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**Monday, March 3rd
to Friday, March 7th, 2014**

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TUESDAY, 4 MARCH, 2014

THE EPHEMERAL ISLANDS -

The natural history of The Bahamas past, present and future. Possible topics can include: Climate change, geology, marine and terrestrial island ecology.



OCEAN INCURSIONS INTO THE CARIBBEAN PINE (*PINUS CARIBEA*) FORESTS ON EAST GRAND BAHAMA: IMPACT ON SOIL CHEMISTRY

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ABSTRACT

Despite the very frequent incidences of hurricane disturbance the true impact of these events on the Bahamas coastal and inland ecosystems remains meagerly studied and minimally understood. Recently, three successive hurricanes: Francis, Jeanne, and Wilma- visibly changed the landscape of the pine forest ecosystem along Grand Bahama's northern coast. We are interested in the elucidation of the more subtle changes such as the nature and extent of chemical changes in the soil. Here we focus on some of the current soil attributes such as pH, conductivity, ion distribution and organic content. We will also attempt to correlate these parameters to changes in the vegetation profile across East Grand Bahama pine forest ecosystem. These post-hurricane conditions reflect the level of disruption to the chemical equilibria within the soil. We specifically focus on ammonium ion content as an instructive indication of disturbance because of its strong predilection to ion exchange with seawater cations.

KEYWORDS: Salt Incursion, Soil Chemistry, Disturbances

THE EFFECTS OF HURRICANE DISTURBANCE AND ITS IMPACT ON EAST GRAND BAHAMA PINE FOREST ECOSYSTEM

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ABSTRACT

Over the years, tropical islands (geographically along hurricane zones) such as the Bahamas experience frequent hurricane disturbances on average every six years. Between 2004-2005, 3 major hurricanes-(1) Francis, (2) Jeanne, and (3) Wilma-devastated the island of Grand Bahama altering the landscape of the pine forest ecosystem in East and West Grand Bahama. Images from the United States Geological Survey (USGS) Landsat photos (2005 and later) revealed higher mortality of pine trees occurred along the Western and Northern side of the island. These images suggest approximately 10-15% of “healthy” pine forests on Grand Bahama were impacted post hurricane, 2004-2005. Frequent hurricane events, such as those to hit Grand Bahama Island in 2004-2005 have the potential to change significantly the landscape of the forest structure over time. Associated with these hurricanes are strong winds, ocean surges, and salt spray, which can have tragic consequences for plants, while altering the soil chemistry and vegetation structures. Additionally, downed trees post-hurricane contributes overall to the increase in the biofuel in the forest understory and too a substantial loss of trees in climax communities. Clearly, plants susceptible to high saline and wind damages are those more likely affected. Here we report on the current post hurricane state of the pine forest ecosystem in East Grand Bahama by measuring the impact of hurricanes on vegetation density (mortality pine trees and ground flora 0.1m).

KEYWORDS: Bahamas Hurricanes, Bahamas Pine Forest, Bahamas Pine Trees Mortality, Bahamas Pine Vegetation Density

LUCAYAN AGRICULTURE: A VIEW FROM THE CENTRAL BAHAMAS

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ABSTRACT

Plant residues found on stone, shell, and ceramic artifacts are helping to construct a picture of Lucayan agriculture during both the Early and Late Lucayan periods. Starch grains, phytoliths, and macrobotanical remains have yielded a variety of at least six different seed and root crops that were brought to the Bahama archipelago by its earliest settlers. These findings contribute to our understanding of Lucayan plant production systems and to the genesis of a unique Lucayan “landscape.”

KEYWORDS: Lucayan, agriculture, imported plants, transported landscape

LUCAYAN WOODEN ARTIFACTS, PLANTS, ENVIRONMENT, GRAND BAHAMA

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ABSTRACT

In the late 1990's, Lucayan wooden artifacts were recovered during excavations of the Deadman's Reef Site, a fifteenth century site located on Grand Bahama. The finds offer insights into the use of wooden objects in northern Lucayan domestic and religious life; Lucayan artistic and symbolic expression; Lucayan perceptions of the animal world; patterns of wood selection for different kinds of objects; techniques of prehistoric wood carving; and preservation conditions allowing for wooden artifact survival in an open-air depositional environment.

KEYWORDS: Lucayan, wooden artifacts, plants, environment, Grand Bahama

MAPPING THE BAHAMAS FROM ANCIENT TIMES TO PRESENT DAY

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ABSTRACT

Todd Turrell started collecting antique maps of the Bahamas, Caribbean and Florida 40 years ago. His collection covers nearly 400 years, and he is currently the editor of a map making company that has completed a modern series of Bahamian island maps. A collection of antique maps owned by Mr. Turrell and colleagues date from 1591 into the 1800's. These maps show the evolution of understanding the land forms in the Bahamas from a European, and later, a North American perspective. The ancient map making techniques, cartouches, paper types and coloring dyes used are as fascinating as the maps themselves. Maps over 400 years old have retained their vivid colors and integrity through the test of time. After a historical map review, a new series of Bahamian maps will be displayed and discussed. The scope of the new mapping project, encompassing over 5 years, will be presented along with a description of new processes and techniques used for their production. The popular series of 22 maps created will be detailed, covering the entire archipelago with individual maps of the major islands of the Bahamas. This presentation will review all of the above aspects, with examples that detail the mapping history of the Bahamas.

KEYWORDS: Antique Historical Maritime Maps

CONSERVATION, OUTREACH AND CITIZEN SCIENCE - COOPERATIVE CONSERVATION, MARINE GOVERNANCE AND LIVELIHOODS

The Role of Recruitment Dynamics in Determining the Effectiveness of Conservation Strategies for Bonefish and Queen Conch in The Bahamas

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ABSTRACT

To develop truly effective conservation strategies for any species, the various components of a species' life history as well as the factors controlling its recruitment dynamics need to be well understood. For species with extended pelagic larval stages, such as bonefish (*Albula vulpes*) and queen conch (*Strombus gigas*), understanding how ocean currents and regional patterns of circulation affect larval transport becomes critical for developing effective management plans. Although we can describe the various stages in the life cycle of each of these economically and culturally important species, we do not know what drives their recruitment. A series of conceptual recruitment models will be presented for both bonefish and queen conch to illustrate how source-sink dynamics and ocean currents may interact to play a major role in determining the recruitment dynamics of these two species. The potential for success or failure of various conservation strategies for each species will then be assessed in light of those alternative models

KEYWORDS: bonefish, conch, recruitment, conservation, management

BAHAMAS BONEFISH CONSERVATION

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ABSTRACT

Habitat degradation and loss are among the top causes of fisheries declines worldwide. This is especially true for species that experience little or no harvest, such as recreational catch and release fisheries. For these fisheries, the amount and quality of suitable habitat should be the main focuses of management and conservation. The common bonefish (*Albula vulpes*) depends upon healthy coastal habitats and supports an important recreational fishery in The Bahamas: the annual economic impact of the recreational tourism-based fishery exceeds \$141 million; there is a long cultural history associated with the fishery, the occupation of fishing guide passed down generations. With commercial harvest and use of nets prohibited for bonefish, the main threats to the fishery are habitat loss and degradation. Recent assessments on Grand Bahama Island and Abaco show healthy bonefish populations associated with healthy habitats. Ongoing tag-recapture research is showing that bonefish have small home ranges within and among years. However, adults undergo seasonal migrations to spawning locations in deep water, which underscores the need for a comprehensive habitat conservation plan. Given the health of bonefish populations and habitats on these islands, habitat conservation should be a top priority to ensure the long-term viability of this economically important fishery. Similar research and conservation is needed for other Bahamas islands to ensure that the recreational bonefish fishery provides ecologically sustainable economic value for the future.

KEYWORDS: Bonefish, habitat, spawning, home range, fishery

GHOST STORIES - PIONEERING BAHAMIAN GUIDES, THEIR STORIES, THEIR KNOWLEDGE AND OPPORTUNITIES FOR COMMUNITY LEVEL SUSTAINABLE RESOURCE MANAGEMENT

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ABSTRACT

Resource management is a complex endeavor, usually completed through Western scientific pedagogy, frequently with little input from local stakeholders. Resource managers are increasingly experiencing failures as a result of this model, and are increasingly seeking alternative sources of knowledge as well as non-traditional forms of policy development, governance and management. Examples from across Canada will be used to illustrate the importance of local traditional ecological knowledge, incorporating local stakeholders and ensuring a co-adaptive management approach to ensuring sustainability of resources. In the Caribbean, accessing traditional ecological knowledge for resource management purposes has been conducted sparsely. This paper outlines a conceptual framework for my PhD dissertation in which I will access knowledge held by pioneering Bahamian Bonefish (*Albula vulpes*) guides, and apply their knowledge through participant GIS to local resource management, working with local stakeholders. Documenting knowledge, stories and experiences these Bahamians have had, will work to empower small island communities, legitimize the Bonefishing industry, enhance local stakeholder involvement through participation in resource management, and ultimately foster greater resource sustainability. Efforts put forth by pioneers of the Bonefish industry have worked to cement a tourism industry generating upwards of \$141 million USD annually, and their contributions need to be recognized. Chronicling the history of Bahamas Bonefishing through accessing pioneering guides will preserve their role in history, provide potentially vital local knowledge about local resources unattainable elsewhere, and through participant GIS, lead to greater awareness about the importance of local conservation measures.

KEYWORDS: Traditional Ecological Knowledge, Bonefishing, Bahamas Tourism, Resource Management, Participatory Approach, Co-Adaptive Management, Sustainable Resource Management

WHY TALK TO FISHERS? THE IMPORTANCE OF INCLUDING LOCAL FISHER'S PERCEPTIONS AND KNOWLEDGE IN ECOLOGICAL RESEARCH: A DEMONSTRATION PROJECT IN SOUTH ELEUTHERA.

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ABSTRACT

International conventions are pushing a conservation agenda and to meet larger scale conservation challenges, through the Convention on Biological Diversity and the International Union for Conservation of Nature, more areas will become protected. International commitments to marine protection include people as part of the system in an ecosystem based management approach. Social dynamics has not always been a priority in many traditional Marine Protected Area (MPA) plans but in recent years, it is becoming a priority. Some protected areas may be considered to be a biological success, having met certain objectives, but may be viewed socially as failures and lack local support. It is imperative that the fishers' perspectives to spatial closures and their involvement are included in all planning and management stages to maximize success. As more areas are considered for protection, more fishers and communities will be impacted in some way. Fishers have local ecological knowledge across a spatial and temporal scale that for many areas, scientific data may be limited. Local fishers can provide information on species, habitat quality, temperature changes, mapping, and spawning aggregation sites. Many local fishers have conservation based approaches and concerns, and will support certain types of closed and protected areas, but are more willing to do so if they are included in marine planning. Results from similar projects undertaken in Tanzania and Canada by the author will support the importance of this work. In South Eleuthera, a proposed MPA is in the early stage of planning. Thus, there is a need to understand the importance of the area, and what the impact and potential support would be of an MPA to local fishermen. This site has been proposed for 10 years with no management plan and the local community has not asked for it. There is little tourism in South Eleuthera, local subsistence fishing, and little funding for management and enforcement; local support, involvement, and compliance is vital. It is also important to focus on the issue of sustainable fisheries along with the conservation of biological diversity as many local communities rely on fishing as their main income and food source. During fall 2013, a pilot project interviewed 9 local fishermen from South Eleuthera. The semi-structured interview process included questions on basic demographics, biological, spatial and temporal changes, mapping, attitudes and perceptions to conservation, and alternative livelihoods. Qualitative and quantitative data were collected. All fishers interviewed said that fisheries and conservation are compatible goals, and respondents provided information on perceived size and abundance changes. The results from this pilot study will be discussed, along with further research in 2014. With further collaboration from local stakeholders, this research is expected to be a demonstration project that could be used throughout the Bahamas at locations that are in the pre-implementation stage of an MPA, and will be important for the planning and management, and potential for local support as The Bahamas moves towards their goal of conserving at least 20% of their marine and coastal environments through MPA systems by 2020.

KEYWORDS: sustainable fisheries, fisher's perceptions, food security, conservation, local knowledge

GOVERNING THE COMMONS IN EXUMA: FROM ELINOR OSTROM TO EXUMAATLAS.ORG

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ABSTRACT

The ethnographic fieldwork and documentation research conducted in Exuma in the context of the project a Sustainable Future for Exuma brings attention to three relevant topics directly linked to strategies of governing the commons: potable water management, fishing, and land tenure and administration. Each of them topics represents essential resources. Their immediate accessibility stresses the tension of three main intervening forces: the claim for ecological conservation, the strong connection of these issues with historical and cultural patterns and traditions, and their relevance for local livelihood. Furthermore, this tension is exacerbated through the identification of each of these forces with existing human stakeholders and with questions of identity, freedom, self-esteem and informality, turning these topics into political and social inquiries. The level of complexity of this situation challenges the efficacy of exclusively created through the use of traditional tools of public administration, such as privatization and institutional control, which are strictly implemented through the inaction of rules and police enforcement. This suggests that a sustainable and resilient implementation may instead require reaching the sort of negotiated and flexible frameworks for “governing the commons” investigated by those such as Nobel Prize Winning economist Elinor Ostrom. This paper has two aims. First, to explore the possibility of using Ostrom’s framework and the case studies she explores as a source to inspire changes in order to make official practices more inclusive, culturally grounded and negotiated tools of governing the commons in the islands. Second to propose an online platform, the exumaatlas.org website, as a preliminary attempt in constructing a shared image of Exuma, a collectively-owned platform open to public contribution where popular and scientific knowledge can coexist.

KEYWORDS: Governing the Commons, Elinor Ostrom, ethnography, empowerment, resource management

APPLYING ECOLOGICAL URBANISM: THE AGENCY OF ETHNOGRAPHY FOR SUSTAINABLE PLANNING AND DESIGN

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ABSTRACT

In his introduction to the Ecological Urbanism book, first published in 2010, Mohsen Mostafavi argues that we need to view the fragility of the planet and its resources as an opportunity for speculative design innovations rather than as a form of technical legitimation for promoting conventional solutions. In other words, design provides the creative key to connect ecology with human settlement in a way that is not in contradiction with its environment. Inspired by Felix Guattari's concept of ecosophy, ecological urbanism works simultaneously on the level of the environment, society, and human subjectivity. If we are to develop a system for design and planning which embraces such a broadened view of ecology "beyond but including environmental concerns" we need to find ways and systems for "tracing associations" in the words of Bruno Latour. Intimate local associations need to be understood in order to anticipate futures that are more likely to be sustainable. Anthropology offers designers, planners, and ecologists, a set of valuable tools useful for tracing and, ultimately, rebuilding associations. A collaborative ethnographic project currently underway in The Bahamas considers the distinctive landscape of Exuma with multiple instruments and with a worldview that is fluid in scale and disciplinary focus. The aim is to rebuild associations into proposals that are socially, aesthetically, as well as environmentally, sustainable.

