

PROTECTED AREAS MANAGEMENT STRATEGY FOR BAHAMIAN TERRESTRIAL VERTEBRATES: IGUANAS AND SEABIRDS

**Bahamian Field Station
San Salvador, The Bahamas
11-12 November, 2000**



Organized by

Conservation Unit, Bahamas Department of Agriculture
and
IUCN/SSC Iguana Specialist Group

In collaboration with
IUCN/SSC Conservation Breeding Specialist Group

Supported by
Fort Worth Zoo
Zoological Society of San Diego



A contribution of the IUCN/SSC Conservation Breeding Specialist Group.

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Additional copies of *Protected Areas Management Strategy for Bahamian Terrestrial Vertebrates: Iguanas and Seabirds Report* can be ordered through the IUCN/SSC Conservation Breeding Specialist Group, 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124.



Bartsch's iguana, *Cyclura carinata bartschi*



Andros island iguana, *Cyclura cyclura cyclura*



Exuma island iguana, *Cyclura cyclura figginsi*



Allen's Cay iguana, *Cyclura cyclura inornata*



Allen's Cay iguana, *Cyclura cyclura inornata*



Acklins iguana, *Cyclura rileyi nuchalis*



San Salvador iguana, *Cyclura rileyi rileyi*



San Salvador iguana, *Cyclura rileyi rileyi*



Least Tern, *Sterna antillarum*



Audubon's Shearwater, *Puffinus lherminieri*



Brown Booby, *Sula leucogaster*



White-tailed Tropicbird, *Phaethon lepturus*



Bridled Tern, *Sterna anaethetus*



Magnificent Frigatebird,
Fregata magnificens - Juveniles

CONTENTS

Opening Remarks by The Bahamas Minister of Commerce, Agriculture, and Industry	8
Executive Summary	9
Map of The Bahamas	10
General Recommendations	12
Andros Sector	15
Central Andros and the Bight Area	15
South Andros	16
Cay Sal Bank	17
North Andros	18
Abacos Sector	19
Great Abaco	20
Grand Bahama	21
Tilloo and Pelican Cays	21
Northern Cays	22
Gorda Cay	22
Southern Bahamas Sector	23
Booby Cay	23
Fish and North Cays, Acklins	24
Great Inagua	25
Mira Por Vos	26
Plana Cays	27
Little Inagua	27
San Salvador Sector	28
Graham’s Harbour	28
Inland Lakes	30
East and South San Salvador Shore and Cays	31
Conception Island	31
Little San Salvador	32
Exuma Sector	33
Great Exuma Cays	34
Allen’s Cay Group	36
Central Exuma Cays Group	38
Ragged Islands	40
Southwestern Cays Group	40
Exuma Cays Land and Sea Park	41
Bahamian Iguana Taxon Accounts	42
Bahamian Seabirds: An International Resource	55
Seabird Distribution in The Bahamas	62
Participants List	63
Appendix: CBSG Workshop and Training Processes	67

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Opening Remarks by the Bahamas Minister of Commerce, Agriculture, and Industry

Hon. Theresa Moxey-Ingraham

As Minister with responsibility for wildlife, I am delighted that the West Indian Iguana Specialist Group has chosen The Bahamas as the venue for its annual meeting this year. I am particularly pleased that you have chosen San Salvador, a gem in our Family of Islands and a landmark in Christopher Columbus' expedition to the New World.

San Salvador and its associated cays are perhaps the most studied islands for natural resources in The Bahamas. They are rich with wildlife and the home of one of the seven subspecies which make up the three species of West Indian rock iguanas (genus *Cyclura*) that are endemic to The Bahamas archipelago.

You are aware that the West Indian iguanas are among the most endangered lizards in the world. They play a critical ecological role in maintaining the health of dry tropical habitats. You also appreciate that without intervention, it is believed that a unique part of the natural heritage of The Bahamas will be lost forever.

A major challenge which we face, however, is spreading that appreciation and getting the general Bahamian public to buy into the absolute need to protect the iguanas. Therefore, the agreement of the West Indian Iguana Specialist Group to co-host along with the Department of Agriculture a workshop on the "Protected Areas Management Strategy for Bahamian Terrestrial Vertebrates" is highly appreciated.

This workshop facilitates the interaction of internationally respected scientists who have been working with iguanas and local stakeholders so that knowledge of and appreciation for iguanas is shared. Having been further exposed, our participants are to be disciples in spreading the conservation message. I understand that while the focus of the workshop will be the Bahamian iguanas, it will also address concerns related to the seabird nesting cays, the hutia habitat, and the white-crowned pigeon nesting cays.

Ladies and gentleman, my Government attaches high priority to the protection and conservation of the natural environment. We recognize the responsibility which we have as Bahamians to sustainably use the natural resources which God has so richly blessed us with so that future generations can also enjoy them. It is for this reason that we have supported the efforts of the international community – research institutions, individuals, and organisations such as the West Indian Iguana Specialist Group – in their work. You can be assured of my Government's continuing support. We particularly want

to see more Bahamians students involved in your research with opportunities for them to be trained.

At this juncture I wish to publicly express thanks on behalf of the Government and the peoples of The Bahamas to all those scientists who have and are conducting research in The Bahamas in an effort to learn more about and protect our iguanas. The work of our own Sandra Buckner is acknowledged and appreciated. If only an ounce of the passion which she exudes has for iguanas were to infect each Bahamian we would be assured of the future for the iguanas in The Bahamas.

Iguanas are protected in The Bahamas under the Wild Animals (Protection) Act. Under that Act "no person shall, without written authority from the Minister: (a) take or capture or attempt to take or capture any animal listed in the schedule; (iguanas are listed in the schedule); and (b) export, or attempt to export, from The Bahamas, any wild animal". All *Cyclura* species are protected internationally, as they are listed on Appendix I to the Convention on the International Trade in Endangered Species (CITES) of Fauna and Flora. Appendix I lists species which are near extinction or very endangered. All international commercial trade is prohibited among CITES signatory nations. The Bahamas is a signatory to CITES.

The Bahamian species of iguanas are all listed as endangered and therefore we seek to ensure that their habitat is protected, or in the event of re-introduction, any proposed habitat is protected prior to translocations taking place. While iguanas are protected by law, The Bahamas has problems with the illegal removal of iguanas from their habitat, molestation on cays visited by tourists, poaching and international illegal trade (smuggling). There is also human consumption, particularly on Andros.

At the moment rock iguanas are found on Andros and 24 small cays on the Great Bahama Bank and in central and southern Bahamas – just on 24 cays out of our 700 hundred islands in the sun. There is a need for the protection of the habitat of some of the terrestrial vertebrates of The Bahamas and I expect that an output from this workshop would be a recommendation to Government of the habitats that require such protection.

Ladies and gentlemen, thank you for having me share with you this morning. I wish you every success with your meeting and workshop.

Executive Summary

Introduction

Iguanas are among the largest and most endangered of the lizards. They are most common in dry subtropical thorn forest areas. They were the largest native vertebrate and the dominant herbivore in their ecosystems. Their numbers and populations are declining throughout the region as a result of direct and indirect human impacts on their habitat, and the intrusion of multiple invasive species, including rats, cats, and mongooses as predators and goats as herbivore competitors. There are seven taxa currently recognized in the Bahamas, although a taxonomic revision based on molecular genetic evidence is underway (C. Malone and S. Davis, Texas A&M University).

The Bahamas has an extremely diverse assemblage of breeding seabirds. As a nation, it supports some of the largest breeding colonies of tropical seabirds known in the Atlantic and Caribbean. Eighty percent of the seabird species nesting in the southeastern United States and Caribbean Basin nest in the Bahamas. The combined diversity and density is significantly greater than that of any other nation in the West Indian region.

Iguanas and seabirds in the Bahamas are today restricted to relict sites. Prior to human contact, it is fairly certain that because of the absence of native terrestrial mammalian predators, iguanas and seabirds had extensive populations on most if not all of the major islands, as well as their offshore rocks and cays.

Workshop Process

The Conservation Unit of the Department of Agriculture of The Bahamas requested the assistance of the Iguana Specialist Group of the Species Survival Commission, World Conservation Union (SSC/IUCN) in preparing an analysis and recommendations of the priority conservation needs of iguanas and seabirds in the Bahamas. The IUCN/SSC Conservation Breeding Specialist Group was requested to assist in the design and implementation of the workshop. Two days were scheduled for process, immediately following the one-day annual meeting of the West Indian Iguana Specialist Group (now the Iguana Specialist Group). The annual meeting reports provided detailed status reviews of the seven iguana taxa, and included other habitat and species information as well. This provided an introduction and background information for the conservation workshop.

The workshop was introduced by Conservation Officer Eric Carey. He provided explicit guidelines for the product to identify priority areas for iguana and seabird conservation in the Bahamas. The document is to be used as a basis for recommendations to the Ministries for actions needed to accomplish these conservation goals. The status of the iguana taxa by location throughout the Bahamas was presented by Sandra Buckner, followed by a similar status review of seabirds by David Lee and Anthony White. Ulysses Seal then introduced the CBSG workshop process and the guidelines for conducting working groups. The Minister then arrived, and after introductions made her supportive remarks to the group, which are included in this report. Individual members of the workshop introduced themselves responded to the question, "What is your highest personal priority for conservation in the Bahamas?" Common philosophies and hopes were widely shared in this process, and many of these comments are included in this report. A forum process was then instituted with members of the workshop asked to come forward and make comments to the minister based upon their special knowledge. She commented and asked questions of each person in the process. Anne Savage made a short presentation on Disney Animal Kingdom's offer to make available much of Gorda Cay (= Castaway Cay), a stop for their cruise ship, for iguana conservation purposes, including potential iguana translocations. She also offered Disney's assistance in education program development.

A plenary discussion reached agreement to divide the Bahamas into five sectors for review and analysis (Andros Sector, Abacos Sector, Southern Bahamas Sector, San Salvador Sector, and Exuma Sector). Because the emphasis was on location-based conservation plan recommendations, each of the five working groups reviewed the cays and larger islands in their sector to assess individual islands, cays, or groups of cays in terms of their iguana and seabird populations. Following this, each group prioritized their lists and selected the top five or six areas for more in-depth analysis. The next step was to assemble information on the characteristics of each location as a basis for identifying conservation needs and goals. The characteristics included: area, biodiversity (iguanas, seabirds, and other known threatened species), ownership, protection, predators, domestic animals, invasive species, human population, human impacts, de-

velopment potential, and tourism potential. This information served as a basis identifying specific conservation problems, key conservation needs, goals for conservation at each location, and recommended specific achievable management actions.

Maps were prepared for each location within each sector, and the locations also identified on a regional map of the Bahamas. Narratives were written for each of the locations which provide the text and documentation for the recommendations. Each group prioritized the locations within their group. The complete set of locations were then prioritized by a subset of workshop participants (S. Buckner, W. Hayes, J. Iverson, C. Knapp, D. Lee, A. White) using a paired ranking technique. The list of prioritized sites recommended for conservation action is presented, noting the Sector to which each site belongs. General recommendations developed by each of the Sector working groups follow.

While the focus of the workshop was to address conservation issues related to iguanas and nesting seabirds, which in many cases inhabit the same islands and cays, it became clear during the workshop that similar

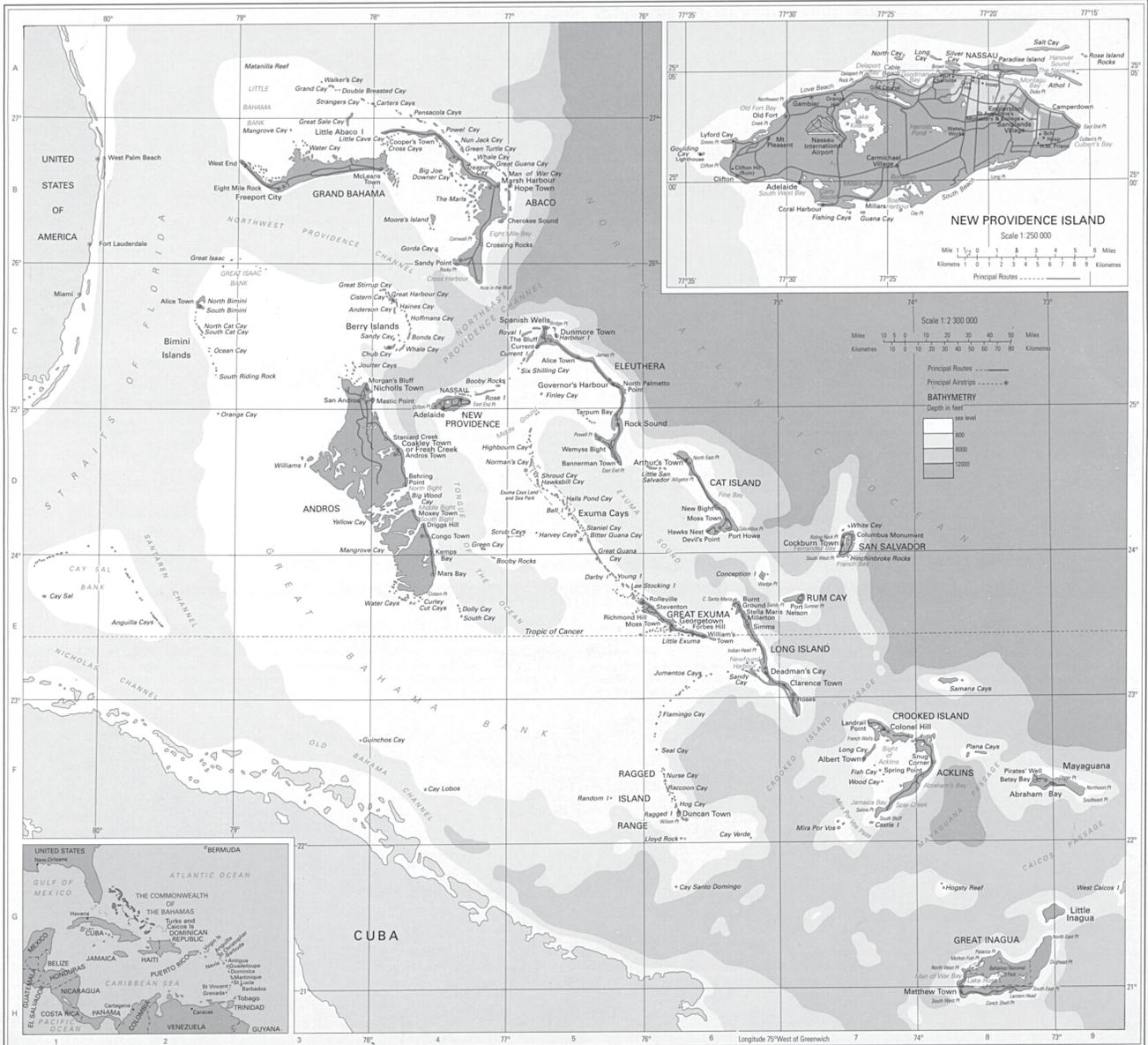
efforts are needed to establish management plans for other key elements of the Bahamian fauna. We strongly recommend that a task force is established to develop conservation priorities for bats, freshwater fishes, and freshwater turtles. All of these groups contain Bahamian endemics that are restricted to extremely small, habitat specific sites. The endemic herpetofauna and terrestrial avifauna likewise deserve attention, but in most cases these are species that will benefit from broad scale landscape management and not protection of small, isolated sites.

It should be noted that this is a working document, intended to be an accurate reflection of the work done at the workshop by the participants with their agreed recommendations, but not subject to the addition of significant new information beyond that included in the original draft. One important outcome of the workshop has been the realization that additional work and analysis, carried out in close collaboration with in-country management officials, will positively contribute to the management and conservation process in the future.

Regional Map of the Caribbean



THE COMMONWEALTH OF THE BAHAMAS



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Copies of this map are obtainable from the Department of Lands and Surveys, P.O. Box NS82 Nassau, New Providence, Commonwealth of The Bahamas.

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General Recommendations

Prioritization of Sites for Conservation Action

Ranking of all of the sites as a combined group by a subset of workshop participants (S. Buckner, W. Hayes, J. Iverson, C. Knapp, D. Lee, A. White) was completed individually subsequent to the workshop, and the results totaled to yield the overall rankings below (1 = highest priority, 26 = lowest priority). Detailed information on each site follows in the individual sector reports. Within individual sector reports, sites are listed in the order of priority recommended by each of the sector working groups.

1. Graham's Harbour [San Salvador Sector]
2. Booby Cay [Southern Bahamas Sector]
3. Great Exuma Cays [Exuma Sector]
4. Central Exuma Cays Group [Exuma Sector]
5. Allen's Cay Group [Exuma Sector]
6. Cay Sal Bank [Andros Sector]
7. Inland Lakes [San Salvador Sector]
8. Fish and North Cays, Acklins [Southern Bahamas Sector]
9. South Andros [Andros Sector]
10. Mira Por Vos [Southern Bahamas Sector]
11. Central Andros and the Bight Area [Andros Sector]
12. Southwestern Cays Group [Exuma Sector]
13. Great Abaco [Abacos Sector]
14. Ragged Islands [Exuma Sector]
15. Northern Cays [Abacos Sector]
16. Conception Island [San Salvador Sector]
17. East and South San Salvador Shore and Cays [San Salvador Sector]
18. Great Inagua [Southern Bahamas Sector]
19. Plana Cays [Southern Bahamas Sector]
20. Little Inagua [Southern Bahamas Sector]
21. Grand Bahama [Abacos Sector]
22. Tilloo and Pelican Cays [Abacos Sector]
23. Little San Salvador [San Salvador Sector]
24. North Andros [Andros Sector]
25. Exuma Cays Land and Sea Park [Exuma Sector]
26. Gorda Cay [Abacos Sector]

General Conservation Recommendations By Sector

Andros Sector

- Survey applicable areas to determine iguana and/or seabird populations.
- Make funding available by government and other agencies.
- Explore methods of achieving necessary enforcement.
- Implement park designation/protection area status.
- Educate local Andros and Nassau population as to conservation issues and needs.

Abacos Sector

- Develop relationships with private land owners to determine whether additional populations of iguanas and seabirds can be established.
- Work to develop legislation to prevent exotic animals and invasive plant species from spreading to other areas [Responsibility: BEST Commission, Bahamas National Trust; Time required: 2 years].
- Develop local community and support programs to limit the deleterious impact of humans (pet trade, raiding of nests for eggs, dogs) [Responsibility: BEST Commission; Time required: Ongoing].
- Work with the appropriate entities to update all maps of the Bahamas and add them to the national GIS program [Responsibility: National GIS Center, Lands and Survey Department Trust; Time required: 3-5 years].
- Encourage all field programs to involve local university students (College of The Bahamas and University West Indies) to assist in the training of future conservation biologists [Responsibility: BEST Commission, Bahamas National Trust, Bahamas Conservation Unit; Time required: 2 years].

Southern Bahamas Sector

Note: These recommendations pertain not only to the Southern Bahamas Sector, but to the Bahamas as a whole.

Research:

- Develop national capacity for research and monitoring.
- Develop research priority list.

- Encourage better cooperation and involvement with research institutions and agencies.

Legislation:

- Perform legislative review and make amendments to prohibit introduction of animals and plants on designated cays and islands
- Conduct legislative review to provide for better management and protection of habitat.

Management Plans:

- Develop conservation fund, incorporating such sources as donations, grants, fines, user fees, and percentage of departure tax, to be used for management, research, monitoring, invasive species management, etc.
- Build capacity for enforcement of regulatory agencies.
- Control invasive species.
- Develop appropriate multi-year plan and budget for comprehensive natural resource management.
- Incorporate local communities into planning, management, and benefits.
- Insure planning is science and ecosystem-based.
- Promote better coordination between specially-protected area management, enforcement, and public education agencies.
- Incorporate scientific information into a National Biodiversity Strategy.

Public Education:

- Encourage better coordination between scientists and national public education efforts.
- Implement national and local public education for tourists, locals, charter companies, dive operators, enforcement and regulatory agencies, NGOs, and judicial and political systems.
- Develop educational materials for cruise ships, pleasure craft, etc., including sensitive areas and cays, and how to interact with those areas.

San Salvador Sector

We note that our management recommendations and those of the other groups will lead to the establishment of many small protected areas on remote cays. We strongly urge that a periodic official presence be maintained in these areas; this can be established by the Department of Agriculture and the Bahamas National Trust scheduling annual or bi-annual visits to the areas under their jurisdiction. The Bahamas Defence Force and the Shedd Aquarium should both be approached to determine if they can provide transportation to these areas.

In our specific management recommendations for Little San Salvador we propose the establishment of an MOU between Holland American Lines and the Bahamas National Trust. We note that this concept could also be employed with other cruise lines using small cays as tourist attractions, e.g. Disney at Gorda Cay and Caribbean Cruise Lines on Little Stirrup Cay.

Education in line with protection of both the habitat of the iguanas and seabird nesting sites and other endemics is considered to be of prime importance. This should be included in the national schools curriculum, possibly in the form of a teachers' workbook for all ages of students together with a student workbook for primary schoolchildren. It is envisioned that the production of these workbooks might be a cooperative effort between the Ministry of Education, together with the College of The Bahamas Department of Education and Division of Natural Science, involving college students in its production, together with the Department of Agriculture, the Bahamas National Trust, and those members of the Iguana Specialist Group conducting research in the Bahamas.

Exuma Sector

- Prohibit introduction of invasive species.
- Develop legislation prohibiting movement of native animals or plants without proper authorization.
- Develop protocols for eliminating existing introduced plants and animals.
- Establish protocol for dealing rapidly with predators in sensitive areas so that the Sandy (= White) Cay problem does not recur.
- Develop education programs for local communities.
- Heighten awareness of Bahamian natural history and conservation, beginning at the primary schools.
- Establish standardized survey techniques for iguanas and seabirds.
- Seek input from the Department of Agriculture before leases of Crown Land are approved.
- Continue survey program for biodiversity on Bitter Guana and Gaulin Cays, and establish a survey program for Noddy, North Adderly, Leaf, White Bay, and Guana Cays.
- Ministry of Agriculture to establish a bank that will contain all the natural history information collected in the Bahamas in order that all reports, updates, etc., will be stored in a central location.

