



# Book of Abstracts



**Tuesday March 15th to Thursday March 17th, 2016**

Performing Arts Centre  
The College of The Bahamas  
Oakes Field Campus



**ATLANTIS**  
PARADISE ISLAND, BAHAMAS



**Theme for BNHC 2016**

## **Reverse the Decline**

Emphasizing the need to not only protect the remaining resources of The Bahamas, but to also work towards a future where biodiversity is thriving better than it is today. This era, which has become known as the Anthropocene, is recognized as such because of the large foot print that humans have posed upon the earth. However, human activities do not have to continue to result in biodiversity loss but can be re-engineered to improve biological diversity. To help move forward and ensure that Bahamians have an ever brighter future, it is imperative that we bring scientists, members of industry, educators and the public at large together to learn from each other and to pave a better way forward.



# Presentations

## **Crab pen survey and harvest analysis of the land crab, *Cardisoma guanhum* Latrielle (Decapoda: Gecarcinidae), fishery in The Bahamas**

**Tami LaPilusa and Kayla Earls**

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Land crabs, including *Cardisoma guanhum* (Decapoda: Gecarcinidae), are an important fishery resource harvested throughout the Caribbean, Central America, and Northern South America. Harvest pressure during the seasonal migration and habitat loss for all stages of the life cycle are universal issues throughout the range and decisions must be made regarding the best way to manage these wide-ranging populations. Andros Island is known to support the largest population of land crabs in The Bahamas though few formal studies are available to provide stock assessment data for the fishery. Additionally, no regulations exist in The Bahamas for this species and little is known regarding the size and sex ratio of harvested land crabs. This project aims to provide preliminary harvest data for the land crab fishery as a means to encourage dialogue between stake holders to enhance monitoring during the spawning migration. Land crab harvesters' catch in five settlements on North Andros, Abaco, and San Salvador Islands were surveyed during the 2014 and 2015 spawn. Sex was recorded and carapace length measured for up to 100 *C. guanhum* per crab pen for up to 100 harvested crabs per settlement. Mean carapace length was calculated to be significantly different between sites and harvested female land crabs were significantly smaller than harvested male land crabs. Female crabs comprised one-third of the harvested crabs during each study season. This preliminary study indicates a need for larger-scale surveys of the land crab fishery to fully elucidate the trends in harvest size and sex ratios. Land crab survey methods from this project can be incorporated into citizen science projects to aid in long-term monitoring of the land crab fishery and for the enhancement of meaningful dialogue between stake holders in The Bahamas.

## **Monitoring *Coenobita clypeatus* populations and the use of touch tanks in conservation initiatives: Helping Soldier crabs win the battle for top coastal scavenger in the Bahamas**

**Melanie DeVore<sup>1</sup>, Deborah Freile<sup>2</sup>, and Sandra Voegeli<sup>3</sup>**

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Soldier crabs (*Coenobita clypeatus*) are scavengers and play an important role in coastal ecosystems. If crabs are removed, ants become significant scavengers and nuisances. A major concern for maintaining Bahamian soldier crab populations is insuring that populations of whelks (*Cittarium pica*) are adequate to support shell use by breeding crabs. Fertilized eggs are transported for a month by female crabs and are deposited into the surf. We observed females depositing eggs in 2015 during a four day period associated with the July new moon. Only the largest females, those predominately in *Cittarium* shells with heights > 60 mm, deposit eggs. Over harvesting of large *Cittarium* shells for bait, food, or the marine curio trade would immediately have an impact on the breeding populations of crabs. A decrease in crab populations will then impact ant species and their population sizes. Selling crabs as pets, predominantly in the U.S. is also problematic. One prominent wholesaler reported to the New York Times in 2000 that they sold one million crabs/year. That same business reported to the Philadelphia Inquirer sales of 200,000 crabs/year in 2014 and that the crabs were obtained from Cap-Haitien and Port-au-Prince, Haiti. It is illegal to export soldier crabs in the Bahamas, however, that does not mean that smuggling of crabs is nonexistent. To help increase the decline of selling crabs in the U.S. we will employ touch tank outreach modules to inform both San Salvadorians, and tourists at Club Med, of the life history of soldier crabs and whelks. With generous support from Seacology, and B.R.E.E.F., San Salvador Living Jewels will work with teachers from throughout the Bahamas during their annual B.R.E.E.F. Teacher's Workshop. In this way,

Bahamian teachers can inform their students of sound conservation practices while tourists can be educated to not buy soldier crabs as pets.

## **Vegetation history of Eleuthera, Bahamas: pollen and charcoal analysis of sediment cores from two sites**

**Eric Kjellmark<sup>1</sup>, Lisa Park Boush<sup>2</sup>, Ilya Buynevich<sup>3</sup>, Amy Myrbo<sup>4</sup>, Mary Jane Berman<sup>5</sup>, Perry Gnivecki<sup>5</sup>, and Eric Brown<sup>4</sup>**

1. Florida Southern College, Lakeland, FL, USA; 2. University of Connecticut, Storrs, CT, USA; 3. Temple University, Philadelphia, PA, USA; 4. University of Minnesota, Minneapolis, MN, USA; 5. Miami University of Ohio, Oxford, OH, USA.

In 2012, sediment cores were recovered from two sites on Eleuthera Island, Bahamas. Samples from both cores were processed for pollen and charcoal analysis in order to reconstruct the vegetation and fire history around each site. The first core was 254 cm long and was obtained from Shad Pond near the coast on the south end of Eleuthera. The second core was 140 cm long and was obtained from Duck Pond Blue Hole in the middle of the island north of Weymes Bight. The sediment from the 180-240 cm depth in the Shad Pond core is a fibrous peat and dates from ~3700 to 4800 cal yBP. The pollen spectrum in the peat is dominated by red mangrove (*Rhizophora mangle*) suggesting that the site was a red mangrove-dominated swamp during this period. The sediment from 100 to 140 cm depth in the Duck Pond core is a pure, fine calcareous mud with only small traces of pollen present. The pollen spectrum in middle portion of both cores is dominated by palm with pollen from rockland and coppice species also present. Palm pollen declines in sediments from both cores at depths that date to ~1100-1300 cal yBP, the time of Lucayan occupation. Palm pollen nearly disappears from Shad Pond sediments younger than ~1300 cal yBP and its sudden drop is coincident with a significant spike in charcoal particles. Palm pollen drops by over ½ in Duck Pond sediments younger than ~1100 cal yBP, but there is initially only a modest increase in charcoal particles. Palm pollen returns in modest amounts toward the top of the Shad Pond core and there is a second, smaller peak in charcoal in sediments that date to ~200-300 cal yBP. This suggests a recovery of palms near the coast beginning in the plantation period. Palm gradually declines toward the top of the Duck Pond core while pollen from *Trema lamarckianum*, a disturbance indicator, becomes very dominant. Charcoal is most abundant in Duck Pond sediments that date to ~200-300 cal yBP and later. The decline of palm pollen and increase in pollen from disturbance species in sediments from both sites ~1100-1300 cal yBP suggests heavy exploitation of palms by Lucayans, particularly near the coast. The later increase in charcoal and significant increase in pollen from disturbance species in sediments from the inland Duck Pond site ~200-300 cal yBP suggests land clearing during the Plantation Period.

## **A history of logging the pine forests of The Bahamas**

**Neil Sealey**

Media Enterprises Ltd., Nassau, New Providence, The Bahamas.

The pine (*Pinus caribaea var. bahamensis*) forests of The Bahamas cover much of the northern islands of Abaco, Grand Bahamas, and Andros, and also exist on New Providence. For much of the twentieth century, these forests were logged by a variety of foreign enterprises, first for their lumber, and later for pulpwood. The companies involved established camps and townships, built sawmills, ports and roads, and provided employment for the early populations of these islands. They introduced modern machinery, and even a railway, to communities mainly unfamiliar with these technologies. Their endeavors paved the way for the subsequent wider settlement and development of these islands. The regrowth of the forests has provided new opportunities for their exploitation, in this case more for water conservation, wildlife biodiversity and recreation rather than commercial profit and export. There has been little

written collectively about this period and these endeavors, and this short account has depended heavily on the professional work of PWT Henry and a number of historians from the relevant islands. Contemporary photographs and production data are included.

## **Forest management practices, the Bahamas perspective: Past, Present, Future**

**Christopher Russell and Arien Sikken**

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Forest inventories on Abaco and Andros have been carried out over the past years under FAO's TCP/BHA/3401 project (2012-2014). The main objectives were capacity building and training Bahamians in sustainable forest management principles through various workshops and activities such as forest inventories. The state of the pine forest in North Andros in 1986 and 2013 is discussed by an analysis of forest inventory data that has been collected in both years under two FAO projects. Data has been collected by visiting sample plots where the DBH (diameter at breast height) and height was measured for every tree. The comparison between both inventories supported by graphs shows the development of the forest over time in terms of stocking, DBH, height, basal area, and stand volumes. The past and future of the logging industry in The Bahamas are discussed by a comparison of the forest management practices that were applied in the period 1900-1970 and forest management practices that are promoted for future initiatives. The proposed National Forest Estate is highlighted for Abaco, illustrating which activities are allowed in the various forest areas under the proposed designations of Conservation Forest, Forest Reserve and Protected Forest. The forest inventory carried out in Normans Castle, Treasure Cay (North Abaco) indicates which data was collected and how this can be used for decision making regarding silvicultural interventions and implementation of sustainable forest management practices in the future.

## **Analysis of Grand Bahama forest using Normalized Difference Vegetation Index (NDVI) to evaluate vegetation changes for post-hurricane season 2004 and 2005**

**Zeko McKenzie**

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In 2004 and 2005, Grand Bahama was affected by 3 consecutive major hurricanes (Frances and Jeanne in 2004, and Wilma in 2005) that altered the island forest landscape. As a result of their impact, Grand Bahama forest experienced changes in its forest landscape. Such changes can be analyzed using the Normalized Difference Vegetation Index (NDVI). The Normalized Difference Vegetation Index is used for the purpose of determining the chlorophyll density present in plant leaves as determined by a light refractive index (usually consisting of several spectral signature bands to composite an image) based on satellite imagery. This study uses the NDVI analysis in ArcGIS v 10.3 to evaluate changes in the vegetation of Grand Bahama's (G.B.) forest post-hurricane season 2004 and 2005. Percent change (i.e. loss in forest vegetation) for G.B. forest was computed from Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper (ETM+) satellite images (cloud free) obtained from the USGS website. For the purpose of detecting and documenting vegetation changes, a mosaic of cloud free Landsat Images from 2004 and 2011 were used in the NDVI analysis to detect vegetation changes, pre- and post-hurricane disturbance, for the two time periods. Preliminary results from the NDVI analysis revealed a minor decline in forest vegetation (mean vegetation loss = 4.8 %) from 2004 to 2011 (7 years), post-hurricane disturbance. However, an evaluation of the 2004 and 2011 Landsat Images indicated

that the greatest vegetation loss occurred east of the island in the northeastern section of the pine forest.

## **A Floristic Study of a Former Landbridge in The Bahamian Archipelago**

**Mark Daniels**

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How does dry forest composition and distribution vary among three neighboring islands in the south-central Bahamas? A floristic study is being conducted on the Bahamian islands of Eleuthera, Little San Salvador and Cat Island to document and describe vegetation communities and to compare patterns of species associations among islands. A total of 75 plots were sampled at the study sites of Lighthouse Point on south Eleuthera (31 plots), Arthur's Town on north Cat Island (34 plots) and the small island of Little San Salvador (10 plots). Trees  $\geq 4\text{cm}$  DBH were measured and identified to species in circular plots of 10m radius, with nested subplots of 3m and 1m to generate counts and cover estimates for species of shrubs and herbs respectively. Plot variables recorded were latitude/longitude, general soil type (organic, sandy, lateritic or muck), elevation and distance from the coastline. Preliminary analysis of tree plot data from Cat Island identified 45 species in 38 genera and 24 families, with dominant species *Acacia choriophylla*, *Metopium toxiferum* and *Guapira discolor*; Eleuthera identified 49 species in 39 genera and 25 families, with dominant species *Guapira discolor*, *Bursera simaruba*, and *Reynosia septentrionalis*; Little San Salvador tree plots identified 19 species in 19 genera and 15 families, with dominant species *Pseudophoenix sargentii*, *Metopium toxiferum*, and *Coccoloba diversifolia*. Clustering, ordination and species indicator analysis will be used to identify patterns of species distribution within and among the three islands. Classifying the variation found in Bahamian dry forests throughout the archipelago will enhance conservation planning and responsible land use practices, helping to mitigate of threats of human activity, invasive alien species, and global climate change.

## **A closer look at a mangrove die-off**

**Ryann E. Rossi<sup>1</sup>, Stephanie K. Archer<sup>2</sup>, Craig A. Layman<sup>1</sup>**

1. North Carolina State University, Raleigh, NC, USA; 2. Pacific Biological Lab, Fisheries and Oceans Canada, Nanaimo, BC, Canada.

Mangroves are important foundation species in coastal ecosystems providing an estimated US \$1.6 billion in ecosystem services worldwide. These services range from providing essential nursery habitat for important reef and commercial marine organisms to land accretion and carbon sequestration. Unfortunately, mangrove forests have been in decline as a result of myriad of factors, particularly human activity. Although human activity is the driving cause of mangrove loss globally (e.g. deforestation and aquaculture) other natural factors such as hurricanes result in drastic mangrove loss. Here, we present a case study from Abaco, The Bahamas in which dwarf Red Mangroves (*Rhizophora mangle*) are dying on the Western side of Abaco in a region known as The Marls. Interestingly, humans have a low impact in this localized region. Preliminary data suggest that these dwarf R. mangle are stressed by multiple factors, one of which is a fungal plant pathogen. We used both laboratory and field observations to identify the fungal pathogen and to assess the severity across Abaco. Field observations consisted of disease incidence surveys at several sites across Abaco along 100m transects. From these surveys, a subset of leaves with lesions present were collected for isolations. Isolations involved sterilizing the leaf surface and cutting a piece of leaf at the margin of the infected area. Leaf pieces were then plated onto acidified potato dextrose agar (APDA). Upon successful growth of fungal hyphae, a subsample of hyphae was collected and processed for DNA sequencing using Polymerase Chain Reaction (PCR) with ITS primers (ITS 4 and 5).

Asexual spores from fungal cultures were harvested to be used as inoculum on new, healthy *R. mangle* leaves. Through Koch's postulates, we have identified a species of *Pestalotiopsis* as the potential pathogen causing severe leaf damage on mangroves in these die-off areas.

## **Great Bahamas Trees!**

**Rick Joyce**

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Trees in the Bahamas are extremely important. The trees greatly benefit from good human care. Valuable trees of the Bahamas include the native forest species, coastal mangroves, tropical fruit trees and introduced landscape trees. The proper pruning and overall care of trees will increase their health and extend their life. Sharing best tree pruning and care practices adds value to trees for the long-term. The International Society of Arboriculture (ISA) is an international organization that advocates sound tree pruning and care around the world. The ISA has a widely recognized "Certified Arborist" program. This arborist certification provides valuable education to anyone that propagates, grows, installs or maintains trees. My tree growing, pruning and care research has been ongoing for over 30 years. As a long-time International Society of Arboriculture (ISA) board member, Certified Arborist and having the Tree Risk Assessment Qualification (TRAQ), I have given hundreds of presentations on the pruning and care of trees. Beyond work as a professional forester, my wife and I operate a wholesale tree and plant growing nursery in Southwest Florida growing thousands of trees, including mangroves and other coastal trees that are native to the Bahamas. In 2015, we contract grew just grew 30,000 mangroves. Improved care of all trees provides extended tree life, strength, beauty and value. Sharing an understanding of basic structural tree pruning to advanced arboriculture will help insure a healthy urban and natural forest in the Bahamas for the long-term. As the Bahamas continues to grow and urbanize, the value and significance of urban forestry science will be introduced. Mangrove trees in the Bahamas command additional care. Mangrove trees and forests are a critically important plant species for the entire Bahamas marine system. A reasonable balance between desire of residents and property owners (e.g.; views, access, navigation) and the health of the marine systems can be achieved by creative design and careful pruning. The goal of this presentation is to share the latest research on tree growing, care and especially on pruning. It is hoped that this presentation will result in an increased interest in Bahamas trees and in the long-term importance of good tree care.