KEYWORDS: Ecological Urbanism, Ecosophy, Anthropology, Bruno Latour, Exuma

SOUTH FLORIDA/BAHAMIAN ECOREGION: A FUTURE FOR SHARED RESOURCE CONSERVATION AND OUTREACH

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ABSTRACT

The South Florida Bahamian Atlantic Ecoregion is defined by a shared biological, physical and oceanographic setting. Separated by only a maritime border, the marine environment of the two contiguous political jurisdictions represents a shared resource. Though operating under the institutional boundaries of the state of Florida, many of the marine and coastal management issues addressed by the Florida Sea Grant College Program transcend the maritime border between Florida and the Bahamas. Florida Sea Grant operates through the University of Florida under a three-tiered approach of Research, Extension & Communication to promote a sustainable marine environment and economy. At the statewide level, faculty specialists and researchers yield research results that can be applied to industry, science and/or management. County-based extension faculty (agents) address priority issues on the local level through a variety of research-based outreach and educational activities. Collectively, this process oriented approach results in a diverse array of regionally tailored approaches to address complex problems. Community partnerships and stakeholder engagement are at the heart of any successful outreach activity and county extension agents often utilize volunteer Citizen scientists (CS) to maximize resources and efficiency. Formalized citizen science projects allow a committed group of stakeholders to get involved with the management or restoration process whilst providing the extension agent a targeted audience for the transfer of knowledge, skills, and the promotion of behavior change. Within the realm of fisheries, trained citizen scientists have assisted Florida Sea Grant on projects concerning goliath grouper, derelict trap removal, and habitat restoration, to name a few. Goliath Grouper- Florida Sea Grant and the Fish and Wildlife Conservation Commission have partnered with CS to collect single-point data on goliath grouper throughout South Florida. These Great Goliath Grouper Counts provide fishery managers with a snapshot of goliath grouper numbers within a constructed time frame and location. When combined with more robust data collection studies, these citizen science counts provide a picture of how the goliath grouper population is changing through time. Derelict traps- South Florida supports three commercial trap fisheries for the blue crab, stone crab and spiny lobster. In recent years, there has also been more awareness of the impact derelict traps have on marine life, the environment and public safety. South Florida Sea Grant Agents have taken the lead in identifying debris hotspot locations and with the assistance of trained CS volunteers, thousands of derelict traps have been removed from south Florida waters during seasonal closures. Habitat restoration- Habitat restoration and enhancement is one of the easiest and most rewarding activities in which volunteer citizen scientists can participate. In south Florida, trained CS volunteers have assisted in the rearing and out-planting of scallop and oyster spat, the collection and planting of red mangrove propagules, as well as participating in habitat monitoring programs. Citizen scientists and community outreach activities are critical tools for successful bottom-up management activities. Many of these complex issues are shared by Florida and the Bahamas alike, and continued and future success for both should continue to utilize stakeholder engagement and participation.

KEYWORDS: Citizen Science, Outreach, Restoration

MISADVENTURES OF MARIA THE HUTIA IN PERFORMANCE: IT'S A TEAM EFFORT

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ABSTRACT

Project Goals: To teach science and conservation through art, To create characters via music, To collaborate with others for a common goal, To discover that the Bahamian ecosystems are tied in with the rest of the world, To create “whole world” connections, such as people/ ecosystems/ issues/ solutions, To share the project with the people of San Salvador in a public performance. Parts of the Children’s book Misadventures of Maria The Hutia had been used by BREEF summer programs at SeaCamp before. This year’s challenge was to adapt it into a public performance by 50+ children of San Salvador aged 8 through 15. A playscript was created using text from the book, tailoring it to animals discussed in other parts of SeaCamp. All campers received their own copy of the book to keep. They read it throughout the week and took daily quizzes. In the story, Maria unexpectedly falls into the sea, which provided the theme for daily swim safety tips. Maria’s journey describes her migration to strange new places. Since this year’s theme was “Migration” it was important for the children to learn that animal migrations go beyond borders and ecosystems, and what better way to find a performance equivalent in music and choreography, specifically in a phenomenon common to every culture on Earth: chanting and group movement. With little to no performance experience but plenty of talent at hand the challenge was to keep over 25 high-energy children at a time busy and focused. Only three section rehearsals and one final rehearsal of approximately one hour each were available, so most of the time was spent learning and practicing the international chants and animal choreography. Speaking roles were taken over by the facilitators, while the children provided the music and movement. The chants were chosen to represent various countries, and in many cases provided a direct first contact with a different culture for the children. A special outing went to a local beach to collect garbage that could be transformed into percussion instruments, thus combining conservation and art activities. The children found plenty of barrels for drums and bottles for maracas. The performance took place at the weekly Thursday night Goombay celebration at Graham’s Harbour on San Salvador in front of an appreciative audience that included the Island Administrator Mr. Gordon Richie. This live performance on stage was a highlight for the campers and community. The day after the performance the children learned about the origins of the chants. Since almost all of the chants came from places outside the Caribbean the children located these places on a globe and made a “whole world view” connection: animal migrations cross political borders, and conserving nature is not just a local issue but needs to be a worldwide effort. Like animal migrations music and theatre transcend ecosystems and can provide a common ground for people from different cultures. The campers learned a whole world view in addition to honing their swimming and snorkeling skills.

KEYWORDS: Performance, collaboration, connections, migration, conservation

THE NAGOYA PROTOCOL, ACCESS, BENEFIT SHARING, THE BAHAMAS

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ABSTRACT

The Nagoya Protocol, under the Convention on Biological Diversity, is generally seen to be beneficial for developing countries where research and development on natural resources takes place. This is notable for many Caribbean countries which are biologically diverse, heavily dependent on their natural resources for tourism, and ecologically vulnerable. The Nagoya Protocol in principle can provide monetary and nonmonetary benefits to these types of countries. The Protocol is important for The Bahamas as a vast amount of research takes place within its borders, without substantial benefits accruing to the country. A number of these research projects have led to patent applications and grants. At the same time, The Bahamas suffers from institutional fragmentation, a lack of awareness of the value of its natural resources, and already struggles to enforce existing environmental laws. The Bahamas has agreed to apply for funding from the Global Environment Fund in order to ratify and implement the Nagoya Protocol. This presentation examines what the Nagoya Protocol could mean for The Bahamas, and some options available to the country for its implementation.

KEYWORDS: Nagoya Protocol, Access, Benefit Sharing

THE EPHEMERAL ISLANDS - THE NATURAL HISTORY OF THE BAHAMAS PAST, PRESENT AND FUTURE. POSSIBLE TOPICS CAN INCLUDE: CLIMATE CHANGE, GEOLOGY, MARINE AND TERRESTRIAL ISLAND ECOLOGY.

A Bahamas Native Flora Society: The Value and Importance of Native Plants

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ABSTRACT

The creation of a Bahamas Native Flora Society will bring valuable attention to the Bahamas native plants and the wildlife those plants support. From migratory birds to the plethora of insects, the native plants function as the grocery store and apartment building to animal life. The native flora represents the natural history and beauty of the islands; the real Bahamas. As an island nation spread over a large distance, there are challenges with travel for a national organization to meet. The concept of having BNFS chapters in the more populated islands would allow for more frequent meetings. A national meeting could happen once or twice a year in Nassau or the Leon Levy Native Plant Preserve. Logistically, BNFS Island Chapters could be established in Abacos, Andros, Eleuthera, Exumas (and MICAL) and New Providence. There are many practical and cultural advantages to the use of native plants in government, commercial and residential ornamental landscapes. It is unfortunate the high use of exotic, and in some cases highly invasive, plants in the new large resorts and projects. Most of these ornamental plants are imported from other countries. THE BNFS could promote and encourage the increased use of native plants in these urban landscapes, thus showcasing the Bahamas native flora. There could be an effort to have government require a specific percentage of native plants in new project design and insure the percentages are complied with. The minimum native plant percentage for new development projects has worked successfully in Florida to increase the use of native plants in landscapes. Working with educators, there are many things that BNFS members could do in schools to increase appreciation and knowledge of the Bahamas native flora with young Bahamians. Classroom programs and field trips could be developed that highlight the historic role that the native plants in early Bahamas human life, including ethnobotany and bush medicine. The value and importance of the native plants in the Bahamas is significant. The possibilities of a Bahamas Native Flora Society (BNFS) to help increase awareness of these plants would be meaningful for the country. BNFS would work under or partner with private and public organizations that have similar missions, like Bahamas Ministry of Environment and Housing, BNT and The Nature Conservancy. BNFS could use the native flora to connect the Bahamas historic past with the future. The BNFS will benefit the Bahamas for many generations to come.

KEYWORDS: native plants “ native plant communities - plant conservation - natural heritage

ENDEMIC VASCULAR PLANTS OF THE BAHAMIAN ARCHIPELAGO

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ABSTRACT

The Bahamian Archipelago consists of approximately 2400 islands occurring in the Atlantic Ocean off the coasts of Florida, Cuba, and Hispaniola. In 1982 Donovan Correll and Helen Correll published the most current synopsis of the floristic diversity of this island chain. Their publication cited a total of 1371 vascular plant species of which 114 seed plants were listed as endemic to the archipelago (~ 8 % of the native flora). In the last 30 years, additional herbarium collections and taxonomic studies have shown that a number of species previously indicated to be endemic to these islands also occur in other regions or have been taxonomically merged into other species. The current number of species considered endemic to the Bahamian Archipelago is 89 (~ 6 % of the total flora). There are 50 endemic species that have a known distribution on one (31 species) or two island groupings (19 species). Biogeographical analyses of endemic plant distributions shows three distinct clusters of species: southern, central, and the northern islands, with a fourth cluster that includes islands with a small area and one medium size island that seems that has been underexplored (i.e., Little Inagua). We anticipate that understanding the conservation status of endemic species and their distributions will help to develop legislation to preserve this Bahamian natural heritage.

KEYWORDS: endemic, rare, redlist, policy, plants

INTERPOPULATION VARIATION IN CONDITION DEPENDENT SIGNALLING: PREDATION REGIME AFFECTS SIGNAL INFORMATION

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ABSTRACT

Evolutionary theory predicts that conspicuous ornaments and structures such as the bright colors and elaborate tails of peacocks reflect the health of the signaler. Therefore, to function as indicators of signaler health these ornaments must maintain a proportional relationship between the degree of signal expression and the signaler's health. These indicator traits are called condition dependent signals. However, because theory also predicts that it benefits the signaler (e.g., peacock) to exploit receiver (e.g., peahens) preferences by exaggerate their signal, essentially lying about their quality, and eroding the predictive ability of their signals. Existing research suggests that signaling costs such as predation risk, or energy costs must prevent low viability individuals from expressing disproportionately conspicuous signals (i.e., lying). However, given widespread ecological variation in signaling costs such as predation risk, it is likely that the strength of condition dependence varies concomitantly. In this study, we assess the effect of variable signal cost, predation risk, on the strength of condition dependence among 15 wild populations of Bahamas mosquitofish (*Gambusia hubbsi*) from Abaco Island, The Bahamas, that use colorful dorsal fins in courtship displays. We found that the signal of interest, fin coloration, predicted body condition. However, this relationship was only apparent in populations subject to predation costs from piscivorous fish. In contrast, populations without predators showed no signs of condition dependence suggesting that variation in ecological costs has important effects on communication system evolution. In summary, while our study addresses only one type of sexual signal (coloration), uses only one estimate of male quality/health (body condition), and focuses on a single type of signaling cost (predation), we confirm a crucial role for ecological signaling cost in communication. Understanding how ecological variation affects basic the communication system of wild populations is an important aspect of predicting the fate of organisms faced with diverse and dynamic ecological challenges in the future.

KEYWORDS: Honest signaling; animal communication; signal cost; sexual selection

ANALYSIS OF THREE SEDIMENT CORES FROM SAN SALVADOR ISLAND, BAHAMAS: A LANDSCAPE RECONSTRUCTION OF LATE HOLOCENE HUMAN DISTURBANCE AND PALEOENVIRONMENTAL CONDITIONS

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ABSTRACT

We are conducting a collaborative archaeological and paleoecological investigation of San Salvador Island, Bahamas. We have obtained three different sediment cores from various parts of the island. Pollen and charcoal were counted in each core to reconstruct past vegetation and fire history. The first core is 57 cm long and was obtained from Triangle Pond on the northwest corner of San Salvador near a Lucayan archaeological site. The basal sediment is sand and turns to organic peat from 54-35 cm. Between 55 and 45 cm, buttonwood mangrove (*Conocarpus erectus*) and black mangrove (*Avicennia germinans*) dominate the pollen spectrum. From 45 to 35 cm, saltwort (*Batis maritima*) and glasswort (*Salicornia sp*) pollen dominate. At 35 cm depth, the sediment becomes calcareous mud and there is a distinct spike in charcoal particles. The charcoal spike is strongly suggestive of nearby activity by Lucayans. Above 35 cm, saltwort and glasswort pollen decline, as red mangrove (*Rhizophora mangle*) and particularly black mangrove, pollen become more abundant. Between 25 and 20 cm, pollen from hardwood coppice species declines as pollen from disturbance species increases. The second core is 50 cm long and was taken from Six Pack Pond in the center of the island. The sediment in this core is relatively uniform calcareous mud with small variations in color. Below 30 cm, the pollen spectrum is dominated by buttonwood mangrove and pollen from species in the eucalyptus family (*Myrtaceae*) along with pollen from other hardwood coppice species. Between 30 and 20 cm, Myrtaceae and coppice pollen declines and pollen from disturbance species increases coincident with an increase in charcoal particles. The third core measured 86 cm and was taken from Little Lake on the north end of the island. The sediment in this core is calcareous mud with several variations in color. From 85 to 60 cm, the pollen spectrum is dominated by red and buttonwood mangrove. Above 60 cm, buttonwood pollen continues to dominate as red mangrove pollen declines. Between 30 and 20 cm, pollen from disturbance species increases coincident with an increase in charcoal particles. Many of the changes in pollen flora and charcoal in the three cores appear to reflect local, rather than island-wide shifts in plant species abundance and fire frequency. These shifts may be related to changes in water level and/or salinity in each water body. However, in all three cores there is a decline in hardwood coppice pollen just before an increase in pollen from disturbance species. This shift occurs at a depth of between 20 and 30 cm in all three cores and may reflect land clearing associated with the plantation period on the island. Triangle Pond shows a charcoal spike not found in the other two cores. This spike appears deeper in the sediments than the increase in disturbance species and may reflect Lucayan activity from the nearby archaeological site.

KEYWORDS: Paleoecology, Lucayans, fire, human disturbance

THE NATURAL HISTORY OF THE LEON LEVY NATIVE PLANT PRESERVE

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ABSTRACT

The Leon Levy Native Plant Preserve (The Preserve) is a 25-acre national park located along Banks Road, south of Governors Harbour, Eleuthera. The Preserve's mission is to showcase vascular plants native to the Bahamian Archipelago, plants used in traditional Bush Medicine, and provide a location and programs for outdoor early childhood education. Apart from these three primary missions The Preserve is dedicated to studying its natural history. Since opening in March 2011, The Preserve has commissioned a series of studies by scientists in different areas of natural history at the Preserve. Surveys have been conducted in Botany, Entomology, Herpetology, Ornithology, Geology, Hydrology, and Climatology.

