerial. Plants or parts of plant living above the ground or water

Alternate. Arrangement of leaf at a node, one per node, appearing on one side of the axis then the other

Apex. The outer end of a leaf, leaf tip

Axil. Upper angle formed by a leaf or branch with the stem

Axillary. Situated in the axil

Biodiversity. (biological diversity), existence of a wide variety of plant and animal species in their natural environments.

Bipinnate. With leaflets arranged on side branches of a leaf axis; twice pinnate

Branchlet. A secondary woody stem growing from the trunk or main stem of a tree

Capsule. A dry, dehiscent fruit formed from two or more fused ovaries

Compound. Two or more separate leaflets

Conifer. Cone bearing trees

Coppice. A thicket or grove of small trees

Cordate. With an indentation and rounded lobes at the base, heart shaped

Coriaceous. Leathery in texture, tough

Crown. The top of a tree, including all of the branches

Cyanogenic. Capable of producing cyanide

Cymes. A determinant flower cluster in which the first flower is terminal on the main axis

Deciduous. Non-evergreen tree whose petal fall off after flowering, and leaves fall off in Autumn or dry season

Dehiscent. Opening spontaneously when ripe to expel seeds

Disking. Plowing to loosen soil

Edentate. Lacking teeth

Elliptic. Narrowed and rounded at the ends and wide at the middle

Entire. Undivided, the margin continuous, not incised or toothed

Epilithic. Growing on rocks

Epiphytic. Growing on another plant

Evergreen. Species that retain their leaves year round

Glabrous. Without hair

Hybrid. Offspring from two distinct species or genera

Hybridize. Cause to produce a hybrid

Glaucous. Covered with a whitish bloom

Globose. Spherical or round

Inflorescence. The flower cluster of a plant

Leaflet. A segment of a compound leaf

Longitudinal. Running lengthwise

Node. Point on a stem where a leaf or branch arises

Nutlet. Small and nut-like

Oblong. Longer than is broad with parallel sides

Obovate. Reverse of egg shape, narrowing near the base, attached at the narrow end

Obtuse. Blunt or rounded at the end

Opposite. Two leaves at the same node

Orbiculate. Circular or nearly circular

Ornamental. Shrub, vine, grasses and ground cover grown for its beauty

Ovate. Outline of a hens egg, broader near the base

Ovoid. Solid ovate or solid oval

Palmate. A leaf resembling an open hand; having lobes radiating from a common point

Petal. One leaf of a corolla

Petiole. A leaf stalk

Pinna (ae). A leaflet or primary division of a compound leaf

Pinnate. Compound leaf with leaflets arranged on sides of a common axis

Pubescent. Covered with short soft hairs, downy

Raceme. A simple inflorescence with flowers arranged along elongated axis

Rhizome. An underground stem or rootstock with scales at the nodes

Rhomboid. Somewhat diamond shaped

Rootstock. A rhizome

Saline. Salty

Samara. A winged, one-seeded, dry fruit

Sand dune. A hill of sand built by Aeolian processes

Serrate. Notched like a saw with teeth

Shrub. A woody plant of smaller proportion than a tree, which usually produce several branches from the base

Simple. Single or uncompounded (leaf)

Sori. A spore dot, or cluster, on the back of the fronds of ferns

Spathe. A broad sheathing enclosing a spadix

Spadix. A spike on the succulent axis enveloped in a spathe

Spike. An elongated rachis with sessile flowers

Spikelet. The basic unit of inflorescence in grasses and sedges

Spore. The reproductive body of lower plants, analogous to the seed

Stamen: Pollen producing male organs of a flower, consisting of the anther and filament

Stand. A group of forest trees of sufficiently uniform species composition

Stolon. A modified stem growing on the surface of the ground

Swayle. A track of low, usually moist areas between ridges

Systemic. A chemical which is absorbed directly into a plants system to either kill feeding insects on the plant, or to kill the plant itself