## **Bonefish Pond Mangrove "Restoration" Monitoring**

**Lindy Knowles<sup>1</sup>, Craig Dahlgren<sup>1</sup>, Felicity Burrows<sup>2</sup>, Janeen Bullard<sup>3</sup>, Agnessa Lundy<sup>1</sup>**

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Mangroves serve an important ecological function as a nursery for juveniles of many economically and ecologically important fish and invertebrate species. Since 1958, New Providence Island has lost 57% of its mangroves, and most of the remaining mangrove systems have been fragmented by roads and other coastal development. Reduction in mangrove area and increases in mangrove fragmentation impair the nursery function of mangroves. One of the largely intact mangrove systems on New Providence is within Bonefish Pond National Park, but even here, development prior to the creation of the park has altered parts of the mangrove system. In 2013, a team of researchers transplanted over 600 red mangrove (*Rhizophora mangle*) trees to a selected the mangrove rehabilitation site within the Bonefish Pond

National Park as part of the Global Environment Facility Full-size Project. This pilot project focused on incorporation mangrove restoration in conservation planning. The restoration consisted of converting a dead-end dredged channel that served no nursery function into a mangrove fringed tidal creek capable of supporting fish and invertebrate populations. Restoration activities consisted of increasing hydrographic connectivity of the channel to surrounding waters and transplanting mangroves. Transplanted red mangrove trees included those from the restored site that were removed to allow for equipment to access the channel; the 1-2 year old trees from the nurseries at the Atlantis resort; propagules from another creek site from the eastern part of New Providence and small trees dug from a freshwater lake on the interior of New Providence. They were planted using a variety of transplantation methods and variable densities in 10m long plots along the restored channel to determine which approach had greater growth and survivorship. Researchers monitored the success of the transplants over the past two years measuring survivorship and growth metrics (height, new branches, and new prop roots) to determine the most appropriate methodology of mangrove transplantation for the Bahamian environment.

### **From students to stewards, Bahamas Awareness of Mangroves (B.A.M.) introduces a transformative mangrove curriculum to Abaco**

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1. Khaled bin Sultan Living Oceans Foundation, Annapolis, MD, USA; 2. FRIENDS of the Environment, Marsh Harbour, Abaco, The Bahamas.

The Bahamas Awareness of Mangroves (B.A.M.) is an immersive, yearlong experiential education program that engages high school students and teachers in Abaco to learn about and restore mangroves through project-based learning. This pilot program is designed to strengthen STEM education and increase ocean literacy, while adhering to Bahamian education standards. Generating behavior change and inspiring Bahamian youth to become environmental stewards are two main outcomes expected from this program. During the academic year, Friends of the Environment (FRIENDS) and the Khaled bin Sultan Living Oceans Foundation (LOF) partner to implement this curriculum in three different installments in two Abaco secondary schools. A tailored curriculum provides students with local and global perspectives on mangrove science and conservation. Each of three program installments includes opportunities for professional development for teachers, and program evaluation and development. B.A.M. facilitates school participation by providing teaching materials and funding for mangrove field trips. The core of the project takes place over eight months when students grow mangrove propagules in their classroom. This part of the program is executed using project-based learning, a teaching method which allows students to explore real-world problems and acquire deeper knowledge over extended periods of time. Using this classroom approach, students will gain the knowledge and skills necessary to investigate the question at hand: Which type of media do mangrove propagules grow best in? Students will then be engaged in a mangrove restoration and cleanup project. Though evaluation results are not available at this time, the expectation is that by providing an experiential, problem-based education program in The Bahamas, students who have learned about the importance of mangroves, took the time to nurture them, and participated in restoration measures may have a sense of ownership and stewardship over the mangroves for years to come.

## **Extirpation and Survival of Abaconian Birds Before and After Human Arrival**

**David W. Steadman<sup>1</sup>, Nancy Albury<sup>2</sup>, and Janet Franklin<sup>3</sup>**

1. Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; 2. National Museum of The Bahamas, Marsh Harbour, Abaco, The Bahamas; 3. School of Geographical Sciences and Urban Planning, Arizona State University, Tempe, AZ, USA.

Using thousands of identified fossils from prehistoric sites on Abaco, we compare the rates of extinction (species-level loss), extirpation (population-level loss), and survival in birds during two crucial periods of time. The first time interval was at the end of the ice age during the Pleistocene-Holocene Transition (PHT) from about 15,000 to 9,000 years ago), long before people lived in The Bahamas. During the PHT, 17 of the 59 species of ice age birds known to have lived on Abaco (29%) did not survive. We attribute these losses to dramatic changes in climate (becoming more warm and moist), habitat (expansion of coppice at the expense of pine woodlands and grasslands), sea level (rising from -100 m to nearly modern levels), and island area (shrinking from ~17,000 km<sup>2</sup> to 1214 km<sup>2</sup>). The next interval of considerable change in birdlife followed the first human arrival on Abaco about 900 to 1000 years ago. No longer surviving are 14 of the 37 species (38%) that we have recorded as fossils dating to the past millennium on Abaco. We believe that habitat change probably has been the primary cause of these losses. While conservation efforts typically (and rightly) focus on rare species, we should not become complacent about understanding the needs of common species that have survived many millennia of both natural and human-induced changes.

## **The population biology, life history, and ecology of the Bahama swallow (*Tachycineta cyaneoviridis*): informing conservation of an endemic bird species**

**Maya Wilson**

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The Bahama swallow (*Tachycineta cyaneoviridis*) is a poorly known and endangered bird species that is endemic to the northern Bahamas. This research project focuses on three central questions regarding Bahama swallow population biology, life history and ecology. (1) What are the features of the current Bahama swallow population biology? Available population estimates indicate a sharp decline in population abundance since the 1970s, and recent anecdotal reports estimate 1500–4000 individuals. However, the last official surveys were conducted in 1995, and there is currently no information regarding the distribution and dispersal of Bahama swallows within their range, which have implications for gene flow and vulnerability to the threats inherent to small populations. I am conducting population surveys to estimate the abundance and distribution of Bahama swallow populations. I am using capture-recapture methods to provide another abundance estimate, and taking small blood samples for genetic analysis to assess the dispersal of populations between islands. (2) What are the life history characteristics of the Bahama swallow? The only existing study of Bahama swallow breeding biology occurred on Grand Bahama in 1995 and, thus life history data for this species are limited. I am expanding these data by closely monitoring active Bahama swallow nests during several consecutive breeding seasons. Bahama swallows breed from early April to late July, laying an average of 3 eggs in pre-existing cavities, primarily abandoned woodpecker cavities in snags of Caribbean pine (*Pinus caribaea*) and utility poles, cell phone towers and buildings. (3) What are the potential agents of decline of Bahama swallow populations? (A) Habitat loss and degradation: Bahamian pine forests were heavily logged through the early 1970s, and continued loss and degradation of pine forests through development and natural disasters poses an ongoing threat. I am conducting surveys of the pine forest and other habitats to assess the availability of nesting structures (e.g. snags) and excavated cavities within those structures. It is clear that cavity resources vary across the landscape, and further analysis will provide insight into extent of suitable breeding habitat. (B) Competition for nesting cavities: The Bahama swallow may

face competition for cavities with other cavity-nesting bird species. I am identifying the species that excavate and utilize the same types of cavities as Bahama Swallows, and designing a cavity nest web illustrating the interactions of these species. Potential competitors include woodpeckers (*Picoides villosus*, *Melanerpes superciliosus*), the American kestrel (*Falco sparverius*) and the invasive House sparrow (*Passer domesticus*). (C) Predation: Increased abundance of nest predators could pose a threat to the Bahama swallow and other species within the cavity nesting community. I am monitoring active nests for depredation to determine whether the rates of depredation of Bahama swallow nests by these species are sufficiently high to contribute significantly to population declines. I have been working with The Bahamas National Trust and other organizations to facilitate and promote this work. One of the goals of this research project is to provide information to assist in the development of strategies to conserve the Bahama swallow and its breeding habitat.

### **The Kirtland's Warbler: Designing conservation programs on the Bahamas archipelago wintering grounds**

**David Ewert<sup>1</sup>, Joseph Wunderle<sup>2</sup>, Dave Currie<sup>3</sup>, Jennifer White<sup>3</sup>, Genie Flemming<sup>3</sup>, and Scott Johnson<sup>4</sup>**

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The Kirtland's warbler (*Setophaga kirtlandii*), one of North America's rarest Neotropical-Nearctic migrants, breeds almost exclusively in Michigan and winters almost exclusively in the Bahamas archipelago. Since 2002, the Kirtland's Warbler Research and Training Project has determined, through focal bird and vegetation surveys, that wintering Kirtland's warblers (KW) primarily use early succession coppice, particularly those areas with relatively high food abundance, including fruit of wild sage (*Lantana involucrata*), black torch (*Erithalis fruticosa*) and snowberry (*Chiococca alba* and *C. parvifolia*). KWs seem to be most abundant in the central Bahamas, and perhaps especially Eleuthera, Cat Island, San Salvador, and Long Island, based on recent surveys using playback of KW song and calls. Our challenge is applying this knowledge to implement practical land management practices that will ensure at least 4,000 KWs can be sustained during the winter. To help ensure long-term availability of favorable habitat for KWs, and associated species, such as the Bahama yellowthroat (*Geothlypis rostrata*), we are working to (1) increase awareness of the KW, especially on those islands with relatively large numbers of KWs, through collaborative work with the Bahamas National Trust, International Program of the U.S. Forest Service, and National Audubon Society, (2) evaluate the potential of the Bahamas Electricity Corporation rights-of-way management to create KW habitat, (3) evaluate the potential of resorts and private interests to create KW habitat, and (4) determine how sustainable agriculture, including goat farming, can create or maintain KW habitat. Our future work will focus on determining how to feasibly maintain suitable early succession habitat for KWs long-term, especially habitat used in late winter when resources are relatively scarce.

### **Preliminary results on studies of the total Lepidoptera present in The Bahamas**

**Jacqueline Miller<sup>1</sup>, Deborah Lott<sup>1</sup>, Mark Simon<sup>1</sup>, Gary Goss<sup>2</sup>, Rick Rozycki<sup>3</sup>, and Nancy Albury<sup>4</sup>**

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Lepidoptera as model study organisms are critical in studies of biodiversity in the Caribbean Basin and especially in The Bahamas, Turks, and Caicos Islands. These insects are excellent bioindicators of particular habitats and habitat quality and are associated with specialized hostplants and involved in pollination. There are currently 84 butterflies (102 taxa) recorded from The Bahamas. However, our knowledge of the moths is very limited and in fact there has never been a complete published checklist of the total Lepidoptera recorded in The Bahamas. Moths account for approximately 95% of Lepidoptera worldwide and some of the current patterns are reflected in the geological history of the islands. The origin of Bahamian Lepidoptera may be derived from Florida or Central America but also from the West Indies, especially Cuba and Hispaniola. The lepidopteran fauna recorded from Florida (3,000) is rather large compared to Cuba (1,590), which based on the size and topography of the latter, should number about 3,500. Given the proximity of Cuba and Florida to The Bahamas, we estimate that there should be approximately 2,000 species. Although we have completed biodiversity surveys on the total Lepidoptera since 2008, we embarked on surveying total Lepidoptera on 12 major islands in The Bahamas in 2014 and 2015. Our goals were to develop and publish an annotated checklist, describe new taxa and list new records of species present, and complete comparative analyses on the biodiversity and biogeography to determine lepidopteran endemism present within the Lucayan Archipelago. Due to urban development and habitat fragmentation, species originally recorded on some islands have resulted in local extinctions. Invasive species have also been introduced and these compete for resources with the native species. Changes in weather patterns including weather patterns and tropical storms play a significant role in the geographic distribution and movement of Lepidoptera in the Caribbean Basin. Lepidoptera are highly visible and serve to promote education and public knowledge of these iconic organisms. Such studies as these provide supportive documentation for conservation management and ecotourism in addition to the more traditional studies on biogeography, biodiversity and ecology. Through these efforts, we can foster value and appreciation of the natural resources in The Bahamas by future generations of residents and ecotourists alike.

## **Will fire ants conquer The Bahamas?: The impact of habitat type on competitive interactions between alien fire ants and ant species assemblages on San Salvador, The Bahamas**

**Daniel Kjar and Zachory Park**

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The imported red fire ant (*Solenopsis invicta*) and the tropical fire ant (*Solenopsis geminata*) are both common, introduced ants throughout most tropical areas in the world. These ants appear to prefer disturbed habitats and frequently interact with humans. These ants are very aggressive, and will attack and sting any animal that disturbs their large nests. The presence of fire ants reduces populations of ground nesting birds, lizards, and mammals. They will also attack ground nesting bees, wasps, and other insects. Our studies on San Salvador Island, The Bahamas, examine the habitat preference and competitive interactions of fire ants with other native and introduced ant species. We observed ant interactions at 136 baits across two field seasons (June 2014 and June 2015) and in 3 different habitat types (Blackland, Palmetto, and plantations). We found 27 ant species at our baits across both years of this study. Across all habitats, 51% of ant visits observed at baits were not native species. The Blacklands had the highest number of native ant species and plantations had the lowest number of native species. Competitive interactions at the baits were relatively predictable within each habitat. When alien fire ants were present at baits they would dominate the bait with few exceptions. Many studies have demonstrated that both *S. invicta* and *S. geminata* prefer disturbed habitats and are not frequently found in native undisturbed habitats. We have observed this on San Salvador, however, the presence of fresh water may allow fire ants to move into and dominate habitats that are relatively undisturbed. Clearing of Blacklands may increase the pressure on native ant species from encroachment of alien fire ants.

## **Trends in early plant-pollinator community recovery following three hurricanes on San Salvador Island** **Carol Landry<sup>1</sup> and Nancy Elliott<sup>2</sup>**

1. The Ohio State University Mansfield, OH, USA; 2. Sienna College, Albany, NY, USA.

The purpose of this study is to identify plant and animal species critical to the recovery of coastal plant-pollinator communities following hurricanes. It is part of a larger research program that seeks to understand the mechanisms that maintain biodiversity in Bahamian coastal plant communities by investigating networks of interacting plants and animals. In coastal plant communities, each species is part of a complex system of interacting organisms, living on terrain sculpted by the wind and the sea. Interactions can be positive or negative; therefore, to understand how biodiversity is maintained in these complex communities, it is necessary to study networks of interacting species, such as plants and their pollinators. Here we present trends that we have observed in the recovery of plant-pollinator communities on San Salvador Island following Hurricanes Irene (Category 3; August 2011), Sandy (Category 2; October 2012), and Joaquin (Category 4; October 2015). Work was performed at the same site locations over 6-10 days during the first half of December 2010-2015, and 12 days in October 2011. We recorded vegetative damage within 200 m of the coast, estimated flowering intensity, and recorded floral visitors observed incidentally or during 10-15 minute timed watches. Damage to the vegetation increased with hurricane strength, while floral diversity and community-wide flowering intensity decreased. Depending on the year, we spent 40 – 90 person hours performing timed watches and making incidental observations of floral visitors between 0900 hours and 1630 hours. Pollinator diversity declined with hurricane strength and was correlated with nesting habitat. Relative to non-hurricane years, ground nesting species (e.g. *Megachile alleni*, Hymenoptera) were less common or absent, stem nesting species (e.g. *Xylocopa cubaecola*, Hymenoptera) were as common, and species that nest in fresh water (e.g. *Palpada albifrons*, Diptera) were more abundant.