Personal Highest Priority of Participants for Conservation in The Bahamas

The most important conservation issue throughout the Bahamas is preservation of the unique island habitats for future generations.

The development of a fully integrated National Park System that fully protects, for future sustainability, a full representation of Bahamian species and ecosystems.

A focus on species and habitat conservation integrated with government and local community support.

Develop a multi-disciplinary approach to long-term conservation that integrates ecosystem preservation, species conservation, community action programs, training, and education programs.

Encourage young Bahamians to pursue post-graduate field studies in conservation biology.

It is most important to give permanent protection to the habitats of the endangered species of the Bahamas.

Fill in the long-term gaps for wildlife and habitat protection and ensure its enforcement.

Working toward the restoration and preservation of all aspects of the Bahamian ecosystem for future generations through education.

Conservation of endemic species of the Bahamas, including the much maligned four snakes.

To develop an effective protected areas system to ensure the long time survival of the remaining rock iguana populations.

Keep and enhance education at every level.

Preservation of critical habitat for native species through means of local participation and personal benefit.

The protection, preservation, and restoration of native Bahamian communities and ecosystems.

Identification of species and ecosystems which can be used for promoting ecotourism, with the ultimate aim of providing employment and economic development for

the people of the Bahamas, while preserving these natural elements for future generations.

Land acquisition for long-term conservation.

The training and employment of Bahamian biologists in the various disciplines required to address the conservation issues in the Bahamas.

A tremendous need for a national public education on value an importance of iguanas, other species, and ecosystems, especially of tourists and local communities as stakeholders in the long-term maintenance for future generations.

Protecting and conserving all wetlands of the Bahamas.

The most important thing is the preservation of endemic taxa in the Bahamas.

Habitat and biodiversity conservation.

Above all, consider the animals and their habitats as the bottom line by communication and cooperation between all government departments and wildlife organizations.

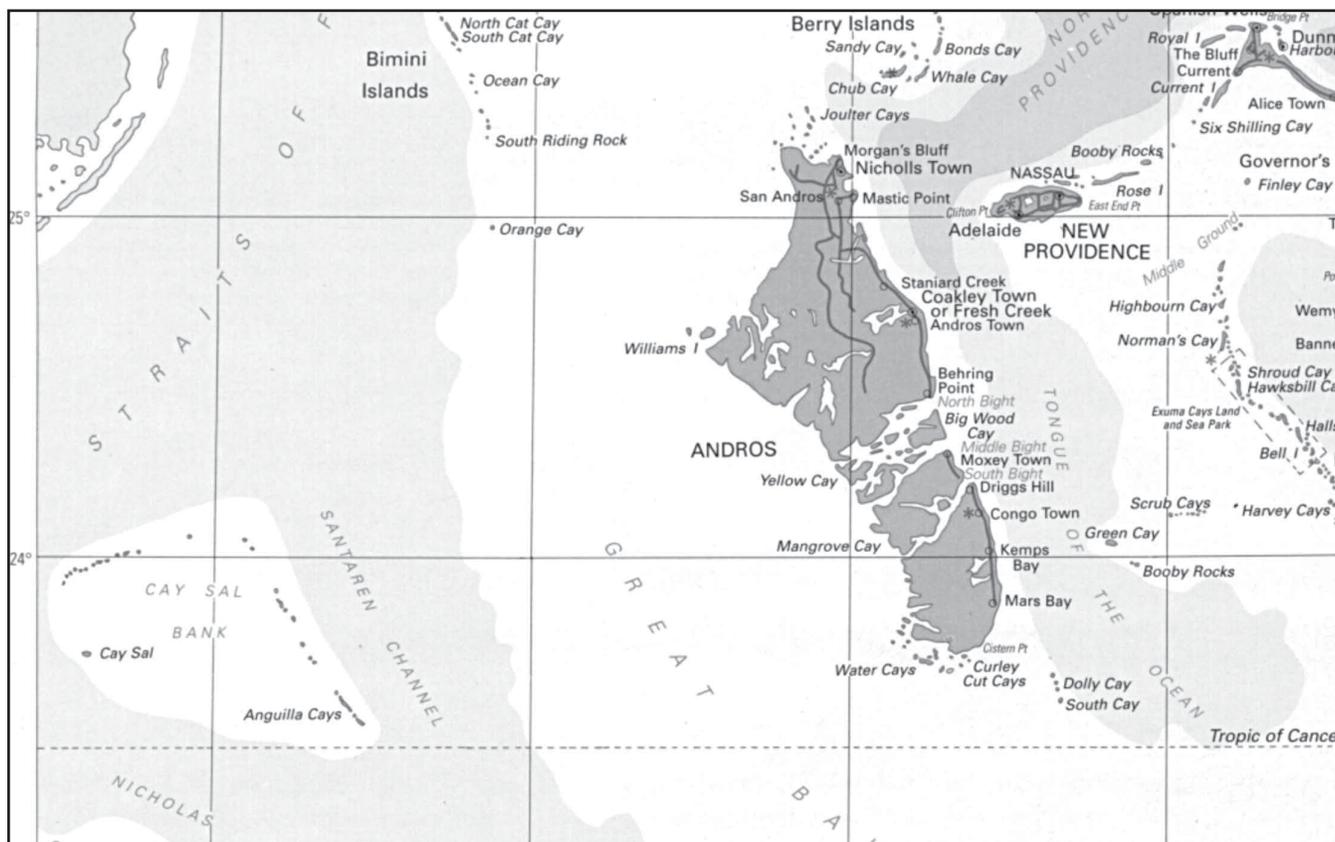
To reach the stage where local communities are fully involved and committed to the preservation of their natural heritage.

To promote conservation minded actions and attitudes among the Bahamian community through extensive wildlife education programs.

Establish a functioning national conservation management system including a truly representative protected areas system.

I am representing the Commissioner of Police and the Royal Bahamian Police Force here today primarily from a Law Enforcement aspect. At the conclusion of these workshop meetings and discussions over the next few days, I would wish to sensitize all Police Officers, particularly those in the Family Islands how important it is to enforce the law as it relates to the smuggling and destruction of our endangered species of animals and birds in the Bahamas.

ANDROS SECTOR



Team Members: John Bendon, Mizpah Bethel, Tim Bethel, Bob Ehrig, Ethan Freid, Chuck Knapp.

Central Andros and the Bight Area

Andros Sector Priority: 1

Overall Priority: 11

Narrative:

Central Andros, from Stafford Creek down to the South Bight, encompasses an area of roughly 3,100 km². Much of this is water but not freshwater. The blue holes have a layer of freshwater above the saline water and there is a table of freshwater under the whole island which supplies New Providence as well as Andros.

Numerous cays, large and small, make up the southern and western section of Central Andros. Thousands of years ago, when the water level was much lower, Andros, New Providence, Eleuthera, Cat Island, Great Exuma, Long Island, and the Ragged Islands made

up a land mass known as Paleoprovidence. Many iguanas (*Cyclura cychlura cychlura*) are known to live around the Northern and Middle Bights. It is thought that flamingos nest in the west, but it is not known where. Research expeditions to discover iguanas take place each year and add to our knowledge; more iguanas are expected to be discovered when the area just north of the South Bight is surveyed in 2001. These expeditions are funded and carried out by the John G. Shedd Aquarium (Chicago, Illinois), in conjunction with the Bahamas National Trust. The Shedd Aquarium makes all of the data it gathers available to the Bahamian authorities, and is the only valid source of reference as to the status of these animals.

There are a number of problems associated with the protection of the iguanas. Although protected by law in all aspects including exportation, their habitat is unprotected. There are introduced predators such as cats, dogs, and hogs, and hunters use dogs to root out iguanas from their hiding places. It is not practical or cost effective to employ wardens to patrol these vast areas. Funding is the root issue and clearly something needs to be done.

One way of achieving this is to provide the local people with a source of income. This could be in the

form of new business for the inhabitants, such as the ability to sell goods to tourists. Goods could include Andros T-shirts and fruit sold at stalls. In addition, a job program for guides could be developed. Such initiatives would only be workable in the few areas that tourists frequent. The root of the problem is that shooting iguanas saves people the cost of buying food. Perhaps goats could be used as the primary meat source, as they breed readily and one goat yields pounds more meat than an iguana. It is important to determine whether people shoot iguanas as a luxury addition to their diet, or as a necessity. We must think of alternatives, as hungry people will not.

Characteristics:

Area: Approximately 3,100 km²; encompasses Stafford Creek, running west from the east coast to the west coast; includes everything south to the south Bight.

Biodiversity: *Cyclura cythlura cythlura* occur at low density, but could possibly be present in large numbers; there are known hatchlings from the Stafford Creek and Blanket sound area; in May, 2000, three people on a research expedition observed two men in a speedboat land on Mangrove Cay South, heard six gunshots, and observed the boat speeding away some minutes later.

Ownership: Crown Land (only in the proposed park areas).

Predators: Dogs and cats near settlements, hogs (egg predators), humans.

Domestic species: Cattle (low numbers), hogs, goats.

Invasive Species: *Casuarina*, *Schinus* (high potential for future threat from northern populations), *Melaleuca* (future threat from increasing populations).

Protection: None, but proposed park for portions of this area.

Human Population: Very low along coastline in isolated settlements.

Human Impacts: Only near settlements along coastline; interior region has no current development (previously heavily logged and supported logging settlements).

Tourism Potential: Very high; area is currently utilized by bonefishing lodges, additionally there are two field stations within the zone that conduct high school and college level environmental education.

Specific Management Recommendations:

1) *Problem:* illegal hunting of iguanas. *Need:* educate and curtail illegal iguana hunting, local enforcement of laws. *Goal:* decrease iguana poaching and increase iguana population density. *Management Actions:* increased enforcement of existing laws, create motivation

for alternative economic opportunities based on ecotourism for locals engaged in poaching.

2) *Problem:* probable egg depredation by hogs. *Need:* reduce the feral hog population. *Goal:* 30% increase of hog take by hunters within three years of program initiation. *Management actions:* establish take incentives for increased hunting; education/awareness programs for hog hunters.

South Andros

Andros Sector Priority: 2

Overall Priority: 9

Narrative:

The Andros iguana (*Cyclura cythlura cythlura*) is the only iguana in the Bahamas that is presently not confined to small cays. Andros is the largest island in the Bahamian archipelago, encompassing an area of 5,959 km², and supporting a human population between 8,000 and 9,000 people, concentrated along the eastern coastal region. The iguanas are scattered through North Andros, Mangrove Cay, and South Andros, which are separated from each other by North, Middle, and South Bights. Currently, the species is listed as vulnerable by the IUCN, with the population arbitrarily estimated between 2,500 and 5,000 animals inhabiting the interior pine barrens (*Pinus caribaea* var. *bahamensis*), particularly where they are broken into small islands separated by extensive low mangrove and marsh. However, recent preliminary surveys reveal that iguana populations in Middle Bight are extremely rare, and those in South Bight are isolated and sparse with only two areas identified as supporting moderately dense populations. Additional surveys are required to accurately estimate the total iguana population size on the island, but 5,000 individuals (reported in the past) may be exceedingly optimistic. The major threat to iguanas inhabiting South Andros appears to be hunting by sponge collectors and crab hunters that camp in the field. A majority of local residents surveyed have eaten or still eat iguanas, and have acknowledged the recent paucity of sightings in historic locales.

Detailed research has not been conducted on this species, and very little is known about its life history, habitat range, and population size. Preliminary surveys reveal that the only moderately dense populations on Andros occur in the Lisbon Creek and South Andros areas; therefore, protecting these populations is

imperative, as areas further north are plagued with feral animals and intense hunting by humans.

South Andros encompasses an area of approximately 1,050 km², most of which is Crown Land with small private holdings along the east coast. Portions of South Andros are proposed for protection, but no protected areas currently exist. The iguana populations are moderately dense in some areas but sparse in most areas. The main issue of illegal hunting needs to be immediately addressed to ensure the long-term survival of the iguana. The primary need for the area is to curtail illegal iguana hunting, along with local enforcement of laws. The main goal for iguana conservation in the area includes decreasing iguana poaching pressure and increasing iguana population densities. Recommended management initiatives include increasing enforcement of existing laws and creating an alternative economic opportunities through ecotourism.

Characteristics:

Area: Approximately 1,050 km²; encompasses South Bank of the South Bight; includes everything to the Curley Cut Cays.

Biodiversity: Isolated iguana populations with large areas without any surveys (information gap); an expedition is planned for May, 2001, at southern tip of Andros where iguanas are believed to occur.

Ownership: Crown Land (with small private holdings along eastern coastline).

Protection: None current, but areas are proposed.

Predators: Dogs, cats, humans, rats, hogs (but low threat potential).

Domestic Species: Information is missing, but it is assumed that domestic goats and other animals are present.

Invasive Species: *Casuarina* along coastline, but lower densities than on Northern Andros; *Schinus* assumed but not verified.

Human Population: Low growth rate.

Human Impacts: Low, with small areas near settlements being cleared, but not explosively; no development inland from coastline.

Tourism Potential: High; excellent for ecotourism; bone fishing lodges exist.

Specific Management Recommendations:

1) *Problem:* illegal hunting of iguanas. *Need:* educate and curtail illegal iguana hunting along with local enforcement of laws. *Goal:* decrease iguana poaching and increase iguana population density. *Management Actions:* increase enforcement of existing laws; create motivation for alternative ecotourism economic opportunities for locals engaged in poaching.

Cay Sal Bank

Andros Sector Priority: 3

Overall Priority: 6

Narrative:

The Cay Sal Bank consists of numerous cays, rocks, and reefs. Located at the most western edge of the Bahamian archipelago, it is strategically situated between Cuba and Florida. For this reason, it is often the stop off point for Cuban emigrants seeking refuge on their journey to the United States. Apart from transients, there is no permanent human population. Illegal fishing by Dominicans and Cubans occurs on the numerous reefs in this area. Cay Sal Bank's largest land mass is Cay Sal, and it is this cay that is most frequently visited by transients and fisherman, as it has the only supply of fresh water, accessible by well. In 1983, Elbow Cays, Double Headed Shot Cays, Water Cays, Deadman's Cay, and Muertes Cays, on the north side of Cay Sal Bank, as well as Anguilla Cays on the south-east corner of Cay Sal Bank, were formally proposed by the Bahamas National Trust in a document to the Bahamas Government for inclusion in the national system of parks. Cay Sal Bank nonetheless remains unprotected.

Cay Sal Bank is an important area for seabirds, where nesting occurs at various times throughout the year. This area is also recognized as an important sea turtle nesting area. Research has shown that turtles nesting at Cay Sal Bank move throughout the Bahamas marine environment. The reef system in this area is healthy, although the potential for damage is high from exploitive fishing activity, diving activity (from Florida based companies operating without Bahamian permits/permission), and the movements of illegal immigrants.

The most immediate significant impacts to the terrestrial ecosystems at Cay Sal Bank are poaching of eggs and nesting seabirds by transient illegal immigrants, and disturbance of sea turtle nesting areas. Due to the potentially strategic location of Cay Sal Bank between Florida and Cuba, there is concern for future human impacts. Cay Sal is the only island that would be capable of supporting development. There have been several attempts to develop this particular cay into a resort location, but government has denied these, for a variety of reasons. Development of this nature is highly likely to occur, making the need for controls to protect the rest of Cay Sal Bank (and portions of Cay Sal itself) critically necessary.

Characteristics:

Area: Approximately 25 km².

Biodiversity: Seabirds, sea turtle nesting.

Ownership: Crown Land.

Protection: None currently, but area has been proposed for park status (Elbow Cay to Double Headed Shot to Muertos Cays and Anguilla Cays).

Predators: Humans on seabirds; cats and rats are assumed present because of occupation by the Defence Force and illegal immigrants.

Domestic Species: None.

Invasive Species: *Casuarina* (limited to Elbow Cay).

Human Population: Not a threat, but does have transient illegal immigrants that are considered to be potentially harmful; depletion of resources by illegal immigrants.

Human Impacts: None, but possible as a result of potential boat traffic between Cuba and Florida; potential for future stop-off point between Cuba and Florida.

Tourism Potential: High (boat route between Florida and Cuba); also an important fishing area (commercial fishing and diving companies from Florida Cays).

Specific Management Recommendations:

1) *Problem:* seabird populations potentially threatened by illegal immigrants and illegal fishing for food. *Need:* increased patrolling of area by Bahamas Defence Force/ United States Armed Forces to arrest the continuous flow of immigrant traffic and thus decrease impacts. *Goal:* Stabilize and maintain seabird population and bring to within carrying capacity of island. *Management Actions:* determine with higher accuracy the status of seabird populations and optimal population numbers based on carrying capacity; within two years determine the stability of the population and the level of threats to the population.

Note: Cay Sal does not need to be protected, but should adjacent land masses on the Cay Sal Bank be protected, then restrictions on development on Cay Sal will need to be implemented such that any development that does occur is not detrimental to the surrounding cays.

North Andros

Andros Sector Priority: 4

Overall Priority: 24

Characteristics:

Area: Approximately 1,050 km²; encompasses the North bank of Stafford Creek, including all areas to the north to Morgan's Bluff.

Biodiversity: Low density *Cyclura cyclura cyclura* population, close to extirpation.

Ownership: Mostly private ownership.

Protection: None.

Predators: Rats, cats, dogs, humans.

Domestic Species: Hogs, cattle, goats.

Invasive Species: *Schinus*, *Casuarina*, *Melaleuca*.

Human Population: High rate of growth.

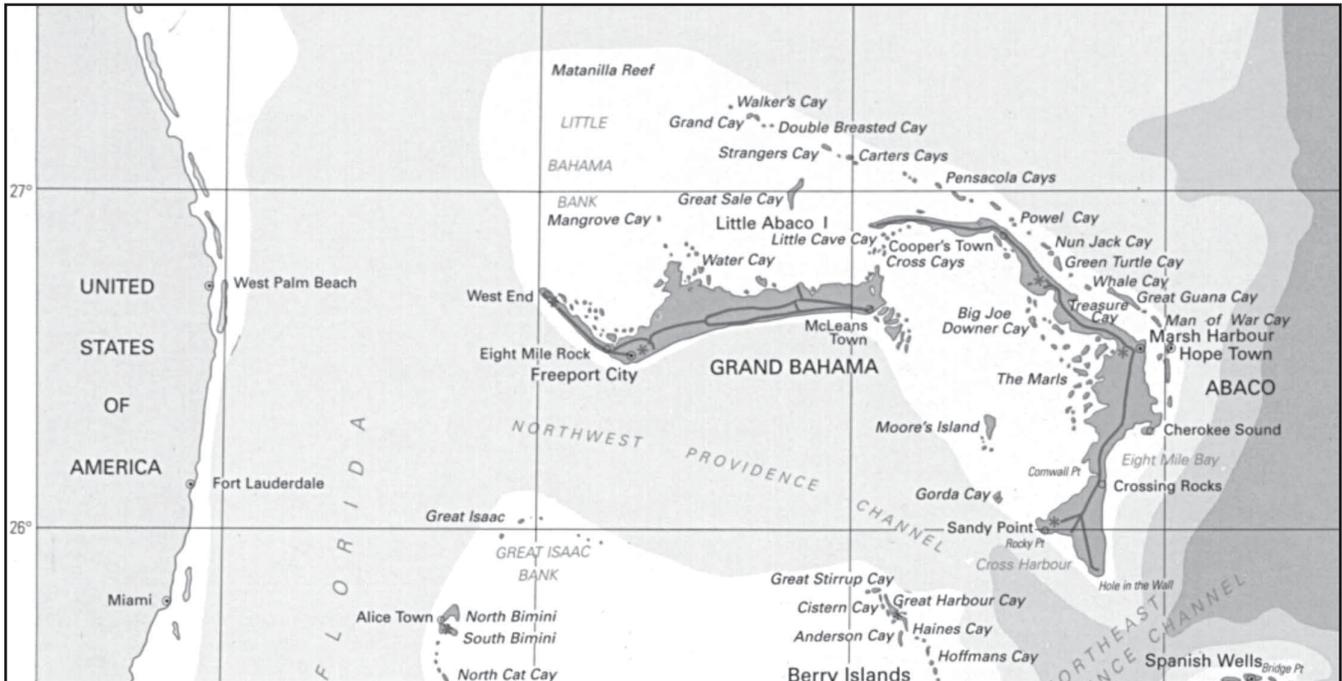
Human Impacts: Large areas of housing and farming.

Tourism Potential: Moderate to high; tourists stay in this area and go to Central Andros and the Bight area to sightsee.

Specific Management Recommendations:

1) *Problem:* iguanas highly likely to be in this area (numbers possibly small) and under threat from poaching and predation by cats, dogs, and pigs. *Need:* assessment/survey of North Andros to determine presence or absence of iguanas. *Goal:* locate iguanas, if any. *Management Actions:* locate predators with a view to elimination; assess poaching; educate locals and visitors through workshops and publicity; present opportunities for locals to earn money as a result of ecotourism (could include training as guides or selling fruit to tourists).

ABACOS SECTOR



Team Members: Quentin Bloxam, Fred Burton, Eric Carey, Anne Savage, Peter Tolson, Peter Vogel, Byron Wilson.