KEYWORDS: Botany, Entomology, Herpetology, Ornithology, Geology, Climatology.

THE LEON LEVY NATIVE PLANT PRESERVE: 3 YEARS OF NATIVE PLANT CONSERVATION

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The Leon Levy Native Plant Preserve first opened to the public on March 24th, 2011 as the first National Park on the Island of Eleuthera. Charged with the mission to highlight native plants, showcase bush medicine, and promote early childhood education, The Levy Preserve covers 25 acres and supports more than 270 species of native plants. The Preserve functions as a site for leisure and adventure seeking for locals and visitors to Eleuthera, in addition to conducting education programs for primary and high school students. The Preserve recently underwent Phase 2 development, which included the addition of a Climatology station for monitoring weather data, a Freshwater Garden to showcase native freshwater species, an Edible History section to depict the history of The Bahamas through what people ate, and an Economic Botany trail featuring economically important species to The Bahamas. In its third year of operations, The Preserve continues to expand its living collection of native plants and has welcomed over 10,000 visitors through its gates.

KEYWORDS: Leon Levy Native Plant Preserve

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THE VALUE OF OUR ECOSYSTEM

Ephemeral Experiences: Mobility and Ecological Values

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ABSTRACT

This paper looks at the ways mobility informs ecological values. In opposition to a positivist, engineering-oriented transportation planning approach, a mobilities analytical framework attempts to understand the way people and things move around a given region using cultural and social inquiry to provide insights into how mobility constructs everyday life. Ethnography and participant observation can result in greater socio-cultural understanding of a given geography and how acting on a transportation system can be understood to have a desired social-cultural outcome. This analytical framework is applied to the focus of our fieldwork, the Exuma Cays Land and Sea Park in Exuma Archipelago. Within much of The Bahamas, Nassau is central to much inter-island transportation, there is stark social stratification by travel mode, as well as tendencies towards informality, especially in Exuma. Within this existing set of logistical practices, examining how different forms of air, sea, and land travel ploy across the geographies of The Bahamas gives context to the various themes from our ethnography. Each travel modality generates its own unique experience of time and space. This paper will seek to correlate a general set of ecological values generated from the sensory and emotive experience of The Bahamas resulting from these practices. Results show how certain forms of mobility in The Bahamas and Exuma, especially those forms characterized by privatization and high speed, can contribute to social segregation and perpetuation of an understanding on ECLSP as being depopulated and pristine. Drawing on existing literature in environmental studies and anthropology, this paper will argue that these conceptions of the environment may lead to certain ecological-political agendas. This literature will be compared and contrasted to results from ethnography in Exuma Cays Land and Sea Park. Finally, this paper will speculate on how changes in transportation planning in Exuma could be used as a mechanism for environmental planning and social development.

KEYWORDS: Mobility, Ecological Values, eco-tourism,

EFFECTS OF TOURISM ON SIZE AND GROWTH IN THE ALLEN CAYS ROCK IGUANA (*CYCLURA CYCHLURA INORNATA*)

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ABSTRACT

The Allen Cays Rock Iguana is endemic to only two small islands in The Bahamas. On the large beach on one of the cays (Leaf Cay) iguanas have extensive contact with humans. Each day powerboats arrive with ecotourists (up to 150 people per day) to feed the iguanas that gather on this beach. This study investigated the impact that this interaction may be having on the size and growth of the iguanas over the last 20 years, by comparing data from iguanas living on or near the beach versus those living on the opposite side of the island away from tourist interaction. Over the past 20 years, the average size of the largest iguanas on Leaf Cay has decreased (more so in males than females). We hypothesize that the decline in body size is due to the removal of the larger males by humans. However, iguanas grew faster and were relatively heavier (i.e., had higher body condition) in areas with human impacts than in areas without human impacts. Although this supplemental feeding seems to have a positive effect on growth and body condition, its effects on other life history traits (e.g., survival and reproduction) are not yet clear.

KEYWORDS: Effects of tourism on size and growth in the Allen Cays Rock Iguana (*Cyclura cychlura inornata*)

THE VALUE OF MARINE ECOSYSTEM SERVICES IN THE BAHAMAS: WHAT HAVE WE DISCOVERED AND HOW DO WE USE THIS INFORMATION TO INFORM POLICY AND MANAGEMENT

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ABSTRACT

Economic values are increasingly recognized as essential pieces of information for justification of conservation spending, including protected area management or coastal zone management. They are also important for informed decision-making, for example as a tool to assess the costs and benefits of a potential action, the potential losses from a threat, the relative merits of different projects, the correct level of funding or compensation and sources of sustainable and equitable funding. Here I present the results from three major analyses of economic values of marine ecosystems in the Exuma Cays. Firstly, a conceptual model of the economic impact of the Exuma Cays Land and Sea Park was devised, followed by estimation of the main impacts. Secondly, benefits transfer was used to estimate the annual ecosystem service flows from the major ecosystem services generated by seven habitat types throughout the Exuma Cays. Thirdly, contingent valuation was used to assess the willingness to pay of visitors to the area, for a number of different improvements, including world heritage designation and highly trained guides for eco-tours. Next, a multi-criteria analysis was undertaken of 18 potential conservation actions related to conservation, ecotourism, fisheries, and sustainable development. Several criteria were explored, including costs, benefits, and feasibility, as well as the distribution of costs and benefits between stakeholders and across time. The projects that are recommended based on these results are presented. Finally, future research needs are discussed in the context of future policy decisions.

KEYWORDS: economic value marine ecosystems policies

STRENGTHENING BIRD-BASED TOURISM AS A CONSERVATION AND SUSTAINABLE DEVELOPMENT TOOL

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ABSTRACT

Limited opportunities for income generation often drive local communities to engage in activities that degrade the natural resource base. Ecotourism is one alternative way to raise incomes in communities living close to biodiversity-rich areas, while helping to conserve the natural environment. The market for Bird based tourism has been growing in the United States and since 1983 the number of bird watchers in has increased by 332% and more than 17 million bird watchers are willing to travel for birding activities. Audubon and the Multilateral Investment Fund (MIF), a member of the Inter-American Development Bank (IDB) group have partnered to create a niche, high-value sustainable birding tourism program in the Americas including Andros Island and Inagua in the Bahamas. The program uses bird-watching to create sustainable jobs in communities while simultaneously protecting biodiversity and natural resources.

KEYWORDS: Ecotourism, sustainable development

THE IMPORTANCE OF THE BAHAMAS TO NORTH AMERICAN SHOREBIRDS

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ABSTRACT

Many North American shorebirds make extraordinary migrations from breeding areas in the middle and northern latitudes to southern wintering areas. These long distance migrations are energetically expensive and shorebirds often arrive at stopover or wintering sites with depleted fat reserves and in need of high quality food and foraging habitat. During the past 4 years, the National Audubon Society, Bahamas National Trust, and partner organizations have identified sites that support significant concentrations of shorebirds during migration and winter. This work has added important new information to our understanding of the importance of The Bahamas to non-breeding shorebirds. This information is very important to developing and implementing successful conservation strategies.

LOSS OF COASTAL MANGROVES ON THE ISLAND OF NEW PROVIDENCE, THE BAHAMAS

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ABSTRACT

The Mangrove forests, formerly called the swamp lands, of the Bahamian islands have been subjected to needs of a growing population and have been lost in the face of unsustainable development. These areas are historically prime real estate for development: filled in to create land, dredged for marinas and fragmented for roads. These areas are also utilized for fishing. The functionality of these degraded mangroves is reduced and habitat for fish is diminished as well. These mangroves function as a nursery habitat for the reef fish surrounding the islands of the Bahamas and protect the investments of those who utilize these areas. A reduced fish habitat impacts the overall quality of the fishing industry. Given the important nature of these habitats each time the ecosystem is degraded the fishing industry feels the impact; albeit long term. The island of New Providence is no different. The city of Nassau houses roughly 2/3's of the Bahamian population. The island of New Providence has seen many key mangrove habitats destroyed, fragmented and degraded during this time. The combination of habitat degradation, increased populations and increased fishing pressure over the last 50+ years has impacted the quality of the fish on the reefs surrounding New Providence. This presentation aims to quantify the area of fisheries habitat lost on the island of New Providence as a result of unsustainable development and show projects and programmes that aim to change the fate of these ecosystems.

KEYWORDS: Mangroves, Coastal, Loss, New Providence

ENVIRONMENTAL SENSITIVITY INDEX (ESI) MAPPING FOR THE BAHAMAS: METHODS FOR ESTABLISHING A NATIONAL COASTAL DATABASE FOR OIL SPILL RESPONSE AND PROTECTION OF COASTAL RESOURCES

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ABSTRACT

Environmental Sensitivity Index (ESI) maps provide a concise summary of coastal resources that may be at risk if an oil spill occurs nearby. Examples of coastal resources include biological resources (such as birds and shellfish beds), sensitive shorelines (such as mangroves and tidal flats), and human-use resources (such as public beaches, resorts and parks). When an oil spill occurs, ESI maps can help responders meet one of the main response objectives: reducing the environmental consequences of the spill and the cleanup efforts. Additionally, ESI maps can be used by planners before a spill happens to identify vulnerable locations, establish protection priorities, and identify cleanup strategies. This paper serves to establish the conventions used in ESI map development for The Bahamas using a spatial dataset with citizens contributing photos and information about their local coastal resources. Some of these mapping conventions were based on the US-NOAA ESI mapping protocols for the coastal United States, particularly the Florida Keys, but much information is missing for the coastal western Bahamas. The major challenge for The Bahamas is the lack of current and quantitative information on critical species distributions. The proposed methods allows a public-private partnership to build a national ESI spatial database to prepare and respond to oil spills effectively.

KEYWORDS: Coastal Ecology, Oil Spill, Citizen Science datasets, GIS mapping

CLIMATE CHANGE AND ITS IMPACTS ON THE BAHAMAS

Origin of Holocene Strandplains of The Bahamas: Influence of Tropical Storms, Sea-level Rise, and the Implications of Pending Climate Change

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ABSTRACT

Late Holocene strandplains are common landforms on the Mid-Atlantic and Gulf coastal plains of North America and throughout The Bahamian Archipelago. In The Bahamas, beach-ridge sets develop seaward of older eolian dune ridges and have added considerable habitable area to the islands over the last 4000 years. We investigate the origin of these strandplains and the influence climate and sea-level rise (SLR) have had on their development. The surficial and subsurface geology of 6 strandplains on Little and Great Exuma, and Eleuthera was studied using sedimentologic and stratigraphic methods, ground-penetrating radar (GPR) imaging, and radiocarbon geochronology. Bahamian strandplains consist of up to 20 semi-lithified beach ridges that are catenary or zetaform in plan view, and anchored to Quaternary headlands at one or both ends. GPR radar-grams confirm that ridges are founded on erosional scarps within foreshore or backshore sands. Outcrops of these basal sediments reveal sedimentologic and paleontologic evidence for a beach origin. In a regime of net progradation, scarps produced by moderate storm erosion cause trapping and aggradation of wind-blown sediments along the length of the contemporary shoreline. Consequently, most beach ridges are capped by dunes that can appreciably increase their heights. Elevations of exposed foreshore limestones and of radar-gram contacts between beach and eolian sediments are within +2 m relative to mean sea level. Because normal tidal variability and storm surges can result in deposition at these elevations, a eustatic sea-level highstand is not necessitated. Whole-rock radiocarbon dates for foreshore limestones and for eolian ridges span 4100-700 cal yBP, with most dates clustering between 1200-700 yBP. This interval coincides with a <3000 yBP interval of increased storminess, established through paleotempestology, and terminating within the Medieval Warm Period. We hypothesize that the more storm-conducive climate, coupled with modest SLR rates and plentiful carbonate sediment, predisposed the archipelago to strandplain formation. Short-lived highstands during times of frequent storm-wave constructional conditions resulted in deposition of elevated beach sequences. These beaches were subsequently scarped during erosional phases and later evolved into foredune-capped ridges of the strandplain. Because most strandplain development proceeded in a regime of relatively slow SLR, predicted future rates of accelerated SLR pose a threat to these coastal landforms. Bahamian strandplain ridges are typically of modest height and are easily over-topped by storm surge. When this is coupled with accelerated SLR, strandplains are likely to become retrogradational and eventually erode. Coastal development and management of strandplains, therefore, should proceed with forethought and caution.

KEYWORDS: sea-level rise, paleoclimate, Holocene stratigraphy, geomorphology, coastal vulnerability

AN INTEGRATED RECORD OF THE GEOMORPHOLOGY, PALEOTEMPESTOLOGY AND PALEOCLIMATE FROM SHAD POND, A SHALLOW LAGOON ON SOUTHERN ELEUTHERA, BAHAMAS

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ABSTRACT

The impact of sea level and climate change on coastal landscapes in The Bahamas has been profound and is on-going. In addition, the effect of cyclonic storms on the islands from a geomorphological as well as an ecological viewpoint is not well understood. We integrated records from sediment cores and penetrating radar surveys to examine the geomorphology, paleotempestology, paleoclimatology, sedimentology, and paleobiology of Shad Pond, a shallow coastal lagoon on the southern tip of Eleuthera, in order to develop an integrated record of coastal response to sea level and climate changes. Sediment cores were taken at three sites along shore-normal transects within Shad Pond. Two basal peat layers were collected from the most distal site from the present barrier and the deepest portion of the lake, yielding radiocarbon ages from ~5,000 cal yBP to ~3700 cal yBP. Proxy records were measured and analyzed on all cores. Sediment composition and granulometry, loss on ignition (LOI), X-ray fluorescence (XRF), as well as pollen and microfossil analysis, provides a comprehensive record of the paleoenvironmental history of the island. Loss on ignition indicates that Site 1, which was the most distal from the coast, was also the most organic rich. In general, organic matter and carbonate content tracked grain size and composition in all cores. High resolution XRF scans of Ca and Sr at Site 1 show elevated levels around 3700-4000 cal yBP that correlates with the top of the peat layer, but the levels vary at Site 3, which was most proximal to the shoreline. Additional XRF measurements of Fe indicate a dust record that is described regionally throughout the Caribbean. In addition to the core records, dune transects and GPR profiles indicate a phased history of the pond, beginning with initial stages as an open lagoon dominated by red mangrove (*Rhizophora mangle*), with black mangrove (*Avicennia germinans*) and buttonwood (*Conocarpus erectus*) present. It is likely that Shad Pond was smaller and connected to the ocean before being separated by the emplacement of the fronting barrier complex. The presence of peat indicates that the sea-level-mediated water table had to be stable long enough to allow for the development and spread of coastal mangroves and the accumulation of organic-rich sediment. Subsequently (~3700 yBP), a flux of sand from the seaward source buried the basal peat. As sea level rose, the pond broadened and expanded seaward. The peat may therefore provide a chronological constraint on mid-Holocene sea-level position on Eleuthera, with potentially additional implications for climatic shifts and storminess in the northern Bahamian archipelago during middle Holocene. Hurricane overwash deposits punctuated the algal mat accumulation throughout this time period. Present day conditions are hypersaline with modern mats forming throughout the lake bottom. It is likely that Lucayan occupation was influenced by the position of the shoreline and this lake was probably hypersaline at the time of their arrival and throughout their inhabitation, corresponding with the Medieval Warm Period 1200-1000 yBP.