## **Genetic identification of an isolated seahorse population in a saltwater lake on Eleuthera Island, Bahamas**

**Emily Rose<sup>1</sup>, Heather Masonjones<sup>2</sup>, and Adam Jones<sup>1</sup>**

1. University of Tampa, Tampa, FL, USA; 2. Texas A&M University, College Station, TX, USA.

Previous work in a saltwater lake, Sweetings Pond, on Eleuthera Island, Bahamas, identified the presence of seahorses belonging to the species *Hippocampus reidi* in the 1980s. Additional samples were collected from Sweetings Pond during the summer of 2014 for species identification using morphological and genetic analyses. Morphological attributes of the seahorses from Sweetings Pond were compared to the two species of seahorses with overlapping distributions in the Bahamas, *H. reidi* and *H. erectus*, but were not informative enough to identify the collected specimens. However, distinct morphological characteristics were identified in the Sweetings Pond population. Next, we turned to molecular markers and utilized a mitochondrial gene (cytochrome b) and a nuclear gene (S7) to identify the species of the Sweetings Pond seahorses. Phylogenetic analyses showed that these samples were nested within the *Hippocampus erectus* clade for both genes. These results indicate that the Sweetings Pond seahorses are an isolated population of *Hippocampus erectus* with a more even torso to tail body ratio compared to other members of the *H. erectus* clade and other tail-biased seahorse species found in their geographic range. As a result of a weak or nonexistent current, no fishing pressures, and a relatively predator-free environment in the lake, this pond presents a unique opportunity to study an isolated population of seahorses evolving with relaxed selection pressures.

## **Population dynamics and habitat preferences of the lined seahorse (*Hippocampus erectus*) inhabiting a Bahamian saltwater lake**

**Heather Masonjones<sup>1</sup>, Emily Rose<sup>2</sup>, Rob Drummond<sup>3</sup>, and Jocelyn Curtis-Quick<sup>3</sup>**

1. University of Tampa, Tampa, FL, USA; 2. Texas A&M University, College Station, TX, USA; 3. Cape Eleuthera Institute, Rock Sound, Eleuthera, The Bahamas.

Anchialine ponds are habitats frequently associated with unique biota that differs dramatically from nearby coastal systems. Sweetings Pond (91 hectares) on the island of Eleuthera (The Bahamas) is such a system, containing an unusual population of the lined seahorse (*Hippocampus erectus*). In this study, we investigated the distribution of seahorses by size and sex across habitat types, relative to habitat availability. Thirty-two 30 X 1 meter benthic transects were established around the pond margin and assessed three times over a year and a half timespan (March, July 2014, August 2015). At each sampling event, photos (50 X 50 cm) were taken at each meter (30 total/transect) to characterize benthic cover. Seahorses were mapped along each transect, recording their holdfast type and photographed for morphological analysis. Holdfast preference was determined by statistically comparing holdfasts available from benthic analysis with actual habitat types to which animals were attached. Across the lake, seahorses were seen at more than double the density in the north end (0.22 animals/m<sup>2</sup>) compared to the south (0.09 animals/m<sup>2</sup>), with no differences in distribution by gender. Adults were sighted more commonly than juveniles, but results may reflect the cryptic nature of these fish more than lack in abundance of this life stage. Animals were associated with every habitat type, with seahorse association reflecting habitat frequency. Compared to research focused on other seahorse species globally, Sweetings Pond animals have a higher habitat density, no holdfast preference, and are shaped differently than other *H. erectus*, indicating a population that is a discrete management unit compared to other *H. erectus*. Given the CITES Appendix II listing of all seahorses and their decreasing numbers worldwide due to overfishing and habitat loss, this population represents a valuable biological resource for Bahamians and one that should be protected.

## **The influence of introduced fish on the presence of endangered cave shrimp: a field and laboratory study**

**Alexio E. Brown<sup>1</sup>, Heather Bracken-Grissom<sup>2</sup>, Robert Ditter<sup>3</sup>, Heather Masonjones<sup>4</sup>, Mary Wicksten<sup>5</sup>, Jocelyn Curtis-Quick<sup>6</sup>**

1. The Bahamas National Trust, Nassau, New Providence, The Bahamas; 2. Florida International University, North Miami, FL, USA; 3. Florida Gulf Coast University, Fort Myers, FL, USA; 4. University of Tampa, Tampa, FL, USA; 5. Texas A&M University, College Station, TX, USA; 6. Cape Eleuthera Institute, Rock Sound, Eleuthera, The Bahamas.

Anchialine ponds are saline land-locked bodies of water located near coastlines with subterranean connections to the ocean. One special feature of these ponds is the endemic species they support. The island of Eleuthera has over 200 of these inland water sites, yet very few of them have been studied. These ponds are fragile systems and are susceptible to anthropogenic disturbances such as pollution, habitat modification and intentional introduction of non-endemic species. A baseline assessment of these ponds was conducted across Eleuthera in 2015. This study found that of the 16 sites visited the majority, 69%, were disturbed by humans. The most frequent impacts were the introduction of predatory species and accumulation of trash in the ponds. The study also identified critically endangered cave shrimp, *Parhippolyte sterreri* and *Barbouria cubensis*, that have never been reported prior to this study. Unfortunately, like anchialine ponds in Eleuthera, there is very little literature on these shrimp. Most research has reported the location of these shrimp, and their morphology and taxonomy. There is a major gap in knowledge about their ecology and

behaviour. The experimental set-up to test shrimp naivety included three shrimp that were placed into a 35-gallon tank with rock refuges. Schoolmaster snapper, *Lutjanus apodus*, were then added to the tank in separate containers and allowed to acclimate for one hour. After the acclimation period, a thirty-minute observation was recorded with a camera, and the location and behaviour of the shrimp (whether in refuge or in the open) were noted every two minutes. Shrimp in the absence of a predator served as a control for this experiment. A better understanding of these cave shrimp will add to the general body of information about anchialine ponds; also inform conservation and restoration strategies of these unique ecosystems.

### **Conservation update on the Sandy Cay rock iguana (*Cyclura rileyi cristata*)**

**Sandra D. Buckner<sup>1</sup>, William K. Hayes<sup>2</sup>, John B. Iverson<sup>3</sup>, Jill M. Jollay<sup>4</sup>, Philip S. Weech<sup>5</sup>, Steve Smith<sup>1</sup>, Pat Hayes<sup>6</sup>, Sheila Iverson<sup>7</sup>, and James Traverse<sup>8</sup>**

1. The Bahamas National Trust, Nassau, New Providence, The Bahamas; 2. Loma Linda University, Loma Linda, CA, USA; 3. Earlham College, Richmond, IN, USA; 4. Tucson, AZ, USA, 5Bahamas Environmental Science & Technology Commission, Nassau, New Providence, The Bahamas; 6. Loma Linda, CA, USA; 7. Richmond, IN, USA, 8. Ardastra Gardens Zoo & Conservation Centre, Nassau, New Providence, The Bahamas.

*Cyclura rileyi* is one of three species of rock iguana endemic to the Bahamas archipelago. All species of *Cyclura* in The Bahamas are protected under the Wild Animals Protection Act 1968 and the Wildlife Conservation and Trade Act, 2004, and are listed on the IUCN Red List of Threatened Species as Endangered or Critically Endangered and are CITES Appendix I. On 3 February 2014, thirteen rock iguanas (*Cyclura rileyi* sp.) were discovered at London Heathrow Airport by officers of the United Kingdom Border Force smuggled in the luggage of two Romanian women arriving from The Bahamas on a British Airways flight. Twelve of the rock iguanas were alive and one was dead. First reported to be “San Salvador” rock iguanas, investigations and the presence of PIT tags confirmed the iguanas were *Cyclura rileyi cristata* from the Exumas. The 12 rock iguanas were repatriated on 9 July 2014. Three of the repatriated iguanas died within 24 hours of arrival back in The Bahamas. The surviving nine Rock Iguanas were quarantined and then on 13 September 2014 were released into the wild on a selected cay within a National Park free of an existing iguana population and approximately 20 km from the source cay in the Exumas. On 24-26 March 2015 with the permission and support of the Bahamas Government (Bahamas Environment Science and Technology Commission) and the Bahamas National Trust twenty-seven *Cyclura rileyi cristata* were selected from the source cay and released on to the cay that was now home to the repatriated rock iguanas. This translocation brought the number of rock iguanas in that sub-population to thirty-six thus establishing a second sub-population of this subspecies previously restricted to one unprotected cay. Monitoring of and research into these two sub-populations of *Cyclura rileyi cristata* will be ongoing.

### **Working to curb wildlife trafficking in The Bahamas and Trinidad and Tobago**

**Scott Johnson<sup>1</sup>, Laura Baboolal<sup>2</sup>, Kareena Anderson<sup>3</sup>, and Sharleen Khan<sup>4</sup>**

1. The Bahamas National Trust, Nassau, New Providence, The Bahamas; 2. Conservation Leadership in the Caribbean, Trinidad & Tobago; 3. Design Engineering Service Limited, St. Joseph, Trinidad & Tobago; 4. Zoological Society of Trinidad and Tobago Inc., Port of Spain, Trinidad & Tobago.

Wildlife trafficking has been a major problem and of great concern in the Caribbean due to the fact that the region is a biological hotspot which is a geographic area that contains a high diversity of species (Myers et al., 2000). There are over 10,000 species of vascular plants and over 1300 species of vertebrates that have been described in the West

Indies (Hedges, 2001). Because of the growing demand for wild animals and its products due to the pet trade, medicinal purposes, fashion, cultural items, trophies and food, wildlife trafficking has been an ongoing issue for many years throughout the world. In the West Indies archipelago, the islands of Trinidad and Tobago and The Bahamas are used as transshipment points to other countries. Many of the local species in both areas are feeling the negative effects of wildlife trafficking. There is an urgent need to reduce the threat of wildlife trafficking. From data gathered by interviews and from reviewing previous assessments there seems to be a lack of capacity to identify and distinguish legal from illegal wildlife and its products which allows the illegally trafficked species to go undetected (Alie, 2010). This represents a major bottleneck in the enforcement and prosecution of wildlife crime. The adoption of quick and accurate methods to identify illicit material would greatly facilitate customs, border enforcement (airport security, custom officers, coastguard and wildlife authorities. The Wildlife Trafficking team of the Conservation Leadership in the Caribbean (CLiC) Program as well as other departments and organizations in the Bahamas and Trinidad and Tobago is currently working on ways to reduce the amount of illegally smuggled wildlife being taken out of our country.

## **A History of The Bahamas through maps**

**Todd T. Turrell, P.E.**

Turrell, Hall & Associates, Inc. Naples, FL, USA.

As a follow up to Todd's talk "Mapping The Bahamas from Ancient Times to Present Day" at the 2014 Natural History Conference, this presentation will use antique maps to tell a brief history of The Bahamas. The new book "A History of The Bahamas Through Maps" is being published by Todd and should be in print just prior to the conference. The presentation will include not only maps but interesting exhibits (from the book) on geological history, a general map of Lucayan archaeological sites in The Bahamas, and an antiqued map of Columbus' route. It will then examine different periods in the country's history with antique maps of that particular era as the backdrop. Six to eight high resolution scans of important antique maps of the Caribbean will be shown, most enlarging the specific area of The Bahamas to support the presentation.

## **The Historical Ecology of the West Indian Monk Seal in the Bahamas**

**David G. Campbell**

Grinnell College, Grinnell, IA, USA.

This paper will present a brief overview of what is known about the archaeological (pre-historic), colonial and 20th Century records of the West Indian monk seal (*Monachus tropicalis*) in the Bahama Islands and elsewhere in the Caribbean. Columbus made no note of the monk seal in the journal of his first voyage to the New World in 1492-1493, although he observed "lobos del mar" on the south coast of Hispaniola. Yet by colonial times, the monk seal was so abundant in the Bahamas that it supported a burgeoning artisanal seal-hunting industry. What can account for these disparities? The answer is the fluctuation of the human population in the Bahamas since 1492: the genocide of the Native Americans soon after contact, the abandonment of the islands by humans for nearly 200 years (during which time the monk seal returned to the islands and flourished), and the arrival of the first European settlers and their slaves (resulting in the extinction of the monk seal by the middle 20th Century). The paper concludes with first-hand accounts of monk seals acquired from Bahamians by Dr. David Sergeant, the author and other scientists aboard the barkentine Regina Maris during her two voyages through remote parts of the archipelago in search of monk

seals, 1981 and 1982.

## **Movement Patterns of West Indian Manatees (*Trichechus manatus*) in The Bahamas**

**Felice Knowles<sup>1</sup>, Diane Claridge<sup>1</sup>, James Reid<sup>2</sup>, and Cathy Beck<sup>2</sup>**

1. Bahamas Marine Mammal Research Organization, Marsh Harbour, Abaco; 2. United States Geological Survey Sirenia Project, Gainesville, FL, USA.

The Bahamas Marine Mammal Research Organisation (BMMRO) and the U.S. Geological Survey/Sirenia Project (USGS) have been monitoring the occurrence and health of West Indian manatees (*Trichechus manatus*) in The Bahamas for over fifteen years. Historic evidence of manatees in The Bahamas is limited to only two sightings from 1904 and 1975, suggesting The Bahamas has not had a persistent manatee population. However, manatee sightings increased significantly during the 1990's commensurate with the increase in the Florida manatee population, greater public awareness, and reporting of sightings to local environmental organisations, such as BMMRO. Through the use of photo-identification and the location and timing of sightings, at least fifteen individual manatees are currently known to inhabit The Bahamas, three of which had previous sighting histories in Florida. Three (Rita, Georgie, and Gina) were periodically radio-tagged to document their movements and habitat use patterns. Tracking and photo-identification data show persistent local resource use and occasional long-distance, deep-ocean movements between islands. Rita and Georgie, tagged as a mother-calf pair, were observed negotiating local habitats, making repeated moves from the Berry Islands to Andros Island. Post-weaning, Georgie left the Berry Islands and twice traveled across the deep waters of the Great Bahama Canyon to Abaco Island (minimum distance of 50km). Gina resided in the northern Berry Islands for fourteen years, and then arrived in Eleuthera in 2014 (100km away) where she was tracked among nearshore habitats and making two, possibly exploratory movements 30km offshore into waters with depths >4,000m. An adult male, Blackbeard, has been photo-documented at Long, Cat, Eleuthera, and New Providence islands, with some repeated trips among these islands. Photo-identification and radio-tracking of individual manatees in The Bahamas have provided insights in the navigational capabilities of individuals to occupy large home ranges, negotiate repeated long distance moves and survive deep-water crossings.

## **Bachelor sperm whales (*Physeter macrocephalus*) in the Bahamas: insights from a multidisciplinary study**

**Charlotte Dunn<sup>1</sup>, Kim Parsons<sup>2</sup>, David Herman<sup>2</sup>, John Durban<sup>2</sup>, Gina Ylitalo<sup>2</sup>, and Diane Claridge<sup>1</sup>**

1Bahamas Marine Mammal Research Organization, Marsh Harbour, Abaco, The Bahamas; 2. National Oceanic and Atmospheric Administration, Washington, DC, USA.