Overall Narrative:

The Little Bahamas Bank stretches for approximately 210 km in the Northern Bahamas in a NW to SE trending axis. It is comprised of two large islands, Grand Bahama and Great Abaco, and a constellation of smaller cays that surround the larger islands. Despite the fact that the bank contains no known extant populations of rock iguanas, it remains as an important and distinct center for biodiversity in the Bahamas. It contains an endemic species of boa, *Epicrates exsul*, and one of the two remaining refugia of the Bahamian parrot, *Amazona leucocephala*. The bank also contains some of the most extensive forests of Caribbean pine, *Pinus caribaea*, in the Bahamas - the habitat of the threatened endemic Bahamian swallow, *Tachycineta cyaneoviridis* and the endemic subspecies of the brown-headed nuthatch, *Sitta pusilla*. The full conservation potential of the bank remains largely unevaluated; seabird nesting areas have not been surveyed, nor has there been a comprehensive survey for relict populations of a presumably extirpated taxon of Little Bank *Cyclura*. The name of a cay east of Great Abaco, Great Guana Cay, provides at least circumstantial evidence that *Cyclura* once occurred on this bank.

The area offers excellent potential for environmentally-friendly tourist based activities. Although the bank is a mixture of public and private holdings, the potential for protected areas is excellent. There are seven national parks on the bank, and extensive holdings of Crown Land both on the main islands and on the cays.

Not surprisingly, the Little Bahamas Bank fauna is under the same types of assaults that assail many island ecosystems: habitat destruction, predation from exotic predators, competition from feral domestic animals, and invasive species of plants. To find solutions to these problems, it is most important to determine which key elements of the Bahamian fauna remain on the bank. Development of a Habitat Assessment Team could determine whether this area contains, or has potential for, seabird species and iguanas. This would be accomplished by developing a seabird nesting site survey, and determining whether there is appropriate habitat for iguanas. Such cays could serve as potential translocation sites for Bahamian *Cyclura*. Work also needs to commence with the appropriate entities to update all maps of the Bahamas and add them to the national GIS program.

Once conservation potential is determined, the extent of the deleterious impacts of invasive plants, such as *Casuarina*, and exotic predators such as feral house cats, raccoons, and black and Norway rats, needs to be assessed. Once it is determined whether invasive species are present, then the appropriate steps for eradica-

tion can be advanced. Also, development of legislation to prevent further exotic introductions is urgently needed.

As no one agency has the funding to address these problems, it is important that new partners be recruited to the program. Additionally, cooperative programs with the College of the Bahamas and the UWI can be initiated to expand available resources. Students are a potential source of future conservation biologists, as well as being an important labor pool for management actions. Partnerships also need to be developed with appropriate entities to develop a land use management plan for the area. Ownership of potential conservation areas, particularly on the cays, needs to be determined. Landowners could be important new partners that could assist in long-term conservation efforts. Similarly, it is important to involve local communities in conservation efforts. Education programs need to be developed to limit the deleterious impacts of humans, such as collection of endemics for the pet trade, raiding of seabird nests for eggs, and release of dogs and other mammals on cays containing iguanas. The potential for tourism that has a direct beneficial impact on local communities without a negative impact on the flora and fauna must also be determined. Community support will be essential in implementation of any management activities. Working together, solutions for the problems that directly threaten the biodiversity of the Little Bahama Bank may yet be found.

Note: This area does not have iguanas and very little information is available on seabird populations. There is some information on other species that warrant attention.

Great Abaco

Abacos Sector Priority: 1
Overall Priority: 13

Characteristics:

Habitat: Contains significant forests of Caribbean pine (forestry management needed); also a significant wetland ecosystem and The Marls (the Pelican Sea National Park can be expanded to include this area).

Biodiversity: Bahama parrot, Bahama swallow, West Indian red-bellied woodpecker, Kirtland's and olive-

capped warbler, double-crested cormorant (marls and wetlands), Abaco boa, Waterhouse's big-eared bat, buffy-flower bat, Bahama funnel-eared bat, big brown bat, red bat, Mexican free-tailed bat, coral reef systems.

Ownership: Crown Land, with 200 km² managed by the Bahamas National Trust.

Introduced Predators: Rats, cats, dogs, raccoons.

Invasive Species: *Casuarina*.

Human Population: Small

Human Impacts: Some development in the area, corporate farming and commercial timber operations.

Tourism Potential: General tourism, yachting, bonefishing.

Specific Management Recommendations:

- 1) Develop an assessment plan to determine whether this area is important for seabirds; target resources need to complete this program within the next five years.
- 2) Actively recruit new partners to the program; target local college [Responsibility: BEST Commission; Time required: Ongoing].
- 3) Develop a sea bird nesting site survey [Responsibility: David Lee, Tony White, and Conservation Unit; Time required: Two years].
- 4) Determine whether this is appropriate habitat for iguanas for potential translocation; target cays surrounding the main island [Responsibility: IUCN/SSC Iguana Specialist Group; Time required: Two years].
- 5) Predator control for Abaco is essential to insure the survival of the Bahama parrot; implement control programs for cats and raccoons [Responsibility: Bahamas Government, international partners; Time required: Ongoing].
- 6) Partner with appropriate entities to develop a land use management plan for the area [Responsibility: BEST Commission, Bahamas National Trust; Time required: Two years].

Grand Bahama

Abacos Sector Priority: 2
Overall Priority: 21

Characteristics:

Habitat: Significant areas of Caribbean pine for which forestry management is needed.

Biodiversity: Bahama swallow, Brown-headed nuthatch, Kirtland's and olive-capped warbler, Abaco boa, buffy-flower bat, big brown bat, red bat, coral reef systems.

Ownership: Crown Land and private holdings.

Introduced Predators: Rats, cats, dogs, raccoons (others?).

Invasive Species: *Casuarina*.

Human Impacts: Partly urbanized.

Tourism Potential: General tourism, heavy use, Freeport is equal to Nassau in tourist visitation; currently has several ecotourism opportunities in place, including three national parks.

Specific Management Recommendations:

- 1) Develop an assessment plan to determine whether this area is important for seabirds; target resources need to complete this program within the next five years.
- 2) Actively recruit new partners to the program; target local college [Responsibility: BEST Commission; Time required: Ongoing].
- 3) Develop a sea bird nesting site survey [Responsibility: David Lee, Tony White, and Conservation Unit; Time required: Two years].
- 4) Determine whether this is appropriate habitat for iguana for potential translocation; target cays surrounding the main island [Responsibility: IUCN/SSC Iguana Specialist Group; Time required: Two years].

Tilloo and Pelican Cays

Abacos Sector Priority: 3
Overall Priority: 22

Characteristics:

Area: Tilloo Cay National Reserve, 5 ha; Pelican Cays Land and Sea Park, 850 ha.

Habitat: Dry scrub.

Biodiversity: Not much known about these cays, but nesting white-tailed tropicbirds are present.

Ownership: Part of Tilloo Cay was acquired by the Bahamas National Trust through a private donation and is now a National Reserve; Pelican Cays Land and Sea Park is also managed by the Bahamas National Trust.

Introduced Predators: Assess whether rats and other introduced species are on the cays.

Invasive Species: *Casuarina*.

Human Population: Unkown.

Human Impacts: Unknown.

Tourism Potential: Protected by the Bahamas National Trust.

Specific Management Recommendations:

- 1) Develop an assessment plan to determine whether this area is important for seabirds; target resources need to complete this program within the next five years.
- 2) Actively recruit new partners to the program (target local college) [Responsibility: BEST Commission; Time required: Ongoing].
- 3) Develop a sea bird nesting site survey [Responsibility: David Lee, Tony White, and Conservation Unit; Time required: Two years].
- 4) Determine whether this is appropriate habitat for iguana for potential translocation; target cays surrounding the main island [IUCN Iguana Specialist Group; IUCN/SSC Iguana Specialist Group; Time required: Two years].
- 5) Partner with appropriate entities to develop a land use management plan for the area [Responsibility: BEST Commission, Bahamas National Trust; Time required: Two years].
- 6) Determine whether invasive species (both plants and mammals) are present [Responsibility: BEST Commission, Bahamas National Trust; Time required: Two years].
- 7) Investigate ownership of these cays to develop new partnerships that may assist in long-term conservation efforts [Responsibility: National GIS Center, Lands and Survey Department Trust; Time required: Ongoing].
- 8) Investigate potential for tourism that will have a direct impact on local communities without a negative impact on the flora and fauna [Responsibility: Agriculture and Fisheries Department; Time required: Ongoing].

Northern Cays

Abacos Sector Priority: 4 Overall Priority: 15

Narrative:

The northern cays consist of seven cays in the arc between Walker's Cay and Pensacola Cay; they may be suitable for iguanas and seabirds. They have not been studied in any detail in terms of seabird nesting and terrestrial vertebrates, and are not currently protected. A marine area in close proximity to Walker's Cay has been proposed for protection.

Characteristics:

Habitat: Dry scrub.

Biodiversity: These cays need to be surveyed to determine if seabirds and iguanas are present (Audubon's shearwaters were at least formerly present).

Ownership: Crown Land and private holdings.

Introduced Predators: Need to assess whether rats and other introduced species are on the cays.

Invasive Species: *Casuarina*.

Human population: Unknown.

Human impacts: Unknown.

Tourism Potential: Yachting, sport fishing.

Specific Management Recommendations:

1) Develop a Habitat Assessment Team (HAT) to determine whether this area is important for sea bird species. The team should consist of a botanist, an ornithologist, a herpetologist, a governmental representative, and a local community representative. The HAT should provide a 3-week floral and faunal survey during the peak nesting season (June).

2) Develop an assessment plan to determine whether this area is important for seabirds; target resources need to complete this program within the next five years.

3) Actively recruit new partners to the program; target local university [Responsibility: BEST Commission; Time required: Ongoing].

4) Develop a sea bird nesting site survey [Responsibility: David Lee, Tony White, and Conservation Unit; Time required: Two years].

5) Determine whether this is appropriate habitat for iguana translocation [Responsibility: IUCN/SSC Iguana Specialist Group; Time required: Two years]

6) Partner with appropriate entities to develop a land use management plan for the area [Responsibility: BEST Commission, Bahamas National Trust; Time required: Two years].

7) Determine whether invasive species (both plants and mammals) are present [Responsibility: BEST Commission, Bahamas National Trust; Time required: Two years].

8) Investigate ownership of these cays to develop new partnerships that may assist in long-term conservation efforts [Responsibility: National GIS Center, Lands and Survey Department; Time required: Ongoing].

9) Investigate potential for tourism that will have a direct impact on local communities without a negative impact on the flora and fauna [Responsibility: Agriculture and Fisheries Department; Time required: Ongoing].

Gorda Cay

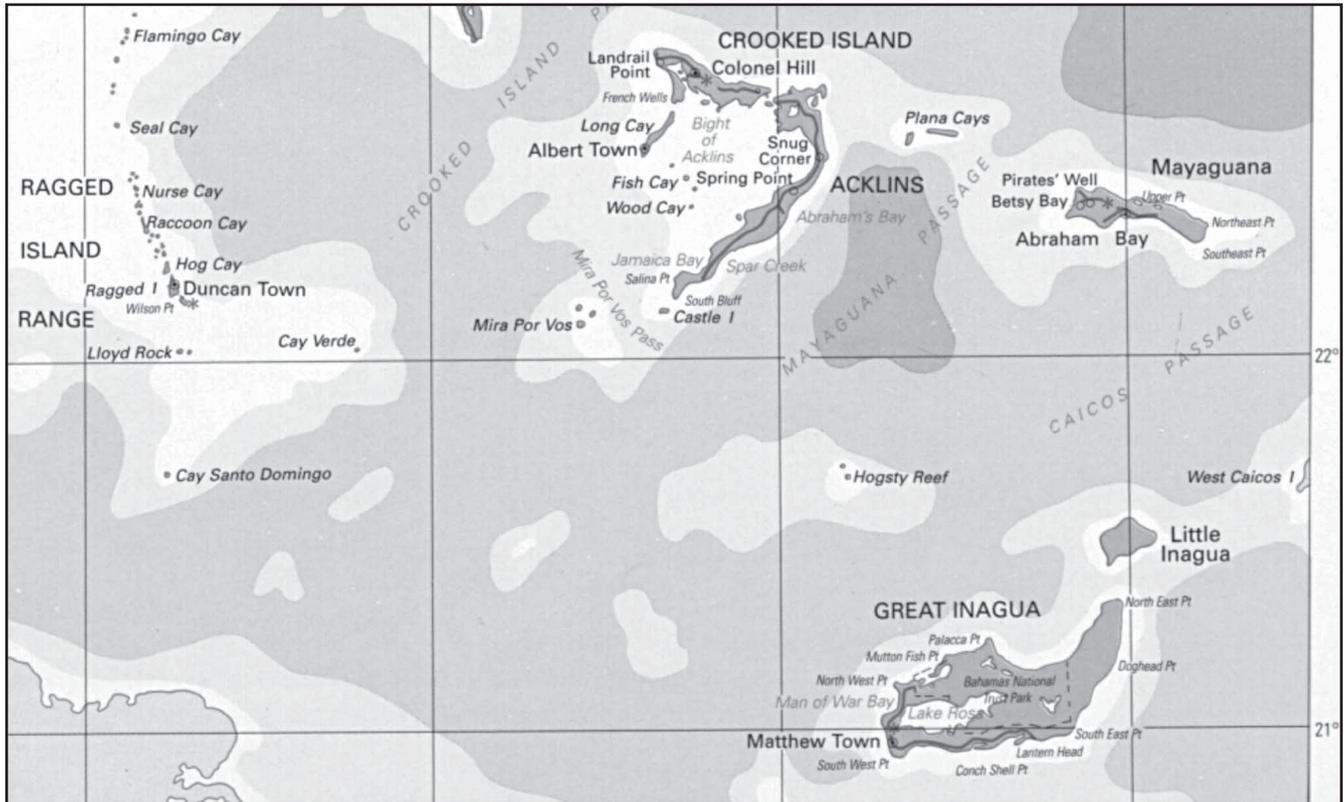
Abacos Sector Priority: 5 Overall Priority: 26

There is a need to determine whether this cay is suitable for a Bahamian iguana release site.

Specific Management Recommendations:

1) Disney's Animal Kingdom (Principal Investigator, Anne Savage) to initiate a habitat assessment of Gorda Cay to determine if it is suitable for supporting an iguana population. Dr. Savage will work in partnership with the IUCN/SSC Iguana Specialist Group and the Conservation Unit to develop an advisory team to assist in this study during 2001. Findings will be reported to the IUCN/SSC Iguana Specialist Group by 2001 meeting (November, 2001) [Responsibility: Anne Savage, Disney's Animal Kingdom; Time required: One year].

SOUTHERN BAHAMAS SECTOR



Team Members: Allison Alberts, Fred Antonio, Miguel Garcia, Glenn Gerber, Karen Graham, Tandora Grant, Rick Hudson, Maurice Isaacs, Joe Wasilewski.

Booby Cay

Southern Bahamas Sector Priority: 1
Overall Priority: 2

Narrative:

Booby Cay is located approximately 150 m off the eastern end of Mayaguana. The island is less than 2 km² in an area with two interior saline ponds that fluctuate in size and salinity depending upon seasonal rainfall. The cay is low-lying, composed of eroded limestone and coral sand. Vegetation is consistent with other limestone cays in the area. The vertebrate species of particular concern is *Cyclura carinata bartschi*, commonly known as Bartsch's iguana or the Booby Cay iguana. This subspecies is restricted to Booby Cay, and represents the only population of *Cyclura carinata* in the Bahamas. This species is listed as Critically Endangered on the IUCN Red List. Preliminary estimates suggest a population of

approximately 1,500 individuals spread throughout the cay. The population consists of individuals of all age and size classes, and the sex ratio appears to be equal.

Although the iguana population appears robust at present, several introduced species threaten the long-term health of the iguana population and the island ecosystem. Goats were first documented on the island in 1988 and have increased in numbers since. The goats use the entire cay, but their impact has been particularly acute on the eastern end of the island, where the vegetation is severely overgrazed and thus suboptimal for iguanas. In addition to goats, the cay is populated by introduced rats that potentially threaten the iguanas and other wildlife. Other threats include hunting by local residents for consumption, and introduced *Casuarina* trees. Booby Cay is Crown Land and has been proposed for National Park status since 1983. Inaccessibility has afforded the cay some measure of protection in the past but limits research and monitoring activities, which should be increased. In addition to iguanas, other species of special interest on Booby Cay include flamingos, nesting osprey, and neotropical migratory birds.

Basis for ranking: Importance for flamingos, only population of a unique subspecies of iguana, immediate goat threat.

Characteristics:

Area: 2 km².

Biodiversity: *Cyclura carinata bartschi* (estimated population = 1,500); flamingos.

Ownership: Crown Land.

Protection: Proposed for protection in 1983.

Predators: Potential hunting; rats.

Domestic Species: Goats.

Invasive Species: *Casuarina*.

Human Population: None.

Human Impacts: Grazing by goats.

Tourism Potential: Remote location.

Specific Management Recommendations:

- 1) If left unchecked, the goat population will continue to expand, increasing their competitive pressure on iguanas and severely damaging vegetation throughout the cay. Given this, goats should be removed from the cay as soon as possible.
- 2) More data are needed to determine the impact of rats on iguanas, but studies on other islands suggest that rats may prey on eggs or young. If indicated, eradicate rats from Booby Cay.
- 3) Under the direction of the Department of Agriculture, introduced *Casuarina* trees should be removed. This is best accomplished by chopping down individual trees and treating the stumps with herbicide.
- 4) Local residents on Mayaguana need to be sensitized to the status and biological uniqueness of the iguanas, native birds species, and overall ecosystem on Booby Cay.
- 5) Pending the outcome of genetic studies confirming the uniqueness of this iguana population, the possibility of establishing an additional population as a safeguard against extinction on Booby Cay should be explored.

Fish and North Cays, Acklins

Southern Bahamas Sector Priority: 2
Overall Priority: 8

Narrative:

Fish (= Guana) and North (= Fish) Cays are located within Acklin's Bight, an extensive area containing at least six other cays. Fish Cay is approximately 74 ha in size, and

North Cay is approximately 52 ha in size. Both are Crown Land. The Acklins iguana (*Cyclura rileyi nuchalis*) population is restricted to these two remote cays, and totals approximately 10,000 to 15,000 individuals. Iguanas once also occurred on the much larger island of Long Cay, but were extirpated sometime after the early 1900s, probably as a result of introduced feral cats and dogs. There are a few other cays in the area that possess suitable habitat for iguanas, at least one of which also has nesting seabirds, including sandwich terns. Fish and North Cays both support important foraging areas for flamingos. Both Fish and North Cays support very diverse vegetation, primarily coppice and mangrove. The shallow mangrove swamps in the bight are important to the local economy for shark, bonefish, and conch fishing.

Although they are uninhabited, Fish and North Cays are visited by conch fisherman, and dog footprints have occasionally been seen. Due to the small body size of these iguanas, their primary threat is the introduction of feral dogs and cats, to which they are particularly vulnerable. In the Turks and Caicos islands, iguanas of comparable size are rapidly extirpated by these introduced mammals. House mice occur on Fish Cay, but have not been seen on North Cay. Both cays face a low level threat from poaching for the pet trade and consumption by local people for food. Neither cay has introduced rats. In 1983, Fish and North Cay, along with Guana and Wood Cays, were proposed for protection by the Bahamas National Trust.

Basis for ranking: Presence of unique subspecies of iguana with the only healthy populations of this species in the Bahamas, no current protection, no current threats.

Characteristics:

Area: Fish Cay = 74 ha; North Cay = 52 ha.

Biodiversity: *Cyclura rileyi nuchalis* (estimated population 10,000 on Fish Cay and 3,000 on North Cay); *Leiocephalus punctatus* and *Sphaerodactylus corticola campter* (both abundant); foraging area for greater flamingoes; apparent nursery for lemon sharks.

Ownership: Crown Land.

Protection: Proposed for protection in 1983.

Predators: Potential poaching; transient dogs.

Domestic Species: None.

Invasive Species: None known.

Human Population: None.

Human Impacts: None.

Tourism Potential: Remote location; little potential for diving (very shallow, sandy waters).

Specific Management Recommendations:

- 1) Education of local people (particularly harvesters and fisherman) who visit the cays as to the uniqueness of the iguanas and the devastating effects of introduced predators on iguana populations and their ecosystems.
- 2) Placement of signage on both cays that explains the protected status of iguanas, the risks iguanas face from cats and dogs, and appropriate etiquette (discouraging feeding of iguanas, trampling of nest sites, and trash dumping).
- 3) Continue ongoing monitoring program for iguana populations through Loma Linda University, with an emphasis on training of Bahamian students.
- 4) Emphasize involvement of local communities in exploring ecotourism potential for sportfishing and iguana viewing.

Great Inagua

Southern Bahamas Sector Priority: 3 Overall Priority: 18

Narrative:

Great Inagua is the southernmost island in the Bahamas, composed of salt lakes and dry evergreen forest. It is approximately 1,500 km² in size, 745 km² of which are protected as a national park, established in 1952 and presently managed by the Bahamas National Trust. In 1965, the Union Creek Reserve was created, comprising an extensive tidal creek system containing a small facility devoted to research on green sea turtles. About 1,000 people inhabit the island, mostly concentrated in Matthew Town. Morton Salt Company owns a large proportion of the island, where they conduct salt extraction operations. The remainder of the island is Crown Land, except for the area immediately surrounding Matthew Town. Great Inagua contains extensive mangrove stands and creeks along the northwest coast, which are important feeding areas for many species. There is also a large interior mangrove lake, Lake Rosa (= Lake Windsor). Both of these sections of the island are incorporated into the national park. Pockets of coconut palms occur on the western side of the island, and the southwest is dominated by dwarf hardwood coppice. Although these areas fall outside of the national park, they still need to be managed

with regard to hunting regulation and invasive species. The eastern end of the island is relatively unexplored and difficult to access.

