

Habitat Fragmentation on Abaco Island: Cause and Effect, and Solutions for Sustainability

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### Abstract

Friends of the Environment (FRIENDS) is a non-governmental organization which was established in 1988 in Abaco, Bahamas with “a mission to preserve and protect Abaco’s marine and terrestrial environments in order to achieve sustainable living for the wildlife and people of Abaco, Bahamas” (Friends of the Environment, 2014). FRIENDS is nearing the end of a strategic planning period and will soon be looking to select goals and programs for future work in biodiversity conservation. This paper addresses threats to biodiversity on Abaco with a focus on habitat fragmentation and looks to discover solutions for effective management of its natural resources. Suggested actions include a review of existing conservation and regulatory documents as well as partnership building to enhance program effectiveness.

*key words:* habitat fragmentation, habitat loss, conservation, planning, biodiversity

## Introduction

### About Abaco, Bahamas

The Bahamas is situated approximately 50 miles east of Florida and covers 124,000 square miles of land and sea (Bahamas Environment, Science and Technology Commission, 2002). Thirty of the islands are inhabited by a total of 351,261 people as of a 2010 census (CIA, n.d.; Department of Statistics of The Bahamas, 2012a). The climate is sub-tropical and is influenced by the Florida Current to the west and the Antilles Current to the east as well as cold fronts during the winter months (Bahamas Environment, Science and Technology Commission, 2002). The Bahamas is an archipelagic nation with a centralized government located in New Providence (Figure 1). Home to the world's first marine protected area, The Bahamas now houses 27 national parks which cover over 1,500 square miles (Bahamas National Trust, n.d.).



Figure 1. Map of The Bahamas ([http://www.nationsonline.org/maps/bahamas\\_map.jpg](http://www.nationsonline.org/maps/bahamas_map.jpg))

Abaco Island is the north-eastern most island in the archipelago, covering an area of 649 square miles (U.S. Army Corps of Engineers, 2004). Abaco is an archipelago in itself, encompassing a unique combination of habitats across land and sea. One of the largest Bahamian islands, Abaco is able to support a sizable fresh water lens which sets it apart from most of the country (Bahamas Environment, Science and Technology Commission, 2002). Abaco has

examples of many Bahamian ecosystem types: pine rocklands, coppice, coastal strand, rocky shores, blue holes and fresh water wetlands, tidal creeks and estuaries, coral reefs and seagrass beds, as well as other fine-scale habitats (Sullivan Sealey et al., 2002). Abaco is home to a rich marine biodiversity, migratory and resident avifauna, herpetofauna, and a single group of native land mammals: bats (Common Bats of the Bahamas, n.d.; Lee, 1996).

Several species of Abaco's fauna are endemic (Carey et al., 2001). Tourism is currently Abaco's largest industry; 82,460 stop-over visitors came in

2011 (Tourism Today, 2011), compared to the islands population of 17,224 (Bahamas Department of Statistics, 2012b). Abaco has experienced past booms in agriculture, sponge harvesting, logging and boat building (Bahamas Environment, Science and Technology Commission, 2002; Bryner & Seegmiller, 2006; Dodge, 1983; Miller, 2007; Sullivan Sealey et al., 2002).

### Background of Human Impacts to Abaco's Environment

Sullivan et al. (2002) cite major threats to Abaco's environment as agriculture, invasive species, timber harvest, development, frequent fires, habitat destruction and habitat fragmentation. Each of these have contributed to the formation of the existing environment in