There is little information regarding the lives of subadult male sperm whales (*Physeter macrocephalus*) between their dispersal from their natal group and subsequent arrival in higher latitudes where they live primarily solitary lives. We integrated a suite of approaches in the field and laboratory to elucidate the occurrence and composition of bachelor sperm whales in the Bahamas. Acoustic analysis from 8 of 21 genetically sexed male sperm whales resulted in size estimates comparable to subadult male sperm whales in other regions (range 8.2–13.4m); field observations and photographs place the remaining males within this same size category. Using photo-identification data, pairwise association indices between males across years (mean=0.02 (sd 0.02), max=0.33) provided support for occasional formation of “bachelor groups”. Genetic pairwise analysis from biopsied individuals revealed that the level of relatedness between males was comparable to pairwise relatedness of genotyped adult females from this region

(pairwise results: 0.046 SM, n=21; 0.062 AF, n=18). However, on average subadult males are more closely related to one another than to adult females, suggesting these males may be immigrants. Inference from satellite transmitter tags (n=27), chemical markers (n=54 biopsies) and photo-identification data also indicated that subadult males have larger ranging patterns than these females. The majority of bachelors were tracked using a deep oceanographic trough (Tongue of the Ocean, TOTO), while adult female groups and their calves rarely use this area. Notably, TOTO is the site of a US naval underwater testing range, and a tagged sperm whale reduced its' surface time by 50% during a multi-ship exercise using mid-frequency active sonar in TOTO. Bachelor whales have been re-sighted in TOTO across years so may be repeatedly disturbed during an important period of growth in their lives. These novel findings increase our understanding of the lives of bachelor sperm whales.

## **Twenty-five years of marine mammal research in The Bahamas reveals complex future management challenges**

**Diane Claridge and Charlotte Dunn**

Bahamas Marine Mammal Research Organization, Marsh Harbour, Abaco, The Bahamas.

The Bahamas Marine Mammal Research Organisation (BMMRO) has been conducting field research in The Bahamas since 1991, providing the only dataset available for many marine mammal species in the region. This work has been filling key knowledge gaps on the population and behavioural ecology to help inform conservation and management directives. Field methodologies have included visual and acoustic line-transect and opportunistic surveys resulting in over 6,000 sightings of marine mammals. Collection of individual-based data has integrated photo-identification, acoustics, remote biopsy sampling, and suction-cup and satellite telemetry tagging. Partnerships with academic institutions and U.S. NOAA Fisheries have resulted in directed studies on distribution and habitat use, population structuring and demographics, foraging ecology, social structure, communication and population-level effects of disturbance. Species that have been the primary focus of this work include eight cetacean species and one sirenian. The objective of this presentation is to share our most important findings and highlight challenges for future management of marine mammals in The Bahamas, with the key goal to contribute to their effective conservation. Significant findings include: vulnerability of a small site-faithful population of Blainville's beaked whales (*Mesoplodon densirostris*) on the U.S. Navy's underwater testing range in Andros; sex-based differences in residency patterns of sperm whales (*Physeter macrocephalus*); large-scale ranging of short-finned pilot whales (*Globicephala macrorhynchus*) into U.S. waters; high persistent organic pollutants measured in melon-headed whales (*Peponocephala electra*); population decline of coastal bottlenose dolphins (*Tursiops truncatus*) in Abaco; and, inter-island movements of West Indian manatees (*Trichechus manatus*). Current and future management concerns for these species will be discussed. Management needs are complex due to a number of contributing factors. Despite high species diversity, many species occur in small localised populations, some of which are vulnerable to human disturbances and therefore in need of more immediate action. Differences in ranging patterns across species (for example, resident beaked whales compared to widely ranging pilot whales) requires both local and international efforts to address their conservation. Variability in marine mammal habitat needs range from shallow mangrove lagoons, much of which is now protected, to submarine canyons, currently none under protection. Developing collaborations throughout the Wider Caribbean Region, identifying key habitats and its quality, and monitoring small resident populations are the focus of BMMRO's future research. Partnerships with Bahamian conservation groups and Government agencies will be key to developing and advancing conservation directives to manage these species in The Bahamas.

## **Examining historical population dynamics for recreational fish species including: bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*), and permit (*Trachinotus falcatus*), through local angling guide knowledge across the Bahamas.**

**Thomas Karrow**

University of Waterloo, Waterloo, ON, Canada.

‘Reversing a decline’ implies negative change; yet in the highly lucrative Bahamian bonefishing industry, long-term data and catch per unit rates common in commercial fisheries do not exist. As a result, assessing declines in associated fisheries populations is challenging, but vital for sustainable resource management and the tourism sector. Bonefishing is an integral component of the tourism industry in The Bahamas consequently; establishing historic population dynamics is critical. This ongoing study addresses these gaps through accessing local ecological knowledge held by senior bonefish guides. Through a mixed methods approach involving semi-formal interviews, guide knowledge was quantified to determine population changes in game fish numbers on Bimini, Grand Bahama and Abaco during field seasons in 2014, 2015, and 2016. Results indicate, shifting baselines, regional variability, and declines in populations of bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*) and other prized marine organisms including, queen conch (*Lobatus gigas*), lobster (*Palinuridae sp.*) and snapper (*Lutjanus sp.*), since the 1950’s when recreational angling tourism in the Bahamas developed. Similarly and unilaterally, guides on all three islands note increases in populations of permit (*Trachinotus falcatus*) in recent years, boding for possible expansion of this fishery sector. Examining historical population dynamics is crucial for assessing decline and critical for effective resource management. Through collaborating with guides (key stakeholders), and encouraging participation, co-management opportunities are fostered, thus prompting greater resource sustainability. Future efforts in this study will focus on Andros and the Exumas in the winter and spring of 2016.

### **A multidisciplinary approach to address bonefish recruitment**

**Elizabeth Wallace<sup>1</sup>, Christopher Haak<sup>2</sup>, and Aaron Shultz<sup>3</sup>**

1. Fish and Wildlife Research Institute, St. Petersburg, FL, USA; 2. Fisheries Conservation Foundation, Champaign, IL, USA; 3. Cape Eleuthera Institute, Rock Sound, Eleuthera, The Bahamas.

Marine fisheries, due to the openness and complexity of these systems, require interdisciplinary management approaches. The range of the Atlantic bonefish, *Albula vulpes*, spans multi-national jurisdictions, adding additional challenges. Practical needs, such as fishery recruitment information, are inherently complex questions that require interdisciplinary data. Integrated approaches incorporating diverse areas of expertise can provide critical information required for effective management. In the recreational bonefish fishery, concern exists due to population declines. However information regarding recruitment dynamics and regional connectivity via both larval and adult stages are lacking. We are addressing this void through a comprehensive assessment employing ecological, behavioral, molecular, and oceanographic data. Field data collection is targeted based on adult telemetry data, juvenile habitats, and oceanographic models of potential larval dispersal routes. High-resolution genetic data will be used to directly examine population connectivity at local and regional scales. This will provide detailed data regarding the sources of new recruits to the recreational fishery: local, regional, or a combination of these sources. Results will determine the appropriate geographic scale for management actions as well as highlight factors important for conservation and restoration efforts.

## **A population estimate for bonefish in South Eleuthera: implications for management and development**

**Zachary Zuckerman<sup>1</sup>, Stephanie Shaw<sup>2</sup>, Michael Allen<sup>2</sup>, Aaron Adams<sup>3</sup>, Aaron Shultz<sup>1</sup>**

1. Cape Eleuthera Institute, Rock Sound, Eleuthera, The Bahamas; 2. University of Florida, Gainesville, FL, USA; 3. Bonefish and Tarpon Trust, Key Largo, FL, USA.

The recreational bonefish industry is worth an estimated \$141 million to The Bahamas, and is considered an important conduit for injecting tourism-generated income into the Family Islands. Despite the economic value of this primarily catch-and-release fishery, baseline data describing population metrics of bonefish in The Bahamas is lacking. Since 2004, a research effort comprised of Bahamian and United States non-governmental organizations, international universities, Bahamian bonefish guides, and volunteer citizen scientist anglers have collaborated to tag, release, and recapture bonefish throughout The Bahamas, with South Eleuthera representing the location of greatest tagging effort. Recapture data have allowed for the first population estimate of bonefish in The Bahamas, suggesting a population size of 3,500 – 4,500 bonefish inhabiting six critical flats and tidal creek ecosystems along a ~40 km of shoreline adjacent to the Great Bahama Bank. In addition, recapture data reinforces high site fidelity in bonefish and the importance of at-risk coastal habitats in supporting the bonefish fishery. The findings here provide baseline data that can be used to compare how future coastal development, habitat restoration activities, or bonefish management strategies may affect population size and habitat use by bonefish in South Eleuthera. In addition, the approach implemented here can and provide a model for generating data to support coastal management strategies and assess the impact of habitat change on bonefish populations throughout The Bahamas.

### **Bonefish & Tarpon Trust: Bahamas Initiative**

**Justin Lewis**

Bonefish & Tarpon Trust, Freeport, Grand Bahama, The Bahamas.

The bonefish (*Albula vulpes*) is an economically important sport fish in the Islands of the Bahamas and throughout its geographical range. Until recently little was known about the species movements and the effects of recreational angling. From 2009 through 2016, in collaboration with fishing guides and recreational anglers, we used mark-recapture to document bonefish movements. Over the course of the study 11,112 bonefish were tagged, and 576 recaptures. Bonefish have high site fidelity, with the majority (71.5%) being recaptured  $\leq 1$ km from release site. However, they also exhibited long distance movements that appeared to be associated with spawning migrations due to the association with full and new moons during spawning season. Even though bonefishing is predominately a catch and release sport, findings from recent catch and release studies on bonefish have shown that improper catch and release practices such as excessive handling, use of boga grips, picture taking, and air exposure can significantly decrease the survival of bonefish post release, leaving them highly susceptible to predation. Through education BTT and our collaborators have been able to reach a wide audience and teach them about bonefish home ranges, spawning migrations, and the importance of best catch and release practices and how essential these findings are for effective conservation of bonefish.

## **Using acoustic telemetry to describe long-distance migrations of endangered Nassau grouper (*Epinephelus striatus*) to and from spawning aggregations in Andros, Bahamas**

**Kristine Stump<sup>1</sup>, Craig Dahlgren<sup>2</sup>, Krista Sherman<sup>3</sup>, Charles Knapp<sup>1</sup>**

1. John G. Shedd Aquarium, Chicago, IL, USA; 2. The Bahamas National Trust, Nassau, New Providence, The Bahamas; 3. University of Exeter, Exeter, Devon, UK.

The Nassau grouper, *Epinephelus striatus*, was once one of the most important fishery species in the wider Caribbean, but due to heavy over-exploitation is now endangered and in decline throughout most of its native range. Over winter full moons, the formation of annual transient spawning aggregations at known locations makes this iconic species particularly vulnerable to overfishing. Recent telemetry research in The Bahamas has shown that Nassau grouper can migrate up to hundreds of miles along shelf edges to the same aggregation sites year after year. Approximately 30 aggregation sites have historically been reported in The Bahamas, known mostly through anecdotal information and local knowledge. Very few have been validated with observations of spawning behavior, and whether or not many of these locations still support active aggregations has only been minimally investigated. Based on previous work, we designed a new study that uses acoustic telemetry to describe long-distance migrations of Nassau grouper to and from reported aggregation sites in Andros, Bahamas. Throughout 2014, an array of acoustic receivers was placed at the Andros shelf edge along suspected migration routes from Chub Cay, Berry Islands to the southern Tongue of the Ocean. In December 2014, 16 adult Nassau grouper were surgically implanted with acoustic transmitters. Tagged grouper were confirmed to migrate along the shelf edge for up to hundreds of miles and in synchronicity with the January 2015 full moon. The telemetry data, paired with recent diver survey data, suggest that the historically prolific High Cay spawning aggregation may be defunct. However, detection data from the January 2015 full moon period suggest Nassau grouper may be migrating to an alternate location.

## **New insights on the postlarvae supply into the Florida spiny lobster population**

**Iris Segura-García<sup>1</sup>, Mike Tringali<sup>2</sup>, John Huny<sup>2</sup>, Stephen Box<sup>1</sup>**

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Larval transport and recruitment are fundamental ecological processes to understand population dynamics in marine species. For the Caribbean spiny lobster, *Panulirus argus*, this represents a real challenge because of their long pelagic larval duration (5-9 months), high natural mortality rates, in addition to difficulty in tracking the dispersal routes and estimating local recruitment. In Florida, the Caribbean spiny lobster represents one of the most valuable fisheries, in both the commercial trap fishery and the popular recreational dive fishery. Despite a great economical importance and that *P. argus* is a well studied species our knowledge regarding dispersal distance and connectivity of geographically separated populations is still limited. In this study, spiny lobster postlarvae (PL), from the Florida Keys and adults from remote populations were genotyped using 14 microsatellite loci. We investigated the extent of genetic relatedness between PL recruits and adults lobsters by performing relatedness and parentage analyses. Our study provides the first genetic evidence suggesting that spiny lobster behave as clusters during their pelagic larval development until the final stages of the recruitment process, and revealed that the Florida lobster population recruits important number of PLs from Belize, Eastern Caribbean and Florida itself. Surprisingly and despite the geographic proximity the analysis did not show a large number of recruits from Bahamas. These results provide key information to improve spiny lobster fishery management and secure its sustainability.

## **Political ecology of The Bahamian spiny lobster fishery and policy implications of an interdisciplinary framework**

**Karlissa Callwood**

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In recent years, The Bahamian spiny lobster (*Panulirus argus*) fishery has transitioned to the use of condos (or casitas) as the primary fishing method. This strategy incurs relatively low costs to construct and deploy, resulting in an estimated quantity of over 200,000 condos throughout the Bahama banks. Collectively, these factors, coupled with an increased level of effort in the form of new fishers and more boats, have contributed to increased levels of competition for an already limited resource, further complicating the development of adequate and sustainable management strategies. The potential for human-induced changes to the ecosystem due to this high volume of condos highlights the need for an interdisciplinary investigation of the fishery that takes into account both natural and anthropogenic impacts. This project focuses on an examination of this increased condo usage, and the implications of this use on how the fishers define, perceive, and adhere to access and property rights through a political ecology lens. This case is amenable to a such an analysis due to the heavy interdependence of ecology and human factors throughout the fishery, allowing for an assessment of how the ecological, social, and economic elements all come together to create and define the fishery, including the implications of this convergence on the overall management. Surveys and semi-structured interviews of Bahamian fishers and other stakeholders were conducted over the course of 3 summers, revealing many conflicting views about the fishery, particularly around ownership of the condos and the lobster within them. A further examination of the data highlighted the emergence of several political ecology themes within the fishery, as well as the importance of considering both internal factors, such as social pressures, local norms, and voluntary agreements, and external ones, including demand and market value defined by a global market, when determining how to sustain and successfully manage the fishery.

## **Would you sleep in a graveyard? Assessing queen conch's behavioral response to knocked shells**

**Claire Thomas<sup>1</sup> and Oliver Dodd<sup>2</sup>**

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Queen conch are in decline throughout most of their range, including in The Bahamas. Overfishing and the harvest of juvenile conch are clear contributors to the decline in Bahamian stock, but there is a prevailing idea among local fishermen in The Bahamas that queen conch are moving away from knocked shells that are tossed overboard at sea by fishermen. With a keen sense of smell and good eyesight, there is reason to believe that conch may be affected by exposure to knocked shells. To address this issue, a laboratory-based experiment was designed to determine if conch change their behavior (e.g., exhibit "avoidance" behaviors) due to the presence of a knocked shell. Conch were collected in South Eleuthera, acclimated in tanks at the Cape Eleuthera Institute wet lab, and then exposed to one of three treatments: a rock (control), an old knocked shell (potential visual cue) and a freshly knocked shell (potential visual and chemical cues). Their behavior and location within the tanks was then monitored for 4 hours, to quantify potential avoidance of the treatment object. Preliminary analysis of the lab trials shows that although avoidance behavior was observed, it was not the predominant response, and there was no significant effect of treatment object on behavior. With declines noted on several family islands, urgent changes in management are necessary to ensure the health of future conch populations. Disposal of knocked shells may influence current conch populations, and laws regulating shell disposal may benefit the conch. Conversely, if conch are unaffected by knocked shells, this information

may be aggressively relayed to fishing communities on the family islands, and closer attention can be paid to management strategies that address the current fishing pressure, and not on shell disposal.