Great Inagua supports probably the largest breeding colony of Caribbean flamingos in the world, and is an important source population for colonization of other areas throughout the region. The flock is estimated at 60,000 or more individuals. The peripheral forests of Great Inagua are one of the last refuges of the Bahama parrot, which represents one of only two extant populations in the Bahamas. The population is estimated at 1,000 to 2,000 individuals. Great Inagua also supports important populations of several other regionally threatened bird species, including the West Indian tree duck, burrowing owl (undergoing rapid decline in the Bahamas), brown pelican (rare endemic West Indian race), reddish egret, snowy plover, roseate tern, white-tailed tropicbird (Western Atlantic endemic subspecies), and a variety of wading birds. Additionally, there are a number of endemic reptiles on Great Inagua, including the Inagua slider (*Trachemys stejnegeri malonei*; numbering less than 2,000 individuals and particularly sensitive to drought), a curly-tail lizard (*Leiocephalus inaguae*), and a racerunner (*Ameiva maynardi* ssp.). Also present are the gecko *Sphaerodactylus inagua* (found on both Great and Little Inagua) and the Bahamian boa (*Epicrates chrysogaster relicquus*).

Feral cats and dogs are present on Great Inagua, impacting both bird and reptile populations. Feral hogs (*Sus scrofa*) represent a serious threat to ground-nesting birds, including the West Indian tree duck, and are a known threat to flamingo nests during drought conditions. The presence of rats has been documented, but their impact on the local fauna is unknown. Donkeys, cows, and possibly goats are present, but their impact on native vegetation has not been assessed. *Casuarina* is present, and in the immediate area where it grows it contributes to beach erosion by inhibiting growth of understory species. Salt overflow from the Morton Salt Company may cause occasional damage to the mangroves, although the company has generally been very supportive of the national park.

Basis for ranking: Diversity, endemism, ecotourism potential, degree of threat, existing protection.

Characteristics:

Area: Approximately 1,500 km².

Biodiversity: Flamingoes (estimated 60,000), white-tailed tropicbird (estimated 25 pairs), brown pelican (estimated 100 pairs), roseate tern (estimated 100 pairs), Bahama parrot, reddish egret (estimated 50

pairs), burrowing owl (population declining), *Leiocephalus inaguae*,* *Trachemys stejnegeri malonei** (estimated < 2,000), *Sphaerodactylus inaguae*, *Ameiva maynardi*,* *Epicrates chrysogaster reliquus* [* signifies island endemic], greater bulldog bat, Waterhouse's big-eared bat, Jamaican fruit-eating bat, buffy-flower bat, red bat.

Ownership: Crown Land and private holdings.

Protection: 745 km² protected in a national park, managed by the Bahamas National Trust.

Predators: Cats, dogs, rats.

Domestic Species: Donkeys, cows, hogs, goats (?).

Invasive Species: *Casuarina*.

Human Population: Approximately 1,000.

Human Impacts: Morton Salt Company conducts salt extraction operations over a large area of the island.

Tourism Potential: Ecotourism has been proposed and is currently being investigated; diving.

Specific Management Recommendations:

1) Eradication/control of both feral cats, dogs, and hogs. Because they are an important food source for the residents, control of feral hogs will need to accommodate the needs and concerns of the local community.

2) Expansion of the national park to include critical habitat for the endemic slider population. Protected areas need to be expanded to include the freshwater wetlands where the turtles occur. Currently, none of these areas are protected within the park and most have been destroyed by the salt works.

3) Education of local residents as to the benefits of conserving the unique ecology and history of the island. Valuable local knowledge should be incorporated into scientific research efforts.

4) An assessment of the impact of the salt industry on the local ecology of Great Inagua needs to be carried out.

5) Control of invasive plant species, particularly *Casuarina*.

6) Expanded enforcement and encourage research and monitoring beyond the national park boundaries.

7) Further exploration of ecotourism potential of the island, including setting up eco-lodges, establishing trails for bird watching, and developing infrastructure, including disaster contingency plans for hurricanes. All of these activities should include increased local participation.

8) Develop cooperative scientific programs and management plans with Cuba, particularly with regard to flamingos.

Mira Por Vos

Southern Bahamas Sector Priority: 4
Overall Priority: 10

Narrative:

Mira Por Vos is a small group of cays located southwest of the Acklins Bight, less than 5 km² in total area. It is a particularly important site for nesting colonies of bridled terns, Audubon's shearwaters (western Atlantic endemic subspecies), and magnificent frigatebirds, and one of the most important sites for brown boobies in the Bahamas (150 pairs). Sooty terns and brown noddies nest here as well. It is Crown Land, uninhabited, and relatively isolated. In 1983, this area was proposed for protection by the Bahamas National Trust.

Basis for ranking: Critical importance for brown booby nesting.

Characteristics:

Area: < 5 km².

Biodiversity: Bridled tern, Audubon's shearwater, brown booby (estimated 150 pairs).

Ownership: Crown Land.

Protection: Proposed for protection in 1983.

Predators: None known.

Domestic Species: None.

Invasive Species: None known.

Human Population: None.

Human Impacts: Unknown.

Tourism Potential: Very remote location.

Specific Management Recommendations:

1) Scientific research on use of these islands by seabirds and their regional importance for seabird conservation, as well as general habitat information and potential importance for other species (e.g., migratory birds).

2) Regular surveillance of the islands for possible egg-ing or other activities that disturb or harm seabird populations.

Plana Cays

Southern Bahamas Sector Priority: 5
Overall Priority: 19

Narrative:

The Plana Cays consist of two uninhabited islands lying between Crooked/Acklins and Mayaguana. Both islands are Crown Land. East Plana Cay is approximately 13 km long, and is the last known natural habitat of the endangered Bahamian hutia, *Geocapromys ingrahami*. The habitat is open, with sandy areas and coastal strand plant communities. The island is also the only habitat of the curly-tail lizard, *Leiocephalus greenwayi*. West Plana Cay has traditionally been farmed for cascarilla (*Croton eluteria*) for the production of Campari. The habitat is very different from that on East Plana, consisting of overgrown coppice containing crumbling structures of dwellings historically used by cascarilla harvesters. The vegetation on the two cays differs significantly in composition and structure, perhaps the result of grazing by hutia. In 1983, the Plana Cays were proposed for protection by the Bahamas National Trust.

Evidence from archeological middens indicates that the Bahamian hutia was once found throughout the archipelago. The only known natural population remaining is on East Plana Cay. However, the species has been introduced to two cays in the Exuma Cays Land and Sea Park, where populations are exploding and have decimated the native vegetation on at least one of the cays. The Plana Cays support important nesting areas for two regionally endemic subspecies of birds, the Audubon shearwater and the white-tailed tropicbird. Sandwich terns nest on the islands as well. Both of these species are very vulnerable in the Bahamas, owing primarily to loss of nesting habitat. Two anolis lizards are found in the Plana Cays, including *Anolis brunneus*, also found on Crooked and Acklins Islands, and *Anolis scriptus sularum*, also found on Crooked, Acklins, and Samana Islands.

There are presently no known human threats to the Plana Cays. However, regular human traffic associated with cascarilla harvesting creates the potential for introduction of invasive species such as fire ants and cats. Natural predation by osprey may constitute a threat to native lizard populations.

Basis for ranking: Diversity, endemism, only natural remaining hutia population.

Characteristics:

Area: East Plana Cay = 13 km²; West Plana Cay = 4 km².

Biodiversity: Audubon's shearwater, white-tailed

tropicbird (estimated 15 pairs), hutia (*Geocapromys ingrahami*),* *Leiocephalus greenwayi*,* *Anolis brunneus*, *Anolis scriptus sularum* (* signifies island endemic).

Ownership: Crown Land.

Protection: Proposed for protection in 1983.

Predators: Osprey.

Domestic Species: None.

Invasive Species: None known.

Human Population: None.

Human Impacts: Unknown.

Tourism Potential: Remote location.

Specific Management Recommendations:

- 1) As soon as possible, determine status of the endemic curly-tailed lizard, *Leiocephalus greenwayi*. Research is needed to assess the feasibility of establishing a second population as a safeguard against extinction on East Plana Cay.
- 2) Formal survey to determine size of the hutia population on East Plana Cay.
- 3) Local education of cascarilla harvesters, and close monitoring to mitigate the potential for introduction of invasive species to the cays.

Little Inagua

Southern Bahamas Sector Priority: 6
Overall Priority: 20

Narrative:

Little Inagua is the largest island in the Bahamas that is not populated by humans. It is approximately 80 km² in area. The vegetation is near pristine, remaining in a highly natural state with very few introduced plant species. The island was once threatened by donkeys, but they have now been removed. This remote island was approved in principle by the government for National Park status in 1999, but official legislation has not yet been signed.

Flamingos occur on Little Inagua, in addition to white-tailed tropicbirds (western Atlantic endemic subspecies) and roseate terns. The island is an important nesting site for green sea turtles, as well as a key stopover for migratory birds. There is also an endemic subspecies of racerunner (*Ameiva maynardi parvinaguae*) that occurs here. Rich, damp soils in a series of remote sinkholes in central Little Inagua provide a unique habitat for royal

palms. Though introduced from Hispaniola, these palms represent the only natural wild stand in the Bahamas. The island also contains blue holes and possible archeological sites that are of potential value for ecotourism. Threats to Little Inagua are few, although introduced rats may be present.

Basis for ranking: Remoteness, government commitment to establishing it as a National Park, important site for seabirds and royal palms.

Characteristics:

Area: Approximately 80 km².

Biodiversity: Flamingo, white-tailed tropicbird (estimated 25 pairs), roseate tern, *Antillophis parvifrons*, Royal palm, Jamaican fruit-eating bat.

Ownership: Crown Land.

Protection: Designated National Park.

Predators: Rats (?).

Domestic Species: None known.

Invasive Species: None known.

Human Population: None.

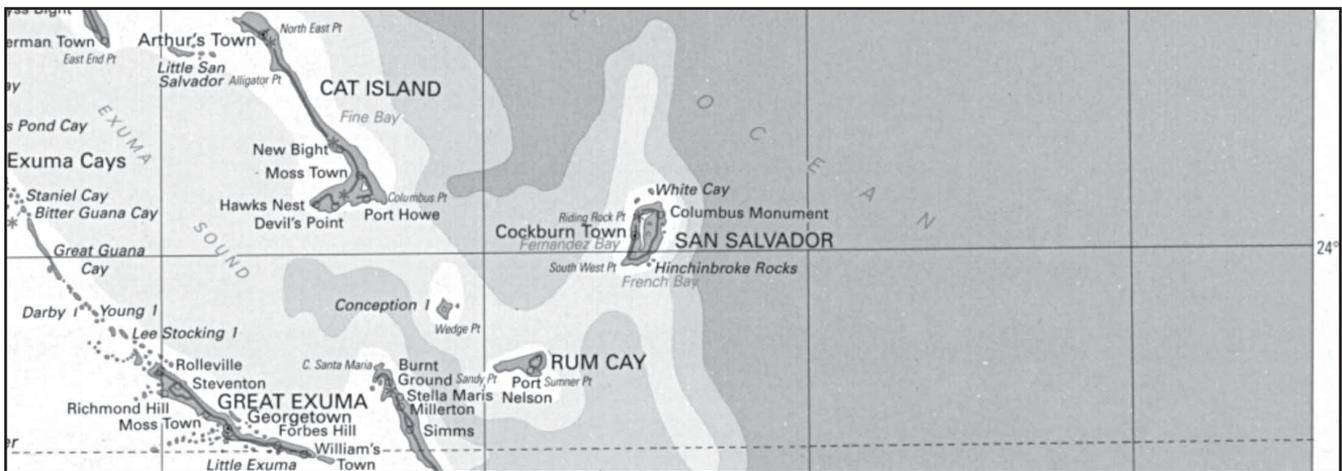
Human Impacts: None known.

Tourism Potential: Remote location; good long-term potential; diving.

Specific Management Recommendations:

- 1) Finalize official protection for Little Inagua Island.
- 2) Little is known of the basic ecology of Little Inagua. Research programs, incorporating local Bahamians whenever possible, would be of great value.
- 3) Explore potential for ecotourism based on birding, blue holes, and possible archeological sites.

SAN SALVADOR SECTOR



Team Members: Tim Bethel, Sandra Buckner, Ron Carter, Don Gerace, Kathy Gerace, Bill Hayes, Robyn Howard, Gary Larson, Tony White.

Graham's Harbour

San Salvador Sector Priority: 1

Overall Priority: 1

Narrative:

The Graham's Harbor region supports one of the most endangered lizards in the world, the San Salvador iguana

(*Cyclura rileyi rileyi*), and the most diverse nesting seabird assemblage in the Bahamas. More than 1,000 nesting pairs of nine seabird species and three heron species nest on these cays. A healthy reef ecosystem is also present. The area has considerable ecotourism potential and the habitats are vital to important, long-term study by researchers and students hosted by the Bahamian Field Station.

Although iguanas and seabirds are protected on the cays, their habitat is not. These cays were proposed as a protected area in 1983 in the Bahamas National Trust's proposal, "The Development of a National Park System for the Commonwealth of The Bahamas," submitted to the government at their request in 1983 in order to protect the habitat of these species.

The San Salvador iguana is endemic to the main island and the offshore cays. This exquisitely colored iguana is regarded as the smallest of the eight species in the wider Caribbean, and among the most critically endangered. At one time many thousands presumably roamed the main island, but human-related activities have all but extirpated iguanas from the main island. Today they are restricted to six tiny cays just offshore or within the inland lakes. Populations on several of these cays have become extirpated in recent decades, including those on Barn Cay (1960s), High Cay (1990s) and Gaulin Cay (1990s). Fewer than 600 remain today, with Green Cay hosting the largest population. Regular population surveys since 1994 confirm that iguana numbers continue to decline. On Green Cay, vegetation and nesting habitat have become degraded by a regionally introduced moth (the larvae of which feast on prickly pear cactus) and recent catastrophic storms (hurricanes Lili in 1997 and Floyd in 1999). Nesting failures in 1999 and 2000 can be attributed to loss of nesting soil from the storm surge of Hurricane Floyd. Rats are present on a number of cays, including Low Cay where recruitment of juveniles into the adult population has been negligible. Apparent outbreaks of disease have been documented on Low Cay (1970s) and Guana Cay (1994). The iguanas prefer rocky areas and, as herbivores, are dependent on vegetation for cover and food. The diversity of plants varies from five species on Pigeon Cay, where the iguanas feed almost exclusively on red mangrove, to more than 40 species on Guana and Low Cays.

There are a number of factors that will make population recovery and management of these iguanas a challenge. The iguanas cannot realistically be reintroduced to the main island because of feral animals, including cats and dogs that roam widely. There are a number of cays on which iguanas can be translocated, but habitat suitability (e.g., presence of rats) will need to be examined and in some cases ownership issues will need to be negotiated. The Green and Manhead Cay populations are subject to frequent human visitation. Public education and management guidelines should be developed to minimize the potential for negative consequences. Because of their small body size, clutch size is small in this species. Survivorship of young iguanas in the wild prior to sexual maturity (5 years or more) is relatively low (<10%). Because rearing young iguanas in a captive facility results in substantially higher survivorship (>90%), a headstarting program based at the Bahamian Field Station or Ardastra Gardens in Nassau would greatly accelerate a translocation program for starting new populations on suitable cays.

Characteristics:

Biodiversity:

- *Green Cay* – 200 San Salvador rock iguanas (*Cyclura rileyi rileyi*), bark anole (*Anolis distichus ocior*), San Salvador gecko (*Sphaerodactylus corticola soter*); 25 pairs bridled terns annually; 100 pairs sooty terns, 50 pairs roseate terns, 20 pairs tricolored herons, 25 pairs Audubon's shearwaters; undetermined bat species (transient).
- *White Cay* – 25 pairs magnificent frigatebirds, 200 pairs brown boobies, 2 pairs red-footed boobies, 5 pairs bridled terns, 5 pairs royal terns.
- *Cato Cay* – 100 pairs brown boobies, 2 pairs red-footed boobies, 300 pairs sooty terns, 50 pairs brown noddies, 12 pairs royal terns, 5 pairs bridled terns, 2 pairs Audubon's shearwaters.
- *Little Gaulin Cay* – *Cyclura rileyi rileyi* (extirpated?); 100 pairs sooty terns, 5 pairs bridled terns, 200 pairs brown noddies, 50 pairs roseate terns, 30 pairs Audubon's shearwaters.
- *Manhead Cay (private)* - 60 *Cyclura rileyi rileyi*, *Anolis distichus*, San Salvador gecko; 35 pairs Audubon's shearwaters, 2 pairs sooty terns, 4 pairs bridled terns, 4 pairs yellow-crowned night herons, 2 pairs green herons.
- *Cut Cay (private)* – 2 pairs Audubon's shearwaters.
- *Shoreline (private)* – 10 pairs white-tailed tropicbirds, possibly Audubon's shearwater.

Threats: Several threats to the ecology of these cays have been identified. These include:

- Destruction of prickly-pear (*Opuntia stricta*) cactus by the larvae of a regionally introduced moth, *Cactoblastus cactorum*. The cactus is a major dietary component of iguanas, but more than 70% of the cactus biomass has declined since 1994.
- Recent catastrophic storms have significantly damaged the vegetation on Green, White, and Gaulin Cays. The nesting habitat of iguanas on Green Cay (loose soil) was washed away during Hurricane Floyd in September 1999.
- Visitors to the cays may trample vegetation, iguana nests, and seabird nests.
- Visitors to the seabird colonies cause frightened adult birds to leave their nests for extended periods of time, which results in heat-related mortality of eggs and chicks due to exposure to the sun. Islanders occasionally collect seabird eggs.
- No invasive mammals are present on the cays. Other potential invasive species, such as fire ants, need to be monitored.

- The boat anchors of visitors cause damage to the reefs when they visit the cays and Gaulin Reef.
- Several diseases of coral reefs have been documented on Gaulin Reef.

Specific Management Recommendations:

1) Graham Harbour should be protected as a unit – the shoreline from Rice Bay west to Singer Bar Point – for the protection of the white-tailed tropicbird nesting sites. The whole area of Graham’s Harbour is approximately 25 km² surrounded by a fringing reef on which are located Green Cay, White Cay, Cato Cay, and Little Gaulin Cay (= Hawknest Cay). All of these cays are Crown Land, and all are important for either iguanas or seabird nesting or both. None of the cays are inhabited by humans, nor is there any development along this particular section of the shoreline.

2) There are several issues related to ecotourism on these cays. Manhead Cay is frequently visited by people who swim to it, particularly student groups from the Bahamian Field Station. The iguanas nest on the grassy area above the bluffs where the nests are subject to trampling. A designated trail for visitors should be established. Green Cay supports the largest remaining sub-population of iguanas and should have a delineated trail for visitors to avoid trampling of iguana nests and damage to sensitive vegetation. Permanent moorings should be established at Green, Little Gaulin, and Cato Cays to avoid damage to the reefs. An additional mooring should be established on the elkhorn reef just north of Gaulin Cay where student groups from the field station frequently snorkel. To protect the seabird colonies, there should be a limit of 10 minutes for guests who visit Gaulin, Cato, and White Cays. This allotted time will prevent heat related mortalities to eggs and chicks when adults are frightened off nests. White and Cato cays could be declared off-limits to all but those who are conducting legitimate research. A public education program on San Salvador should be implemented to raise public awareness about the value of this island and its associated cays. A brochure should be prepared to provide to all visitors who go out to the cays.

3) Contact should be maintained with the owners of private land and at the first sign of development a translocation program for iguanas should be developed. Accordingly, suitable sites (e.g., Cut Cay) free of invasive species should be identified. At the present time, there does not appear to be any development proposed for either Cut Cay or Manhead Cay.

Inland Lakes

San Salvador Sector Priority: 2
Overall Priority: 7

Narrative:

The inland lakes support a diverse bird population, as well as two populations of critically endangered iguanas, *Cyclura rileyi rileyi*. Among the 1,000 or more pairs of 17 nesting waterbirds is a viable population (approximately 100 pairs) of the San Salvador cormorant, a bird endemic to the Bahamas. The lakes and cays within them are very remote and seldom visited by humans. However, rats have been seen on Guana and Pigeon Cays, where they may threaten the iguana and bird populations. The lakes are hypersaline, but are connected by subterranean channels to the ocean. Thus, the cays, some of which are under 1 m in elevation, are vulnerable to inundation by rising seawater.

Characteristics:

Biodiversity:

- *Pigeon Cay* – 75 *Cyclura rileyi rileyi*, San Salvador gecko, *Anolis distichus*; 50 pairs laughing gull, 3 pairs reddish egrets, 10 pairs tricolored herons, 3 pairs green herons, 10 pairs double-crested cormorants (endangered Bahamas race).
- *Cormorant Cay* – 100 pairs double-crested cormorants (endangered Bahamas race), 30 pairs reddish egrets, 10 pairs tricolored herons.
- *Guana Cay* – 50 *Cyclura rileyi rileyi*.
- *Various cays in inland lakes* – double-crested cormorant (endangered Bahamas race), least tern, gull-billed tern, laughing gull, least grebe, white-cheeked pintail, black-necked stilt, willet.

Threats: Cats, dogs, rats, hunters.

Specific Management Recommendations:

1) Guided ecotourism boating trips could be developed between the dock on Little Lake at Cockburn Town and the Lighthouse dock area in United Estates. This trip would provide an opportunity for observing numerous birds, including the endemic double crested cormorant, and the endangered San Salvador iguana. Since this type of boat trip was the major means of transport on San Sal-

vador prior to the 1950s, there is also great historical significance in such a trip, as well as an opportunity to observe the hand dug channels between the lakes and the beautiful Dixon Hill Lighthouse, one of the last remaining, hand-operated lighthouses in the world.

East and South San Salvador Shore and Cays

San Salvador Sector Priority: 3
Overall Priority: 17

Narrative:

The offshore cays to the East and South of San Salvador, as well as the southeast shoreline of San Salvador, support one of the last remaining colonies of the San Salvador iguana, *Cyclura rileyi rileyi*, and numerous seabird nesting areas.