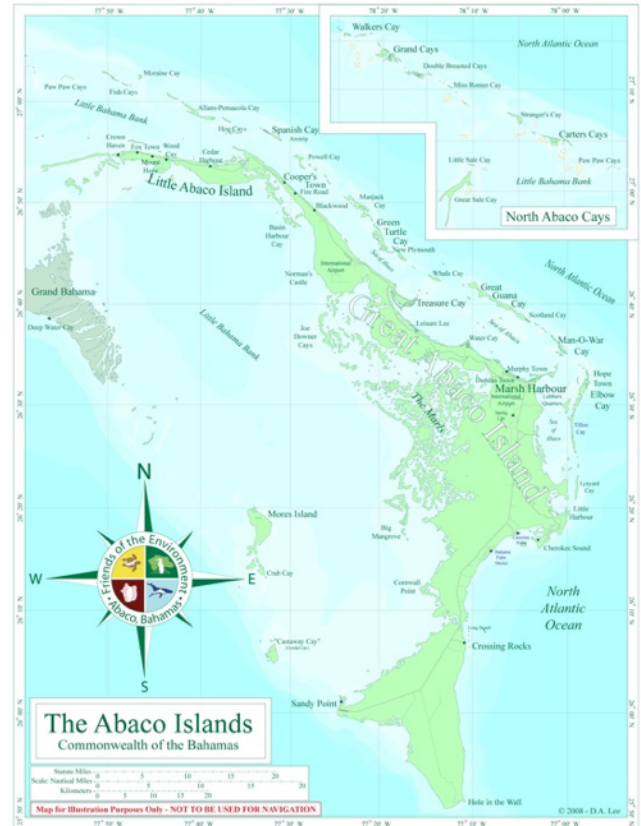


Figure 2. The Abaco Islands.

Abaco. From the late 1700's through the 1800's pioneers in Abaco tried numerous farming initiatives including cotton, pineapples, citrus, and sisal, however the poor soil and political climate of countries importing the products did not bode well for the industries (Dodge, 1983).

The early to mid-1800's was the boat-building prime of Abaco and much lumber was sourced from Abaco's coppice forests to build them (Dodge, 1983). In the early 1900's Abaco's pine forests were extensively logged for both lumber and pulpwood "leaving only 5 seed-bearing trees per acre"; a grid of roads was created across the island to access the pinelands which connected some remote communities of Abaco for the first time by land (Dodge, 1983).

Automobiles began to arrive soon after. Once the pine forest had been logged as much as was feasible, land leases were traded and large patches of land were farmed for sugar cane; Dodge mentions "the fields were 2 to 3 miles wide and 17 miles long" (1983). When the sugar cane was no longer viable, the land was left to its own devices and large areas of sugar cane were still evident in the early 1990's. Feral pigs and a few cattle now roam the island, leftover from farms and stocked by hunters who wish to continue their sport. Local hunters often set fires to flush feral pigs out of hiding, which affects the normal fire regime (Sullivan Sealey et al., 2002).

Tourism started slowly in the 1950's and has been growing steadily since, with the exception of a large boom in construction of second homes and rental properties after Hurricane Floyd (1999) during a duty levy on construction materials (Dodge, 1983). The island is being developed on an ad-hoc basis with no available guidance in the form of a land-use plan or vision, though some guiding principles exist (see Appendix 1). Anthropogenic activities are the main threat to biodiversity in Abaco. This is evident even in the fossil record as the disappearance of several species has been linked to the arrival of the first humans in Abaco approximately 900

years ago (Steadman et al., 2014). This paper seeks to investigate the role of habitat fragmentation in impacts to Abaco's environment with a look to finding solutions for sustainable development and long-term conservation planning for the programs of a local non-governmental organization - Friends of the Environment, Abaco, Bahamas.

## **Discussion**

### **About Habitat Fragmentation**

Abaco's ecosystems are at risk because of the rapid rate and random nature of development on the island (Sullivan Sealey et al., 2002). Decisions for the placement, type and scale of development are often made by off-island bureaucrats with poor site-specific knowledge about Abaco's human communities and ecosystems. Because of the network of roads on the island and the high desirability of coastal property there are few places where humans can not or will not access or develop. It is important to recognize both habitat loss and habitat fragmentation as threats to biodiversity on Abaco, as well as to clarify the differences between them. Habitat loss, as the name implies, results in total loss of habitat form and function, such as the installation of a softball field in a former forest, and is often a large scale occurrence (Fahrig, 2003). Habitat fragmentation on the other hand is a little more complicated; habitats are broken into smaller pieces (patches) and depending on the type of fragmentation can have both negative and positive impacts on biodiversity and community structure (Fahrig, 2003; Hooftman & Diemer, 2002). An example of habitat fragmentation is the construction of a road across tidal wetlands (Valentine-Rose et al., 2007a and 2007b).

While habitat loss and habitat fragmentation are assessed differently, they can also occur simultaneously (Fahrig, 2003). The patterns of habitat loss within a larger landscape context can cause fragmentation and impact biodiversity by reducing the ability of species to disperse and exchange genetic material (Fahrig, 2003). In general, habitat loss in Abaco seems to result from human consumptive use of land (or sea) e.g. clear-cutting for development, and habitat fragmentation comes about from the need to increase access, such as dredging through a seagrass bed or the construction of roads (Fahrig, 2003). Scale of habitat fragmentation becomes relevant when focusing on a particular species and its requirements.