## **Queen conch (*Lobatus gigas*) population density predicted by benthic habitat type in The Bahamas.**

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The iconic queen conch (*Lobatus gigas*) is an economically and culturally important species in much of the Caribbean. However, heavy harvest has proved unsustainable and pushed conch populations into decline. As a result conch populations are now threatened or endangered throughout most of their range. Conservation efforts in The Bahamas are underway to promote a sustainable fishery, but first the remaining populations need to be assessed, a particularly challenging goal given the patchy distribution of conch in habitats where they occur. For a decade, towed observer surveys have been used to describe the coarse densities of conch over wide swathes of The Bahamas. We added a digital record to over 100 km of traditional towed surveys in the Exuma Islands, the Sandbores at the southern end of the Tongue of the Ocean, and in the Schooner Cays by including a continuous stream of geolocated images of the seafloor to complement counts of queen conch. We assembled photomosaics of our tows and classified benthic habitat into seagrass (3 densities), sand, rubble, gorgonian plain, patch reef, and hard-bottom. Habitat quantities (m<sup>2</sup>) were factors in multinomial generalized linear regression model analysis of the variable response conch abundance. Our model can be applied to existent satellite habitat maps compiled by the Bahamas Biocomplexity Project, to predict conch population sizes and properly parameterize models of larval transport. Furthermore, our modified survey method can ground-truth satellite datasets, is a low-cost marine habitat mapping technique, and is an effective tool for surveying rare or elusive species in benthic marine systems.

## **Conch: Shaping a Sustainable Fishery Through Science**

**Frederick Arnett, Leander Lacy, Shiela M.W. Reddy, Felicity Burrows, and Shenique Albury-Smith**

The Nature Conservancy, Nassau, New Providence, The Bahamas.

Throughout the Caribbean, the queen conch (*Lobatus gigas* formerly called *Strombus gigas*) is considered a precious marine resource. Fisheries managers, researchers and some community members recognize there is a decline in conch populations in both The Bahamas and regionally. This decline motivated a collective effort in The Bahamas by The Nature Conservancy, The Bahamas National Trust (BNT), the Department of Marine Resources (DMR) and other conservation partners to improve sustainability of the conch fishery through the Conchervation Campaign. However, a major challenge to this effort is that little is known and documented about whether the general population of The Bahamas is aware of the status of the fishery, how they use and value conch, and whether they would support new conservation measures. To address this gap, a study of Bahamians' knowledge, attitude, and practices (KAP) related to conch was executed through focus group meetings with the fishing community, expert interviews, and a national phone survey of the general population. The presentation will highlight the major findings of the KAP survey. Building upon the KAP Survey, The Nature Conservancy is now conducting an assessment of the national conch fishery. The assessment includes a comprehensive literature review to determine the status of queen conch in The Bahamas, a stakeholder analysis to determine the local economic market and consumer consumption rate of queen conch throughout The Bahamas and an evaluation of The Bahamas management structure for the queen conch to determine

gaps and strategies to improve sustainability measures and management of the conch fishery while taking into consideration Bahamian livelihoods. The information produced from this assessment will give natural resource managers and decision-makers a better understanding of the status of The Bahamas conch populations given the demand for conch and threats affecting conch populations.

## **A spatio-temporal analysis of somatic growth dynamics of hawksbills in The Bahamas and West Atlantic**

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Hawksbill sea turtles (*Eretmochelys imbricata*) are long-lived, major consumers in coral reef habitats that move over broad geographic areas. We assessed spatio-temporal effects on hawksbill growth dynamics (3541 growth increments) over 24 study sites throughout the West Atlantic and The Bahamas during a 33-year period (1980-2013). We also explored relationships between growth dynamics and climate indices. We used generalized additive mixed model analyses to evaluate 10 covariates, including spatial and temporal variation that could affect growth rates. Growth rates throughout the region responded similarly over space and time. The lack of a spatial effect or spatio-temporal interaction and the very strong temporal effect reveal that hawksbill growth rates in The Bahamas and West Atlantic are likely driven by region-wide forces. Between 1997 and 2013, mean growth rates declined significantly and steadily.

Regional climate indices have significant relationships with annual growth rates: negative with Caribbean sea surface temperature (SST) and positive with the Multivariate El Niño Southern Oscillation Index (MEI). Declines in growth rates between 1997 and 2013 throughout the West Atlantic and The Bahamas most likely resulted from warming waters through indirect negative effects on foraging resources of hawksbill sea turtles.

## **Assessing the knowledge and perceptions of Bahamians concerning sea turtles and their conservation**

**Annabelle Brooks<sup>1</sup>, Rachel Miller<sup>1</sup>, and Kate Kincaid<sup>2</sup>**

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The shallow banks environment of The Bahamas is an important foraging ground for juvenile and sub-adult individuals of four of the seven species of sea turtle. Green, loggerhead, hawksbill, and leatherback sea turtles frequent coastal habitats such as tidal mangrove creeks, seagrass beds, and coral reefs throughout the archipelago. Mating and nesting individuals have also been anecdotally documented in certain locations, yet little data exists on these events. Sea turtles were traditionally harvested for their meat and shells, and were considered to be a valuable resource for fishermen and an important local food source. In 2009, the Department of Marine Resources of the Bahamian Government implemented a nationwide ban on the take and sale of all sea turtle species and products in response to global declines in sea turtle populations. This major conservation milestone was not accompanied by any significant awareness and education and outreach initiatives. Despite the ban being in place for six years, there is evidence of continued poaching of sea turtles throughout the islands. Studies have shown that local community participation and support is essential to the success of a conservation program, and this can be encouraged through educational training. No studies have investigated how extensive knowledge of the sea turtle harvest ban in The Bahamas is, nor how those who are aware of the regulation perceive the ban and sea turtle conservation efforts in general. The goal of this study was to determine the extent to which Bahamians in Eleuthera know about the harvest ban and sea turtles in general. Overall, 48 individuals from 9 settlements participated in a 12-question, semi-structured interview. Questions were designed to collect quantitative and qualitative data through the use of yes/no, Likert Scale statements, and open-ended questions. 67% (n=32) of respondents were aware of the ban on the harvest of sea turtles; 19% (n=9) agreed with the ban, but did not know why the ban was in place, while 8% (n=4) disagreed with the ban, claiming turtles are an important food source that does not need to be regulated. 19% (n=9) believe it is important to protect populations for future generations, while 8% (n=4) believe that a seasonal closure should exist for sea turtles, much like those for Nassau grouper and crawfish in The Bahamas. The most commonly reported food source for sea turtles was conch (33%, n=16). It is possible that because loggerheads eat conch, Bahamians are associating that diet with all species of sea turtles found in The Bahamas, including the relatively abundant and herbivorous green sea turtle. Overall, it appears that Bahamians are accepting of the ban and support the regulation, with 96% (n=48) of interviewees stating that it is important to protect sea turtles. This research provides an opportunity to determine the knowledge gap between conservation planners, resource managers and local community stakeholders. The information collected to date is encouraging for the successful development and implementation of education and awareness programs that will motivate the environmentally responsible behavior essential for the conservation of endangered species.

## **The reproductive success of the green sea turtle, *Chelonia mydas*, at The Atlantis Resort, Paradise Island**

**Keisha Russell and Michelle Liu-Williamson**

Atlantis Resort, Paradise Island, The Bahamas.

Atlantis, Paradise Island has displayed Green sea turtles for the past 20 years. During this time these amazing animals have matured and thrived at our facility resulting in successful reproduction. Around the world, the Green sea turtle has suffered great decline and is listed as an endangered species. The significant decrease in the population, combined with studies that estimate only 1 in 1,000 hatchlings will survive until adulthood, has spurred the Marine Aquarium team at The Atlantis to strengthen its conservation efforts for this species. Over the past several years, there has been marked improvement in the number of egg clutches and hatch rate percentages at the facility due to data collection on the species, improved infrastructure to the breeding environment and innovative techniques for the transfer and incubation of the eggs. The reproductive successes of the Green sea turtle has also provided a platform to educate the public and heighten awareness, especially to school-age children on the action steps that can be taken for the survival of this majestic resource for the Bahamas. From the data that has been collected and the observations made from the Green sea turtles at Atlantis, plans are now underway to implement a similar program to aid in the conservation efforts of another turtle species appearing on the endangered species list.

### **The Dollars and Sense of Sharks in The Bahamas: Non-consumptive economic valuation as a tool for conserving elasmobranch resources**

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As apex predators, sharks have significant ecological value in our oceans, however this argument has had little influence in halting ongoing population declines around the world. The non-consumptive value of marine resources such as whales, turtles, and sharks is emerging as one of many new tools in the conservation toolbox. In this study, the non-consumptive value of sharks and rays in The Bahamas was examined from several standpoints: scuba diving and tourism, film and television, and research interests. Each sector was surveyed regarding its economic contributions to The Bahamas economy, either through in-person confidential interviews, or online anonymous surveys. In addition to the economic assessment of all of the above sectors, recreational scuba divers were surveyed to generate qualitative data including 1) their knowledge of shark conservation, 2) their motivations to visit The Bahamas for scuba diving, 3) their agreement with baited shark diving, and 4) their willingness to pay a premium that would help support shark conservation and management in The Bahamas. Our assessment provides not only an overall value of these animals at the national level, but a sector-specific and species-specific valuation as well. We demonstrate that conservation of elasmobranch resources has vast benefits for the economy of The Bahamas, and we discuss further policy recommendations for the future of shark management in the island nation and wider Caribbean.

### **To cull or not to cull invasive lionfish? Well... it depends**

**Nicola Smith<sup>1</sup>, Stephanie Green<sup>2</sup>, John Akins<sup>3</sup>, Skyler Miller<sup>4</sup>, and Isabelle Côté<sup>1</sup>**

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In conservation, culling is commonly used as a means to eradicate invasive species or to reduce their populations to levels that minimize ecological impacts. Culling can be an effective tool but it is labor-intensive, costly and its effects are sometimes unpredictable. In the Caribbean, culling is widely used to control invasive Pacific red lionfish, *Pterois volitans*, predators that have substantially reduced native prey fish abundances on some coral reefs. However, the

effectiveness of these control efforts is unclear. We assessed the effectiveness of lionfish culling at variable frequencies in a 21-month-long field experiment on natural reefs off Eleuthera, The Bahamas. Surprisingly, culling every 6 months was more effective at reducing lionfish densities than culling every 3 months, resulting in average declines in lionfish densities of 75% and 63%, respectively, relative to unculted reefs. However, these reductions in lionfish densities did not result in gains in native prey fish biomass or species richness, which remained indistinguishable from unculted reefs. Furthermore, lionfish densities were greater on culled than on unculted reefs following Hurricane Irene, and this result persisted for several months following the disturbance. Density-dependent lionfish movement and natural disturbances appear to play a role in limiting the effectiveness of lionfish culling at local scales.

### **The lionfish invasion: cause the decline**

**Jocelyn Curtis-Quick<sup>1</sup>, Alanna Waldman<sup>1</sup>, Alicia Hendrix<sup>1</sup>, Alexio Brown<sup>2</sup>, Jason Selwyn<sup>3</sup>, Lad Akins<sup>4</sup>, Stephanie Green<sup>5</sup>, Isabelle Côté<sup>6</sup>**

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The lionfish invasion has become an issue of critical concern in the Western Atlantic. There is substantial research demonstrating the negative effects of the invaders on native reef fish. Surprisingly, little is known about the long-term impacts of invasive lionfish on fish assemblages and the cascading effects on reef benthic cover. More specifically, the reduction in herbivorous species and the implications for coral and algae cover. This study presents monitoring data conducted over a five-year period on patch reefs surrounding South Eleuthera, The Bahamas. Sixteen patch reefs were monitored, half of which had lionfish removed quarterly to compare invaded versus non-invaded sites. All sites were surveyed for benthic cover and complexity annually, and fish biomass and abundance surveys were conducted quarterly. This experimental design allows for an assessment of the long-term impacts of the culling program as a form of reef protection. In addition to culling, lionfish removal efforts through the creation of a lionfish market have been developed on Eleuthera. The Island School in collaboration with the Cape Eleuthera Institute started a lionfish fishery. Buying lionfish from local fishermen year around The 'You Slay, We Pay' campaign resulted in more than 1500lbs of the invaders being brought in by just six fisheries during 2015. This is a significant amount, particularly when compared to the 35lbs removed by the long-term culling program over the same period. The lionfish market has the potential to reduce the number of lionfish from Bahamian reefs. The growth in demand for lionfish meat and fins for jewelry can be achieved by increased awareness and education resulting in wide scale removal efforts and support the decline.

### **Overview of Coral Reef Health of The Bahamas: Current status and recent trends**

**Craig Dahlgren<sup>1</sup>, Krista Sherman<sup>2</sup>, Judith Lang<sup>3</sup>, and Patricia Kramer<sup>4</sup>**

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The health of Bahamian coral reefs is affected by multiple threats from global, regional and local human impacts, which have increased over the past 40 years or more. As a result, corals and the fish and invertebrates that depend on them have seen dramatic declines. Here we give a synoptic overview of the current state of Bahamian coral reefs and the

important fish and invertebrate populations associated with them. The current health of coral reefs in various parts of The Bahamas was determined using comprehensive assessments of reef health, using the Atlantic and Gulf Rapid Reef Assessment (AGRRA) or comparable survey methods, which include assessments of the condition of benthic communities, coral populations, and populations of key fish and mobile invertebrate species. Results of these surveys were used to evaluate and compare important indicators of reef health on reefs throughout The Bahamas and the Caribbean region. Additional data from other sources and survey types are also included to complement these data. In some locations, repeated surveys over 5 to 20 years enables us to document changes in reef health. Results indicate that Bahamian Reefs are generally in Poor condition for most indicators, but conditions throughout the country vary considerably. Based on our analyses, some of the key threats driving declines in reef health are identified and strategies to reverse the decline of Bahamian reefs are presented.

### **Cold-Water Corals - the Hidden Ecosystem in the Seaways of The Bahamas**

**Gregor Eberli<sup>1</sup>, Thiago B.S. Correa<sup>1</sup>, Mark Grasmueck<sup>1</sup>, Kimberly Galvez<sup>1</sup>, John K. Reed<sup>2</sup>, and Dierk Hebbeln<sup>3</sup>**

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The deep seaways surrounding the Bahamas contain a thriving ecosystem of cold-water coral reefs. These corals live in several hundred meters of water depth in cold and dark waters. Like their shallow-water counterparts, these corals form diverse ecosystems that are highly adaptable to varying environmental conditions and develop a wide variety of mound morphologies. The largest cold-water coral province of the region exists in the Straits of Florida where cold-water corals far outnumber the shallow-water corals on the Florida shelf. Several research cruises, using multibeam bathymetry echosounders, remote operated underwater vehicles equipped with cameras, and submersible dives have documented the unexpected abundance and variability of cold-water communities in the Bahamas. They form coral mounds that can be as high as 200 meters and several hundreds of meters wide. The mound morphology is primarily controlled by ocean currents and the topography created by sedimentation processes along the slope. While currents are rather uniform in strength coral mound coverage and height varies widely. At the toe-of-slope of Great Bahama Bank large mounds (120m) follow low-relief ridges that trend perpendicular to the platform, while in the middle of the Straits mound coverage is high (70%) but mound height is small (5-10m). In all locations, however, the mounds are teeming with live, harboring a diverse fauna that include 21 species of cold-water corals, a variety of sponges, several species of stalked crinoids and sea urchins. Several of the sponges have been harvested for medical research as they contain compounds that can be synthesized to produce medication for cancer treatment. The coral mounds are also the habitat for a large number of deep-water fish. The cold-water corals also offer the unique opportunity to study the effects of climate change, ocean acidification, and global warming on the deep waters of the oceans.