KEYWORDS: Eleuthera, Hurricanes, Sea Level, Climate

SEA LEVEL RISE IN THE EXUMA CAYS AND NEW PROVIDENCE: PAST, PRESENT, AND FUTURE

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ABSTRACT

Throughout Earth's history, sea level fluctuated due to natural cycles of ice buildup (glacial times) and melting (interglacial times). Presently, as polar ice caps are still melting, sea level is rising by about 4 millimeters per year and the Bahamas are at risk. By 2100, it is estimated sea level may rise as much as 6.6 feet (2.0 meters), which would have a huge impact on the islands of the Bahamas. One way to estimate the impact of future sea-level rise is to assess the impact of past sea-level changes on the Bahamas. The Exuma Cays and New Providence contain preserved fossil reefs, sand shoals, beaches, and dunes that provide insights to geologists of past sea level in the Bahamas. During the past 500,000 years, sea level was the same or higher than today's sea level three times (~125,000, ~330,000, and ~400,000 years ago). During these episodes, sediments that turned into rocks were added to the Exuma Cays and New Providence. These accumulations contain the record of the sea level change. Normally, sea level changes slowly (tens to hundreds of thousands of years) but our data from the Exuma Cays and New Providence indicate sea level can change rapidly (10+ meters within thousands of years, very fast for geologic time scales). Until recently, climate scientists did not accept that this was possible. Cores from the Exuma Cays and New Providence document flooded coastal areas, migrating beach ridges, and reefs buried by marine sands due to this fast sea level change. Although other factors control the long-term sea-level changes, melting ice is the main mechanism that presently causes sea level to rise. Currently, sea level is rising approximately 31 centimeters per century in South Florida. Taking into account the current rates of sea level rise and projecting the effects of ocean warming, polar ice melt, and other factors, sea level may rise 1.3-2.1 feet (0.4-0.6 meters) by 2050 and 4.1-6.6 feet (1.2-2.0 meters) by 2100. A rise of this magnitude would have devastating effects on the islands of the Bahamas. Low-lying coastal areas will be submerged, including parts of New Providence and the Exuma Cays. In addition, with higher sea levels, the spring high tide levels and storm surge levels will also increase. By analyzing a Digital Elevation Model (DEM) using ArcGIS, we can assess the effects of the projected levels on the Exuma Cays and New Providence. All of the islands of the Bahamas will experience some amount of sea level rise by 2100. Therefore, it is imperative that the Bahamas take into account future sea level rise projections when planning future island development.

KEYWORDS: Sea level, climate change, geology, Exumas, New Providence

RESPONSES OF MANGROVE FISH TO CLIMATE CHANGE

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ABSTRACT

Future climate change scenarios for tropical climates are currently predicting an increase in oceanic temperature, an increase in ocean salinity and a reduction in ocean pH. Many marine organisms appear to be quite sensitive to small changes in oceanic conditions, and, in response to changing oceanic environments, fish can experience energetically costly physiological disturbances, or they may choose to seek more favourable water conditions. Mangrove fishes reside in a dynamic and extreme environment within tropical oceans, and also play vital roles in within the marine community, but their responses to future climate scenarios has received relatively little attention. The objective of this study was to quantify the response of mangrove fishes exposed projected future oceanic conditions, and compare physiological and behavioural responses to these different environments. The water quality parameters used included an increase in salinity, a reduction in pH, elevated temperature, and a treatment that combined both increased temperature combined with reduced pH. Water conditions were manipulated by gradually adjusting ambient seawater in the direction of change that exceeds predictions by the Intergovernmental Panel on Climate Change. Blood samples were taken from each fish and analysed for indicators of stress, and behavioural responses were also quantified. Results from this experiment will contribute to our understanding of how performance, and ultimately fitness, of these fishes, will change under future climate scenarios, and which facet of future oceanic environments will be the most challenging for mangrove fishes.

KEYWORDS: Climate Change, Physiology, Behavior, Stress

BIOPROCESSING OF INVASIVE CASUARINA FOR BIOETHANOL PRODUCTION

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ABSTRACT

The invasion of exotics into terrestrial, coastal and marine ecosystems has dramatically increased worldwide over the past decades. Invasive species represent one of the main threats to native biodiversity worldwide and especially to isolated ecosystems such as islands. At the same time, the energy demand from these isolated but human-dominated islands continually increases and becomes more dependent on petroleum importation. Given the rising costs of petroleum-based fuel and dwindling oil reserves, there has been much global debate and research centered on the production of renewable biofuels from lignocellulosic biomass as an alternative or complement to petroleum. The objective of this research is to utilize the biomass of *Casuarina equisetifolia* (Casuarina) in the Bahamas to produce bioethanol from fermentable sugars. Casuarina is native to Australia and has already invaded and thrived in coastal and inland areas of the Bahamas. A strategic and integral plan for the management of this species is thus vital for the conservation of native Bahamian biodiversity. Casuarina represents a non-native feedstock source for bioenergy conversion since it has flourished throughout the islands and current national projects are capitalizing solely on its removal. The processing of lignocellulosic biomass is an emerging field for the production of bioproducts such as biofuels, bioplastics and biobased chemicals that would otherwise be produced by petroleum. The source of lignocellulosic should be cost-effective to harvest and not compete with food sources. With these criteria, this research will catalyze the prolific Casuarina growth into a steady source of biomass feedstock for biofuel production. This integral management strategy has the potential to regulate the abundance of existing Casuarina populations while preventing its further spread into undisturbed native Bahamian habitats. Our approach to conservation and bioenergy conversion represents an innovative method for invasive species management. The biochemical route of Casuarina conversion will employ microorganisms and environmentally benign reagents. Milled samples of Casuarina wood will undergo hydrothermal pretreatment to degrade its lignin and hemicellulose constituents, and allow greater accessibility of cellulose to subsequent enzymatic hydrolysis into fermentable sugars. Analysis of the wood extracts for its lignin, oligosaccharides, acid and organic compound content will be then conducted to evaluate the quantity and quality of these profitable chemicals. Saccharification of Casuarina can provide a favorable substrate for bioethanol production via fermentation pathway. The overall results of this research will provide a dual benefit for native biodiversity conservation and national development of the Bahamas. The viability of this combined ecological and economical approach by means of biomass-to-ethanol could turn into a profitable and sustainable pathway for invasive species management of Casuarina and other invasive plant species throughout the islands of the Bahamas. Ultimately, this study will also help to steer the Bahamas into a direction of energy security by renewable biofuels, which would provide a platform to advance national development in the sector of biodiversity conservation, engineering and biorefinery.

KEYWORDS: Biofuels, Biomass, Casuarina, Invasive, Lignocellulosic

PATCH REEF HEALTH ASSESSMENT USING NEW MAPPING TECHNIQUES AND BIOINDICATORS: A CASE STUDY OF DAVE'S PATCH REEF, EASTERN ANDROS IS., BAHAMAS

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ABSTRACT

Research was conducted January 2012 through July 2013, at a small (3,574.67 m²), isolated back reef area known to Forfar Field Station as Dave's Patch Reef (DPR). DPR is a shallow water, diverse reef ecosystem surrounded by *Thalassia* sea grass beds and sand. It is located approximately one kilometer off the eastern coast of Andros Island, Bahamas, near Stafford Creek, just outside the Andros Marine Park. A detailed map using GPS and Google Map integration was created. The health of the patch reef was assessed using data collected by the Roving Diver Technique. The data was analyzed using macro-invertebrate and fish bioindicators identified in previous studies. Results indicate that the use of Google Maps augmented by on-site GPS control was an easy, yet accurate method to create base maps for similarly sized areas quickly and inexpensively, with minimal training. Major stationary invertebrates such as hard and soft coral, and sponges were mapped and categorized. The biological assessment, based on five factors: 1) reef size, 2) coral and sponge diversity, 3) other macro organism diversity, 4) coral disease, and 5) algae cover, showed that this particular patch reef is in good health, with a moderately high and stable fish and macroinvertebrate diversity. The Roving Diver Technique proved to be quick, easy, inexpensive, and reproducible. In addition to the actual data collected and the assessment done on the reef itself, a secondary purpose was to test new mapping techniques and the relatively untested Roving Diver Technique for collecting reef census data. The researchers hoped that, if each proved satisfactorily reliable, they would offer a new methodology for other baseline and temporal comparison research to be done on similar reefs throughout the area. This method is completely noninvasive, and, as such, could be used within the confines of marine protected areas. This research shows that this methodology is a viable alternative to transect monitoring for reef health evaluation.

KEYWORDS: Reef Health Assessment, Bioindicators

THE INVASION OF THE EXOTICS AND ITS MANAGEMENT

Invasive Vertebrate Threats in The Bahamas: What They Are, Where Do We Go From Here and What Is To Be Done?

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ABSTRACT

Invasive species are increasingly being recognized as growing threat in the Bahamas, most recent examples being the Lionfish and Cane Toad. Substantial evidence documents invasive species severe impacts on global island biodiversity and as the major cause of island species extinctions, behavior change and habitat damage. Invasive vertebrates in particular are identified as the major threat to Caribbean island biodiversity. Invasive species however present a non-traditional set of characteristics that challenge conservation programs, development and financing agencies. Invasive species are cryptic, biological organisms, with impacts sometimes confounded with abiotic factors and human interventions. Invasive species are sometimes entrenched historically in perceptions of local nature, or can be accepted as novel components of ecosystems, and their spread supported by commercial practices. To date as well, most studies of invasive species impacts are biological, but economic or social valuations are few. With an archipelagic geography, extended coastlines, open trade and an expanding tourism economy, and related dependency on ecosystem services, The Bahamas as a Small Island Developing State (SIDS) has especially increasing challenges in identifying and consolidating human, technical and financial resources to overcome invasive species threats. Increasing global experience however demonstrates that technical solutions do exist to remove invasive species threats from islands. In The Bahamas as well a conservation framework exists within the expanding National Land and Sea Park System, the possibility of national (government, NGO and business) and international partnerships and existence of iconic species as Rock Iguanas (*Cyclura sp.*) to incorporate remedial actions and to communicate successes. An update is presented on threat status in The Bahamas, information and capacity gaps, the technological tools used to develop this knowledge, recent regional developments, international technical and funding initiatives that the Bahamas can take advantage of to overcome this threat, restore island ecosystems and associated benefits to the national economy and options for the future.

KEYWORDS: Invasive Species, Capacity, Planning, Funding

MTIASIC BAHAMAS LIONFISH CONTROL PILOT PROJECT: ITS FINDINGS AND IMPLICATIONS FOR LIONFISH MANAGEMENT

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ABSTRACT

Biological invasions pose one of the greatest threats to biodiversity worldwide. To address this issue The Bahamas conducted a pilot experiment to develop control strategies for Indo-Pacific lionfish populations (*Pterois volitans* and *P. miles*) in various habitats. Objectives included: 1) to determine the extent of lionfish colonization in mangrove creeks; 2) to evaluate the effectiveness of different lionfish removal frequencies via netting and spearing on lionfish abundances in a variety of habitats; and, 3) to evaluate the effectiveness of different lionfish removal frequencies on native fish communities in various habitats. We used a combination of belt transects and modified roving diver surveys to assess native fish communities on four islands (i.e. Andros, Eleuthera, northern Exuma cays, and New Providence) in three habitats (i.e. coral patch reefs, mangrove creeks and nearshore recreational areas) over a two-year period. Additionally, lionfish were removed on either a quarterly, bi-annual or annual basis, depending on habitat and island. Key findings indicated that lionfish were not commonly found in mangrove creeks of the central Bahamas. However, when lionfish were present in mangroves, lionfish densities were relatively low, lionfish recolonization rates following manual removals were slow, and lionfish were likely to reside in creeks with high native fish diversity. Similar to other published studies, lionfish consumed both ecologically and economically important native fish species. Lastly, the effectiveness of different lionfish removal frequencies varied depending on habitat, experiment duration and the occurrence of natural disturbances (i.e. hurricanes). Managing lionfish in The Bahamas will require a strategic approach based on the efficacy of removals in various habitats, financial feasibility and national capacity.

THE NATIONAL INVASIVE SPECIES STRATEGY FROM 2003 TO NOW: ITS EVOLUTION AND IMPLICATIONS FOR RESPONDING TO IAS IN THE BAHAMAS

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ABSTRACT

The first National Invasive Species Strategy (NISS) for The Bahamas was developed and approved in 2003. This first NISS was developed through stakeholder collaboration and led by the BEST Commission with support from international agencies focused on invasives, like the Global Invasive Species Programme (GISP), Invasive Species Specialist Group (ISSG) and the Islands Initiative. The work was funded by The Bahamas Government and the Environment Project Fund of the Foreign and Commonwealth Office (FCO) of the British Government. The first NISS built on initial work completed under the Inter-American Biodiversity Information Network Invasives Information Network (I3N) Project in which databases on invasives species, expertise and programmes were developed and made accessible on the Worldwide Web. The 2003 NISS was the first response of the Government of The Bahamas in recognition of IAS as a very real threat to Bahamian biodiversity. It outlined basic concepts of invasion, including mechanisms for control and management. It detailed a Code of Conduct for Government agencies as well as voluntary codes of conduct for specific sectors, such as farms and aquaria. It publicized the first list of known IAS in The Bahamas and recommended twelve basic actions for implementation of the Strategy. This NISS was revised in 2013 and continues the trend of stakeholder collaboration. Its revision was led by the Department of Marine Resources (DMR). The work has been funded by The Bahamas Government and the Global Environment Facility (GEF) under the regional project, Mitigating the Threats of Invasive Alien Species in the Insular Caribbean (MTIASC). The regional MTIASC project was coordinated by the Centre for Agricultural Bioscience International (CABI) in conjunction with the United Nations Environment Programme (UNEP). The 2013 NISS details management objectives related to collaboration, prevention, early detection and response, control, monitoring, education and awareness, research, policy and legislation and economic tools. Key highlights of the revised Strategy include the role of Customs in IAS management and an implementation strategy spanning the time period 2013 – 2023 with a number of ongoing tasks.