### **Edge Effect**

As habitats are fragmented and broken down into smaller patches new edges are created which can expose the habitat to contrasting weather conditions, predators, parasites and a change in habitat quality (Armstrong et al., 2008; Fahrig, 2003; Smith & Smith, 2001; Tschardtke, Steffan-Dewenter, Kruess, & Thies, 2002). Edges created by habitat fragmentation can be as abrupt as a parking lot next to a forest, or gradual as with a pine forest adjacent to coppice habitat (Smith & Smith, 2001). Where gradual transition zones occur there can be a greater diversity of species present because of the mixing of habitats (Smith & Smith, 2001; Tschardtke et al., 2002). However, edges expose vegetation to more light and wind, which changes the temperature (and humidity) of the habitat and affects growth patterns and community structure depending on the tolerance of local plants to light, shade and heat (Smith & Smith, 2001). This is particularly relevant to the forests of Caribbean pine and coppice on Abaco Island as well as their associated

under-stories. Edge effects can also occur in marine environments and are common amongst seagrass beds (Tanner, 2005).

### **Local Causes of Habitat Fragmentation**

Habitat fragmentation on Abaco is influenced by a number of anthropogenic activities as well as some natural occurrences. Development on the island has created a demand for building materials, thus logging and clear-cutting, hill cutting and quarrying, and sand mining have extended beyond the boundaries of towns into undeveloped areas. The building of roads to access the coast has caused the fragmentation of many tidal creeks across the island; additional logging roads bisect Caribbean pine and coppice forests (Sullivan Sealey et al., 2002).

Excavation is illegal without a permit (Statute Law of The Bahamas, 2001), however, remoteness encourages delinquency due to lack of enforcement (Bryner & Seegmiller, 2006). Opening up of terrestrial habitat by these activities leaves native ecosystems susceptible to the impacts of invasive plants such as Australian Pine (*Casuarina spp.*), Hawaiian Seagrape (*Scaevola taccada*) and Brazilian Pepper (*Schinus terebinthifolia*) (Manrique, Cuda, & Overholt, 2011; Sealey, McDonough, & Lunz, 2014). Feral cats and other invasive animals take advantage of areas disturbed by humans (habitat edges) and prey on native animals (Armstrong et al., 2008; Stahala, 2005).

Hurricanes and fire are the main causes of natural disturbance in Abaco. Hurricanes and other major storms can be responsible for damage to coastlines and vegetation as well as displacement, reduced fitness, and mortality of wildlife (Stahala, 2005). Fire can be responsible for widespread and irregular vegetative change, both from direct impacts and indirectly from



shifts in community structure post fire (Donner et al., 2009; Sanderson et al., 2001; Sullivan Sealey et al., 2002).

Coral is both an animal and a habitat and it can experience fragmentation as a result of hurricanes and other storms as well as human behavior (Brandt et al., 2013; Lirman, 2000; Rudd, 2013). Coral fragmentation can increase local susceptibility to disease transmission by reducing the distance between individuals and by decreasing the overall health of impacted colonies (Brandt et al., 2013; Lirman, 2000). However, corals can re-propagate from fragments, so in this case, fragmentation could help reduce the risk of the genes from a single colony being extirpated (Fahrig, 2003). Fragmentation can also aid in dispersal of the colony and with expansion of the entire reef environment (Lirman, 2000), which could help reduce competition between fish species in the short-term while the habitat is recovering (Bonin et al., 2011).

### **A broader conservation landscape**

The conservation landscape for Abaco extends beyond the borders of the island as there are many migratory species that rely both on Abaco's environment and habitats elsewhere for survival. This raises the need for threats such as habitat fragmentation and loss need to be considered locally, regionally and internationally to encompass the full scale of a species' requirements (Sanderson et al., 2001).