### **Untold value of Bahamas reef communities: biodiversity and biomedical studies of sponges and octocorals**

**Shirley A. Pomponi, John K. Reed, Joshua D. Voss, and Amy E. Wright**

Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL, USA

Harbor Branch Oceanographic Institute has conducted numerous undersea research expeditions in The Bahamas over the past four decades using snorkeling, scuba and manned submersibles. Samples of sediment, sponges, gorgonians and other organisms were collected for biodiversity, biomedical and ecological research. Primary study sites were the western and southern margins of the Little Bahama Bank, the northern Grand Bahama Bank and the outer islands

including San Salvador, Eleuthera, Cat, Acklins and Long Island. The majority of the samples are sponges and octocorals, which represent both the most abundant species in the habitats investigated and our sampling preferences over other common organisms such as echinoderms. Factors influencing observed biodiversity patterns include the geomorphology of the bank margins, hydrodynamics, sediment flux, light penetration and storm exposure. Among corals, diversity, abundance and distribution are further affected by disease outbreaks and thermal stress. Sponge- and octocoral-derived chemicals have been identified in our laboratories and may be useful in treating cancer, inflammation, bacterial infection and malaria. All samples were collected with permits identifying their evaluation for biomedical utility. The archived samples and data may be of value in evaluating patterns and changes in biodiversity over time, and genetic connectivity between The Bahamas and other regions of the wider Caribbean. The presentation will highlight our findings regarding distribution of organisms in The Bahamas and some of the chemicals and biological activities identified from the samples.

### **Deep-water carbonate mound and associated hardground habitats along the western margin of Little Bahama Bank: keys to the past and a baseline for the future.**

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A broad swath of carbonate mounds lies along the western margin of Little Bahama Bank at depths of 300-700 m. Submersible observations reveal that these mounds support often dense and highly diverse assemblages of attached, suspension-feeding invertebrates dominated by octocorals, sponges, crinoids, arborescent zoanths, and stylasterid and scleractinian corals. Many occur no further north. Biozonation on hard substrates appears chiefly dependent on depth (and associated parameters, e.g., temperature) and current flow. Elongated lithoherms in 500-700 m with up to 50 m vertical relief support three faunal zones: ahermatypic branching scleractinians upcurrent, arborescent zoanths on and near the crest, and stalked crinoids and octocorals on flanks and downcurrent end. Surrounding hardgrounds support many flank taxa accompanied by additional taxa absent from mounds. Mounds in 300-400 m with up to 30 m relief support dense assemblages on gentler upcurrent slopes and flanks, including stalked crinoids on upcurrent slope and crest, octocorals on flanks, and branching ahermatypic corals and basketstars at and near the crest. Steep downcurrent slopes are chiefly barren. In 500-600 m on the southwestern bank margin, mounds distinct from lithoherms and with up to 40 m vertical relief support a dense assemblage dominated by lithistid sponges and ophiacanthid ophiuroids; limited local biozonation here may be associated with a weaker flow regime. Fishes associated with mounds include potential fishery species such as wreckfish (*Polyprion americanum*), misty grouper (*Hyporthodus mystacinus*), alfonsino (*Beryx decadactylus*), sixgill shark (*Hexanchus griseus*), and Cuban dogfish (*Squalus cubensis*), although it is unknown if any occur in commercially viable numbers. Several long-lived taxa reflect the great stability of at least some of these habitats and can serve as proxy records of historical biogeochemical and oceanographic/climate changes, e.g., zoanthid *Kulamanamana sp.* (formerly *Gerardia sp.*) colonies may reach 1,800±300 y old. However, faunal diversity remains poorly known--new species continue to be discovered--and almost nothing is known of population dynamics, trophic dynamics, or life cycles. Therefore, the combination of apparent long-term habitat stability and severely limited data on ecology and physiology of the inhabitats makes further study of these environments a priority.

## **Reef Rehabilitation and Facilitating the Recovery of Endangered Coral Species**

**Craig Dahlgren<sup>1</sup>, Andy Stamper<sup>2</sup>, Tanya Kamerman<sup>3</sup>, and Amber Thomas<sup>4</sup>**

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Live coral cover on Bahamian reefs has seen dramatic declines over the past 40 years due to global, regional and local threats and stressors. For some species like staghorn coral (*Acropora cervicornis*) and elkhorn coral (*A. palmata*), population declines are estimated to have exceeded 90%. While reefs were once able to rebound from these impacts, the resilience of reefs has been compromised to the point where they can no longer recover from natural stressors or human impacts that kill corals. The loss of resilience can be attributed to a number of factors that prevent new coral larvae from settling to reefs and surviving, including the overgrowth of reefs by macroalgae or turf algae and sediment mats due to increased nutrients and/or reduced grazing. For species that have seen dramatic declines in their populations, recruitment failure is also due to the fact that low population densities limit gamete production, and greater distances between remaining fragments in the population can reduce fertilization success. One strategy for overcoming these obstacles that has gained popularity is the use of coral nurseries for fast growing branching corals like staghorn and elkhorn coral. Typically these nurseries rely on asexual propagation by natural or artificial fragmentation, where small pieces of corals are grown to larger sizes and then outplanted to reefs. We examine the success of this approach in The Bahamas based on five years of coral outplants from nurseries off Southern Abaco. Factors that influence the outplant success are addressed, and the viability of this approach for reef rehabilitation and species recovery is discussed. We also discuss other nursery models and complementary strategies necessary for coral reef restoration and species recovery efforts to succeed.

## **Underwater art as a conservation tool: raising awareness, relieving pressure on natural reefs**

**Casuarina McKinney-Lambert**

Bahamas Reef Environment Educational Foundation, Nassau, New Providence, The Bahamas.

In October 2014, the Bahamas Reef Environment Educational Foundation (BREEF) embarked on the creation of the country's first underwater living art gallery. The Sir Nicholas Nuttall Coral Reef Sculpture Garden is a one of a kind snorkeling and scuba diving experience for Bahamians and visitors that serves as a multipurpose hub for the marine environment including: 1. A perfect fusion of art, education and marine conservation 2. Provides habitat for fish, corals and other marine organisms 3. Diverts snorkelers and divers away from natural reefs and thus providing space for natural rejuvenation. 4. An exceptional outdoor classroom for environmental education 5. A study site for public participation in scientific research Since day 1 the site has garnered local and international attention while raising awareness on threats to coral reefs such as climate change and oil pollution. After a series of surveys, fish abundance and organism biodiversity have shown an increase. There is also evidence that the ever-changing art installation is relieving some human impacts on natural reefs, thus helping to reverse the decline of coral reef ecosystems in the recently announced Southwest Marine Managed Area.

## **Interpopulation variation in a colorful sexual signal: the role of predators and water color**

**Sean Giery and Craig Layman**

North Carolina State University, Raleigh, NC, USA.

Sexual communication systems are subject to a diversity of natural selection pressures. However, few studies explicitly examine the effects of multiple natural selection pressures. Here, I report on a study in which I describe how visual signals in Bahamian mosquitofish (*Gambusia spp.*) appear to evolve along two well-known axes of natural selection – optical environment, and predation risk. To evaluate the importance of these natural selection agents I sampled adult male mosquitofish and their putative natural selection agents from 21 populations on Abaco island. The results of this study show that the optical environment, water color, was clearly the more important driver of divergent sexual coloration in this study system. Yet, the most notable result from this study was an unexpected, hump-shaped pattern of phenotypic divergence along the water color gradient. I suspect evolutionary and ecological mechanisms may drive this pattern and will discuss these possibilities.

## **Marine debris in The Bahamas: the presence of microplastics in the environment and recreationally important fish**

**Zachary Zuckerman**

Cape Eleuthera Institute, Rock Sound, Eleuthera, The Bahamas.

Anthropogenic stressors including overharvest, climate change, and pollution have been implicated as major influences on shifting the ecology of nearshore and offshore marine ecosystems. In particular, the identification of regional ocean “garbage patches” has resulted in increased awareness of the impact of marine debris (i.e., plastics) on the ocean environment while emphasizing the need to quantify biological consequences of plastic pollution. Ingestion of plastic by seabirds, marine mammals, and fishes, for example, are documented to result in asphyxiation, a false sense of fullness and subsequent starvation, and the bioaccumulation of pollutants. Data on the ingestion of marine debris by highly migratory pelagic fishes of economic and ecological importance to the western North Atlantic Ocean (e.g., tunas, dolphinfish, and wahoo), though, is lacking. The objectives of the current study are to quantify and categorize plastic debris in the Exuma Sound, as well as document plastic ingestion by pelagic sportfishes in The Bahamas. To accomplish this, towed trawl transects were conducted in the northern Exuma Sound to collect and enumerate surface plastics, and stomach content analyses were performed on fish carcasses collected from local anglers. Findings indicate that plastic ingestion by pelagic fishes harvested in The Bahamas is prevalent, with 21% - 30% of each species (dolphinfish, wahoo, yellowfin and blackfin tunas) containing plastic in their stomach. Plastic densities in the Exuma Sound are comparable to those measured in the North Atlantic “Plastic” Gyre, but demonstrate greater temporal and spatial variability,. In addition, trawls conducted immediately following Hurricane Joaquin allowed for the first quantifiable observation of the redistribution of marine debris following a large storm event. The results here indicate that highly sought-after fishes of importance to commercial and recreational fisheries are contaminated by plastic, highlighting the need for further research into how adverse effects on fish and human health.

## **Elevated metabolism, limited stamina: ecological implications of elevated CO<sub>2</sub> on a key grazer**

**Aaron Shultz<sup>1</sup>, Zachary Zuckerman<sup>1</sup>, Georgiana Burruss<sup>1</sup>, Philippa Bayford<sup>2</sup>, Dominic Ruddok<sup>2</sup>, Kelly Hannan<sup>3</sup>, Michael Bowleg<sup>1</sup>, and Jocelyn Curtis-Quick<sup>1</sup>**

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Ocean acidification has been identified as a threat to coral reef communities in subtropical and tropical regions. Studies

have indicated that fish may have positive, negative, or neutral physiological responses to elevated pCO<sub>2</sub>, and these responses are likely species-specific. More recently, research has indicated that elevated pCO<sub>2</sub> has a pronounced effect on the behavior (e.g., predator evasion) of many coral reef fish. Very little research has addressed how grazers, key to coral reef health, may respond to acidified seawater predicted to occur as the climate changes. The purpose of this experiment was to assess the feeding behavior, swimming performance, and metabolic responses of parrotfish exposed to elevated pCO<sub>2</sub>. To do this, striped parrotfish (*Scarus iserti*) were acclimated to ambient sea water at 8.2 pH (120 μatms), seawater manipulated to a pH of 7.9 (320 μatms), and seawater manipulated to a pH of 7.6 (710 μatms) over a 24 hour period and held in these conditions for 14 days. Elevated pCO<sub>2</sub> resulted in higher metabolic rates relative to control fish, which may alter feeding activity. Fish chased until exhaustion traveled shorter distances and fatigued more quickly in elevated pCO<sub>2</sub> relative to ambient conditions. These results indicate that parrotfish may need to consume more food to meet energetic demands and may be more susceptible to predation under elevated pCO<sub>2</sub> conditions in the future. Grazing by parrotfish may be enhanced under future climate change scenarios, but their increased susceptibility to predation may offset their capacity to manage algal growth on coral reefs.

### **Hurricanes in the Bahamas—Past, Present and Future**

**Lisa Park Boush<sup>1</sup>, Amy Myrbo<sup>2</sup>, Mary Jane Berman<sup>3</sup>, Perry Gnivecki<sup>3</sup>, Ilya Buynevich<sup>4</sup>, Eric Kjellmark<sup>5</sup>, and Michael Savarese<sup>6</sup>**

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On September 28, 2015, Hurricane Joaquin formed in the SW Atlantic, and made landfall in the Bahamas as a CAT 4 hurricane several days later. The storm had significant impact on Acklins, Crooked Island, Long Island, Rum Cay and San Salvador Island, causing at least \$60million USD in damages. This event represented the third CAT 3 hurricane or higher that has struck the island of San Salvador in the past eleven years. San Salvador as well as Long Island experience a tropical cyclone every 2.23-2.47 years, with the average years between direct hits approximately 5 years. The historical records of hurricanes are significant, but longer-term records are needed to understand the true relationship between climate change and tropical cyclone formation. We reconstructed the paleotempestological record of tropical cyclones in the Bahamas from coastal ponds on Eleuthera and San Salvador. Sediment cores from Shad Pond (Eleuthera), Salt Pond and Clear Pond (San Salvador), establish a >6,000 year record based on multi-proxy indicators of loss on ignition, grain size analysis and elemental concentrations of Ca, Br and Fe. Based upon these comparative records, there is a strong relationship between hurricanes and ENSO. Three major phases have been developed in the late Holocene beginning with a closing off of all three ponds at approximately 3700-3900 ybp. This was followed by a period of climatic variability. During the Medieval Climatic Optimum, storminess increased. In recent centuries, tropical cyclones have reached the levels of that time period. As sea level increases at rates estimated between 20-80 cm in the next 50 years, and as global air and sea surface temperatures rise, it is anticipated that hurricane intensity and frequency will increase accordingly, especially in non-El Niño years. Further, with increased sea levels, coastal erosion also will likely increase, causing major property losses in the future.

### **Hurricane Joaquin: Effects Upon the Coastal Geology of San Salvador Island, Bahamas**

**Michael Savarese<sup>1</sup>, Ilya Buynevich<sup>2</sup>, Jon Caris<sup>3</sup>, H. Allen Curran<sup>3</sup>, Bosiljka Glumac<sup>3</sup>, and Lisa Park Boush<sup>4</sup>**

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On 28 September 2015, Hurricane Joaquin formed in the SW Atlantic, making landfall in the Bahamas as a CAT 4 hurricane several days later. The island of San Salvador sustained significant infrastructural effects, with >80% of the houses receiving damage. An assessment of the storm impact on the coast was undertaken in January 2016 using orthophotos and digital elevation models generated from drone flights, ground-penetrating radar imaging to assess subsurface indicators, and ground surveys to document erosion. Storm surge was not a critical phenomenon for most of the island, and persistent flooding and breaching of coastal barriers was not common. The south shore was one region where tidal amplification and wave action were of consequence. Here, 5-meter-high cliffs were overtopped, causing erosion at the leading edge and significant movement of boulders within an extensive, 6.3 ha boulder field. New boulders, as large as 3 m in diameter, were generated, and older boulders from prior storms, estimated to weigh 1-3 tons, moved up to 26 m inland. The principal road was inundated by debris and awaits repair. Along the east and west coasts, hurricane impact caused substantial dune scarping and some overtopping. However, no dune systems were breached. Overtopping into backdune areas occurred at numerous locations along both coasts, onto the circum-island Queen's Highway, and into a few swale lakes. Coring of 4 lakes revealed a record of the event as depositional tempestites. Scarped dunes lost as much as half their volume with retreat as far as the dune crest. Some foredune scarps are already showing signs of repair via eolian ramp formation. These scarps will remain as recognizable subsurface features in future geophysical images. A rejuvenated tidal channel was scoured along the southeastern coast, establishing an ephemeral connection to Pigeon Creek. A massive overwash fan of approximately 1 ha now blocks the mouth of this channel. Overall, no significant, irreparable coastal change occurred as a consequence of Joaquin. Although the storm imposed economic hardship, much of its geomorphologic legacy will be modified by fairweather processes.

## **Exuma Topics: A Framework for Synthesizing Collective Fieldwork**

**Gareth Doherty**

A Sustainable Future for Exuma, Harvard University Graduate School of Design, Cambridge, MA, USA.