Subglobose. Nearly spherical in shape

Suborbiculate. Almost orbiculate or orbicular

Thicket. A dense growth of shrubby plants

Toothed. Dentate

Tree. A woody plant with one main stem, relatively tall

Trigonous. Three angled

Unisexual. Flower having either male or female parts

Wetland. An habitat that may be wet most of the time or seasonally

Whorl. With three or more leaves at the node

Photo Credits

Plate A
http://commons.wikimedia.org/wiki/File:Starr_061108-9754_Colubrina_asiatica.jpg

Plate B
The Global Invasive Species Team *http://www.invasive.org/gist/photosc-f.html*

Plate C. *Melaleuca quinquenervia,* Pacific Islands ecosystems at risk*: Melaleuca quinquenervia*
http://www.hear.org/Pier/imagepages/singles/starr_031108_0008_melaleuca_quinquenervia.htm

Plate D. Wikimedia: *Melaleuca quinquenervia*
http://upload.wikimedia.org/wikipedia/commons/8/8e/Melaleuca_quinquenervia_%28leaves%29.JPG

Plate E. Califlora.net: *Melaleuca quinquenervia*
http://www.calflora.net/losangelesarboretum/images/melaleuca_quinquenervia.jpg

Plate F
Haematoxylon campeachianum, Planetes et botanique *http://www.plantes-botanique.org/galerie-gua08*

Plate G
Haematoxylon campeachianum, Planetes et botanique *http://www.plantes-botanique.org/galerie-gua08*

Plate H
Haematoxylon campechianum, *http://caliban.mpiz-koeln.mpg.de/mavica/icon/3500/03032.jpg*

Plate I
Pimenta racemosa, Killer Plants http://www.killerplants.com/plant-of-the-week/20070122.asp

Plate J
Pimenta racemosa, Natural Products and Drugs, www.np-d.com/images/Pimenta%20racemosa.jpg

Plate K
Spathodea campanulata, The New York Botanical Gardens *Ethnobotany and Florists of Beliez.*
http://www.nybg.org/bsci/belize/gallery.html

Plate L
Missouri Botanical Gardens
http://www.mobot.org/gardinghelp/plantfinder/plant.asp?code=A621

Plate M
http://botany.csdl.tamu.edu/FLORA/imaxxpon.htm

Plate N
www.kingsnake.com/westindian/cestrumdiurnum1.JPG

Plate O
http://www.hear.org/starr/plants/images/image/?q=031108-3193

Plate P
http://www.fmnh.helsinki.fi/nayttelyt/ktp/sisalto/kasvihuoneet/03.htm

Plate Q
http://commons.wikimedia.org/wiki/File:Starr_080610-8101_Syngonium_podophyllum.jpg

Plate R
http://www.kingsnake.com/westindian/manexotics1.html

Plate S
Imperata cylindrical *http://commons.wikimedia.org/wiki/File:Imperata_cylindrica.jpg*
http://home.vicnet.net.au/~sbea/html/plants/vegbycommon.html

Plate T
Neyraudia reynaudiana
http://www.coralsprings.org/environment/sandyridge/Vegetation%20Survey/BurmaReed.cfm

Plate U
Panicum repens http://www.virtualherbarium.org/lf/
http://commons.wikimedia.org/wiki/File:Starr_050902-4373_Panicum_repens.jpg

Plate V
Pennisetum purpureum
http://www.hear.org/starr/plants/images/image/?q=031108-0231

Plate W http://www.virtualherbarium.org/lf/

Plate X http://commons.wikimedia.org/wiki/File:Starr_050902-4373_Panicum_repens.jpg

Plate Y http://www.hear.org/starr/plants/images/image/?q=031108-0231

Plate Z
http://t1.gstatic.com/images?q=tbn:PvTNn5BEPtxc8M:http://www.kingsnake.com/westindian/pennisetumpurpureum1.JPG