Characteristics:

Biodiversity:

- *Goulding Cay (private)* – 150 *Cyclura rileyi rileyi*, San Salvador gecko, *Anolis distichus*; bridled tern, 6 pairs Audubon’s shearwaters.
- *High Cay (private)* – *Cyclura rileyi rileyi* (extirpated?), San Salvador curly-tailed lizard, San Salvador gecko; 16 pairs Audubon’s shearwaters, various seabirds (colonies now extirpated).
- *Hinchingbrook Rocks* – Bridled tern.
- *Middle Cay* – San Salvador gecko; various seabirds (colony now extirpated).
- *Nancy Cay* – 2 pairs brown noddies.
- *Low Cay (private)* – 75 *Cyclura rileyi rileyi*, *Anolis* sp., San Salvador gecko, San Salvador blind snake; 4 pairs Wilson’s plovers, 6 pairs bridled terns, 4 pairs Audubon’s shearwaters, 4 pairs royal terns.
- *Snow Bay shoreline including “Dumb Cay” (private)* – white-tailed tropicbird, Wilson’s plover, American oystercatcher, unknown numbers of sooty, bridled, and other terns.

Conception Island

San Salvador Sector Priority: 4
Overall Priority: 16

Narrative:

Conception Island is an unspoiled 850 ha island in the southern Bahamas, and is a National Park. It is an important sanctuary for migratory birds and a breeding site for green sea turtles. The island also has historical significance as one of the first landfalls of Columbus in the New World. However, informal surveys and anecdotal data have shown that Booby Cay and South Rocks located just offshore have a larger number of breeding seabirds than Conception Island. Booby Cay and rocks are not part of the park, and do not have the same protection that the park does. The Bahamas National Trust has already recommended to government that this area be included within the Conception Island National Park.

Reptiles recorded from Booby Cay are *Sphaerodactylus nigropunctatus*, *Anolis sagrei*, and *Epicrates striatus*. These reptiles are still being studied to determine their subspecific status. Fourteen pairs of royal terns nested on South Rocks in 1981. The vegetation on this cay includes large stands of gum-elemi and an elevated sand flat with grasses and small area of wetland.

Seabirds recorded nesting on Booby Cay and South Rocks include Audubon’s shearwater, white-tailed tropicbird, sooty tern, bridled tern, royal tern, and brown noddy. Audubon’s shearwater and white-tailed tropicbird are both regionally endemic subspecies whose populations are declining in the West Indies; the Bahamas has a significant portion of the West Indian populations. Booby Cay and the South Rocks are probably the largest single nesting location for white-tailed tropicbirds other than Bermuda. Bridled terns are also a regionally endemic subspecies that warrants protection. Its habit of nesting in small groups with other terns makes it extremely difficult to census and monitor, but there is little doubt that the West Indian population is declining. Booby Cay may also have a large colony of white-crowned pigeons. If true, this is an additional reason to provide protection.

Characteristics:

Threats: *Casuarina*, domestic species visiting island with tourists.

Specific Management Recommendations:

- 1) Census breeding seabirds on Booby Cay and South Rocks. The Conservation Unit should implement this recommendation. Estimated cost: 2 people for 3 days plus transportation which can be reduced by combining this census with other projects in the southern Bahamas.
- 2) Check for presence of breeding white-crowned pigeons on Booby Cay. This can be completed by the same team that conducts the census in recommendation (1).
- 3) Remove *Casuarina* from Conception Island to prevent spreading.
- 4) Continued support for the recommendation for expansion of Conception Island National Park [Responsibility: National Trust].
- 5) Monitor seabird breeding success on a regular basis. The Conservation Unit should be responsible until Booby Cay and South Rocks are included in the National Park, at which time responsibility should be transferred to the Bahamas National Trust.

Little San Salvador

San Salvador Sector Priority: 5
Overall Priority: 23

Narrative:

Little San Salvador and the nearby cays and rocks, including Tee and Goat Cays are an important nesting site for white tailed tropicbirds, laughing gulls, royal terns, roseate terns, bridled terns, sooty terns, brown noddies, and burrowing owls. White-tailed tropicbirds are a species of regional concern with a population that is declining in the West Indies. Roseate Terns are a species of international concern listed by World Bird Life. The Bahamian population represents a significant portion of the distinctive West Indian population of the species. Seabirds in general are declining in the West Indies due to pollution and habitat disturbance. Active colonies should be protected wherever feasible.

Little San Salvador is privately owned; the ownership of the offshore cays is not known. Little San Salvador and the cays were proposed as a protected area in 1983 in the Bahamas National Trust's proposal, "The Development of a National Park System for the Commonwealth of The Bahamas," submitted to the government at their request. Little San Salvador was subsequently sold, and is now used by the Holland American cruise line to give their passengers an "out island" experience. Informal reports indicate that the tourists use only the western portion of the island and have no direct impact on the offshore cays.

We desire to protect the established seabird populations and burrowing owls as much as possible in consonance with the island's ongoing use as a tourist attraction. In order to accomplish this we recommend that the Bahamas National Trust negotiate an MOU with the Holland American Line to ensure minimum impact on the remainder of Little San Salvador and offshore cays, and ensure that proper protection is in place to prevent accidental introduction of exotic predators. The benefit for Holland American could be a formal endorsement of their environmental practices on the island by the Bahamas National Trust.

For further protection of the existing environment on Little San Salvador we recommend that the *Casuarina* trees be cut down. These trees kill all ground cover growing underneath the canopy. Over an extended period of time, the lack of ground cover will lead to beach erosion. We recognize that cutting all of the trees at one time would reduce the aesthetic appeal to tourists. Therefore, we recommend that the removal of the trees be the subject of the aforementioned MOU and the responsibility of Holland American Line.

We recommend that the Bahamas National Trust determine the ownership of the offshore cays and rocks and have them designated as protected areas. This action will provide additional protection to the seabirds on these cays.

EXUMA SECTOR



Team Members: Paul Dean, Bill Hayes, John Iverson, Lis Hudson, Chuck Knapp, David Lee, Catherine Malone, Basil Minns, Jane Minns.

Overall Narrative:

The islands within the Exuma chain are considered by many to be the most beautiful islands in the world, and are therefore visited heavily by tourists each year, espe-

cially by boat. The economic benefits from the yachting industry is significant, yet it also brings with it potential negative costs to the ecosystem. The fragile reef and terrestrial environments need continued effective management and enforcement. The Great Exuma center of Georgetown is the focus of tourists arriving by air and is the main support center for yachting. Continued education of local inhabitants, and especially of arriving tourists, is needed to make people aware of the conservation needs of the region.

Great Exuma Cays

Exuma Sector Priority: 1
Overall Priority: 3

Narrative:

The highest priority for the Great Exuma Cays is the preservation of its iguana population. Of the two species of Bahamian iguanas inhabiting the Exuma chain, *Cyclura rileyi cristata* is resident in this sector (Sandy Cay, off the southern tip of Little Exuma). *Cyclura rileyi cristata* is arguably the most delicate and beautiful Caribbean iguana. Its small size, colorful pattern, easy accessibility by boat, and relative lack of protection has made this population vulnerable to the illegal pet trade. Genetically and morphometrically, *Cyclura rileyi cristata* is the most distinct taxon among the three designated subspecies, and is represented by only one population on Sandy Cay (= White Cay). Putative smuggling, predation by a raccoon (removed in 1997), possible negative effects of a dense rat population, and unknown historic stochastic events may have contributed to the recent catastrophic decline in *Cyclura rileyi cristata* over the last decade to a population of less than 200 individuals today. Most alarming is the fact that the current census reports a disproportionate number of males (nearly 95%). Iguana females may well have been selectively targeted by the raccoon. Furthermore, within the remaining population of females, the average standard body length measures are below the normal size for reproductive success. In spite of recent programs to eliminate introduced predators, the accumulated effect of population decimation suggests that any population recovery will be slow and vulnerable to stochastic events. Successful recovery will require continued monitoring and careful management. Contingency plans must be made to provide rapid response by the conservation community should further population decline occur.

A headstarting program established on an adjacent cay (Leaf Cay) and/or another appropriate location should be considered as intervention if indicated by further decline. Unfortunately, Leaf Cay is overrun with rats, and adjacent Hog Cay is privately owned. Sandy Cay should be designated as a satellite site in the proposed Great Exuma National Park. Increased awareness by the local community to the sensitivity of the iguana population to human activity and the illegality of removing iguanas should be a target of local education.

The second highest priority for the region is to develop a survey strategy for the many cays adjacent to Great Exuma that have not been recently surveyed. Biodiversity and baseline data are needed for many cays, especially those known to be occupied by significant sea bird colonies.

Characteristics:

Soldier Cay

Area: 2.5 ha.

Biodiversity: White-crowned pigeon, noddy tern, sooty tern.

Ownership: Private.

Protection: None.

Introduced Predators: Unknown.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: None.

Tourism Potential: Moderate.

Management Needs: None.

Bird Cay

Area: 0.5 ha.

Biodiversity: Noddy tern, sooty tern.

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None, but heavy egg poaching.

Development: None.

Tourism Potential: None.

Management Needs: None.

Duck Cay

Area: 2 ha.

Biodiversity: White-crowned pigeon, noddy tern, sooty tern, laughing gull.

Ownership: Crown Land.

Protection: None, but under consideration as a National Game Reserve.

Introduced Predators: Heavy gull predation on eggs.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: None.

Tourism Potential: None.

Management Needs: Approve Game Reserve Status.

Channel Cays

Area: 2 cays, 1 ha each.

Biodiversity: noddy tern, sooty tern, sandwich tern, roseate tern.

Ownership: Crown Land.

Protection: National Game Reserve.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: No potential.

Tourism Potential: None.

Management Needs: Census for baseline information.

Lili Cay

Area: 0.2 ha.

Biodiversity: Seabirds devastated by poachers.

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development Potential: None.

Tourism Potential: None.

Management Needs: Monitor for return of seabirds; conduct a census to establish baseline information.

Moriah Harbour Cay

Area: 5 ha.

Biodiversity: Least tern, gull-billed tern, oyster catcher, nesting osprey.

Ownership: Crown Land.

Protection: Slated to become national park.

Introduced Predators: Feral cats.

Domestic Species: Goats.

Invasive Species: *Casuarina*.

Human Population: None.

Development Potential: None.

Tourism Potential: Unknown.

Management Needs: Remove feral and domestic animals; monitor nesting birds.

Grog Pond, mainland Great Exuma

Area: 3 ha.

Biodiversity: Nesting herons.

Ownership: Crown Land.

Protection: Under consideration as a National Game Reserve.

Introduced Predators: Cats and dogs.

Domestic Species: Goats.

Invasive Species: None.

Human Population: Surrounded by subdivision.

Development Potential: Already developed.

Tourism Potential: High.

Management Needs: Protect with National Game Reserve status.

North Channel Rocks (Five Rocks)

Area: 1 ha total.

Biodiversity: Noddy tern, sooty tern, roseate tern.

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development Potential: None.

Tourism Potential: None.

Management Needs: Protect seabird populations; census to obtain baseline information on numbers; investigate impact of large hermit crab population preying on nestlings.

Pigeon Cay

Area: 3 ha.

Biodiversity: White-crowned pigeon, noddy tern, sooty tern, sandwich tern; large curly-tail lizard (*Leiocephalus*) population.

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development Potential: None.

Tourism Potential: High.

Management Needs: Protect seabird population; survey to obtain baseline numbers.

Pelican Cays (three cays)

Area: 1 ha total.

Biodiversity: Noddy tern, sooty tern, bridled tern, sandwich tern.

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development Potential: None.

Tourism Potential: None.

Management Needs: Protect seabird population; survey to obtain baseline numbers.

Sandy (= White Cay)

Area: 25 ha (including adjacent sand dunes).

Biodiversity: 140-210 *Cyclura rileyi cristata* (the only population of this subspecies; crashed due to predation by raccoon and rats; 95% male sex ratio); nesting osprey, nesting gulls.

Ownership: Crown Land.

Protection: None.

Introduced predators: Raccoon and rats, both removed.

Domestic Species: None.

Invasive Species: *Casuarina*.

Human Population: None.

Development Potential: None.

Tourism Potential: Very low.

Management Needs: Continue to monitor for rats and other invasive species, with immediate control as necessary; control *Casuarina*; educate day visitors from Georgetown; heighten awareness of natural history and conservation of iguana population; add signage; evaluate potential *Cyclura rileyi cristata* headstarting program for nearby Leaf Cay and/or other geographically proximate cays in response to low number of adult females and potentially depressed recruitment.

Specific Management Recommendations:

1) This area is of relatively low priority with the exception of Sandy Cay; investigate the feasibility of relocation of iguanas to a suitable nearby island to establish a new population as a buffer against extinction.

Allen's Cay Group

Exuma Sector Priority: 2

Overall Priority: 5

Narrative:

The Allen's Cay Group (longitude -76.83W, latitude 24.75N) contains four small cays (Allen's Cay, 4 ha; SW Allen's Cay (= U Cay), 3 ha; Leaf Cay, 4 ha; Flat Rock Reef Cay, 4 ha) which are of conservation concern. Allen's Cay is Crown Land, as is Flat Rock Reef Cay, and hence their biota is protected by Bahamian law; the latter cay was leased at one time, but the lease has lapsed. The other two cays are privately owned. Because of their

proximity to Nassau, all of these cays are regularly visited by recreational boaters and tourists. At least one tour company makes daily visits to Leaf Cay.

All of these cays are inhabited by the endemic Allen's Cay Iguana, *Cyclura cychlura inornata*. Allen's Cay has six iguanas (non-reproducing), but two of the other cays support viable and sizable iguana populations that are increasing (250 on SW Allen's Cay and 350 on Leaf Cay). The number of iguanas on Flat Rock Reef Cay is unknown (iguanas were introduced to Flat Rock Reef Cay in the mid-1990s). These populations are well studied by John Iverson, Earlham College, who has documented the following.

Two apparently natural populations of *Cyclura cychlura inornata* occur in the Allen's Cay group of Exuma Islands. The population on Leaf Cay appears to be increasing due to food supplementation by tourists. SW Allen's Cay iguanas also receive food supplementation, although at a much lower rate, and the population is also apparently increasing. Both populations are in excellent condition demographically, with good annual recruitment and high survivorship (with individuals known to be over 30 years of age).

A few iguanas are also known from Allen's Cay, but no reproduction is occurring because of lack of nesting substrate. Sand for nesting could be easily provided, but should only be done after careful consideration of possible negative interactions between these iguanas and the Audubon's shearwater population known to cohabit the island.

Between 1988-1990, eight individuals from Leaf Cay were used to found a protected population on Alligator Cay in the Exuma Land and Sea Park. This population has increased about ten-fold in a decade and is currently thriving. Sometime between 1994-1996, iguanas were apparently introduced to Flat Rock Reef Cay (0.5 km north of Leaf Cay). Anecdotal observations suggest the population is growing, and survey work in May of 2001 is planned to assess the status of the population.

The only significant threat to the two original populations (Leaf and SW Allen's Cays) seems to be excessive feeding by the tourists on Leaf Cay. Other than signage, the iguanas, while legally protected, receive no actual protection.

The other species of primary conservation concern is the Audubon's shearwater, *Puffinus lherminieri*. This shearwater is a tropical pelagic species represented in the western Atlantic by an endemic subspecies consisting of a total population of only about 5,000 pairs. A significant percentage of these breed in the Bahamas. This bird nests on three of these cays (Allen's, SW Allen's, and Leaf), and possibly on Flat Rock as well, representing perhaps the second largest known colony in the world.

Other than possibly house mice, there are no invasive species and no introduced predators on any of these cays. The only significant threat to the two original iguana populations (Leaf and SW Allen's Cays) seems to be excess feeding by tourists. Because of the ecotourism potential of such interactions, we propose that 1) feeding continue to be allowed on Leaf Cay, 2) tour leaders be educated as to the appropriate foods, 3) feeding be banned on SW Allen's Cay (via a single new sign that replaces the two current signs prohibiting harassment and dogs), and 4) the Department of Tourism be involved in developing a plan to tax tourists for the privilege of feeding the iguanas. Funds generated can be used to support other conservation efforts in the Bahamas.

Characteristics:

Allen's Cay

Area: 4 ha.

Biodiversity: 6 *Cyclura cyphura inornata* (last censused in 1990, no nesting); second largest known Audubon's shearwater colony.

Ownership: Crown Land.

Protection: None.

Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: None planned.

Tourism Potential: Low.

Management Needs: Protect cay for nesting Audubon's shearwater; consider resident iguanas for use in other relocation programs.

SW Allen's Cay (= U Cay)

Area: 3 ha.

Biodiversity: 250 *Cyclura cyphura inornata* (nesting, population increasing); Audubon's shearwater.

Ownership: Private.

Protection: None.

Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: None planned.

Tourism Potential: High ecotourism potential, problem of tourists feeding iguanas.

Management Needs: Ban feeding and add "No Feeding" signs to existing identification, as well as "No Dog" signs; enforce regulations; continue yearly population surveys (ongoing project, John Iverson, Earlham College). Of regional importance is the maintenance of SW Allen's Cay in as undisturbed a state as possible.

Leaf Cay

Area: 4 ha.

Biodiversity: 350 *Cyclura cyphura inornata*, nesting, population increasing; Audubon's shearwater.

Ownership: Private.

Protection: None.

Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: None planned.

Tourism Potential: High ecotourism potential; problem of tourists feeding iguanas.

Management Needs: Realizing that we cannot stop the feeding of this iguana population by tourists, we propose exploiting the ecotourism potential of this population, including education about nutrition and the biology and conservation status of the iguanas. This should involve the Department of Tourism. This iguana population should also be considered as a source population for relocation to Disney's Castaway (= Gorda) Cay, if approved. Yearly population surveys should be continued (ongoing project, John Iverson, Earlham College).

Flat Rock Reef Cay

Area: 4 ha.

Biodiversity: Introduced *Cyclura cyphura inornata* (population size unknown, but will be censused in May, 2001; introduced between 1994-1996), nesting observed and juveniles recorded; nesting laughing gulls.

Ownership: Crown Land.

Protection: None.

Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development: None planned.

Tourism Potential: None.

Management Needs: Monitor future population growth; conduct genetic evaluation to determine source of animals if funds are available.

Specific Management Recommendations:

1) We recommend banning feeding on SW Allen's Cay, and adding "No Feeding" signs to existing identification, as well as "No Dog" signs. Regulations need to be enforced. Yearly population surveys should be continued (John Iverson, Earlham College, ongoing project).

2) On Leaf Cay, realizing that we cannot stop the feeding of the *Cyclura cychlura inornata* population by tourists, we propose exploiting the ecotourism potential of this population by requesting donations from commercial tour companies visiting the island. We need to provide educational information about nutrition and the biology and conservation status of the iguanas. This should involve the Department of Tourism. Iguanas from this population should be considered as a source population for relocation to Disney's Castaway Cay, if approved. Yearly population surveys should be continued (John Iverson, Earlham College, ongoing project).

3) Protect Allen's Cay for nesting Audubon's shearwater, *Puffinus lherminieri*. Consider abandoned iguanas at site for inclusion with other relocation programs.

4) Monitor future population growth of introduced *Cyclura cychlura inornata*, on Flat Rock Reef Cay; evaluate genetics to determine source of animals if funds are available.

5) A recent proposal for relocation of iguanas to Castaway Cay (= Gorda Cay) should be seriously considered. Because we know that relocation of Allen's Cay iguanas has been successful elsewhere, the Leaf Cay animals are already strongly habituated to humans, and the iguana population appears to be above the island's carrying capacity (as a result of the food supplement by tourists), we believe that Leaf Cay represents the most logical source population for possible relocation of founder animals to Castaway Cay. More discussion among all participants is needed to determine the appropriate number, sex, and age of the founders, as well as the optimal timing for introduction. In addition, these discussions should clearly delineate Disney's part in this mutually beneficial relationship. Disney has the means to support education (which must be both local and international), field research, population monitoring, and conservation efforts for iguanas throughout the Bahamas.

6) The Department of Tourism should be involved in developing a plan to tax tourists for the privilege of feeding the iguanas, which would be used to support a variety of conservation efforts in the Bahamas.

Central Exuma Cays Group

Exuma Sector Priority: 3

Overall Priority: 4

Narrative:

A series of seven islands in the central Exumas is critical for long term protection and management. The key species of concern is the endemic Exuma Island iguana, *Cyclura cychlura figginsi*, and one of these cays is also important to the white-tailed tropicbird, *Phaethon lepturus* (Bitter Guana Cay). Several other species of seabirds also nest on these islands. The islands of concern in this region are Bitter Guana Cay (88 ha), Gaulin Cay (23 ha), Noddy Cay (9 ha), North Adderly Cay (12 ha), Leaf Cay (25 ha), White Bay Cay (7 ha), and Guana Cay (2.5 ha). Collectively, these islands now support 1,000-1,500 iguanas. On Bitter Guana Cay, a population of over 800 iguanas was reduced to 20-30 individuals as a result of illegal hunting. Most of the other islands discussed here currently support several hundred iguanas each.

The Exuma Island iguana uses a variety of habitats, including sandy beaches, xeric limestone devoid of vegetation, and areas of vegetation with and without sand on rock substrates. Limestone crevices and sand burrows are used as retreats at night and during adverse weather. All but one of these islands are Crown Land, and hence should be protected under Bahamian law. The one privately owned island is Leaf Cay off Norman's Pond Cay. Rats, (*Rattus* sp.) are established on Bitter Guana Cay, Gaulin Cay, and Leaf Cay. There are no other introduced predators, domestic animals, or invasive species documented on any of these islands. These islands are all uninhabited and unprotected. Several have high potential for tourism. Bitter Guana Cay has an extensive area for anchorage.

Characteristics:

Bitter Guana Cay

Area: 88 ha.

Biodiversity: 20-30 *Cyclura cychlura figginsi* (population collapsed from ~ 800 individuals due to hunting for food), nesting and active recruitment; white-tailed tropicbird, white-crowned pigeon.