The Bahamas is an archipelagic nation consisting of hundreds of islands and cays varying in size and proximity, interconnected and porous, and constantly in flux through land, sea, subterranean, and sky. Within The Bahamas, Exuma represents a vital space for biological diversity, and understanding the multiple ecologies of Exuma is crucial for the future of the nation. Through three years of collective anthropological fieldwork between students from the College of The Bahamas and Harvard Graduate School of Design, A Sustainable Future for Exuma worked to understand the shifts, key topics, and circulating patterns within and between Exuma. Throughout 2013-2015, students travelled to and lived within Exuma, engaging in conversations with various stakeholders throughout the cays. Student produced notes and images elucidated crucial socio-cultural patterns, which were then processed and visualized through the online tool, Exuma Topics. This online interface provides an interactive framework for processing data collected during field research. With more than 260,000 words and more than 2,000 photographs formatted and sorted by multiple themes onto digitized notecards, the user can sift through field research and observe patterns as they visually emerge across speakers, years, and cays. Exuma Topics acts as a framework to build collaborative fieldwork and is a proposed model for synthesizing a range of multi-media research conducted in an expansive region by multiple actors. Exuma Topics aids as a tool to help interactively depict the breadth and depth of nuanced socio-cultural patterns pertinent to life in Exuma. Preliminary findings from Exuma Topics suggest the importance of imagining design proposals relating to

public space and food security. Multiple emerging themes, ranging from mobility to food, land, and water, can continue to inform collective, participatory, and imaginative projects, hopefully leading to a more sustainable future for Exuma.

## **Safeguarding the Natural Resources of San Salvador through Science, Partnership & Community Participation**

**Lakeshia Anderson**

Bahamas National Trust, Freeport, Grand Bahama, The Bahamas.

Successful establishment and management of national parks are dependent upon cooperative relations between local communities and Park managers. Participatory engagement of stakeholders is therefore an essential component of the planning and development of national parks to build consensus, and long-term and trustful relationships.

The Bahamas National Trust (BNT) rebuilt long-term partnerships with the San Salvador Living Jewels Foundation (SSLJ) and the Gerace Research Centre (GRC) on the island of San Salvador. A combination of education and outreach activities were implemented to raise support and awareness for protecting the park values identified through a wealth of scientific assessments, while also planning for visitor use and economic opportunities for local communities on San Salvador. Through project funding from the Critical Ecosystems Partnership Fund (CEPF), BNT and its partners engaged the communities and resource users in a participatory approach, resulting in the establishment of the San Salvador National Park System followed by a collaborative management planning process. The San Salvador National Park System is made up of five (5) new national parks encompassing marine, terrestrial and wetland ecosystems; the five (5) new areas are the Graham's Harbour Seabird & Iguana National Park, the West Coast Marine Park, the Pigeon Creek & Snow Bay National Park, the Southern Great Lake National Park, and the Green's Bay National Park.

## **Ecosystem-based Development for Andros Island, The Bahamas: A Policy Review**

**Shenique Albury-Smith**

The Nature Conservancy, Nassau, New Providence, The Bahamas.

The Nature Conservancy's Bahamas Program is working with The Natural Capital Project (NatCap) to support the design of the Andros Island Master Plan with spatially detailed assessments of the current ecosystem service benefits provided to the Bahamian people, and the ecosystem service values accruing to specific sectors and communities under alternative options for future development. As a part of this process TNC and NatCap are working with the project's Technical Advisory Committee and other stakeholder groups to understand policy and development issues and to map how people currently use terrestrial, coastal and marine areas of Andros Island. The compilation and review of statute law, regulations and policies is helping to determine the full range of legislation that supports a particular human activity in The Bahamas in general and Andros in particular. Through the policy scoping efforts over 100 documents have been compiled and catalogued shedding light on the current gaps in policy and also helping to craft several future development scenarios that will lead to an ecosystem-based development masterplan for Andros.

## **Issues and Challenges with Integrated Coastal Zone Management (ICZM)**

**Carlos Palacios**

Caribbean Coastal Services, Nassau, New Providence, The Bahamas.

Carlos Palacios is the Director of Operations at Caribbean Coastal Services, and the Team Leader for Component 1 for the IDB-funded Feasibility Studies for a Climate Risk-Resilient Coastal Zone Management Investment Program, which is being executed in association with SEV Consulting Group. The preparation of a national policy framework for climate change-resilient Integrated Coastal Zone Management (ICZM) in The Bahamas is the first critical step in protecting its local coastal and marine resources, and the services they provide, as best we can from natural and anthropogenic impacts on a global scale. By identifying and prioritizing issues and challenges in ICZM with stakeholders, we can effectively address critical areas of concern for both public and private sectors by concentrating our efforts on those that matter most to the Bahamian people. Preliminary discussions were previously held with a group of stakeholders at an inception workshop in February 2016, however additional feedback is required to draw conclusions on what priority ICZM issues and challenges are in The Bahamas. One of the primary challenges identified thus far is defining the extent of the coastal zone. With key stakeholders gathered at the Bahamas Natural History Conference, the Component 1 Team hopes to engage the audience for their input on the National ICZM Policy Framework for The Bahamas.

## **Re-engineering Tourism for the Anthropocene: Cases from The Bahamas**

**Amelia Moore**

University of Rhode Island, Coastal Institute, Kingston, RI, USA.

The Anthropocene is a creative concept that unites many different forms of global environmental change under the mantle of anthropogenesis. In this talk, I argue that the concept is a geological indicator and scientific buzzword, and it is also a political tool with potential to redefine what policy makers and developers design for the future. One facet that is often overlooked is that the Anthropocene is a concept with commercial potential. In this paper, I investigate the commercial potential of the Anthropocene through the lens of sustainable tourism ventures in The Bahamas. Using examples from my long-term anthropological research on the subject in the country, I describe the ways in which the Anthropocene idea participates in the creation, redesign, and rebranding of island and coastal destinations as emergent tourism products. My goal is to explore and critique the creativity of the Anthropocene idea as its core themes are used as tools for capitalist and conservationist innovation. I will conclude by presenting future interdisciplinary research goals for The Bahamas that can assess the legitimacy of these emergent developments at the intersection of tourism, conservation, and sustainable development policy.

## **Innovation, Entrepreneurship, and the Environment: Leveraging the Power of Capitalism to Solve Our Most Pressing Problems**

**Joseph Steensma**

Washington University in St. Louis, St. Louis, MO, USA.

There is little question that many of the environmental challenges faced in the Bahamas and around the world are a product of poorly regulated markets, rampant consumerism, and unfettered capitalism. But what if the same forces that have caused these problems could be harnessed to solve our most pressing environmental challenges? The author

addresses the power of entrepreneurship and innovation to positively impact the natural environment of the Bahamas and beyond. Concepts such as social entrepreneurship, environmental capital, development of markets, subsidy and taxation are explored. Examples of policies and financial instruments that have positively impacted the growth and development of 'environmental enterprise' are discussed. Case studies of innovative and entrepreneurial approaches to environmental problem solving are offered as models for discussion.

## **Conservation Status of Bahamas Boas**

### **R. Graham Reynolds**

University of North Carolina Asheville, Asheville, NC, USA.

The Bahamas Archipelago is currently known to support four of the 12 recognized species of West Indian boas (genus *Chilabothrus*). These relatively large terrestrial vertebrate predators are crucial components of Bahamian Island ecosystems, yet little data exist to inform conservation policy and management for these endemic species. Importantly, one species was just discovered in 2015, indicating that biodiversity surveys still have the potential to yield previously unknown large endemic vertebrates in the archipelago. This new species was judged to be Critically Endangered based on IUCN Criteria. I will discuss the current state of our knowledge on Bahamas Boa biology, distribution, natural history, and conservation concerns. I will also discuss the results from a 2015 IUCN Red List Assessment Workshop which evaluated the conservation status of Bahamian Boas. Our intention is to augment protective measures for these species through continued focused study, as well as recommend policy and management guidelines for reptile conservation in the region.

## **Science and Conservation at the Leon Levy Native Plant Preserve**

### **Ethan H. Freid**

Bahamas National Trust, Nassau, New Providence, The Bahamas.

The Leon Levy Native Plant Preserve since its inception has worked on the conservation of terrestrial plants in the Bahamian Archipelago. In addition to studying the general natural history (Botany, Geology, Herpetology, Entomology, and Ornithology) of the Preserve, a series of long-term projects have been initiated including Permanent Forest Plots (PFP), the implementation of the Global Strategy for Plant Conservation (GSPC), and the establishment of a climate-monitoring program. The PFP's have shown two distinct forest types at the Preserve that show similarity to other studies through the archipelago in one plot and large differences in species composition in another one. The Preserve and the Bahamas National Trust are actively working to implement 12 of the 16 targets from the GSPC at the site by the 2020 goal. The climate monitoring program was started in 2013 and is collecting data on seven weather variables in 5, 15, 60 minute and 24 hour increments. The program also is collecting data inside the Preserves forest for comparative purposes and to work towards an understanding of relationship between weather and forest ecology. All of these programs will continue into the foreseeable future.

## **Prioritising the E-Word: Developing Bahamian Specific Sustainable Development Plans**

**Nikita Shiel-Rolle**

Young Marine Explorers, Nassau, New Providence, The Bahamas.

The Bahamas must take an immediate and proactive approach to combat the imminent threat of climate change and the loss of biodiversity. As the country works towards achieving the 2030 Sustainable Development goals, a systematic and strategic approach must be implemented to ensure the country's success. If Sustainable Development goals number thirteen (To take urgent action to combat climate change and its impact.) and fourteen (To conserve and suitably use the ocean, seas and marine resources.) are not achieved, the socioeconomic well being of Bahamians will be severely impacted. The best available science will be required to achieve these sustainable development goals, however, science alone will not enable us to reach our target. The implementation, management and compliance necessary to meet the development goals, particularly in an archipelagic nation like The Bahamas will depend on citizen engagement and self-regulation. Cultivating the behavioral changes required to combat climate change and prevent the loss of biodiversity requires engaged and scientifically literate citizens. A central challenge to cultivating active citizenship and sustainable behavior in The Bahamas is resolving the poor educational outcomes for youth leaving the public school system. In order for The Bahamas to meet the 2030 sustainable development goals, all practitioners developing action plans must make general education, environmental education, science literacy, and citizenship central components in their conservation plan. As a country that depends directly on our natural resources to support our economy and well being, education cannot continue to be an after thought in conservation planning. The Young Marine Explorers three-year Conservation Program will be presented as a solution that can be integrated into island specific sustainable development plans. The Conservation program trains youth to address the imminent socioeconomic and environmental implications that climate change and other environmental threats pose to The Bahamas. The program accomplishes this by engaging youth in leadership development and in-depth environmental education. It features a three-year curriculum designed for secondary school students centered on three themes (1) Ocean, (2) Biodiversity and (3) Sustainability. Each theme year has specific learning outcomes achieved through twenty-six after-school and Saturday field activities. YME's curriculum has been designed to correspond with the Bahamians public education learning objectives; matching content to academic expectation to create a coherent curriculum.



## **Fishing Pressure and Environmental effects with Fishing Grounds on Growth and Sexual Maturity of Queen Conch (*Strombus gigas*) in the Bahamas**

**Cordero M. Johnson**

College of the Bahamas, Nassau, New Providence, The Bahamas.

The Queen conch is an important part of the culinary tradition of the Bahamas and neighboring regions. The natural abundance of conch within the Bahamas has decreased due to overfishing (Stoner & Mueller 2013, Theile, 2001). This research presents an analysis of Queen conch lip thickness of six distant fishing grounds within the Bahamas. The data was acquired from the Bahamas Department of Marine Resources; With a goal of determining how selective fishing impact conch maturity and to provide regularity information to the Government of the Bahamas which can inform future decision making in fisheries within the archipelago. Mean LT of 15.5 aids Stoner et. al (2012) argument whilst the distance and depth determined maturity. The theory of optimal foraging was proven indicating that maximizing landings (returns) whilst simultaneously minimizing effort. Therefore encroaching on locations with which require little diving effort and fuel consumption. Results also indicate that Man-O-War Channel and Memory Rock may be capable of colonizing more encroach shallow locations (Once Undisrupted Mating May be Continuous 1:1 ratio). The study suggest that the Department of marine resources should address lack of uniformity in conch selection through standardize lip thickness (mm) at potentially 15mm. Whilst studying Fishermen and Fleet Dynamics (Hilborn (1985 p. 3)) to develop understanding the interaction between exploited stocks and human activities

## **Bark with Little Bite: the Tale of the Royal Bahamian Potcake**

**Charlkesha Rahming**

College of the Bahamas, Nassau, New Providence, The Bahamas.

This study aims to add historical value to the domestic dog in the Bahamas. Originating from the gray wolf, *Canis lupus*, the domestic dog, *Canis familiaris*, has quite a story to tell. Ten dogs from Marsh Harbour, Abaco, were used in the study, in an attempt to trace their ancestry to a place of origin. Twenty three breeds were identified. The American Staffordshire Terrier was the most abundant among the breeds. Also, seven regions were identified to show where the breeds came from, with Europe having the largest number of breed origination.

## **Population Assessment of the *Ameiva auberi* sub-species in The Bahamas**

**Shannan Yates**

College of the Bahamas, Nassau, New Providence, The Bahamas.

The *Ameiva auberi* sub-species in The Bahamas are commonly call forest runners, blue tail lizards or lion lizards and show some sexual dimorphism. They are active lizards that will typically inhabit the coppice and forge in open areas. *A. auberi* species tend to be diggers and burrowers creating homes in the soil, and are dependent on rainfall which can be constant or unpredictable causing reproduction to be year-round. The population of the *A. auberi* sub-species in The Bahamas is relatively unknown. Currently there are 12 sub-species located throughout The Bahamas. The overwhelming evidence of small islands being threaten by global warming and resulting in habitat lost has seen studies being done to evaluate populations of marine wild life, avian wild life and some terrestrial species. Unlike most lizards populations that seem to have denser population in a general area, the *A. auberi* population seem to be sparsely

distributed over a large area for a lizard of its size. A comparison of two populations with regards to sex and total body length and home range will be considered among *Ameiva auberi bilateralis*, the Ragged Island Ameiva and *Ameiva auberi thoracica* on the island of Eleuthera.

### **Population Density Study on Lizard Species Found at The Leon Levy Native Plant Preserve**

**Tamarind Johnson<sup>1</sup>, Ethan Freid<sup>2</sup>, Joe Wasilewski<sup>3</sup>, Shannan Yates<sup>1</sup>, Francesca Rahming<sup>1</sup>, and Shontes Hall<sup>1</sup>**

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According to The Commonwealth of The Bahamas Fauna And Flora Fact Sheet number five, The Bahamas has twenty-nine species of lizards, which includes several rare and endangered iguana species and curly tailed lizards. My research focused on lizard species found in The Bahamas because of my natural curiosity with lizards and their behavior. Lizards are all around The Bahamas whether they are inside of homes, schools or government buildings. After performing initial research on all lizard species found in the Bahamas I discovered that some lizard species that were located one island but may not be present on another island. This discovery led me to perform a density population study on lizard species found in Eleuthera specifically at The Leon Levy Native Plant Preserve. My objectives were to assess the lizard population, along with the environmental and anthropogenic factors that may have influenced the present lizard population and compare data collected over a period of time from different sites at The Preserve.