KEYWORDS: Bahamas, control, invasive alien species, management, strategy

THE ENVIRONMENTAL AND ECOLOGICAL IMPACT OF CANE TOAD ON NEW PROVIDENCE: INVESTIGATING THE ROLE OF CANE TOAD IN THE CONSUMPTION OF BENEFICIAL/DETRIMENTAL FAUNA

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ABSTRACT

The invasive cane toad, *Bufo marinus* re-classified as *Rhinella marina*, were collected, dissected and their stomach content analyzed. These toads have been observed in the Southwestern District of New Providence, specifically in the area of Lyford Cay. The stomach content analysis of the cane toads examined showed that they consumed primarily invertebrates, vertebrates, and plant materials. The more abundant specimens belong to the order isoptera, hymenoptera, diptera, coleoptera and class gastropoda. The vertebrates consumed were unknown as only bone fragments were observed. Further their stomach contents also contained plant materials and other unknown some of which appear to be dog food. From the results, the food choice consumed was a reflection of prey availability and not prey preference. The beneficial organisms that are part of their diet are not being consumed in proportions that might be detrimental to the environment and many of them might be considered as pest. An important issue in the context of environmental and ecological impact is whether the population is food-limited considering the area to which it is confined. Another consideration is whether the population can be expected to grow further. As for environmental and ecological impacts the cane toad has, it is recommended that efforts be made to continue to reduce their numbers. Cane toad has a metamorphous life history; therefore they have the potential to have environmental and ecological impact in the future. Further if their numbers are not controlled they can impose predation pressure on the invertebrates in the area.

KEYWORDS: Cane toad, Stomach Content

CITIZEN SCIENCE AND COMMUNITY INVOLVEMENT AS A TOOL TO MANAGE INVASIVE CANE TOADS (*RHINELLA MARINA*) IN THE BAHAMAS

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ABSTRACT

In early August 2013 it was confirmed that a “new invader” the Cane Toad aka Marine Toad (*Rhinella marina* formerly *Bufo marinus*) was found on the western end of New Providence. It was first thought the appearance of a single cane toad may have been a waif, but based on further sightings, and evidence of breeding within wetlands confirmed the presence of the introduced invasive species. The cane toad is not just any invasive species but a very toxic introduced species able to produce toxin from the parotoid glands lying just behind its eyes and capable of killing small pets and causing severe skin reactions in humans. All stages of the Cane toad’s life-cycle (i.e. eggs, tadpoles and adults) are poisonous. The only reports of human deaths have been in instances where people have consumed toads and even soup made from toad eggs. It is listed as one of 100 World’s Worst Invaders (www.issg.org). Knowing the fecundity of the species, swift action had to be taken to control the potential spread of the toad throughout New Providence and possibly The Bahamas. In order to eradicate the species, the strategy addressed the following: Establishment of a task force; The capture and destruction of all life stages (including eggs, tadpoles and adults) by a core team; Development and distribution of educational material; and Training of support staff in the identification and handling of cane toads. Community members became the greatest asset in the fight against the cane toads. They became the on the ground support team by reporting sightings as well as collecting animals. Since eradication efforts have begun hundreds of cane toads have been collected while several invaded ranges that housed toadlets were discovered. All specimens were euthanized and properly disposed of. There is no definitive answer to how long the Cane toads have been here but there is one confirmed report dating back to 2011 and one anecdotal report to 2010. What we do know is that they are reproducing and we have to continue to work to control and possibly eradicate the species. There have been confirmed sightings outside of the original confined area and unless a greater effort is made to eradicate the cane toad it is believed that they will spread throughout New Providence and other islands. The introduction of the cane toad asks a very significant question as to whether the nation’s borders are being managed effectively. As a country, what should be done to minimize such invasions? As global travel and trade increases, the pathways for invasive species to establish themselves in new lands also increase. Such invasions undermine our economy and endanger our natural treasures. These stealth invaders, unchecked by natural controls, spread across our islands and wreak havoc within already fragile native species and ecosystems. Invasive species are now considered by some as the second-leading threat to imperiled natives, behind habitat destruction.

KEYWORDS: Cane Toad, Invasion

CASUARINAS - UNWELCOME AND AGGRESSIVE INVADERS ON THE BAHAMIAN SEASHORE

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ABSTRACT

A review of the extent of casuarina invasion and the measures taken to arrest it. This examination follows from previously published work by the author over the last ten years. Casuarinas have been identified as having an erosional impact on sandy shorelines due to their ability to replace dune-binding native vegetation. Under storm conditions this causes irreversible degradation of beaches and dunes. This study examines the extent of the impact throughout the Bahamas with specific mention of islands throughout the archipelago, from Grand Bahama to Inagua. Generally casuarinas are most aggressive where the land has been disturbed by coastal development, and undeveloped shorelines are generally casuarina free. Some intermediate states are illustrated. The most populous islands are therefore the most vulnerable, and islands in the southern Bahamas have many unaffected beaches. Some developers have either initially or subsequently attempted to remove casuarinas from the shore and these attempts are examined.

KEYWORDS: Casuarinas, coastal erosion, Bahamas, exotics

THURSDAY, 6 MARCH, 2014



ENDEMIC, ENDANGERED AND WINTERING BIRDS: A COMPLETE CONSERVATION APPROACH

The Kirtland's Warbler: Challenges of bridging ecology, education, outreach, and economy

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ABSTRACT

The Kirtland's Warbler (*Setophaga kirtlandii*; henceforth KW), an endangered migratory bird species, breeds almost exclusively in Michigan, USA, and winters almost exclusively in the Bahamas archipelago. Although virtually all conservation efforts for the migratory warbler have been focused on its breeding grounds, recent research findings also indicates a need for conservation on its migratory stopover sites and its Bahamas wintering grounds. However, to meet the KW's needs throughout its whole life cycle requires collaboration and cooperation for effective conservation. Cooperative, international efforts are essential to translate research to on-the-ground conservation in a comprehensive ecological, socioeconomic context. The Kirtland's Warbler Research and Training Project (KWRTTP) was initiated in 2002 to achieve three goals established by Bahamian and USA conservationists and biologists: (1) describe the winter ecology of the KW and apply results to conservation programs, (2) increase conservation capacity of The Bahamas, and (3) describe the ecology of resident and wintering birds associated with Kirtland's Warblers and apply results to conservation programs. Here we report on objectives (1) and (2). The KWRTTP has established that the KW requires early successional coppice (roughly 3-30 years since disturbance), especially those with fruiting snowberry (*Chiococca alba*), wild sage (*Lantana involucrata*), and black torch (*Erithalis fruticosa*), and KWs may be relatively common on goat farms. The most important areas for conservation may be sites with abundant fruit of wild sage and black torch in late winter, when food resources are often relatively scarce and birds are preparing for spring migration. Although more survey work needs to be done, the central Bahamas, including at least Eleuthera, San Salvador, Long Island, and possibly Exuma and Exuma Cays, host many KWs. In addition, we have collaborated with others to identify effects of the KW winter ecology on the breeding grounds and better describe migration routes. We are currently working with private and government landowners on Eleuthera to determine how we might manage lands that both benefit the landowners and the KW. We will present results from experimental work and qualitative assessments that suggest some possible approaches to management. Conservation capacity and outreach has been achieved through KWRTTP. Eight students have both (1) participated in field work in both The Bahamas and Michigan, (2) completed their undergraduate degrees with project support or encouragement, and (3) four students have returned to The Bahamas to assume conservation positions, in both government and non-government positions, and thus increase capacity. We anticipate other students will return following completion of post-undergraduate education. Conservation activities engaged by students with positions in The Bahamas include (1) training primary, secondary and university students, (2) outreach to local communities, (3) forest management and policy, (4) coral reef conservation, (5) conservation planning, (6) environmental assessment, and (7) KW research. Our work has also spawned ecotourism activity on Eleuthera and led to exploratory work in goat farming and rights-of-way management.

KEYWORDS: Bahamas, Kirtland's Warbler, whole life cycle, winter ecology, conservation

STABILITY, RESILIENCE, AND RESISTANCE OF PARROT POPULATIONS TO ENVIRONMENTAL DISTURBANCES IN THE BAHAMAS

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ABSTRACT

Geographic isolation puts endemic parrots at risk of extinction due to environmental disturbances. We studied the stability, resilience, and resistance of parrot populations on Great Abaco and Great Inagua, using count data adjusted for changes in detection to estimate density, abundance, and rate of change before-after disturbances. Great Abaco was struck by Category 3 hurricanes in 2004 and 2011, and wildfires were frequent during 2003-2012. Cat removal was conducted at parrot nest sites in southern Abaco during 2009-2012. A Category 4 hurricane struck Great Inagua in 2008, and droughts occurred in 2004 and 2008-2009. The Great Abaco parrot population resisted disturbances and responded quickly to cat removal with increases in breeding pair productivity, female survival, and density in 2012. Food abundance was higher and less clumped on Great Abaco than on the much drier Great Inagua, where the hurricane and drought caused a 63% decline in the parrot population in 2009. Recovery time was estimated to be 2-4 years, and as expected the Great Inagua parrot population rebounded to pre-hurricane level in 2013. Long-term research and monitoring allowed us to better understand the response of isolated parrot populations to disturbances and management seeking to increase reproduction and the survival of nesting females. Estimated density was 0.171 parrots/ha (95% CI = 0.125-0.233) and population size was 5,373 parrots (95% CI = 3,928-7,321) in 31,421 ha on Great Abaco in April 2012. Estimated density was 0.287 parrots/ha (95% CI = 0.219-0.378) and population size was 18,888 parrots (95% CI = 14,421-24,860) in 65,734 ha on Great Inagua in August 2013.

KEYWORDS: Bahama parrot, Great Abaco, Great Inagua, resilience, resistance, stability

LONGITUDINAL EVALUATION OF WINTERING BIRDS ON NORTH ANDROS ISLAND

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ABSTRACT

Because of its size, proximity to the continental United States, and its diversity of terrestrial and aquatic ecosystems, Andros Island should be a veritable aviary for migratory birds. For thousands of years migratory birds have used Andros as a winter home. The past 75 years, however, have represented a very turbulent and dynamic time for the island itself and the birds that have historically resided here over the winter months. Logging operations changed the landscape and microclimates of the island for many years, and though the landscape and ecosystems remain altered compared to their natural past, there are many positive indications that migratory birds are finding their way back to Andros. This presentation will focus on 20 years of observations made on North Andros Island. Three major points will be addressed: 1) The importance of Andros Island in the survival of migratory and resident birds that are endangered, threatened, or near threatened species. 2) What changes in wintering and year round resident bird populations have been observed over the past twenty years and possible causes of these changes. 3) What can be done to further protect or even enhance fragile ecosystems on the island that are important to birds?

KEYWORDS: Andros, Birds, Ornithology, Endangered Species

PROTECTED AREA & FISHERIES MANAGEMENT

Working with the Bahamas Dive Industry to Implement a PADI Distinctive Specialty Course on Coral Nurseries and Restoration

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ABSTRACT

In an effort to help restore degraded Acropora coral reefs and increase coral reef resilience throughout the Bahamas, The Nature Conservancy's Northern Caribbean Program has begun working with relevant stakeholders to establish and maintain in-water coral nurseries. These nurseries will provide a bank of corals that can help repair damaged Acropora reefs caused by human induced factors and major storm events. Currently the Conservancy has established nurseries in the southwest area of New Providence and off Central Andros Island. It is intended that such efforts will be replicated throughout the Bahamas. Since the health of coral reefs ultimately affects Bahamian livelihoods, it is important to inform and involve all stakeholders in restoration efforts. The Conservancy is therefore working with Stuart Cove's Dive Bahamas to implement a Professional Association of Diving Instructors (PADI) Distinctive Specialty Course that focuses on coral nurseries and restoration, taught by trained instructors, in order to involve both local and visiting recreational divers in coral restoration efforts. During the course, divers learn about the importance and methods of establishing coral nurseries in order to help restore degraded reefs. Trained local divers are then tasked with performing basic maintenance and monitoring of specific nurseries by conducting monthly maintenance dives. Through this course, the public will be educated on the coral restoration process, dive shops will develop a sense of ownership for the nurseries while undergoing restoration efforts and the coral nurseries are maintained. The Conservancy recently held the first instructor training session for four instructors at Stuart Cove's Dive Shop in Nassau, Bahamas. The instructors were guided through academic sessions on how to teach the classroom portion of the course which included lessons on improved underwater skills such as teaching good buoyancy, cleaning coral propagation structures in the nursery, and monitoring and measuring coral fragments. Once instructors complete additional PADI requirements, Stuart Cove's will be the first dive shop to offer the course in the Bahamas and help to continue collaboration of conservation efforts with the recreational dive industry in the Bahamas.

KEYWORDS: coral, restoration, training

ESTABLISHING CRITICAL RESOURCE THRESHOLDS FOR MARINE HABITATS IN THE EXUMA CAYS LAND AND SEA PARK

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ABSTRACT

During 2010-2013, quantitative and qualitative assessments of fish and benthic community structure were conducted across 21 sites within and outside the Exuma Cays Land and Sea Park to determine critical resource thresholds for key habitats (i.e. coral reefs, mangroves and seagrasses) and to develop a long-term monitoring programme to improve park management. Sites were selected based on relative potential anthropogenic impacts such as fishing, diving, and coastal development and included two mangrove sites, five seagrass sites, five shallow channel reefs, two fringing reefs, three shallow forereefs, and four deep forereefs. Surveys were conducted annually at all sites with more frequent sampling at Parrotfish Reef and Danger Reef to detect seasonal changes in fish and benthic communities. Species density and biomass data were collected for fish species, spiny lobster (*Panulirus argus*) and *Diadema antillarum* observed during 30 x 2m belt transect surveys. Relative abundance of commercial fish species, queen conch and invasive lionfish was assessed using transect and timed roving diver surveys. Dominant benthic cover was estimated using point-intercept sampling within 1-m² quadrats. Approximately 40 quadrats per reef site and 20 quadrats per seagrass site were sampled with surveyors deploying quadrats haphazardly a minimum of 1 meter distance from previous quadrats. Species lists of major taxa were also compiled for each quadrat at all reef and seagrass sites. Similarities in fish and benthic community structure and biodiversity composition across reef sites, types, surveys, and divers were analyzed using non-parametric Analysis of Similarity (ANOSIM) and PERMANOVA (Permutational ANOVA and MANOVA) tests. Multi-dimensional scaling (MDS) plots were used to visualize similarities among sites. SIMPER analysis was also used to determine which species contributed most to the observed differences. Overall, there was very little seasonal or annual variation in reef fish communities, but some overall temporal variation in benthic communities. For reef habitats, ANOSIM analysis shows that fish communities at the sites sampled varied by habitat type ($R=0.749$, $p=0.01$) but not by sampling period ($R = 0.034$, $p>0.26$).

In contrast, benthic communities across all sites showed some significant annual variation. Other than a short-term visible decrease in algal cover following Hurricane Irene in 2011, temporal shifts tend to be relatively subtle and require statistical analysis for better understanding. Surveys of the two mangrove habitats within the Shroud Cay creek system showed some differences in fish populations among sites that were relatively consistent across the three year sampling period. In seagrass beds, conch densities did not change over the three-year study for most sites but there was a significant decrease in density at the seagrass site near Bell Island and Seagrass 17 near Cistern Cay. While most sites showed no dramatic differences in fish and benthic communities across surveys, areas near development or other impacts may require more frequent monitoring to detect important changes.