Lee (1996) reports that 31% of birds recorded during a winter survey in the Abaco National Park were migratory. Migratory bird species seen wintering in Abaco include the endangered Kirtland's Warbler, which nests in Michigan (Donner et al., 2009) as well as Piping Plovers originating from a threatened population in the north-eastern United States (Pover,

2012). Both Kirtland's Warblers and Piping Plovers are habitat specialists, which puts them at extra risk from habitat fragmentation (Donner et al., 2009; Fahrig, 2003; Pover, 2012; Tschardt et al., 2002). Friends of the Environment is currently partnering with Conserve Wildlife Foundation of New Jersey on a Piping Plover outreach project (CWFNJ, 2013); adding projects with similar foci can help with global conservation of threatened species.

On a much larger scale, sea turtles utilize habitats in Florida, The Bahamas and other parts of The Caribbean. (NOAA Fisheries, 2013). Additionally, important marine species such as queen conch, spiny lobster, Nassau grouper and bonefish may rely on regional current patterns for dispersal (Callwood, 2010; Murchie et al., 2013) and as such should be part of a cooperative management concern with other Bahamian islands. A national and regional approach to conservation planning should be taken for key marine species in order to share resources and maximize the effectiveness of projects.

### **Future steps**

It is suggested that a review of existing conservation plans, collected by this author, be undertaken to synthesize the recommendations of past authors for Abaco (see Appendix 1). Habitat loss is a drastic change which can be costly or impossible to reverse, so long term planning should look to preserving key habitat areas that feature high amounts of biodiversity and contribution of ecosystem function. Habitat loss should be avoided because of the possible repercussions to native biodiversity. Habitat fragmentation can happen on the short or long term and is generally smaller scale than habitat loss (Fahrig, 2003). Mitigation for habitat fragmentation should take place in the form of changes in behavior and "attitudes regarding tourism, development and natural resources" (Sullivan Sealey et al., 2002).

Habitat fragmentation, while a potentially significant contributor to negative impacts on Abaco's biodiversity on its own, should be assessed in concert with habitat loss and behavioral disturbances (Miller et al., 1998) in order to create a comprehensive management plan. It would be important to review existing research projects which are addressing regional work on sensitive species. Friends of the Environment should seek partnerships with those groups to work locally in an effort to improve regional biodiversity. This would be a good avenue to start building programs for the upcoming Abaco Research Center (an expansion of Friends of the Environment).

### **Conclusion**

Abaco Island is host to a unique combination of ecosystems and species. Biodiversity is at risk from habitat fragmentation, but also from other threats such as habitat loss, invasive species, pollution and natural disasters. These threats, as well as an organism's unique position in the conservation landscape should be considered when planning for conservation and management of Abaco's biodiversity. A number of guiding documents already exist which can be useful to program planning for Friends of the Environment in this regard. Partnerships are encouraged to support conservation of species that breach geographic boundaries and to help build programs for the upcoming Abaco Research Center.

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## Appendix 1

Table 1. A listing of reports with potential use to guide future conservation planning in Abaco and program development for Friends of the Environment, Abaco.

<b>Date</b>	<b>Author(s)</b>	<b>Topic</b>	<b>Island Area</b>
1999	Hammerton and Larson (editors)	THE COMMONWEALTH of THE BAHAMAS: National Biodiversity Strategy and Action Plan	All Bahamas
2001	Carey et al.	Protected Areas Management Strategy for Bahamian Terrestrial Vertebrates: Iguanas and Seabirds.	Andros, Abaco and Grand Bahama, Southern Bahamas, San Salvador, Exuma
2002	Sullivan Sealey et al.	An Ecoregional Plan for the Bahamian archipelago	All Bahamas
2005	College of the Bahamas	State of the Environment Report	All Bahamas
2005	Marks, L.	Participatory Planning for Recreation Management in Abaco National Park, Bahamas	Abaco
2005	SENES Consultants Ltd.	National Environmental Management Action Plan (NEMAP) for The Bahamas	All Bahamas
2006	Bryner, C.L. and Seegmiller, K.M.	Taking a Regional Planning Approach to Create Conceptual Futures for Abaco, The Bahamas	Abaco
2007	Thurlow, K.E. and Palmer, M.	The Bahamas Ecological GAP Analysis	All Bahamas
2008	Bahamas National Trust	General Management Plan: Abaco National Park	Abaco
2008	Andrew's University	Planning Abaco: A proposal to restore a sustainable settlement tradition prepared for the people of Abaco	Abaco
n.d.	Tingey, R. and Knowles, J.E.	Results of Abaco Marine Marxan Analysis	Abaco