### **Using Citizen Science to Help Protect An Endangered Shorebird**

**Brendan Toote<sup>1</sup>, Anishka Morris<sup>1</sup>, A’Nyce Butler<sup>1</sup>, Shannan Yates<sup>1</sup>, and Scott Johnson<sup>2</sup>**

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The Piping Plover (*Charadrius melodus*) is a small, highly endangered migratory shorebird that depends on the Bahamas for its annual survival. There are three nesting populations in North America: the Northern Great Plains, The Great Lakes and the Atlantic. Every year, these populations migrate to the southern U.S., Mexico, Cuba and the Caribbean to spend the winter. Although researchers knew about their wintering grounds in the southern US and Mexico, it wasn’t until 2006, when the Audubon Society, the Bahamas National Trust with support from Environment Canada surveyed The Bahamas and confirmed their presence. Connectivity studies in 2010 confirmed that the Bahamian birds were from the Atlantic breeding population and during the 2011 International Plover Census, over 1000 Piping Plovers were found across The Bahamas, representing almost 20% of that population! This find identified The Bahamas as a critical wintering habitat for this endangered species. The International Plover Census is conducted every five years, is coordinated by U.S. Geological Services and in the Bahamas BNT and involves the help of both U.S. researchers and increasingly local Bahamian participants. Citizen science has been an important tool to bridge the gap between science and communities and this year’s census, students from the college of the Bahamas participated in the research work and will present on their experiences and findings.



# Posters

## **Impacts of reptile trade on conservation efforts and animal welfare**

**Taylor Harper and Tami LaPilusa**

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In February 2014, thirteen endangered San Salvador Rock Iguanas were smuggled from The Bahamas into the United Kingdom. The animals were seized at Heathrow Airport and eventually repatriated to The Bahamas, however, one of the animals died during the return transit. This incidence is not an isolated one, as both legal and illegal trade of reptiles continues to climb worldwide. In response, certain reptile populations around the world are suffering declines in numbers compounding decline due to environmental and other factors. For small populations in particular, like the San Salvador Iguanas, a decline of thirteen individuals can be devastating. The rise in reptile trade has brought with it many issues concerning population decline and the concern over the continuation of many species. In addition to issues regarding populations, the reptile trade and its practices also jeopardize the welfare of individual animals. The lack of regulations during transport and concerning collection protocols contribute to reptilian health issues, as well as population decline, respectively. Poor enforcement of reptilian collection and endangered species laws contribute to over collection, especially of endangered species. The reptile dealer's lack of concern for reptile health leads to poor health in transport and inadequate exotic veterinary care for animals seized during trafficking. This project explores confounding issues necessary for regulating reptile trade, and maintaining health of individuals both in transit through legal trade and while in quarantine at Animal and Plant Health Inspection Service (APHIS) facilities. While these deficiencies create a grim outlook for the future of the reptile trade and conservation, the combined use of regulations, legislation, and education can combat the increase in reptile trade and issues concerning reptilian health. Regulations for reptile transport and collection procedures will help more animals to survive, and keep populations viable. Increased enforcement of laws will aid the effectiveness of those regulations. Educating transport officials, law enforcement, and exotic animal veterinarians will give reptile trade and conservation a brighter future.

## **Current status of management regulations for the land crab (*Cardisoma guanhumii*) fishery in the Caribbean, Central, and South American regions.**

**Taylor Waldrop and Tami LaPilusa**

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The land crab (*Cardisoma guanhumii*) is an economically important fishery resource throughout its Caribbean, Central, and South American range. Decades-long overharvest and habitat decline has necessitated management regulations restricting not only the harvest season, but also the sex and size of harvested land crabs in many of these countries. For example, Brazil limits *C. guanhumii* harvest to only males of carapace length greater than 8 centimeters. The Islands of The Bahamas are home to a bountiful land crab harvest during the spring spawn, with Andros Island being celebrated as 'the bank' with annual harvest estimates of \$20M. Currently, no land crab harvest regulations exist in The Bahamas, though harvest of females is discouraged. Few formal studies provide catch data for the fishery and the most recent habitat assessment was conducted in the early 1980's, which compounds the task of compiling meaningful fishery data with which to determine if the land crab harvest can be sustained at current levels, especially since current fishery data is limited to counting the land crab sacks being shipped to Nassau or counting crabs in harvester's pens. This project involved surveying primary literature and government fisheries databases throughout the range of *C. guanhumii* to provide a summary of established management regulations and implementation constraints. The aim of this summary is to provide a framework for ongoing discussion and collaboration within land crab stake holder community in The Bahamas and highlight the need for future work to include an updated habitat assessment on Andros Island and large-scale collection of fishery catch data.

## **Working to Improve Management of The Bahamas Spiny Lobster Fishery**

**Felicity Burrows<sup>1</sup> and Wendy Goyert<sup>2</sup>**

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The Bahamas is known to have a productive spiny lobster (*Panularis argus*) fishery and thriving lobster industry. Despite the fact that lobster populations seems stable, threats including illegal, unregulated and unreported harvesting of lobsters still exist ultimately affecting lobster abundance. To help maintain the lobster fishery, The Nature Conservancy, The Bahamas Department of Marine Resources, The Bahamas Marine Exporters Association (BMEA), Friends of the Environment, other conservation partners and fishing communities are working with the World Wildlife Fund (WWF) and The Bahamas Government to implement a fishery improvement project (FIP) for the Bahamian lobster fishery. The FIP involves working with stakeholders to move the fishery toward meeting international sustainable fisheries standards set by the Marine Stewardship Council (MSC) while preserving a healthy marine ecosystem and maintaining Bahamian livelihoods. Recommendations from stakeholders and experts were used to develop an action plan that prioritizes activities that must be addressed to improve management of the fishery. Some of these activities include collecting fisheries dependent data; conducting outreach and education efforts; improving monitoring, enforcement and management and; conducting bycatch analysis and stock assessments. Since the project's inception, 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 a lobster stock assessments; implemented a Harvest Control Rule and; established a Government appointed Spiny Lobster Working Group consisting of various stakeholders that will advise The Bahamas Government of strategies that aim to improve management and governance of the lobster fishery. Overall the expected results of the FIP will consist of improved documentation and management of lobster stocks, sustained lobster populations and, greater environmental stewardship.

## **Stable Isotopes Reveal Over-Winter Increases In The Proportion Of Predaceous Arthropods Consumed By The Endangered Kirtland's Warbler**

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The Kirtland's warbler (*Setophaga kirtlandii*) is an endangered migrant songbird that winters almost exclusively in The Bahamas. Our observations indicate that the warbler feeds on arthropods (insects and spiders) and fruit during the winter. To determine the extent of the warbler's diet variation among and within four winters and between adults and juveniles we used mixing models within a Bayesian framework (SIAR, stable isotope analysis in R; Parnell et al. 2008) to estimate the proportional contribution of each diet item to blood carbon and nitrogen. Mean  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values for each of five diet items (based on prior observations) including predaceous arthropods, herbivorous (including omnivores, detritivores) arthropods, and fruits of snowberry (*Chiococca alba*), black torch (*Erithalis fruticosa*), and wild sage (*Lantana involucrata*) were used in the SIAR model to account for variation in C and N in different sources. Trophic enrichment factors used in the model were based on studies of similar-sized songbirds. Results indicated little variation in proportional representation of the five diet items between adults and juveniles, although there was considerable variation in the proportional of the different diet items among winters, especially for fruits of *C. alba* and *L. involucrata*. During each winter, the proportional contribution of predaceous arthropods (mostly spiders) to the warbler's diet

increased from early to late winter. By late winter (Mar.-April), predaceous arthropods were proportionately the highest or among the highest of the five items contributing to the diet. Late winter is usually the dry season when fruit abundance declines. Thus, predaceous arthropods, such as spiders, may be especially important for the warbler in drought years when fruits are scarce in The Bahamas. Therefore food resource rich sites, which also support abundant spider populations in late winter, may be of conservation importance for the warbler.

## **Curbing the removal of the ‘curbs’: Removal of the chiton *Acanthopleura granulata* and its impact on Bahamian carbonate intertidal zones**

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The polyplacophora *Acanthopleura granulata* or West Indian fuzzy chiton is a visible bio-eroder on the intertidal zone in the Caribbean. Previous studies have indicated that bio-eroders are important agents in the production of rubble, sand, silt and clay that characterize carbonate environments (Scoffin et al., 1980; Glynn, 1988; 1996). In San Salvador, the excreta of chitons has been observed to produce between 227 and 445 g CaCO<sub>3</sub> m<sup>2</sup>/yr (Rasmussen and Frankenberg, 1990; Brandt, 1996). Many carbonate-sediment budget studies have demonstrated that both constructive and destructive processes are closely balanced; both are needed to maintain an equilibrium in carbonate environments. Chitons have also been used as food sources in the Caribbean (Keegan, 2009); from the early Lucayan inhabitants, who are thought to have overexploited these animals (Blick, 2007), to the slave communities of Martinique and other West Indian areas (Wallman, 2014) to the current practice of making ‘curb’ salad in the Bahamas. Indeed some researchers (Melo et al., 2011) promote chiton consumption amongst the general population as a way to help prevent chronic diseases from mineral deficiencies. Fuzzy chiton populations were studied at locations on Abaco and San Salvador Island, Bahamas to investigate the overall state of these populations. The intertidal area on secluded/ undisturbed- private shores (The Regatta, Marsh Harbour, Abaco) and accessible shorelines (Sandy Point, Abaco and North Point, San Salvador) were strikingly different. Chiton size and density at The Regattas was much larger (67% of individuals between 4-6 cm & densities of 14 ind./m<sup>2</sup>) as compared the accessible shorelines, where individuals were either not present (Abaco) or numbered less than 1/m<sup>2</sup>; considerably less than the 5.5 ind./m<sup>2</sup> reported by Rasmussen and Frankenberg (1990). Their size was less than 3cm. The over-harvesting and removal of chitons can have a cascading effects on community structure and function in intertidal areas. Moderate levels of bio-erosion may benefit shorelines by contributing toward topographic complexity and sedimentary substrata that present additional space for a multitude of other species to congregate and for the inhibition of algal growth.

## **Conservation Biology of the Critically Endangered Bahama Oriole: Status, Threats and Reversing the Decline**

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The Bahamas and adjacent Caribbean islands are home to eight island endemic orioles, half of which are listed by IUCN as Threatened or Near Threatened. The Bahama oriole (*Icterus northropi*) is listed as Critically Endangered. This species is currently restricted to Andros, as it was extirpated from Abaco during the 1990s due to unknown causes. The only formal study of this species was a PhD thesis by Dr. Melissa Price who estimated that only 141-254 individuals remained (J. Field Ornithology, 2011). We have initiated a collaborative project to: 1) determine the current status of the population, 2) evaluate and mitigate current threats, and 3) ultimately "reverse the decline" and plan for long-term population viability (including possible reintroduction to Abaco). First, we will start with an estimate of the current population size using "distance sampling" to obtain estimates of current numbers -- with statistically robust confidence intervals. We will conduct both breeding season and non-breeding season counts to determine which habitats are crucial to the species during the whole annual cycle. Second, we will monitor breeding success and evaluate known threats including cowbirds, nest predators, introduced feral predators and lethal yellowing disease of palm trees. Coconut palms are the orioles' preferred nesting tree, and we will determine whether lack of sufficient nesting trees or the dropping of dying fronds with attached nests may be causing population declines. Third, we will begin to work with a range of stakeholders to determine the next steps for ensuring the survival of this charismatic species. Recent training of local residents provides the first steps toward community involvement and using the Bahama oriole as a key species for making ecotourism part of the recovery of this charismatic species. Ultimately, translocation of some individuals to Abaco could be an important strategy to consider given the risks inherent in having the species restricted to a single island complex. The Bahamas National Trust and the University of Maryland (UMBC) are leading this collaborative effort, with the support of Audubon and the American Bird Conservancy. We would like to hear from other partners that could contribute resources to the project. We have secured a starter grant from the MBZ Species Conservation Fund, and we are seeking additional funding to enable a comprehensive long-term approach to reversing the decline of this species.

### **Plankton dynamics of a species-poor Bahamian saltwater lake: which prey do lined seahorses (*Hippocampus erectus*) prefer?**

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Relatively little is known about the diet preferences of seahorses, except that they are ambush predators. Sweetings Pond, a tidal salt lake on the island of Eleuthera (The Bahamas) contains an unusual high-density population of lined seahorses (*Hippocampus erectus*). These anchialine ponds often have unique biota differing dramatically from nearby coastal ecosystems, even varying in planktonic composition. In this study, we investigated diet preference of lined seahorses by comparing available planktonic dietary components. Replicate 2-minute, surface plankton and 2-min tows above the seafloor were collected with a 150  $\mu$ m 0.5 m net at each end of the 1600 m long lake just after dawn and before dusk across October 2015. In addition, 12-hour light traps collected benthic organisms overnight at each sampling timepoint. A non-lethal gastric lavage technique was performed to assess seahorse diet breadth, anesthetizing animals with a 0.05% clove oil solution and flushing food items through their continuous gut with fresh water following the methods of Castro and colleagues (2008). Animal size, reproductive condition, and gender were assessed using photographs taken at each sampling event. Overall, the plankton community of the pond was dominated by calanoid copepods, with calanoids, harpacticoids, and cyclopoids observed in all tows, and amphipods, annelids, metazoans, echinoderm larvae and shrimp observed intermittently. Few differences were observed by either time of day or location of tow. Light traps were characterized by copepods and shrimp, with additional genera represented that were not observed in plankton tows. Seahorses across size and gender consumed predominantly

copepods, with few differences observed except that larger animals preferred larger foods. Seahorse numbers globally are on the decline due to overfishing and habitat degradation, and thus, Sweetings Pond animals represent a unique opportunity to study a healthy, intact population to gain a deeper insight into seahorse food requirements on a larger scale.

### **Baseline Information on Anchialine Ponds of Eleuthera, The Bahamas**

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The Bahamas has an abundance of anchialine ecosystems, i.e., landlocked ponds with subterranean ocean connections. These ponds are under threat, poorly studied, and in urgent need of protection. The island of Eleuthera has over 200 of these inland water sites that have little to no baseline data. The purpose of this study was to collect baseline data on the anchialine ponds of Eleuthera. Specifically, the objective was to identify sites with endemic species and to determine the extent of human disturbance to prioritize sites for conservation. Ponds (n=16) were assessed in terms of their biota, physical characteristics, water quality and the level of human disturbance. The water quality data did not indicate pollution to be an issue. However, human disturbance was present at 69% of the sites studied in the form of litter dumping and/or the introduction of species. In the few non-impacted sites, species previously not recorded on Eleuthera were found. These species included critically endangered cave shrimps, *Parhippolyte sterreri* and *Barbouria cubensis*. Additionally, migratory birds were observed at the majority of the ponds, species such as the white-cheeked pintail duck, grebes and cormorants. This further highlights the need for immediate conservation of the anchialine systems in order to protect these unique habitats and biota. Not only are these ponds intrinsically invaluable to the species they support but they offer tremendous opportunity for ecotourism development. Currently, the Bahamas National Trust estimates that less than one percent of the tourists that come to The Bahamas each year visit anchialine ponds.

### **Comparison of Management of Invasive Species within The Bahamas**

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The Bahamas has a number of invasive alien species (IAS) that has spread and become destructive to native species and ecosystems; Invasive species can cause loss of biodiversity, spatial and temporal displacement of native species as a result of competition within their new environment, resulting in economic impacts of neighbouring communities. The presence of these IAS degrades environments and drive up the cost of management in rehabilitation of impacted areas. The National Invasive Species Strategy (NISS) lists all invasive species found within the Bahamas. Management of these invasive species are usually funding dependent, usually inconsistent and many methods are not efficient. The NISS notes that there is insufficient research done for invasive species. This poster consolidates knowledge of selected terrestrial IAS from the Critical Situational Analysis (CSA), The NISS, the Bahamas Invasive Species Field Guide and the

Green Sweep manual to provide background information on each species methods of eradication for selected species before suggesting ideal methods and timelines for future management.