KEYWORDS: biodiversity composition, community structure, coral reefs, mangroves, seagrasses, anthropogenic impacts

IMPLEMENTING THE BAHAMAS SPINY LOBSTER FISHERY IMPROVEMENT PROJECT TO IMPROVE MANAGEMENT OF THE FISHERY

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ABSTRACT

The Bahamas is known for its productive spiny lobster (*Panularis argus*) fishery and is one of the leading exporters of lobster tails worldwide. Granted the fishery seems stable, threats impacting this fishery still exist including illegal harvesting of undersize lobsters and harvesting during the closed season. To improve management and sustainability of the lobster fishery, The Bahamas Department of Marine Resources, The Bahamas Marine Exporters Association (BMEA), The Nature Conservancy, Friends of the Environment in Abaco and other conservation partners are working with the World Wildlife Fund (WWF) to implement a fishery improvement project (FIP) for the Bahamian lobster fishery. The FIP's goal is to work with stakeholders to advance the fishery toward meeting sustainable fisheries standards set by the Marine Stewardship Council (MSC) while preserving a healthy ecosystem. An MSC pre-assessment was initially done to assess the current fishery status against the MSC standards and identified gaps where improvement is needed. Input from stakeholders and experts were used to develop a workplan highlighting priority activities that need to be completed in order to address the gaps identified. These activities include collecting fisheries dependent data; conducting outreach efforts; improving monitoring, enforcement and management strategies and; performing a stock assessment. Currently, the Bahamas has implemented a catch certificate program; a zero tolerance policy within the BMEA against the harvesting and buying of illegal size lobsters; conducted both an Illegal, Unreported and Unregulated and lobster stock assessments and; established a Government appointed Spiny Lobster Working Group consisting of NGOs, fishermen, and government representatives, that will advise the Government of strategies geared towards improved management and governance. The results of the FIP will include improved documentation and management of lobster stocks, sustained lobster populations and, better stewardship of the marine environment.

KEYWORDS: lobster, sustainability, fisheries

TOOLS OF THE TRADE: DEVELOPMENT OF MICROSATELLITE GENETIC MARKERS TO INFORM MANAGEMENT STRATEGIES OF THE LAND CRAB (*CARDISOMA GUANHUMI LATREILLE*) FISHERY IN THE BAHAMAS.

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ABSTRACT

The land crab *Cardisoma guanhumi* (Latreille), is overharvested throughout its range, resulting in harvesting regulations in multiple countries/protectorates. A lack of polymorphic markers hampers genetic-based conservation for the species. We characterized 13 microsatellite loci, eight of which are polymorphic in the heavily collected populations of *C. guanhumi* on Andros Island, The Bahamas. These markers were utilized to further elucidate the genetic diversity of the land crab populations in The Bahamas and Coral Gables, Florida, USA to inform management strategies for this commodity species.

KEYWORDS: land crab conservation genetics microsatellite

REHABILITATING AND ENHANCING MANGROVE HABITATS WITHIN BONEFISH POND NATIONAL PARK

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ABSTRACT

During 2010-2013, quantitative and qualitative assessments of fish and benthic community structure were conducted across 21 sites within and outside the Exuma Cays Land and Sea Park to determine critical resource thresholds for key habitats (i.e. coral reefs, mangroves and seagrasses) and to develop a long-term monitoring programme to improve park management. Sites were selected based on relative potential anthropogenic impacts such as fishing, diving, and coastal development and included two mangrove sites, five seagrass sites, five shallow channel reefs, two fringing reefs, three shallow forereefs, and four deep forereefs. Surveys were conducted annually at all sites with more frequent sampling at Parrotfish Reef and Danger Reef to detect seasonal changes in fish and benthic communities. Species density and biomass data were collected for fish species, spiny lobster (*Panulirus argus*) and *Diadema antillarum* observed during 30 x 2m belt transect surveys. Relative abundance of commercial fish species, queen conch and invasive lionfish was assessed using transect and timed roving diver surveys. Dominant benthic cover was estimated using point-intercept sampling within 1-m² quadrats. Approximately 40 quadrats per reef site and 20 quadrats per seagrass site were sampled with surveyors deploying quadrats haphazardly a minimum of 1 meter distance from previous quadrats. Species lists of major taxa were also compiled for each quadrat at all reef and seagrass sites. Similarities in fish and benthic community structure and biodiversity composition across reef sites, types, surveys, and divers were analyzed using non-parametric Analysis of Similarity (ANOSIM) and PERMANOVA (Permutational ANOVA and MANOVA) tests. Multi-dimensional scaling (MDS) plots were used to visualize similarities among sites. SIMPER analysis was also used to determine which species contributed most to the observed differences. Overall, there was very little seasonal or annual variation in reef fish communities, but some overall temporal variation in benthic communities. For reef habitats, ANOSIM analysis shows that fish communities at the sites sampled varied by habitat type ($R=0.749$, $p=0.01$) but not by sampling period ($R = 0.034$, $p>0.26$). In contrast, benthic communities across all sites showed some significant annual variation. Other than a short-term visible decrease in algal cover following Hurricane Irene in 2011, temporal shifts tend to be relatively subtle and require statistical analysis for better understanding. Surveys of the two mangrove habitats within the Shroud Cay creek system showed some differences in fish populations among sites that were relatively consistent across the three year sampling period. In seagrass beds, conch densities did not change over the three-year study for most sites but there was a significant decrease in density at the seagrass site near Bell Island and Seagrass 17 near Cistern Cay. While most sites showed no dramatic differences in fish and benthic communities across surveys, areas near development or other impacts may require more frequent monitoring to detect important changes.

KEYWORDS: Mangrove Nursery Restoration Rehabilitation Enhancement

SCIENCE BEHIND EXPANSION: HOW STUDIES OF THE ANDROS IGUANA HELPED DEMARCATÉ BOUNDARIES FOR THE WEST SIDE NATIONAL PARK, ANDROS ISLAND

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ABSTRACT

The purpose of conservation reserves or national parks should be to retain the diversity of biological elements and ecological processes inherent in nature that would otherwise be lost through current or future habitat degradation. Reserves are typically developed with three, non-mutually exclusive, biological motivations including 1) preservation of large and functioning ecosystems, 2) to preserve biodiversity, and 3) to protect particular species of special interest. In the case of the recent terrestrial expansion of the West Side National Park on Andros Island, the motivation to protect the Andros Iguana, an iconic and endemic species, resulted in fulfilling all three biological motivations. Here, I present data on how research of the Andros Iguana (*Cyclura cyclura cyclura*) over the course of a decade informed the expansion boundaries of the West Side National Park. Research focused on home range and habitat use of adults, nesting ecology of females, dispersal and survival of hatchlings, as well as broad-scale population surveys. Tourists were also interviewed to gauge their willingness to pay fees for access to a national park.

KEYWORDS: Andros Island, Conservation, Iguana, National Park

THE ROLE OF RAPID ECOLOGICAL ASSESSMENTS IN DESIGNATING MARINE PROTECTED AREAS

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ABSTRACT

Rapid Ecological Assessments (REAs) are frequently used to collect baseline data, assess the relative health of habitats and identify current and potential threats to the area. Information derived from REAs is used to help environmental resource managers designate new marine protected areas (e.g. national parks, marine reserves) and monitor ecological changes over time. During 2013, five (5) REAs were conducted at Lucayan National Park, Cross Harbour (Abaco), the Marls of Abaco, East Grand Bahama and the Joulter Cays (Andros). The Atlantic Gulf Rapid Reef Assessment (AGRRA) protocol version 5.5 was used to conduct quantitative and qualitative coral, fish and benthic surveys of reef habitats. A combination of belt transects and roving diver fish surveys were used to assess fish diversity, abundance, size and species richness within mangroves and seagrasses. Preliminary results indicate that fish and benthic community structures within coral reef and mangrove habitats of East Grand Bahama and Lucayan National Park were highly diverse. In contrast, the composition of fish and benthic communities within coral reefs and mangroves of Cross Harbour and the Joulter Cays varied by site and habitat. For example, patch reefs in Cross Harbour had greater coral diversity, coverage and more abundant fish species than forereefs. Fish and benthic communities within the Marls were not diverse and the area is of minimal value for reef-fish species. Overall, the results of the REA support the expansion of Lucayan National Park and the establishment of new parks in East Grand Bahama, Cross Harbour and the Joulter Cays, which would protect critical marine habitats, endangered corals, ecologically and commercially important fish species and invertebrates.

KEYWORDS: marine protected areas, rapid ecological assessments, fish community structure, benthic community structure, diversity

THE BAHAMIAN MARINE ENVIRONMENT

A snapshot of Unpublished Studies on the Nassau Grouper *Epinephelus striatus* and the Queen Conch *Strombus gigas* in Bahamian waters

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ABSTRACT

The Nassau grouper and queen conch have been two of the most prized marine species in the West Indies and Caribbean regions. The Nassau grouper is now commercially extinct throughout much of its range. It has been listed as an endangered species by the World Conservation Union, and is a protected species in U.S. federal waters. The Bahamas has one the last significant stocks of Nassau grouper in the world, and these are also threatened. The queen conch has been disappearing through-out the tropical seas. In the Florida Keys they were placed under protection over forty years ago and have not recovered to this day. Based on the rapidly declining populations, the Caribbean Marine Research Center initiated research on the two species in the mid-eighties in waters surrounding the Exuma Cays, Bahamas, which included pilot studies of the general behavior and life history of the species. Overall objectives were to identify major nursery grounds, habitat preferences, density identification, migration and general behavior, all of which could help with management strategies and stock enhancement based on sound scientific principles. Over a two-year period, we studied shallow juvenile queen conch nurseries at Norman's Pond Cay, Children's Bay Cay and Leaf Cay. Non-lethal techniques utilizing scuba and snorkeling facilitated observations of behavior, underwater tagging, growth measurements, and counts. Results included a population mean density of 1.48/m² on grass beds and adjacent sand shoals with sizes ranging from 80mm-120mm (0+ and 1+ year classes). Tagging results showed little movement out of the nursery grounds with the exception of two events in which the juvenile conch gathered by the hundreds of thousands, forming a swath about 7 meters wide and hundreds of meters long with all the conch moving perpendicular to the length of the swath. We concluded it was a strategy to redistribute an over-populated stock on the feeding grounds. Results showed the study site to be recruitment rich and important to the health of the queen conch population in the Exuma Cays. A study of Nassau grouper was conducted between 1985 and 1988 off Lee Stocking Island, Exuma Cays. Standard scuba and snorkeling techniques were used to observe the fish in shallow grass beds and offshore adult habitats. Length-frequency curves were based on underwater observations. The results of the study revealed that, by 25mm in size, juvenile Nassau grouper singularly seek out abandoned conch shells and other structures on the grass beds and defend their home against all intruders, big and small, with density levels extremely sparse. Approximately seven months later, at 100mm in length, they abandon the offshore grass beds and move into adjacent shallow coral heads. At 300-350mm the grouper move into deeper water.

HABITAT LOSS IN BIMINI'S LEMON SHARK NURSERIES: COMMUNITY CHARACTERIZATION BEFORE AND AFTER A DISTURBANCE

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ABSTRACT

The lemon shark, *Negaprion brevirostris*, is a large coastal elasmobranch that relies on shallow nearshore nursery areas for increased juvenile survival throughout its range. In Bimini, Bahamas, mangrove-fringed shorelines serve as nursery grounds for hundreds of juvenile *N. brevirostris*, providing both protection from predation and ample foraging. Recently, the construction of a large resort and marina complex has altered the natural environment through mangrove removal, seabed dredging and the filling of wetlands, with potential effects not only on nursery-bound lemon sharks, but also on the resources upon which they rely. The Bimini system is one of the most well-studied in all elasmobranch literature. Given the wealth of pre-disturbance data, this study was a unique opportunity to quantify potential post-development changes to the community. To describe community diversity and structure, nearshore seining was conducted between 2009 and 2011 to examine marine faunal communities in both the disturbed and a nearby intact control nursery. These data were compared to data collected prior to habitat degradation, from 2000 to 2003, using identical methods, in both nurseries. Using multivariate principal coordinate analysis (PCO), permutational ANOVA (PERMANOVA) and common community diversity indices, this before-after control-impact (BACI) analysis showed that since the disturbance, there have been significant changes in overall community structure, as well as significant declines in multiple taxa. Mojarra, the most important prey item for juvenile lemon sharks within the nursery, experienced one of the most dramatic declines. These declines, found in mean abundance of most taxa in the disturbed nursery, including those important in *N. brevirostris* diet, can have effects on the growth, survival, habitat use and home range of the nursery-bound sharks in this insular system. Because many marine species rely on coastal habitats at some or even all life stages, the loss or degradation of these areas can have significant negative consequences on biodiversity. With the threat of continued development within Bimini's lemon shark nurseries, it is important to consider precautionary management principles. The protection of essential nursery habitats in Bimini may be critical to effective conservation and management of *N. brevirostris*, and the importance of Bimini's lagoons as essential fish habitat in a nursery capacity should be weighed against future development plans.

KEYWORDS: mangroves, development, biodiversity, mojarra, essential fish habitat

THE POTENTIAL IMPACT OF COMMERCIAL SHELL COLLECTING IN THE BAHAMAS: ECOLOGY AND CONSERVATION PRACTICES

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ABSTRACT

Curios and handicrafts comprised of marine products are commonly sold to tourists throughout the Caribbean. Though the majority of material comes from the Pacific; Trinidad and Tobago (4%) and Haiti (2%), as well as other countries in the Caribbean are also sources (Tissot et al., 2010). Currently we know very little regarding the biology, distribution and population sizes of many marine mollusks commonly targeted by curio collectors. But estimates put the trade of invertebrates at 2500 metric tons (Tissot et al., 2010) or 9-10 million animals mostly mollusks, shrimp and anemones (Wabnitz et al., 2003). The lack of information and published studies makes assessing the impact of shell collecting difficult. Recently we began to survey the sources of curios sold in the Bahamas, the U.S and from inventories of wholesale companies supplying shells to souvenir shops and hobby supply stores. In general, most shops in both the Bahamas and US are obtaining their shell inventory from wholesalers who operate large scale collecting operations in the Philippines and Indonesia. Most shells of Caribbean origin sold by wholesalers are harvested “slit” conchs. Large, decorative shells, including King Helmet (*Cassis tuberosa*), Queen Helmet (*Cassis madagascariensis*), and Trumpet Triton (*Charonia variegata*) shells, are currently largely obtained from Haiti. Wholesale suppliers often list “Bahamian Sea” Fans and “Bahamian Starfish” as part of their inventories. On smaller retail scales, opportunistic shell stalls are a source of marine curios on docks and public beaches. Besides conchs, helmet shells, starfish and True Tulip (*Fasciolaria tulipa*) shells are offered for sale. Other smaller shells for sale have included West Indian Top-Shells (*Cittarium pica*). Some of these shells appear to have been obtained alive while others were crabbed or collected from beach drift. Some mollusks, displayed in stores where lobster is available for purchase, appear to have been obtained from traps as by catch either alive or as crabbed specimens. In 1993-94 survey of by catch from lobster traps in Florida (Matthews et al., 2005), urchins and hermit crabs were common and Green Sea Urchin (*Lytechinus variegatus*) was often retained for sale in the curio trade. In the Bahamas, the lack of research on the impact of shell collection makes it difficult to determine best management practices. Collection of live animals has the potential to damage near shore habitats as rocks and corals on the reef flat may be overturned to obtain the live mollusks. Shell material washed on beaches contributes to sediments and also provides housing for hermit crabs. Current data we have for San Salvador Island indicates a decline in population numbers of King Helmet and Trumpet Triton over the past 15 years. Only one living Trumpet Triton has been encountered over the last five years. Since large shells are not commonly sold to tourists on the island, this decline could be linked with another factor other than collecting. The threat for large, carnivorous mollusks, with small population numbers, is a concern that needs to be addressed.