Ownership: Crown Land.

Protection: None.

Introduced Predators: Rats.

Domestic Species: None.

Invasive Species: Rats?

Human Population: None.
Development: None planned.
Tourism Potential: Very high, perfect anchorage.
Management Needs: Continue surveys; education programs are needed for tour operations, and nearby settlements to discourage hunting of iguanas for human consumption; eradicate rats; monitor nesting iguanas; discourage feeding by tourists.

Gaulin Cay

Area: 23 ha.
Biodiversity: 250-300 *Cyclura cyclura figginsi*, healthy population.
Ownership: Crown Land, had been leased but lease has lapsed.
Protection: None.
Introduced Predators: Rats.
Domestic Species: None.
Invasive Species: None.
Human Population: None.
Development: None planned.
Tourism Potential: High.
Management Needs: Continue surveys; education programs are needed for nearby settlements to raise awareness; eradicate rats.

Noddy Cay

Area: 9 ha.
Biodiversity: Approximately 225 *Cyclura cyclura figginsi*, healthy population; breeding colony of noddy terns.
Ownership: Crown Land.
Protection: None.
Introduced Predators: None.
Domestic Species: None.
Human Population: None.
Development: None planned.
Tourism Potential: None (no beaches).
Management Needs: Establish a survey program; designate as a Protected Area.

North Adderly Cay

Area: 12 ha.
Biodiversity: Approximately 250 *Cyclura cyclura figginsi*, healthy population.
Ownership: Crown Land.
Protection: None.
Introduced Predators: Unknown.
Domestic Species: None.
Invasive Species: None.
Human Population: None.

Development: None planned.
Tourism Potential: None.
Management Needs: Establish a survey program.

Leaf Cay

Area: 25 ha.
Biodiversity: Perhaps 10-15 *Cyclura cyclura figginsi*, going to be translocated; white-crowned pigeon, Bahama pintail.
Ownership: Private.
Protection: None.
Introduced Predators: Rats.
Domestic Species: None.
Invasive Species: None.
Human Population: None presently.
Tourism Potential: None.
Management Needs: Proceed with translocation of iguanas to Pasture Cay, Exuma Cays Land and Sea Park, because of concerns about introductions of dogs and the development of Leaf Cay.

White Bay Cay

Area: 7 ha.
Biodiversity: Approximately 225 *Cyclura cyclura figginsi*, population stable.
Ownership: Crown Land; leased, but in litigation.
Protection: None.
Introduced Predators: None.
Domestic Species: None.
Invasive Species: None.
Human Population: None.
Development: Initiated, but now halted.
Tourism Potential: High.
Management Needs: Establish a survey program.

Guana Cay

Area: 2.5 ha.
Biodiversity: Approximately 90 *Cyclura cyclura figginsi*, population stable.
Ownership: Crown Land.
Protection: None.
Introduced Predators: None.
Domestic Species: None.
Invasive Species: None.
Human Population: None.
Development: None.
Tourism Potential: Moderate.
Management Needs: Continue to survey (Chuck Knapp, University of Florida, ongoing project).

Specific Management Recommendations:

- 1) Establish a National Park on Bitter Guana and Gaulin Cays as first priorities. A second priority is designation of Protected Area status for all Crown Land cays.
- 2) Education programs are needed for nearby settlements to help discourage hunting of iguanas (for human consumption), as well as for tour operations regarding the protected status and rarity of these animals.
- 3) Continue to survey islands by monitoring iguana populations and exotic predators and developing a list of native biota.
- 4) Remove or control rats.
- 5) Discourage feeding of iguanas by tourists.
- 6) Follow-up on reports that iguanas were dispersed by Hurricane Floyd from Guana Cay by performing a systematic survey of the source population.
- 7) Proceed with the translocation of *Cyclura cychlura figginsii* from Leaf Cay to Pasture Cay in the Exuma Cays Land and Sea Park.

Cay Verde

Area: 17 ha.

Biodiversity: Brown booby, magnificent frigatebird, bridled tern, laughing gull, sooty tern, brown noddy.

Ownership: Unknown.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: None.

Development Potential: None.

Tourism Potential: None.

Management Needs: Census to establish baseline information on seabird populations.

Specific Management Recommendations:

1) Cay Verde is a high priority for conservation, protection, and monitoring, as it has boobies and frigate birds. There is a need for a thorough survey to establish what protection is necessary for the nesting species. This site offers an excellent opportunity for partnering with the National Defence Force, as they are often in the area for drug surveillance and refugee interception. This opportunity could be used to provide the Defence Force with the most up-to-date information on the ecological importance of these species.

Ragged Islands

Exuma Sector Priority: 4
Overall Priority: 14

Characteristics:

Ragged Island

Area: Approximately 16-20 km².

Biodiversity: Poorly known, but includes *Epicrates striatus mccranei*.

Ownership: Private.

Protection: None.

Introduced Predators: Unknown.

Domestic Species: None.

Invasive Species: None.

Human Population: Small settlement.

Development Potential: Unknown.

Tourism Potential: Moderate.

Management Needs: Census needed for all vertebrates.

Southwestern Cays Group

Exuma Sector Priority: 5
Overall Priority: 12

Narrative:

Three remote cays, Cay Verde, Cay Lobos, and Santo Domingo Cay, situated at the extreme southern end of the Bahamas, have long been neglected by the scientific community. There has never been a census of Cay Verde or Cay Lobos. These two cays were visited by Tony White, Eric Carey, and Paul Dean in 1998, with the assistance of the Bahamas Defence Force. During their visit to Cay Verde, they found many nesting seabirds, including brown boobies, magnificent frigatebirds, laughing gulls, and bridled, sooty, and noddy terns. They also observed an *Anolis* lizard and a racer, but no iguanas. On Cay Lobos, they found a nesting colony, including roseate, least, sandwich, and sooty terns. They did not find any iguanas on Cay Lobos. Prior to this trip, Santo Domingo Cay had not been surveyed since 1800, when

it was reported to have a colony of nesting seabirds. When visited by Tony White, Eric Carey, and Paul Dean, no sign of any nesting birds was found, as the cay was being washed over by the sea.

Characteristics:

Cay Lobos

Area: 6 ha.

Biodiversity: Roseate tern, least tern, sandwich tern, sooty tern.

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None

Invasive Species: None.

Human Population: Occasional Cuban refugees.

Development Potential: None.

Tourism Potential: None.

Management Needs: Census to establish baseline information.

Santo Domingo Cay

Area: 15 ha.

Biodiversity: Nesting seabirds?

Ownership: Crown Land.

Protection: None.

Introduced Predators: None.

Domestic Species: None.

Invasive Species: None.

Human Population: Cuban refugees.

Development Potential: None.

Tourism Potential: None.

Management Needs: Census to establish baseline information (last recorded survey taken in the mid-1800s).

Specific Management Recommendations:

- 1) The Ministry of Agriculture should contact the Bahamas Defence Force and request assistance action by the end of January, 2001.
- 2) The Ministry of Agriculture should schedule annual survey dates for both 2001 and 2002 by the end of February, 2001. Ideally, surveys should be carried out after mid-May to insure that all species of interest are present.
- 3) The Ministry of Agriculture should request all participants in these surveys to have all reports and data in by July, 2002.

- 4) The Ministry of Agriculture should complete final biological survey reports for Cay Lobos, Cay Verde, and Cay Santo Domingo for presentation to the Minister of Agriculture by the end of 2002.

Note: More information on these cays is needed to understand their importance for nesting seabird colonies. A complete biological census must be undertaken by the Conservation Department of the Ministry of Agriculture before the end of 2002. This can be accomplished by the Bahamas Defense Force.

Exuma Land and Sea Park

Exuma Sector Priority: 6

Overall Priority: 25

Narrative:

Within the Exuma Land and Sea Park are five islands of primary importance to seabird and iguana populations: Bush Hill Cay, Shroud Cay, Long Cay, Alligator Cay, and Waderick Wells Cay. This park is under management by the Bahamas National Trust.

While the Exuma Land and Sea Park was established primarily as a marine sanctuary, it contains a variety of uninhabited cays and rocks that support a number of species of conservation concern. Collectively, these islands have a very diverse seabird fauna, with several species present in large numbers. Species of primary conservation interest are Audubon's shearwater, *Puffinus lherminieri*, and white-tailed tropicbirds, *Phrethan lepturus*. Both are currently under study by the North Carolina State Museum.

There are introduced populations of Acklins Bight iguanas, *Cyclura rileyi nuchalis*, on Bush Hill Cay, and Allen's Cay iguanas, *Cyclura cychlura inornata*, on Alligator Cay.

Characteristics:

Biodiversity: Introduced *Cyclura rileyi nuchalis* on Bush Hill Cay, white-tailed tropicbirds on Shroud Cay, the world's largest known colony of Audubon's shearwaters on Long Cay, introduced *Cyclura cychlura inornata* on Alligator Cay, white-tailed tropicbirds on Waderick Wells Cay; introduced hutia on Little Wax Cay.

BAHAMIAN IGUANA TAXON ACCOUNTS

From: Alberts, A.C. (editor). 2000. *West Indian Iguanas: Status Survey and Conservation Action Plan*. IUCN – the World Conservation Union. Gland, Switzerland. 111p.¹

Bartsch's iguana, *Cyclura carinata bartschi*

By Sandra Buckner and David Blair

Description

Bartsch's iguana is greenish to brownish-gray, with a yellow dorsal crest, faint yellow-brown reticulations on the bodies of the adults, and a golden iris (Auffenberg 1976). Large specimens are approximately 770mm total length. Schwartz and Carey (1977), who examined nine specimens (seven in life), recorded an SVL of 335mm in the largest male and 285mm in the largest female. They state, "in general their body colors seem to be somewhat paler (tending towards creams to pale grays) than those of nominate *carinata* (gray to dull tan)." As this subspecies has not been studied in the field, the paler body color may be accounted for by temperature or time of year when specimens were observed.

Distribution

This subspecies is restricted to Booby Cay, located 0.5km off the eastern end of the island of Mayaguana in the southern Bahamas. The cay is 2km in length, approximately 750m wide at its northeastern end, narrowing to less than 100m, and again widening to approximately 250m at its southwestern end. Approximately 30% of the cay is taken up by two ponds. Iguanas probably originally ranged over the entire cay but were likely concentrated on the eastern half where the vegetation was more dense. There are historical anecdotal references to the presence of iguanas on Mayaguana. However, there have been no recent sightings on the island, which has an area of 285km² and a human population of approximately 500 concentrated on the western half. There are no roads extending to the eastern end of the island and it is conceivable that iguanas still exist in this area.

Status of Population in the Wild

Surveys indicate that iguanas were fairly numerous in 1988 and 1997 with all age classes present, indicating a healthy reproducing population. However, this subspecies is restricted to one population on a single small cay with a high point of 6.2m and most of its area below 3m. Although no census has been conducted, it is unlikely that the population exceeds 500 animals, and is estimated to be between 200 and 300 (Blair 1991a; Bendon 1997).

Ecology and Natural History

No research has been conducted on this subspecies. Like the Turks and Caicos iguana, this subspecies is primarily herbivorous throughout life, although insects, mollusks, crustaceans, arachnids, lizards, and carrion are occasionally consumed. Burrows or crevices in or under rocks are used for retreat.

Habitat

Like the Turks and Caicos iguana, Bartsch's iguana probably inhabits rocky coppice and sandy strand vegetation habitats (Iverson 1979). D. Blair reported that he saw one group of about ten goats on the eastern portion of the island in 1988. The vegetation was heavily grazed and stunted, and the area was littered with goat droppings. J. Bendon reported the presence of goats in 1997, but indicated that they did not appear to be impacting the habitat severely.

Threats

The immediate threat to the single population of Bartsch's iguana is the presence of goats, introduced to Booby Cay by the individual who holds the land under Crown Lease. The cay is not readily accessible from the settlements on Mayaguana which could be the reason this population has survived so far. However, the cay is visited on an irregular basis by local conch fisherman, who sometimes overnight there. Catastrophe, particularly in the form of a hurricane or hurricane surge, is a very real threat.

Current Conservation Programs

All Bahamian rock iguanas are protected under the Wild Animals Protection Act of 1968. There have been no reports of poaching of iguanas on Booby Cay and it is not known if any are taken by local fishermen for consumption. The Bahamas National Trust has proposed to the Bahamas Government that Booby Cay, which is also of significant value for nesting seabirds, be named a protected area under the national parks system.

¹ Much of the information included herein dates back to the mid-1990s, and updated information is forthcoming; in the interim, additional information for each taxon can be obtained from the contact persons listed at the end of each account.

Representatives of the Wildlife Committee of the Bahamas National Trust and the Department of Agriculture began to survey the status of the iguanas on Booby Cay in early 1995 and to initiate removal of feral goats. There are no other research programs in progress or currently proposed for this subspecies, and no captive programs currently exist.

Critical Conservation Initiatives

- Removal feral goats from Booby Cay. Prior to such action, the status of the Crown Lease will need to be reviewed and ownership of goats determined.
- Establishment of protected area status for Booby Cay.
- Institutional strengthening of responsible agencies to develop enforcement capabilities.
- Initiation of a national education program for tourists and residents.

Priority Projects

- 1) Assess the present status of the population on Booby Cay, identify plant species cay-wide, and monitor vegetation changes after removal of goats.
- 2) Determine whether any subpopulations exist at the eastern end of Mayaguana, and establish captive breeding programs with the potential goal of restocking on Mayaguana.

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Andros Island iguana, *Cyclura cyclura cyclura*

By Sandra Buckner and David Blair

Description

The Andros Island iguana is a large rock iguana which attains a total length of close to 1500mm (Auffenberg 1976). The subspecies is dark-gray to black, with yellowish green or orange tinged scales on the legs, dorsal crest, and particularly the head. With maturity, the yellow slowly changes to orange-red, especially in large males (Auffenberg 1976).

Distribution

This subspecies is found on Andros Island on the western edge of the Great Bahama Bank. Andros is the largest of the Bahamian islands with an area of 5,959km² and a human population of 8,000-9,000 concentrated in the eastern coastal region. Andros iguanas are scattered through North Andros, Mangrove Cay, and South Andros, which are separated from each other by the North, Middle, and Southern Bights. The subspecies range is ill-defined with only assumptions and speculations available as to its status. North Andros, with extensive pine barrens and blue holes and creeks, is the area where most sightings of iguanas currently occur. This is the more populated area where old logging roads allow access to the interior. According to Auffenberg (1976), "though historically found over all of Andros, iguanas are now largely restricted to the western two-thirds of the island group, with the range becoming generally broader southward. They reach maximum abundance and size at the present time in the 'pine-yards,' particularly where they are broken into small islands separated by extensive low mangrove and marl flats".

Status of Populations in the Wild

While estimates put the wild population at 2,500 to 5,000 distributed in three or more subpopulations (Hudson et al. 1994), these figures could be much too optimistic as only occasional animals are observed, and these in scattered locations. Alternatively, due to the remoteness and difficulty in accessing much of the region, large subpopulations could be encountered, particularly in the central and southern regions of the island and in the western reaches of north Andros.

Ecology and Natural History

While it is expected that the natural history of these iguanas is similar to that of the other two *Cyclura cychlura* subspecies, no in-depth research studies have been conducted.

Habitat

The Andros rock iguana is the only iguana in the Bahamas that is not now confined to small cays. One preferred habitat of this subspecies is under the open canopy of the pine barrens (*Pinus caribaea* var. *bahamensis*), which offers a variety of fruits, flowers, and leaves of plants suitable for consumption by rock iguanas. The karst rock provides suitable retreats.

Threats

In the absence of any detailed research, the major threat to the Andros Island iguana is the proliferation and expansion of the range of feral pigs. While this is recognized both locally and nationally, appropriate methods of control have yet to be determined. Particularly in north Andros, feral pigs pose a very real threat to the recruitment of iguanas as they are known to rout out eggs from iguana nests. Feral and domestic dogs are also a threat to both juvenile and adult animals. The status and degree of threat posed by feral cats on Andros is unknown. Many local residents are apparently unaware of the protected status of the Andros iguanas and may occasionally take them for human consumption.

Current Conservation Programs

Like all Bahamian rock iguanas, this subspecies is protected in the Bahamas under the Wild Animals Protection Act of 1968. However, no areas have been specifically designated for the protection of iguanas on Andros and no specific conservation programs are in place.

There are currently no captive programs for this subspecies. There is one old individual at Ardastra Gardens and Zoo in Nassau. No one has been located who recalls the iguana being brought to the zoo and as yet no records have been found. This iguana, first observed and photographed by S. Buckner in 1991, was still alive as of June, 1997. One large male, a long term captive held by a private resident of South Andros, was still alive in 1984. Attempts to breed this animal have resulted in the death of at least two other iguanas, presumably females.

Critical Conservation Initiatives

- Education of local people regarding the protected status of this iguana and its vulnerability to introduced mammals, particularly dogs and pigs.

- Institutional strengthening of responsible agencies to develop enforcement capabilities.
- Protection of suitable iguana habitat and possible relocation sites.
- Initiation of a national education program for tourists and residents.

Priority Projects

- 1) Determine the status of the population and its range, including the existence of viable subpopulations on south Andros.
- 2) Conduct ecological studies and collect natural history data, ideally with the involvement of local residents.
- 3) Establish captive breeding programs.
- 4) Institute control measures for introduced species.

Note: Conducting comprehensive research on Andros will be both logistically difficult and time consuming. The northern part of north Andros has old logging roads that would enable access by appropriate vehicles. Over the rest of Andros, lack of roads or even tracks, myriads of mangrove islands, swamps and very shallow waterways make travelling in all but the eastern coastal region extremely difficult and hazardous. In terms of personal safety, it is not recommended at this time that a solo or even two-person party attempt such a project in any part of Andros. Research trips might be conducted in conjunction with other projects such as ongoing research into the blue holes of Andros. Suitable vehicles, shallow draft boats, and other equipment would be required.

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Exuma Island iguana, *Cyclura cyclura figginsi*

By Chuck Knapp

Description

The Exuma Island iguana is often regarded as the smallest of the three subspecies of *Cyclura cyclura*. Although Schwartz and Carey (1977) list the animal as obtaining a maximum size of 315mm SVL, recent studies by C. Knapp indicate that individuals occasionally reach 470mm and 3.25kg (Bitter Guana Cay) to 542mm and 8.15kg (Leaf Cay). Barbour (1923) describes the Exuma Island iguana as being conspicuously different from the other subspecies in having tiny supranasals usually separated by a small, azygous scale and two pairs of prefrontals, the posterior pair of which is greatly enlarged.

Coloration is variable between populations. Adults from Bitter Guana and Gaulin Cays are dull gray-black with diffuse pale gray spots. The crest scales are either white or a light red. The head scales are black tinged with orange on the snout and infralabials (Schwartz and Carey 1977). Adults from Guana Cay are dull black with diffuse pale white ventral and gular coloration. The upper labial, temporal, parietal, nuchal and ocular scales are light blue, while the dorsal crest scales are either gray with red tinge or intense scarlet. Schwartz and Carey (1977) describe juveniles as possessing approximately seven black bands which become slightly diagonal laterally and alternate with pale gray bands. All bands are heavily mottled with small pale dots.

Distribution

The subspecies is known from seven small cays scattered over 80km throughout the central and southern Exuma island chain of the Bahamas. Anecdotal information suggests additional inhabited cays, but verification is necessary. The determination of range through historic records is problematic due to certain cays sharing multiple names (e.g., Guana = Prickly Pear = Noddy). Bitter Guana and Gaulin Cays constitute the northern extent of the population. Four cays, White Bay, Noddy, North Adderly, and Leaf Cays, all located northeast of Norman's Pond Cay, compose the nucleus of the range. Guana Cay, southwest of Great Exuma, forms the southern boundary of the population.

Status of Populations in the Wild

The exact size of the total population is not known. Formal surveys using standardized transect techniques have

been conducted only on Guana, Gaulin, and White Bay Cays (Carey, 1976; Windrow, 1977; C. Knapp, unpublished data). The extent of the remaining population is based on estimations of iguana densities through comparative observations (J. Iverson, unpublished data; C. Knapp, unpublished data). Standardized and subjective survey techniques estimate the population to be between 1,000-1,200 animals.

While the majority of subpopulations appear relatively stable, some are in need of monitoring. Barbour (1923) refers to Bailey's collecting expedition on Bitter Guana Cay, from which the holotype specimen was procured, noting that "the iguana was found abundant on the Cay, no less than nineteen being taken in an hour or so." Three surveys of Bitter Guana in 1993, 1995, and 1997 yielded only seven total iguana sightings. Conversations with yachtsmen familiar with the area confirm that the iguanas are being taken as a food source.

Ecology and Natural History

Except for the Guana Cay population, few formal natural history studies have been conducted. The Guana Cay population was studied in the 1970s (Wilcox et al. 1973; Carey 1976; Windrow 1977; Coenen 1995) and is currently being reinvestigated along with the other remaining populations (Knapp 1995; 1996).

Adult iguanas are herbivorous, and are arboreal as well as terrestrial feeders. Preferred food items are seasonally dependent and primarily consist of flowers, fruits, young buds, and leaves of *Rachicallis americana*, *Reynosia septentionalis*, *Strumpfia maritima*, *Jacquinia keyensis*, *Erithalis fruticosa*, *Coccoloba uvifera*, *Coccothrinax argentata*, *Eugenia axillaris*, *Suriana maritima*, and the rotting fruit of *Casasia chusiifolia* (Windrow 1977; C. Knapp, unpublished data). Coenen (1955) reports the iguanas as coprophagous. They actively forage for the feces of the zenaïda dove, *Zenaida leucocephala*, and the white-crowned pigeon, *Columba leucocephala*.