KEYWORDS: mollusks, marine products, shell collecting, commercial shell trade, invertebrates

SPONGES IN SEAGRASS: FROM SPECIES INTERACTIONS TO ECOSYSTEM FUNCTION

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ABSTRACT

Seagrasses are an important foundational species in nearshore ecosystems worldwide. They serve as nurseries, feeding grounds, stabilize sediments, and store carbon. Because of their ecological importance, understanding controls on seagrass productivity is critical. Bahamian nearshore waters host extensive beds of turtle grass (*Thalassia testudinum*; hereinafter seagrass) that support diverse invertebrate communities, including many species of sponge. In this study, we investigated the interaction between seagrass and *Halichondria melanadocia* (hereinafter sponge), which commonly grows around the base of seagrass shoots in Bahamian waters. Seagrasses in Bahamian waters are often nutrient limited and many species of sponge are known to increase nutrient availability through transformation of nitrogen into forms usable by primary producers. We hypothesized that the presence of sponges will impact seagrass productivity through one of two mechanisms: shading of seagrass (decreased productivity) or increased nutrient availability as a result of sponge presence (increased productivity). We quantified the percent cover of seagrass and the abundance of sponge at six sites surrounding Abaco Island, Bahamas. Seagrass shoots growing in close proximity with and without sponges growing were analyzed for nutrient content. Finally, we determined the effect of sponge presence on the growth of seagrass. Seagrass may facilitate sponge abundance by providing substrate for the sponge, as the density of sponge increased with increasing seagrass cover. There was no evidence that sponges provide nutrients to the seagrass as there was no significant difference in the morphology or nutrient content within paired seagrass samples. Our results suggest that *H. melanadocia* and *T. testudinum* have a commensal relationship where the seagrass is unaffected by the sponge while the sponge benefits from settlement substrate provided the seagrass.

KEYWORDS: Sponges, Seagrass, species interactions, ecosystem function, commensalism

SURVEYS IN THE JUMENTOS CAYS AND RAGGED ISLANDS FURTHER DEFINE DISTRIBUTION CHARACTERISTICS OF QUEEN CONCH IN THE BAHAMAS

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ABSTRACT

Data from ten queen conch fishing grounds in The Bahamas reveals a clear trend of overfishing, particularly of populations closest to settlements. Recent surveys in both the northern and southern Bahamas demonstrate this trend. Average adult densities in the 2013 conch survey of the remote Jumentos Cays and Ragged Islands were the highest found in five years of surveying active, commercial conching sites throughout the country. The average density of adults was 122 conch/ha, well above the minimum density needed for reproduction (56 conch/ha); however, density values decreased generally from the more isolated northern Jumentos Cays to the more populated southern Ragged Islands. Results from a similarly extensive survey of near shore populations in the Bight of Abaco in 2012 were more discouraging. Average “adult” densities in the Sandy Point study area averaged 6.4 conch/ha (hectare) and increased only to 9.8 conch/ha west of More’s Island, which are both numbers well below the minimum required for reproduction. In the entire survey of south Abaco fishing grounds only three mating pairs were observed. The establishment of a Marine Protected Area is recommended for the Jumentos Cays to ensure that reproduction will feed conch grounds down current. Well recognized indicators of overfishing now characterize queen conch populations in the Bight of Abaco and other grounds close to human populations. A strategy to rebuild these stocks is necessary to avoid fishery collapse. Management measures that could be considered include: a) partial or total closure of the fishing grounds until densities recover, b) ending the use of compressed air for conch fishing, c) establishing a minimum lip thickness for harvest, d) establishing a total allowable catch at the fishing grounds and e) instituting a closed season for conch fishing.

KEYWORDS: Queen conch, surveys, Bahamas, Ragged Islands

THE BAHAMIAN MARINE ENVIRONMENT

A Fisheries Independent Study Documenting 30-Year Trends in Shark Diversity and Abundance in the Eastern Exuma Sound, The Bahamas

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ABSTRACT

Global declines in elasmobranch populations are well documented; however, the majority of studies rely upon fisheries dependent datasets that are commonly criticized due to the variable nature of fishing techniques over time. Fishery-independent surveys offer a more rigorous approach to detecting long-term changes in abundance and diversity of shark populations. Seasonal surveys were conducted from 1979 through 1981 in an area off the south coast of Eleuthera, The Bahamas. From 2011-2013 these surveys were exactly recreated, with a goal of identifying trends the diversity and abundance of elasmobranchs over the last 34 years. Catches for both historical and modern surveys were dominated by Caribbean reef (*Carcharhinus perezii*) and tiger (*Galerocerdo cuvier*) sharks. These two species showed distinct seasonal trends in relative abundance whereby *C. perezii* were significantly more abundant in the autumn ($F=16.64$, $p<0.001$), in contrast to *G. cuvier* which were significantly more abundant in the spring ($F=8.03$, $p=0.007$). Preliminary analysis indicates a 50.2% reduction in the relative abundance of *G. cuvier* over the last 34 years ($F=4.76$, $p=0.035$), in contrast to a 57.9% increase in the relative abundance of *C. perezii* in the same period ($F=5.73$, $p=0.021$). Changes in catch composition may be the result of differences in the extent of trans-boundary movements between the species, which as a result of the Bahamian longline ban instituted in the 1990s, imposed variable exploitation rates. This study highlights the importance of understanding long-term seasonal movement patterns when designing management and conservation strategies for elasmobranchs.

KEYWORDS: Diversity, Abundance, Long-term Trends, Fisheries-Independent Data

LOW ABUNDANCE AND RECRUITMENT OF BLAINVILLE'S BEAKED WHALES ON A NAVY RANGE IN THE BAHAMAS

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ABSTRACT

Assessing population demographics of beaked whales on navy ranges is important for identifying whether population-level effects result from regular exposure to military sonars. At the US Navy's Atlantic Undersea Test and Evaluation Center (AUTEK) in the Bahamas, Blainville's beaked whales (*Mesoplodon densirostris*) cease foraging and move tens of kilometres away during multi-ship sonar exercises, returning days later when the testing has ceased. Higher energetic costs associated with displacement, combined with lower energy intake if foraging is disrupted, provide a possible mechanism to reduce individual condition. Energetic demands suggest this is of particular concern for lactating females, and may result in lower reproductive success and population consequences. In this study we assessed the potential impact of disturbance by comparing abundance and age composition of Blainville's beaked whales in two areas of equal size (~300 km²) inside and away from the AUTEK range. We fit Bayesian hierarchical models to photo-identification data collected from 2005-2010 to estimate abundance at AUTEK where mid-frequency active sonars are regularly used; and off southwest Abaco Island (~170 km away), a control study site where navy sonar is not used. Notably no individuals were seen in both study sites and adult females exhibited long-term site fidelity. There were 39 reliably-marked whales identified from high-quality photographs at AUTEK and 65 at Abaco, and we estimated a high probability ($p=0.88$) that average annual abundance was lower at AUTEK. A multinomial model of photographically-determined age-class counts revealed that there was a high probability ($p=0.85$ and 0.91) of a lower proportion of calves and sub-adults, respectively, at AUTEK. We hypothesise that repeated exposure to navy sonar at AUTEK may have contributed to lower recruitment and calf survival, and that effects on sub-adult numbers and overall abundance suggest prolonged disturbance over at least the last decade. Slope

KEYWORDS: beaked whales, abundance, Navy sonar, disturbance, calf survival

REPRODUCTIVE SUCCESS OF THE CRITICALLY ENDANGERED SMALLTOOTH SAWFISH (*PRISTIS PECTINATA*), AT ATLANTIS, PARADISE ISLAND, BAHAMAS

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ABSTRACT

The smalltooth sawfish is one of the most endangered fish in the world and is listed as critically endangered on the IUCN Red List. Atlantis, Paradise Island has displayed smalltooth sawfish for 18 years and has been working on their breeding program for several years. In 2012 Atlantis achieved a major milestone as the first facility in the world to have reproductive success of this species. With only 13 smalltooth sawfish in zoological facilities around the world and with wild populations declining at a rapid rate, this is an extremely critical first step in creating a sustainable managed population.

KEYWORDS: reproduction critically endangered smalltooth sawfish

PREY SELECTION BY *OCTOPUS VULGARIS* AT SAN SALVADOR, THE BAHAMAS: DO INDIVIDUALS SPECIALIZE?

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ABSTRACT

Studies of resource use usually examine population averages, ignoring variation among individuals. We are interested in the inter-individual variation in the selection of prey because individual-level resource specializations have implications both for the ecology (e.g., interaction outcomes, population dynamics) and evolution of a population. We characterized the ecological niche of the common Atlantic octopus, *Octopus vulgaris*, in the near-shore waters of San Salvador, The Bahamas, by collecting individual middens (piles of prey remains). Snorkelers searched sites for dens and collected middens in two ways. For some octopus, we made one-time collections of middens; for others, we marked the den and collected prey remains periodically. The remains (composed of mollusk shells and crustacean exoskeletons) were identified to species in the laboratory. We calculated individual and population-level diet specialization using the proportionality similarity index (PSi) and used Monte Carlo techniques to classify individuals as specialists or generalists. We found that there are both specialists and generalists within all the populations sampled. Diet and the frequency of specialization varied geographically, although interpretation of this pattern is hampered by low sample sizes at some locations. Diets measured from multiple collections were significantly less specialized than those with single midden collections, suggesting that one-time collections provide a biased record of octopus prey selection. Within regions, diets of specialists varied among individuals. We conclude that *O. vulgaris* is a generalist species with specialist individuals. Further investigation is needed to determine why there are differences in prey selection among locations and among specialists.

KEYWORDS: individual specialization, octopus, diet

SPATIAL AND TEMPORAL PATTERNS IN THE ABUNDANCE AND DIVERSITY OF PLASTIC MARINE DEBRIS ON BEACHES IN SOUTH ELEUTHERA, THE BAHAMAS

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ABSTRACT

There is a paucity of information on the spatial and temporal patterns in the abundance and distribution of marine debris on beaches throughout The Bahamas, making it challenging to inform and support policy aimed at reducing litter. Monitoring beach debris is also essential for mitigating threats towards humans and wildlife. Here, we used protocols established by NOAA and Five-Gyres Institute to allow trained citizen scientists to quantify debris type and abundance. We surveyed 16 beaches across South Eleuthera, Bahamas, twice between April 2013-October 2013. Location proved to have an effect on plastic debris abundance as there was a significant difference between plastic deposits/m² on beaches on the windward side of the island versus the leeward side. Mean macro-plastic debris (>2.5cm) ranged from 2.18 items/m² on the windward side of the island to 1.07 items/m² on the leeward side. Micro-plastics represented 41% of all plastic found between all locations, and mean plastic weight ranged from 22.2g/m² on the windward side to 7.34g/m² on the leeward side. By selecting beaches at varying distances from major litter sources, beach surveys can provide useful, insights into the origins of plastic debris. Monitoring of stranded litter should concentrate on estimating the accumulation rate of debris on beaches, because this gives a measure of the amount of litter at sea. This study is the first of its kind for The Bahamas and offers baseline data on the types and abundance of plastic debris found throughout the country.

KEYWORDS: Plastic Pollution, Beaches, Marine Debris, Citizen Science, Eleuthera, windward, leeward

A CULTURALLY RELEVANT AND ISLAND SPECIFIC CORAL CONSERVATION APPROACH

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Few Bahamians are involved in conservation efforts, information about distribution of corals, connectivity between reefs, and threats to reef systems are often not communicated to locals. An island-specific, culturally relevant approach to reef conservation that engages communities in dialog on coral reef resources and its management is necessary. A literature review of Bahamian stony corals was conducted and six “umbrella” coral species identified to be the focus of stewardship action. Reefal habitat of the archipelago was uniformly mapped with standard terminology. Critical coral habitat used by local communities was identified and threats assessments assessed local barriers to conservation. Local communities can make stronger connections to conservation programs that can speak to specific information about their local reefs. The identification of Bahamian priority coral species, their critical habitat and localized threats was necessary in the development of effective local stewardship programs tailored towards achieving conservation goals. Standardizing reef classification throughout the Bahamas is a tremendous step forward. Combining scientific assessment and local engagement enables a culturally-relevant analysis of threats to corals. Local communities need specific information about coral reefs to be involved in management strategies. Outreach must be tailored to local communities and address local threats.

KEYWORDS: Coral Conservation. Island Specific and Culturally Relevant , Priority Corals

POSTERS



POSTERS

THE SAN SALVADOR VOLUNTEER LIONFISH SURVEY PROJECT

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ABSTRACT

The lionfish *Pterois volitans*, a native of the Indo-Pacific, was accidentally introduced to the western North Atlantic Ocean off South Florida in the early 1990s. Since 1999, lionfish have spread rapidly throughout the western North Atlantic, including the Bahamas, and south into much of the Caribbean. In at least some areas of the Bahamas, the lionfish has quickly reached high densities. Lionfish are predators of small crustaceans and (mostly) fish. The potential effects of large numbers of lionfish on Caribbean reefs include reductions in the abundances of small reef fishes, increases in algal cover from reduced herbivory, and further declines in commercially important species, such as groupers, from competition for food. The goal of this project is to document temporal trends in the distribution and abundance of lionfish at San Salvador, Bahamas. Using procedures similar to volunteer reporting programs conducted by the Reef Environmental Education Foundation (REEF) and the US Geological Survey Nonindigenous Aquatic Species program, volunteer SCUBA divers and snorkelers collect and report sightings of lionfish around San Salvador Island. Since December 2011, a total of 61 reports of lionfish have been turned in by volunteers. The data are being used to build a long-term database of lionfish abundance and distribution around the island. These data will be useful to a variety of resource agencies and researchers working on understanding and mitigating the effects of the lionfish invasion of the western Atlantic.

KEYWORDS: lionfish, citizen science, invasion, San Salvador

COASTAL CHANGE ON SAN SALVADOR ISLAND FROM 1989 TO 2014

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ABSTRACT

In 1988 Daryl Darnell Clark completed a Masters thesis on the sediment composition on the 16 beaches of San Salvador Island, Bahamas. A follow-up study has been completed during 2013 to determine the change in sediment type and sorting on the island. Sand samples from many of the beaches Clark investigated were collected in 2010. These samples were processed to determine particle size, sorting, texture, and kurtosis. Additional samples were collected in December 2013 from each of the 16 beaches studied by Clark. The results of analyses of the 2010 and 2013 samples were compared to Clark's analyses of the island's beaches to determine any changes that have occurred since 1988. The changes were viewed in the context of several intense storm events, including tropical storms and hurricanes that affected San Salvador over that time period. Clark determined that the major determinant of sediment sorting and structure on San Salvador beaches was coastal morphology; however, strong energy events such as major storms also have contributed to coastal change. Factors causing change, or lack thereof, on the coastline of San Salvador can be applied to coastal change on other Bahamian islands.

KEYWORDS: San Salvador, coast, beach sediment

ASSESSING THE IMPACT OF INVASIVE MAMMALS ON ENDEMIC VERTEBRATE FAUNA OF THE BAHAMAS: A QUANTITATIVE APPROACH USING NEXT-GENERATION SEQUENCING

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ABSTRACT

Invasive species, especially mammals, have devastating impacts on island ecosystems. They have been known to cause significant population loss and species decline in endemic island vertebrates. Feral cats are very successful ecosystem invaders they can survive without access to fresh water and are highly adaptable to almost any environment. It is estimated that feral cats threaten 10% of critically endangered birds, mammals, and reptiles worldwide. We therefore hypothesize vulnerable endemic vertebrate species in the Bahamas are being extirpated by these invasive predators. We propose to use an innovative application of next-generation sequencing, dietary DNA barcoding from scats, in order to quantitatively assess the impact these predators are having on the biodiversity of this tropical island. Despite the fact feral cats are apparently causing significant damage to Caribbean ecosystems, no substantial study of their diet has been done on any island in the region. The complex biotic interactions between predators and prey need to be well understood in order to mitigate further loss of endemic species. We will conduct our field study in Abaco National Park on the island of Great Abaco in the Bahamas. We will collect feral cat scat from the park for genetic analysis at the Sackler Institute for Comparative Genomics laboratory at the American Museum of Natural History. We will quantify the dietary ecology of feral cats by using dietary DNA barcoding. This method involves using a general vertebrate sequencing primer to capture the full diversity of prey in a scat sample. Using a next-generation sequencing platform, we will be able to monitor diets in populations of feral cats in the Bahamas by directly sequencing the prey DNA in their scats. This high throughput method has the ability to sequence prey DNA so it can be identified to the species level. This method is especially powerful because it generates hundreds of thousands of sequences and can detect rare prey sequences if they are present. This project is of vital importance because we need to obtain more data on predator-prey relationships and dietary ecology of invasive species in the Caribbean in order to maintain these one-of-a-kind tropical environments. We will present this research proposal in order to illustrate the utility of this new method and its potential for informing wildlife conservation in the Bahamas.

KEYWORDS: conservation, genomics, invasives, biodiversity

GEOLOGIC HISTORY OF THE EXUMA CAYS AND NEW PROVIDENCE

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ABSTRACT

The Exuma Cays and New Providence are composed of carbonate sand and corals that were deposited and later lithified (turned into rock) during different stages of geologic history. This sand formed in the ocean in several different environments including: coral reefs, subtidal sand shoals, sea grass beds, channels, beaches, and dunes. The rise and fall of sea level has been the dominant factor controlling the formation of the Exuma Cays and New Providence. Today, geologic mapping and coring provides us with information of the Bahamas geologic history and therefore provides insights into what the effects of future sea level rise will be in the Bahamas. Since 2007, we have been conducting several large-scale projects to decipher the geologic history of the Exuma Cays and New Providence. The focus of this research is to understand both the island formation and the relationship to the adjacent shallow water sandy environments, and how sea level past, present, and future affect these islands. New Providence and the Exuma Cays are composed of either Holocene (<6,000 ybp), Pleistocene (marine isotope stage (MIS) 5e, ~125,000 ybp), and/or older Pleistocene rocks. Shallow water environments adjacent to the islands are dominated by a variety of carbonate grains (including ooids, peloids, and skeletal grains) within high-energy shoals, tidal channels, patch reefs, stable seagrass beds, and low-energy, bioturbated sand flats. To document the present status of the Exuma Cays and New Providence, we analyzed satellite imagery, mapped the geology of the islands, and mapped the shallow offshore environments. To decipher the formation of the islands, we drilled short (<1 meter) and long (up to 23 meters) rock cores. Mapping and coring the Exuma Cays and New Providence revealed that sea-level fluctuations are the dominant controlling factor on island formation. When sea level is high, new sand forms and this sand gets deposited in beaches and storm beach ridges adjacent to existing islands. Wind accumulates some of the sand into dunes forming the highest points on the islands. Soon after deposition the sediment starts lithifying and turning into rock. During glacial times, sea level falls and the Bahamas are completely above water and dry. For example, 18,000 years ago sea level was ~120 meters (394 feet) lower, exposing all of the Bahamas and adjacent banks. During these times, no sand is being formed and the sand previously deposited turns into rock. Exposure to fresh water also forms karst holes (blue holes) on the bank. When sea level rises again (when the ice melts and the ocean warms) the sand factory starts again and makes a new cycle of sand and adds to the islands formed by the previous period. Over the last 500,000 years, there were only three times when sea level was the same or higher than today's sea level (~125,000, ~330,000, and ~400,000 years ago). It was during these episodes that the rocks that make up the Exuma Cays and New Providence were formed. Today, parts of these islands are still growing while other parts are being eroded away.

KEYWORDS: Geology, Sea Level, Exuma Cays, New Providence, Pleistocene

HURRICANES AS AN EXTRINSIC FACTOR INFLUENCING BAHAMIAN INSECT BIODIVERSITY

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ABSTRACT

MacArthur and Wilson's ideas about island biogeography have been applied broadly and widely to many different systems in an attempt to gain an understanding of biodiversity. However in many cases, the basic concepts they describe do not completely explain the variation observed in natural systems. Such is the case for the insect distribution observed in the Bahamas. If, however, we overlay other extrinsic factors, such as hurricanes, it might be possible to increase the predictability of the available models and more completely describe island biogeography in the Bahamas. Island size, distance from colonization source and extinction rates are the basic components of MacArthur and Wilson's arguments and these have been found to account for as much as $R = 0.5$ of the distribution of major Bahamian insect groups. These broad categories, especially island size, might influence factors such as rainfall and temperature as well as the severity of predictable weather patterns such as hurricanes. The islands, oriented from northwest to the southeast, consistently catch storms moving off the coast of Africa in the autumn and this predictability adds yet another wrinkle to the biogeographical distribution of the insect communities. The size of the island potentially creates a refuge from the high winds and heavy rainfall that are hallmarks of hurricanes. Since October 2004, surveys of the insect communities on San Salvador, the Bahamas, have been made using net collection of individuals, sweep sampling of the vegetation, malaise traps and yellow-bowl traps for ground dwelling insects. Insect families have been observed to vary seasonally with predictable increases following hurricane disturbance, but there were no consistently seen dominant groups (orders or families) following hurricanes with a major San Salvador impact during 2004-2013. The dominant groups observed perhaps reflect the first groups to become re-established rather than anything else. These data provide a basis for future comparisons of insect community recovery following major hurricane impact on San Salvador and other Bahamian islands.

KEYWORDS: hurricanes, insects, biodiversity, biogeography, Bahamas

EMPLOYING LOCAL ECOLOGICAL KNOWLEDGE THROUGH STAKEHOLDER-DRIVEN MARINE RESOURCE MAPPING ON LONG ISLAND, BAHAMAS

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ABSTRACTS

Local stakeholder engagement is crucial for the successful management of marine resources. Building on the prior initiative of the Bahamas National Trust (BNT), the Long Island-based Ocean Crest Alliance (OCA) has been spearheading an effort to increase awareness of the benefits of localized management of commercial and recreational fisheries, as well as the non-consumptive use of marine resources through tourism. OCA and BNT reached out to the University of Florida Conservation Clinic to provide research and logistical support to a series of stakeholder meetings designed to gauge the interest of Long Islanders in formalized marine protection. At the meetings, Long Island fishers were able to find consensus on areas and resources that have been depleted, those that may need further protection to prevent them from being depleted, and the root causes of depletion. The stakeholder meetings also helped BNT to supplant Long Islanders limited conception of MPAs as “no take” marine parks with a broader notion of “multi-use” marine management based on local ecological knowledge. Participatory mapping exercises at these meetings resulted in the local fishers expressing general agreement that a multi-use marine managed area may be appropriate for Long Island. Support to the UF Law Conservation Clinic was provided by the Guy Harvey Foundation and Florida Sea Grant.

KEYWORDS: stakeholder, marine managed area, multi-use

DISCOVERING THE MIGRATORY CONNECTIVITY FOR THE ENDANGERED KIRTLANDS WARBLER

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ABSTRACT

Understanding the migratory connectivity of species is essential to their conservation. This is especially true for the endangered Kirtland's Warbler (*Setophaga kirtlandii*) that primarily breeds in the Jack Pine habitats of Michigan but has a poorly known migratory and winter distribution. In late May of 2012, we attached twenty-four light-level geolocators to Kirtland's warblers in northern Michigan. Twenty-nine Kirtland's were captured and observed as controls. In June 2013, we recaptured seven geolocated birds but only six were carrying devices. Departure on fall migration in 2012 commenced between October 3rd to 9th. One individual left earlier (September 7) and could not be mapped because of movement during the fall equinox (7 Sept – 6 Oct). For the remaining five warblers, fall migration took on average 18 days. Non-breeding locations varied, but most overwintering sites were centered on the Bahamas, but could also include northeastern Cuba and western Haiti. Spring migration commenced from between April 24th to 27th, followed a more western route compared to fall, and took on average 20 days. We found minimal evidence that geolocators resulted in negative impacts. After attachment, over-summer persistence was lower (67% vs. 89%) but annual return rates higher (44%; vs. 27%) for geolocated versus control Kirtland's, both lower than reported in previous studies (50-65%). Nest success was similar for geolocated (4.2 fledged; n=5) versus controls (3.9 fledged; n=9) warblers. Determining the migratory routes and winter distributions of Kirtland's warblers throughout the annual cycle is a high conservation priority and will help inform future efforts to locate essential non-breeding season habitats.

THE CUBAN CROCODILE (*CROCODYLUS RHOMBIFER*) FROM LATE QUATERNARY FOSSIL DEPOSITS IN THE BAHAMAS AND CAYMAN ISLANDS

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ABSTRACT

Late Quaternary fossil deposits from The Bahamas, Cayman Islands, and Cuba contain fossils of the Cuban crocodile *Crocodylus rhombifer*. This species survives today only in Cuba and Isla de la Juventud (formerly Isla de Pinos); the populations in The Bahamas and Cayman Islands are locally extinct. Large fossil samples, including skulls, are known from underwater caves (blue holes) on Abaco in the northern Bahamas and organic peat deposits on Grand Cayman. Diagnostic cranial characters shared by the fossil crocodile skulls from Abaco and Grand Cayman and recent skulls of *C. rhombifer* from Cuba are: short, broad, and deep rostrum; prominent orbit; concave interorbital region and cranial roof; strong ridge on internal margin of the orbit and lateral margin of the cranial table; large, rounded protuberance on the posterolateral corner of the squamosal; premaxillary-maxillary suture on the palate transverse at the level of the first maxillary tooth; and 13 teeth in the maxilla. Using a ratio derived from living crocodylians of head length (premaxilla to parietal) to total length of about 1:7.2, approximate total lengths for fossil specimens of *C. rhombifer* from Abaco range from 1.3–2.3 m (mean 1.9 m) and Grand Cayman from 1.6–2.0 m (mean 1.7 m). Quaternary crocodylian remains are known from many other islands in The Bahamas, including Acklins, Crooked Island, Eleuthera, Grand Bahama, Mayaguana, New Providence, and San Salvador; however, most of these fossils are not complete enough for a species identification. Shells of an extinct species of the land tortoise *Chelonoidis* from Abaco and Mayaguana with crocodylian bite marks, jaws and teeth of capromyid rodents from Grand Cayman that appear to have been digested by a crocodylian, and data from carbon (¹³C/¹²C) isotopes derived from crocodile bones, as well as the lack of large freshwater vertebrates, suggest that *C. rhombifer* in The Bahamas and Cayman Island had a diet primarily consisting of terrestrial vertebrates. Evidence from stomach contents and behavioral ecology of extant Cuban crocodiles from Cuba further supports the terrestrial feeding habits of *C. rhombifer*. Radiocarbon (¹⁴C) dates on crocodile postcranial bones from Sawmill Sink and Dan's Cave on Abaco range from 2,780–3,680 years Before Present (BP). Radiocarbon dates on peat associated with fossils of *C. rhombifer* from the Crocodile Canal site on Grand Cayman range from 375–860 years BP. These dates confirm that Cuban crocodiles survived into the late Holocene on Abaco and into the historic period on Grand Cayman. Evidence from a variety of sources, including radiocarbon dates, fossil and archaeological sites, and historical records confirms that the local extinction of crocodiles in The Bahamas and Cayman Islands occurred within the past 500 years, probably resulting from overhunting by humans. Fossils of *C. rhombifer* on Grand Cayman and Abaco, and probably throughout The Bahamas, verify that the Cuban crocodile was considerably more widespread in the West Indies during the Late Quaternary.

BUILDING ON EXISTING MODELS TO CREATE A MECHANISM FOR EXPANDING RESEARCH, EDUCATION AND OUTREACH PROGRAMS IN ABACO

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ABSTRACT

Friends of the Environment (FRIENDS) was established in 1988 to address local concerns of unsustainable use of the marine environment. Through partnerships and funding support the volunteer-driven organization grew to open an office, hire staff and establish an array of ongoing programs. These programs are guided by FRIENDS' strategic plan and mission to "preserve and protect Abaco's marine and terrestrial environments in order to achieve sustainable living for the wildlife and people of Abaco". FRIENDS seeks to achieve that mission by educating the general public about Abaco's environment and has placed special focus on school-based education providing over 10,000 educational experiences since the education program started in 2006. While this is a notable success, FRIENDS has realized that there are further needs for research, education and outreach on Abaco that must be addressed to further its mission. After much consideration, information gathering and consultation with stakeholder groups, FRIENDS devised the Abaco Research Center (ARC), which will provide the needed facilities to house researchers, lab and learning spaces, and be an example for sustainable building for Abaco. The Abaco Research Center will cater to Bahamian and international-based scientists as well as students in secondary and tertiary level programs. Targeted courses will bring researchers and students together to encourage scholarship in the sciences and provide internship opportunities. Abaco offers access to most of The Bahamas' ecosystem types as well as a network of national parks and protected areas that can support research. ARC will provide logistics services to visiting researchers and seek outreach partnerships to expand on the benefits of local research for education and management of natural resources. The project is in the development phase and aims to open doors in 2015

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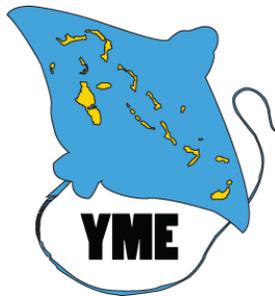
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