The iguana populations exhibit an unusual social system for the genus, displaying neither territorial nor hierarchical behavior. Carey (1976) suggests that this relaxed social structure allows the population to remain dense under conditions of limited resources. He further states that a hierarchical social system on small cays would retard genetic variation by restricting prime nesting sites, food supplies, and retreats to a few dominant animals. Adult iguanas have been seen basking in large aggregations without evidence of aggression towards conspecifics throughout the majority of their range (C. Knapp, unpublished data). At times, the iguanas dem-

onstrate assertive and/or challenge displays in the form of headbobs. These usually only occur when one lizard violates the space of another or during sex recognition. When minor skirmishes do occur over preferred food items, the largest animal is always victorious (Windrow 1977; Coenen 1995).

Nesting has been observed on Guana Cay, with females digging a nest burrow approximately 61cm long and 8-13cm deep. Gravid females will actively defend an incomplete tunnel from conspecifics but will not defend the nest site after oviposition. The only excavations of nest chambers revealed three eggs each in two nests (Coenen 1995).

Habitat

The Exuma Island iguana utilizes a variety of habitats, including sandy beaches, xeric limestone devoid of vegetation, and areas of vegetation with or without sand or rock substrates. Limestone crevices and sand burrows are used as retreats at night and in adverse weather conditions. Presently, habitat appears to be relatively secure as cays supporting iguanas are small and free from human settlement. However, recent observations on White Bay Cay uncovered trails hacked through the interior and coconut palms planted on the beach. The island is currently for sale and in danger of tourist development.

Threats

Conversations with locals suggest that removal of animals from their home cays for tourist attractions elsewhere could constitute a significant threat. Although such activities probably occur on a small scale, they may reflect the larger problem of smuggling of iguanas from the Bahamas for illegal wildlife trade. Some cays are visited regularly by locals and yachtsmen, and dog tracks have been observed on Bitter Guana Cay. In addition to possible hunting pressure, predation by dogs may be contributing to the apparent decline of that population. In 1981, J. Iverson reported the presence of rats on Gualin Cay; this was subsequently confirmed by C. Knapp in 1995 (unpublished data). The effect of rats on this population is unknown, but past research indicates the detrimental consequences of rats on island reptiles (Cree et al. 1995). Certain cays possess diminutive nesting sites and the possibility of a season's recruitment being decimated by severe weather conditions is genuine.

The isolation of iguana-inhabited cays creates a problem for consistent population monitoring. Discrete environmental events including hurricanes could endanger certain populations. For example, Hurricane Lily engulfed Great Exuma and her satellite cays on 18 Octo-

ber 1996. The effects of Lily on the Guana Cay iguana population were not observed until May, 1997 (S. Buckner, personal communication).

Current Conservation Programs

All Bahamian rock iguanas are protected under the Wild Animals Protection Act of 1968. C. Knapp is continuing field surveys to assess current populations and to better define the geographic distribution of the subspecies. The Leaf Cay population was newly discovered in 1997. Blood samples are being collected from each study population to establish genetic profiles for different cays. Potential threats unique to each cay are being documented in order to provide the Bahamian government with information that will aid in setting conservation policies. Also, the vegetation and habitat condition on cays not currently supporting iguanas is being investigated for possible translocation programs.

The Bahamas National Trust has erected signs on Gualin Cay notifying the public of the protected status of the iguanas. The Bahamian government currently does not recognize any captive breeding programs, although unsanctioned breeding of these iguanas is apparently taking place in the United States.

Critical Conservation Initiatives

- Establishment of additional national parks to afford iguana populations more protection. Additional wardens and funds will need to be made available to patrol parks and monitor iguana populations.
- Implementation of an education program for locals and cruising yachtsmen to inform people of the rarity of Bahamian iguanas. Such programs should stress the detrimental impact that dogs, cats, and smuggling exert on small iguana populations.
- Continuation of efforts to instill in all Bahamian citizens national pride regarding their unique iguanas.

Priority Projects

- 1) Determine the status of the population throughout its range.
- 2) Examine the possibility of translocations to other suitable cays.
- 3) Carry out genetic studies on all populations.
- 4) Conduct ecological, behavioral, and natural history studies on each population.
- 5) Establish a captive breeding program.

Note: The remoteness and inaccessibility of cays inhabited by iguanas makes field research expensive and time-

consuming. The John G. Shedd Aquarium is currently funding research but other avenues for support need to be developed in order to accomplish the research goals in a timely manner.

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Allen's Cay iguana, *Cyclura cychlura inornata*

By John Iverson

Description

The Allen's Cay iguana is a large (to 1000mm total length) subspecies of *Cyclura cychlura* characterized by a lack of horn-like frontal or prefrontal scales, rostral scale in contact with the nasal scales, slightly enlarged prefrontal scales separated from frontal scale by four scale rows, usually two portmental scales, and dorsum pigmented gray-black with cream, pink, or orange mottling. Pink or orange pigment is most obvious on the posterior lower labial scales, the preauricular scales, and the enlarged mid-dorsal scale row.

Distribution

Only two breeding populations of this subspecies are known, on Leaf Cay (4ha) and U Cay (also known as Southwest Allen's Cay; 3ha) in the northern Exuma Island chain in the Bahamas. Probably less than seven adults also occur on Allen's Cay (7ha), but no evidence of breeding has been found there during 12 years of study.

Status of Populations in the Wild

Based on a 17-year mark and recapture study, approximately 130 subadult and adult iguanas (> 8 years old) occur on Leaf Cay and 100 on U Cay. Juvenile population estimates are not precise, but in March are probably near 100 for each island. The entire wild population of this subspecies is less than 500 individuals. The populations have generally been stable over the past 17 years, with recruitment occurring on both islands every year. However, some removals from Leaf Cay by poachers and Bahamian zoo and park personnel are known to have occurred over the past decade. Although the two main populations are generally stable, the two cays are heavily visited by tourists.

Ecology and Natural History

Most of the details of the life history of this iguana remain unstudied. What is known has been accumulated during approximately biennial visits by J. Iverson. During these trips, lizards have been marked and recaptured, primarily for growth and survivorship studies. These iguanas can apparently survive on the very smallest rocky islets as long as sufficient vegetation is present for food; however, areas of sand are necessary for nesting. Hatched egg shells have been found on several occasions, but always in sandy areas. The lack of breeding on Allen's Cay may be due to insufficient areas of exposed sand above tidal influence.

Recapture studies have shown that Allen's Cay iguanas average about 113mm SVL (157mm tail length, 56g) in March at approximately six months of age. Average growth rates are over 20mm SVL per year during the first year, declining to about 15mm per year by age 5.5 at about 206mm SVL (Iverson and Mamula 1989; J. Iverson, unpublished). Growth in females then begins to slow, whereas in males growth continues at the same rate until about 300mm SVL. The result is considerable sexual dimorphism in size. The largest known adult male was 476mm SVL and weighed 4.8kg, whereas the largest female was 368mm SVL and weighed only 2.1kg. Large adults of both sexes usually grow less than 10mm per year. Males and females cannot be sexed externally, but can be sexed fairly reliably by hemipenal probing. Based on minimum age for adults first caught in 1980

and still alive in 1992 and/or 1993, some of these iguanas live beyond 25 years of age.

Allen's Cay iguanas are active diurnally, spending the night in burrows they have dug or in natural retreats in or under rocks. They are primarily herbivorous, feeding on fruits, leaves, and flowers of most of the plants present on their tiny islands. They will climb up into the vegetation to feed. They are also opportunistically carnivorous, as evidenced by crab claws in their feces. In addition, humans regularly feed the iguanas (particularly on Leaf Cay) everything from table scraps to fresh produce. The effect of food supplementation on the life history of these lizards remains unknown, but deserves study.

Nothing is known about reproduction in this species, but mating probably occurs in May, with egg-laying commencing in June. Jolly-Seber models of recapture data suggest that survivorship of subadults and adults exceeds 90% per year. During the non-breeding season, these lizards appear to have dominance hierarchies rather than strictly defended territories; however, this may be because tourists frequently feed the iguanas on the main beach areas, perhaps causing a breakdown in the natural social system. Their behavior during the breeding season is unknown.

Habitat

The natural habitat of this iguana on Leaf and U Cays has not been significantly disturbed by human activity, even though a number of introduced ornamental plants occur on these cays (e.g., *Casuarina*, lilies, palms). All potential habitats on both Leaf and U Cays are occupied by iguanas, including some suboptimal areas of bare, honey-comb limestone. Additional habitat is available on Allen's Cay, but without sandy areas for nesting, the island apparently cannot support a breeding population. Dredging of sand from the harbor between Allen's Cay and Leaf Cay to upland areas on Allen's Cay could double the potential habitat area for this iguana.

Threats

The only significant current threat to these populations is the removal of iguanas by humans. The problem is exacerbated by the fact that these cays offer good anchorage less than a day's sail from Nassau; for example, during March, 15-20 yachts and 1-2 local boats are anchored there each night. Regular reports of actual or attempted poaching are made to the warden of the Exumas Land and Sea Park to the south. In addition, iguanas are occasionally removed for exhibit purposes in Bahamian zoos, parks, and gardens. Illegal exploitation for international trade is undocumented, but probably occurs.

Current Conservation Programs

The Allen's Cays iguanas are protected nationally under Bahamian law, but enforcement is difficult without a warden present. The warden of the nearby Exumas Land and Sea Park can potentially respond to reports of poaching, but that is not always practical. Fortunately, signs erected on the islands explain the vulnerability of these lizards, and most visitors on yachts radio the authorities if anyone is seen harassing the iguanas. Unfortunately, visitors also enjoy feeding them unnatural foods. Long-term investigations of growth, survivorship, and population status of these iguanas are ongoing by J. Iverson, but a study of their reproductive ecology is urgently needed.

A few captive Allen's Cay iguanas are currently maintained at the Ardastra Zoo and Nature Centre Different on Abaco. Captive breeding is a goal, but long-term plans for any offspring produced need to be developed.

Critical Conservation Initiatives

- Establishment of regular patrols to enforce protection, prevent exploitation, and discourage feeding of iguanas.
- Initiation of a national education program for tourists and residents.

Priority Projects

- 1) Collect age-specific reproductive data on the marked population of Allen's Cay iguanas for which long-term growth data already exist.
- 2) Explore the feasibility of modifying sinkholes on Allen's Cay to create nesting habitat for iguanas.
- 3) Continued monitoring of the introduced population on Alligator Cay.

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San Salvador iguana, *Cyclura rileyi rileyi*

By William Hayes

Description

Schwartz and Carey (1977) concluded that the San Salvador iguana is the largest subspecies of *Cyclura rileyi*, with a maximum size of 307mm SVL. More recent studies (Hayes et al., unpublished) indicate that many individuals of the San Salvador iguana on Low Cay, a satellite of San Salvador Island, exceed 350mm SVL, and attain a size of up to 395mm SVL (890mm total length). Although iguanas on Guana Cay within San Salvador's Great Lake also average over 300mm SVL, those on other cays rarely do.

The species is characterized by the absence of zygous scales in the prefrontal suture, rostral scale always in contact with nasals, first prefrontal never in contact with precanthal, dorsal crest scales on the neck always higher than on the body, body crest scales almost never higher than postsacral crest scales, and a variety of other scale-count features (Schwartz and Carey 1977). Characters that distinguish San Salvador iguanas from the other two subspecies include several features of facial scalation and poorly defined postsacral crest scales.

Dorsal coloration of San Salvador iguanas is striking but variable. Dorsum colors of red, orange, yellow, green, or brown are usually punctuated by darker markings and fine vermiculations. Males generally exhibit more color (red, orange or yellow) and contrast than females, especially at warmer body temperatures. Juveniles are solid brown or gray, often with a slightly paler middorsal band having faint longitudinal stripes or indistinct darker areas near the middorsal crest. Juveniles lack the brighter coloration and vermiculations of adults, as well as the dorsal chevrons or pale diagonal markings present on juveniles of other taxa.

Distribution

Fossil remains found by Olson et al. (1990) indicate that San Salvador iguanas once occurred throughout the island of San Salvador (area 150km²). Today, however, sightings on the mainland are exceedingly rare, occurring most often on the eastern side between Great Lake and Storrs Lake. Although the Lucayan Indians may have hunted iguanas in earlier centuries, the extensive agricultural practices and other human activities of the last 100 years likely represent the greatest contribution to the iguana's demise. At present, San Salvador iguanas appear to be restricted largely to five tiny offshore cays (Gaulin, Goulding, Green, Low, Manhead) and two cays

within Great Lake (Guana and Pigeon; Hayes et al. 1995). They were presumably extirpated on at least six additional cays, with two extinctions occurring in recent decades (discounting an unconfirmed sighting on High Cay in 1991). The seven inhabited cays range in size from 1-12ha and total approximately 26ha of marginal to excellent habitat.

Status of Populations in the Wild

Recent censuses by Hayes et al. (1995) suggested that approximately 500-600 individuals remain. However, they suspected that juveniles were underestimated in their surveys, and have since learned that a moderate population thrives on Pigeon Cay, the one known population they had not yet visited. Nevertheless, this subspecies likely numbers fewer than 1,000. Populations on the isolated cays vary from perhaps as few as 10 (Gaulin Cay) to as many as 250 (Green Cay). Several populations are threatened by human-related causes and appear to be declining.

Ecology and Natural History

The habitat on cays presently occupied by iguanas varies greatly. Vegetation on offshore cays is similar in varying degrees to coastal rock, sand strand and sea oat, and coastal coppice plant communities described on the mainland (Smith 1993). However, for cays within inland lakes, the vegetation resembles the blacklands coppice (Guana Cay) and mangrove (Pigeon Cay) communities on the mainland. Habitats on the mainland of San Salvador are highly diversified and suitable enough to harbor large iguana populations, but feral animals are numerous in many areas.

The number of plant species on each cay varies from ten on Green and Gaulin Cays to more than 40 on Guana and Low Cays (Moyroud and Ehrig 1994; Hayes et al., unpublished data). Mean and maximum body sizes of iguanas vary significantly from cay to cay, and are positively correlated with plant diversity, suggesting nutritional constraints on body size (W. Hayes et al., unpublished data). Iguanas are largest on Low Cay and smallest on Manhead Cay. Previously reported measurements of body size (Schwartz and Carey 1977) were limited to samples from cays having low plant diversity. Thus, prior recognition of *Cyclura rileyi* as the smallest of the rock iguanas may be an artifact of historical extinctions resulting in extant populations being confined today largely to the most inaccessible cays having minimal plant diversity.

Iguanas are locally most common in the vicinity of limestone rock outcrops and/or patches of sea grape (*Coccoloba uvifera*). On some cays they are numerous in patches of buttonwood (*Conocarpus erectus*) where they ascend into the foliage to browse. On Pigeon Cay they are frequently encountered basking on the limbs of mangrove trees, often several meters or more above the ground.

The iguanas share their habitat with nesting seabirds on several cays, most notably on Gaulin Cay where brown noddies (*Anous stolidus*) and sooty terns (*Sterna fuscata*) are extremely dense (100+ nests/ha).

Aspects of feeding and reproductive ecology remain unstudied but are likely similar to other rock iguana species. Adult males appear to be territorial throughout the year. As in other Bahamian taxa, courtship and mating probably occur in May, followed by nesting and egg-laying in June or July. Copulations have been observed by investigators visiting the cays during the last week of May (W. Hayes, unpublished data). Stejneger (1903) reported a clutch that numbered five eggs. Hatchlings probably emerge from nest burrows in September or October. Like other rock iguanas, San Salvador iguanas presumably require sandy areas for nest construction. Such habitat appears to be limited on Guana Cay, but the presence of several juveniles in 1994 is indicative of successful nesting there.

Habitat

On most cays, iguanas range widely throughout all available habitats. However, on Low Cay iguanas are largely restricted to areas of sea grape that comprise a relatively small portion of the island. Although a manmade structure is under construction on High Cay where iguanas are thought to be extirpated, none of the other cays are inhabited and, at present, are seldom visited. On several cays where iguanas have disappeared the habitat appears suitable for reintroduction; however, these cays may harbor feral rats that could be incompatible with reintroduction efforts unless they are first extirpated.

Considerable habitat has been lost on the main island of San Salvador. Nevertheless, extensive areas of excellent but very remote habitat remain which could support large populations of iguanas if development on the island could be halted (which appears unlikely). Thus, while habitat availability does not presently limit the mainland population, it may well hinder the prospect of increasing the total population size via future reintroductions.

Threats

Although remote and relatively difficult to access, populations on the cays are still threatened by human-related causes (Hayes et al. 1995). All size classes of iguanas are readily seen on Goulding, Green, Manhead and Pigeon Cays, which suggests the presence of healthy, stable populations. However, juveniles are conspicuously scarce on Guana and Low Cays, and possibly absent on Gaulin Cay. The scarcity of juveniles on Low Cay is probably attributable to the presence of feral rats only recently detected there (Hayes et al. 1995). The iguana

population consists almost entirely of large, aged adults. More recently, rats have also been seen on Guana, High, and Pigeon Cays. Considering the apparent impact of rats on insular populations of the tuatara (*Sphenodon punctatus*), an iguana-sized burrow-nesting reptile in New Zealand (Cree et al. 1995), rats probably pose a serious threat to survival of iguanas on several cays and need to be exterminated soon. Rats may also impact iguana populations indirectly by affecting vegetation, especially on cays with low plant diversity.

The once dense population on Guana Cay (Ostrander 1982) has become greatly reduced in recent years. A mysterious die-off occurred in spring 1994, as evidenced by the discovery of eight adult carcasses and an estimated surviving population of only 24 individuals (Hayes et al. 1995). Because the carcasses all appeared to be in similar states of decay, they may have died within a narrow time frame from similar, but unknown, causes. Although natural disease is a possible cause, so too might be mosquito control efforts, recently implemented for the benefit of the growing tourism industry. The ticks which infest these iguanas have not been found on any other cay, and may have rendered the lizards more vulnerable to the agent(s) causing their deaths. Juvenile iguanas may also be scarce as a consequence of the die-off; their carcasses may have decayed quickly or escaped detection. However, nesting habitat appears to be restricted, which could limit the numbers of juveniles and affect future recruitment. Nesting habitat is also limited on Pigeon Cay and nesting failure is inevitable in wet years when lake surface level inundate the nests. It is unclear why the population on Gaulin Cay is so low (possibly fewer than 10) and juveniles appear to be absent. This small, potentially inbreeding-depressed population may no longer be viable.

The larvae of a moth (*Cactoblastis cactorum*) introduced decades ago to the West Indies are now rapidly devastating prickly-pear cacti (*Opuntia stricta*), an important food source for iguanas, on several cays. The dense population of lizards on Green Cay is especially vulnerable, particularly since destruction of the cacti will be nearly complete within a matter of years, there are no known means of controlling the moth, and the remaining vegetation (nine plant species) represents a meager diet compared to other rock iguana species (Auffenberg 1982). The impact of this ecological disturbance needs to be closely monitored.

Rapid development on the island of San Salvador will undoubtedly threaten the populations further. Feral dogs and cats are already numerous in local areas, but will increase as more resorts and housing tracts are constructed. This would seriously jeopardize any possible reintroductions of iguanas to the mainland, unless

protected areas of considerable size could be set aside. Pollution of Great Lake due to environmentally unsound landfill practices may threaten the fragile mangrove community that harbors a moderate iguana population on Pigeon Cay. Eventually, tourists may discover the attributes of the iguanas themselves, which could increase potentially detrimental human-iguana contacts.

Current Conservation Programs

At present, W. Hayes and R. Carter are collecting baseline data on all populations of *Cyclura rileyi* to aid conservation management decisions. Initial efforts involve population surveys, assessment of threats to survival, and genetic sampling. Genetic analyses are essential to resolve the taxonomic identities of the nominate taxa, to assess the degree of divergence among individual populations, and to evaluate heterozygosity (which may reveal inbreeding depression). Divergence may be sufficient that the genetic identity of most or all populations will need to be maintained.

Further steps include concentrated searches for isolated colonies on the mainland and on the southernmost lakes, as well as reintroductions of iguanas to previously inhabited cays. For San Salvador iguanas, candidate cays for reintroduction (and source animals) include Barn Cay (from Guana Cay), Cato Cay (from Green Cay), Cut Cay (from Manhead Cay), and High Cay (from Low Cay). However, further research is necessary to determine the suitability of each cay, and to assess what corrective actions would be necessary to render each suitable for reintroduction (e.g., removal of feral rats or supplementation of nesting habitat). Reintroduction of iguanas on the mainland should be undertaken only if protection of a large area can be assured. Excellent mainland areas presently uninhabited by humans include the land bridge east of Storrs Lake (where a major resort and marina are planned), the area between Storrs Lake and Great Lake, and the peninsula east of Pigeon Creek. Additional comparative research planned for the isolated populations of this taxon includes vegetation analyses and studies of reproductive strategies, seasonal dietary shifts, and behavioral ecology.

At present, no legal captive breeding programs exist outside the Bahamas. The Bahamian government has wisely refused to issue export permits for any rock iguana taxa. However, Ardastra Gardens in Nassau (New Providence Island) currently holds two juveniles and plans to implement an in-situ program. Captive programs could be highly valuable for repatriation efforts, particularly if the genetic integrity of individual populations needs to be preserved.

A public relations campaign is planned to heighten awareness and appreciation among island resi-

dents for their endemic iguana. Brochures have the potential to provide basic information and to promote the need for complete protection of the cays on which the iguanas live. Residents should be alerted to the protected status of the iguanas and urged to report to authorities anyone seen visiting the cays. Bringing feral animals to any cay should be legally forbidden. If possible, especially if the tourism industry continues to escalate, the Bahamas National Trust should declare the cays a land and sea park and hire a warden to patrol the region.

Critical Conservation Initiatives

- Limitation of access to cays, particularly to discourage feeding of iguanas by tourists.
- Further protection of the cays by incorporation into a national park by the Bahamas National Trust. As some of the cays are privately owned, this will require working with landowners.
- Institutional strengthening of responsible agencies to develop enforcement capabilities.
- Initiation of a national education program for tourists and residents.

Priority Projects

- 1) Continue to sample and survey individual populations on an annual or biannual basis.
- 2) Eradicate rats on infested cays.
- 3) Monitor the impact of the *Cactoblastis* moths and rats on vegetation.

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White Cay iguana, *Cyclura rileyi cristata*

By William Hayes

Description

The White Cay iguana is smaller than the San Salvador iguana (up to 280mm SVL), and can be distinguished by a combination of several scale features, including well-defined postsacral crest scales (Schwartz and Carey 1977). The dorsum of adults is usually gray with brown to orange-brown vermiculations. The dorsal crest scales, forelimbs, and portions of the head and face are typically highlighted in orange. Juveniles resemble young San Salvador iguanas, but lack a dark area in the pale zone of the middorsum.

Distribution

This subspecies occurs on only a single island, White (Sandy) Cay, in the southern Exumas of the Bahamas. This island is small, comprising about 25ha (Schwartz and Carey 1977). The iguanas were probably much more widely distributed during the last ice age when many of the Exuma Cays were presumably connected due to lower sea levels. They possibly occupied additional adjacent cays in recent centuries, but if so have vanished without a trace.

Status of Population in the Wild

The single population is confined to only one island, which can support only a limited number of iguanas. According to Lincoln-Peterson surveys conducted in 1997, the size of the population has been estimated at 150 to 200 individuals.

Ecology and Natural History

Except for informal visits mainly to collect specimens, this isolated subspecies has been largely ignored by scientists. Essentially nothing has been published about its ecology or natural history.

Habitat

The vegetation of White Cay is fairly typical of the coastal rock habitat described by Smith (1993). The northwestern portion of the cay, where iguanas are least common, is comprised of a dense forest of thatch palm (*Thrinax morrisii*). The remainder of the cay is dominated by *Strumpfia maritima* and sea grape (*Coccoloba uvifera*) interspersed among rock and sand. Introduced Australian Pine (*Casuarina litorea*) is well-established along

the low dunes of the southern shoreline. Seven-year apple (*Casasia clusiifolia*) dominates the sand dunes of several smaller cays to the south that are separated from White Cay by a narrow tidal flat that iguanas presently do not cross. In 1997, the vegetation appeared to be unaffected by Hurricane Lily, which scored a near-direct hit in October 1996. Iguana density is greatest along the periphery of the cay where rocky crevices are most numerous.

Threats

Illicit smuggling and the possibility of introduced animals are likely the greatest threats to this population. From photos that appeared in the April 1994 issue of a popular reptile magazine, it is clear that at least some *Cyclura rileyi*, potentially from White Cay, have been recently smuggled. At least eight individuals of *Cyclura rileyi*, presumably of this subspecies, were discreetly exhibited in the showrooms of several Florida reptile wholesalers in 1993 (R. Ehrig, personal communication), which suggests that more than a trivial number of animals were taken. Another potential threat is inbreeding depression, due to centuries or longer of effective isolation.

In 1996, S. Buckner, R. Carter, J. Iverson, and W. Hayes observed footprints of a raccoon on White Cay. It may have dispersed there on its own after several were formerly introduced to nearby Hog Cay. Although that animal has since been confirmed dead, it appears to have predated a significant proportion of the iguana population, particularly juveniles and females. Black rats formerly threatened the iguana population, but have since been removed from the cay.

Current Conservation Programs

A grant from the Chicago Zoological Society has facilitated eradication of black rats from White Cay. The project was a collaborative effort of the Iguana Specialist Group, the Bahamas National Trust, the Bahamas Department of Agriculture, and Zeneca Agrochemicals, Inc., which donated the rodenticide used in the eradication. Two cays that appear promising as potential sites for establishment of a second wild population of the White Cay iguana have been identified. Although they have yet to be surveyed on the ground, both look appropriate from the air, both are Crown land, and both have active seabird nesting colonies, a good sign that introduced predators are absent. W. Hayes and R. Carter visited White Cay in 1996 to obtain blood samples and other measurements from the iguanas and to evaluate their status.

Critical Conservation Initiatives

- Acquisition of White Cay within the park system of the Bahamas National Trust. The island is remote enough that local policing of the cay is unlikely.
- Institutional strengthening of responsible agencies to develop enforcement capabilities.
- Education program discouraging visitors to the cay from dumping garbage and feeding iguanas.

Priority Projects

- 1) Maintain a program of rat control.
- 2) Assess the current status of the population, and consider candidate cays for establishing a secondary population. It might be wise to consider a distant location (such as in the Land and Sea Park of the northern Exumas) as a safeguard against extinction resulting from weather.
- 3) Conduct annual or biannual censuses of the population.

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Acklins iguana, *Cyclura rileyi nuchalis*

By William Hayes and
Richard Montanucci

Description

The Acklins iguana can be distinguished from the San Salvador and White Cay iguanas by a combination of several scale features, including four rows of scales between prefrontals and frontals, three rows of loreals, and eight supercilliaris (Schwartz and Carey 1977). As in San Salvador iguanas, the caudal verticils in Acklins iguanas are not as enlarged as in White Cay iguanas and the enlarged postsacral scales form a shorter row. In addition, recent data suggest that the Acklins iguana has significantly more femoral pores than the other two subspecies (W. Hayes and R. Carter, unpublished data). Like the other subspecies of *Cyclura rileyi*, adult Acklins iguanas are strikingly handsome, resembling San Salvador iguanas with orange/yellow highlights on a darker gray to brown background. Juveniles are also similar to those of young San Salvador iguanas.

Distribution

Natural populations of Acklins iguanas are found only on Fish Cay and North Cay in the Acklins Bight, Bahamas. They formerly occurred on at least Long (Fortune) Cay, and probably once roamed other cays in the vicinity, including the much larger Crooked and Acklins Islands. An additional introduced population with five founding individuals became established on a small cay in the early 1970s.

Status of Populations in the Wild

The two remaining populations in the Acklins Bight appeared to be reasonably healthy when visited by D. Blair in 1991 (Blair 1992a). All size classes were well represented on Fish Cay, but fewer juveniles were seen on North Cay. In May, 1997, R. Carter and W. Hayes estimated iguana populations on North and Fish Cays to be approximately 3,000 and 10,000 individuals, respectively. R. Ehrig and R. Montanucci visited the introduced population in 1993. They estimated 140 to 180 individuals present on the cay, presumably all descendents of five founder animals from the Acklins Bight (S. Buckner, personal communication). By 1997, the introduced population was assessed by R. Carter and W. Hayes to consist of 300 individuals. The total population is currently estimated at 13,000 or more iguanas.

Ecology and Natural History

Only anecdotal information on the natural history of this subspecies is available. Like other rock iguanas, male Acklins iguanas appear to be highly territorial. Males have been observed in jousting matches involving open-mouthed territorial displays, and will chase other males out of defended areas. Scars in the form of bite marks have been observed which probably result from these activities.

Habitat

Habitat on Fish and North Cays has not been adequately evaluated. The introduced population is probably at or near carrying capacity. Vegetation on this cay appears to be in excellent condition as determined by R. Moyroud.

Threats

No evidence of feral animals or other threats have been identified in the Acklins Bight populations. Introduced hutia (*Geocapromys ingrahami*) may be affecting the vegetation on the cay adjacent to that harboring the introduced population, although they have not yet crossed the channel separating the two cays. Further, with only five founder animals, genetic heterozygosity of this population may be compromised. On all cays, the potential for illegal poaching remains a threat.

Current Conservation Programs

W. Hayes and R. Carter are currently evaluating body size and genetic relationships among the three populations. They visited the Acklins Bight in 1996, as well as the introduced population, in order to obtain blood samples and measurements from the iguanas and to evaluate their status.

Critical Conservation Initiatives

- Acquisition of North and Fish Cays as a park by the Bahamas National Trust. Both islands will need to be purchased, as they are privately owned.
- Institutional strengthening of responsible agencies to develop enforcement capabilities.
- Initiation of a national education program.

Priority Projects

- 1) Accurately census the three extant populations to determine population size.
- 2) Assess current threats to each population. Should they become a problem, introduced hutia will need to be controlled.
- 3) Explore the potential for restocking vacant cays in the Acklins Bight with iguanas.

- 4) Conduct genetic studies similar those that being carried out for the San Salvador iguana. In particular, the introduced population should be examined.

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Bahamian Seabirds: An International Resource

By Anthony White and David S. Lee

The Bahamas has an extremely diverse assemblage of breeding seabirds, and it supports some of the largest breeding colonies of tropical seabirds known in the Atlantic and Caribbean. Eighty percent of the seabird species nesting in the southeastern United States and the Caribbean Basin nest in the Bahamas. The combined diversity and density is significantly greater than that of any other nation in the West Indian region.

In the early 1980s, van Halewyn and Norton (1984) summarized the status of and conservation issues for seabirds of the Caribbean region. Sprunt (1984) provided a similar summary for the Bahamian archipelago. Since then, more detailed studies in the region, and within the Bahamas *per se*, have revealed that, for a number of species, the population estimates made in the early 1980s were too high. In the few cases where population monitoring has occurred, dramatic declines in the number of nesting pairs have been recorded. The original problems identified in the 1980s have not been resolved (egg collecting, exotic predators, pollution, habitat destruction and colony disturbance), and in many cases these problems have become more severe over the last 15 years. Primarily because of the growing tourism industry, development of coastal habitats has increased and small isolated cays and rocks, which were formerly relatively safe nesting sites, are now being developed or are visited by tourists and recreational boaters seeking remote island experiences. Ironically, the seabird colonies are becoming part of the attraction for the ecotourism industry. Presently, most of the species nesting in the Bahamas, in fact throughout West Indies region, are represented by tremendously reduced populations with aggregate populations totaling only a few thousand pairs.

Because of the isolated nature of many of the island groups in the Bahamas, a significant percentage of the region's seabirds nest here. While these birds each nest on particular rocks and cays which are under the political jurisdiction of the Bahamas, they are in fact a true international resource. These species all disperse long distances to forage while feeding young and move further yet when not tied to specific breeding sites. For example, Audubon's Shearwaters and Bridled Terns, which nest in the Bahamas, commonly forage in the Gulf Stream off the Carolina coast when not in their breeding

modes. Many of the seabirds foraging in Bahamian waters may be of Cuban or Dominican breeding stocks. Young Sooty Terns hatched in the Bahamas spend the first years of their lives off the west coast of Africa, and there are numerous examples of sub-Arctic and sub-Antarctic species that migrate through Bahamian waters.

In August 1997, an International Seabird Workshop was held at the Society of Caribbean Ornithology's annual meeting in Aruba. The Bahamas was well represented at this meeting. Participants addressed conservation issues related to seabirds in the West Indies region and discussed steps needed to preserve seabird populations. All in attendance agreed that research and standardized monitoring had been largely neglected throughout the region, and that problems addressing these issues were critical to the long range survival of a number of locally breeding seabirds. Furthermore, because of the general lack of information studies on the biology, distribution, conservation status, and management needs was greatly needed. Since that meeting a publication addressing the needs of the region's seabirds has been published (Schreiber and Lee 2000) and a number of studies which address conservation issues of seabirds in the Bahamas have taken place (i.e., McGehee et al. 1999) or are in progress. A book on the birds of the Bahamas (White 1998) has been published that updates what is known about seabirds in the Bahamas, and a computerized mapping data base which tracks the status of nesting sites in the Bahama archipelago, Greater and Lesser Antilles, and Trinidad and Tobago has been prepared (Mackin 2000). Collectively, these efforts illustrate what an important assemblage of breeding seabirds the region supports.

In former times, the relatively predator-free islands of the region housed much more abundant seabird populations that were perhaps ten times or more greater than those of modern times (Pregill et al. 1994). Human habitation of the islands started about 7,000 years ago in the West Indies, and less than 2,000 years before present in the Bahamas. Evidence suggests that the initial impact on nesting seabirds was devastating. With the arrival of man, seabirds became a common, easily obtained source of food, as evidenced by middens on St. Croix, the Bahamas, and elsewhere (Palmer 1962, Steadman et al. 1984, Pregill et al. 1994, Steadman 1997, Wetmore 1938). This exploration was followed by a period of European contact during which human predation on seabirds and their eggs continued, and continues today, but to a lesser degree. A variety of introduced mammals, including both predators and competitors, compounded the problem. Over-grazing by feral goats and sheep is

causing major erosion problems and destruction of nesting trees on some islands. The practice of using islands as a natural corral was wide spread in the Bahamas, and in a few areas continues today. Generally, seabirds were driven from nesting on the primary islands where human habitation and exotic mammalian associates have dominated the landscape. For the most part, seabird colonies are now restricted to offshore rocks and cays and inaccessible cliff faces.

It is difficult in modern times, now that populations are so decimated, to fully appreciate the extent of pre-European contact, and human reliance on seabirds as a source of food for the people in this region. Marine birds provided an excellent, easily obtainable source of protein for a good percentage of the year. Because of this, the various seabirds of the region were extensively exploited. The loss of seabirds from tropical islands is estimated to be between 90 and 99% (Pregill et al. 1994, Steadman 1985, 1989, 1995) with total expiration rates from single island groups being extremely high. In some cases, single species became a primary source for subsistence hunters, and continual collecting over many decades greatly depleted them.

Most tropical seabirds in the Bahamas now exist at modest to relatively low densities. They normally feed at sea at great distances from breeding sites, and typically produce just one slow-growing chick per year. The combined result is that seabirds are more vulnerable on their breeding sites than most land birds because of the protracted period of nest occupancy and the concentration of significant portions of their total population to a few sites. Furthermore, populations are slow to recover from disturbance because of low reproductive output. The entire populations of most nesting seabirds in the Caribbean consist of only several thousand pairs, and numbers in the Bahamas typically are measured in hundreds of pairs. To put the size of these populations in perspective to those in regions where exploitation has been less severe, and to give some indication of abundance in times past, we point out that if all the Bahaman nesting species were combined, the number would be less than 10% of the total number of Leach's Storm Petrels (*Oceanodroma leucorhoa*) from a single 6.3 km² nesting site off eastern Canada (Sklepkovych and Montevecchi 1989). In fact, of the 21 species of seabirds nesting in the Bahamas and West Indies, over half of these represent small populations whose conservation status is of current concern. Many of these are endemic species or races, and several are taxa with all or the majority of the world's population residing in the region.

The Current Fauna

To place the fauna of the Bahamas in perspective, we will briefly compare it with that of the entire West Indies region. The breeding seabird fauna of the West Indies consists of three species of Procellariiformes (petrels and shearwaters) one of which nests in the Bahamas, seven species of Pelicaniformes (pelicans and their relatives) all but one of which nest or is believed to nest in the Bahamas, and 12 species of Laridae (gulls and terns) all but two of which nest in the Bahamas. Of the Bahamian species, Audubon's Shearwater (*Puffinus lherminieri*), White-tailed Tropicbird (*Phaethon lepturus*), Brown Pelican (*Pelecanus occidentalis*) and Bridled Tern (*Sterna anaethetus*) are all represented by regionally endemic subspecies. Roseate Tern (*Sterna dougallii*) is regarded as threatened by the U.S. Fish and Wildlife Service, with perhaps as many as 40% of the world's population breeding in the West Indies. While the Roseate Terns of the region do not have a distinct subspecific status, they are visibly different from those of other regions.

Of the 22 seabird taxa nesting in the West Indies 16 nest in the Bahamas (73%). Of the six endemic taxa of the region, four occur in the Bahamas. Five species and one subspecies are considered to be "Critically Endangered" (one of these is in the Bahamas), three are "Endangered" (all of which are in the Bahamas), four are "Vulnerable" (three of these are in the Bahamas), and two are "Near Threatened" (both of these are in the Bahamas). Thus, fourteen of the 22 seabirds of the West Indies region are of conservation concern and nine of these nest in the Bahamas. This is based on a study by Schreiber (2000) using IUCN criteria. If one looks at the greater region and excludes species which are relatively common to abundant breeding species in the southeastern United States, a much more realistic picture emerges as to real conservation priorities in the region. Species nesting in the Bahamas with Atlantic populations (many of which are endemic subspecies) which mostly have aggregate populations of less than 5,000 pairs are Audubon's Shearwater, White-tailed Tropicbird, Brown Pelican, Brown Booby (*Sula leucogaster*), Magnificent Frigatebird (*Fregata magnificens*) and Bridled Tern. These are considered the priority species for this report, but we recognize that a number of other seabirds which are rare in the region, but not of conservation concern globally, also deserve protection. To this list we have added the endemic race of the Double-crested Cormorant (*Phalacrocorax auritus*). This species, while re-

lated to seabirds, is a brackish water bird which ecologically is best regarded as one of the brackish/freshwater interface. Its limited distribution suggests that it does not disperse at sea.

The following birds are ones which we consider to be priority species for directing country wide conservation efforts:

Double-crested Cormorant: An endemic dwarf subspecies (*Phalacrocorax auritus heuretus*) known only from San Salvador, Eleuthera, and Rum Cay. Nesting on the latter two islands is suspected but not proven. Total population is less than 1,000 pairs. The Florida subspecies which has bred in the northern Bahamas is not regarded as a regional priority.

Audubon's Shearwater: The nominate subspecies (*Puffinus lherminieri lherminieri*) is a western Atlantic endemic with a known total population of 3,000 to 5,000 pairs. Probably over half of these nest in the Bahamas with perhaps a third of the total population breeding on a single island.

White-tailed Tropicbird: Western Atlantic endemic subspecies (*Phaethon lepturus castesbyi*) with a total population of about 5,000 pairs. Approximately twenty percent of these nest in the Bahamas. Only Bermuda has a larger population.

Brown Pelican: Rare endemic West Indian subspecies (*Pelecanus occidentalis occidentalis*) with a total population believed to be only 1,500 pairs. Fifty to one hundred breed on Great Inagua. The continental race (*P. o. carolinensis*), not a bird of regional priority, has bred in the northern Bahamas.

Red-footed Booby: Approximately 8,000 to 10,000 pairs nest in the West Indies. Only known breeding site in the Bahamas is Graham's Harbor (White and Cato Cays) where two or three pairs nests. The race occurring here is *Sula sula sula*, a subspecies which occurs throughout the Atlantic.

Brown Booby: Approximately 5,000 to 8,000 Brown Boobies nest in the West Indies region. Of these 200 to 1,500 nest in the Bahamas. *Sula leucogaster leucogaster* breeds throughout the Atlantic, Indian Ocean and along the Great Barrier reef of Australia.

Magnificent Frigatebird: This species has severely declined in the Bahamas and the West Indies Region. Present population is 4,000 to 5,000 pairs with as few as 100 pairs nesting in the Bahamas. The Magnificent Frigatebird (*Fregata magnificens*) has a very restricted global range outside the West Indies.

Roseate Tern: This tern is a species of global conservation concern. A small disjunct and distinct population occurs in the greater Caribbean region. The

present regional population is 4,000 to 6,000 pairs with the size of the Bahama population unknown (likely exceeding 1,000 pairs). *Sterna dougallii dougallii* occurs only in the Western North Atlantic.

Bridled Tern: The race of Bridled Tern in the western North Atlantic is endemic (*Sterna anaethetus melanopectera*) with a total population believed to be between 4,000 and 6,000 pairs. As many as half of these may nest in the Bahamas.

Other seabird species that nest in the Bahamas include Laughing Gull (*Larus atricilla*), Gull-billed Tern (*Gelochelidon nilotica*), Sooty Tern (*Sterna fuscata*), Least Tern (*Sterna antillarum*), Royal Tern (*Sterna maxima*), Sandwich Tern (*Sterna sandvicensis*) and Brown Noddy (*Anous stolidus*). The Neotropic Cormorant (*Phalacrocorax olivaceus*), while not a seabird per se, is related to pelicans, frigates, and tropicbirds, also breeds in the Bahamas. The Bahamas supports major breeding colonies of Sooty Tern and Brown Noddy. Both are common seabirds with broad pantropical breeding distributions.

The Problems

Conservation of Bahamian seabirds has been largely overlooked. Most global assessments of areas said to be important to seabirds have been based on density and biomass figures, yet in the Bahamas seabirds were so depleted prior to European contact and further depleted during the colonial period, that comparative inventories are unavailable for primal populations. Because previously large populations of seabirds were not well documented in the literature, declines in our regional species have not received the same amount of concern and attention as have some temperate and boreal seabirds. The serious conservation issues today are the continuing series of single event destruction of the small, seemingly unimportant relict colonies that remain. This site by site destruction has been spread out over time, not focused in any particular section of the Bahamas, or on any specific species, and for the most part is poorly documented.

Another problem that has hampered seabird conservation is that historically, ornithology in the Bahamas has focused on land birds, particularly on the taxonomy, zoogeography and conservation of endemics. Seabirds of the region have been neglected over the years. Moreover, because seabirds now typically are confined to remote areas where it is difficult and expensive to conduct research, little work has been done on them. As a result, we have limited information about the past or current status of most seabirds, and even less knowledge about their local natural history. This makes development of

conservation criteria difficult. If we are to preserve seabird populations in the Bahamas, we must develop long-term plans for basic research and conservation and implement them through agreed upon priorities.

The rapid economic growth throughout the Bahamas jeopardizes even the remote areas where seabirds now restrict their nesting activities. Growing tourism and other development in the Bahamas is directly threatening many remaining nesting colonies. Seabird nesting islands often have precisely the characteristics desired by tourists seeking remote, isolated tropical retreats. In many cases the beauty and wildlife of the area draws tourists, but given the intolerance of nesting seabirds for human disturbance, tourists' activities can easily destroy the resource they come to see. Tourist management and the training of tour guides as to the vulnerability of seabirds is needed. In the late 1990s, the Bahamas National Trust initiated an ongoing program to train local guides. The increased number of charter boats and recreational boats has brought man and his pets into repeated contact with isolated seabird colonies with devastating effects. One problem which seems to be of increasing concern is the presence of transient and marooned refugees who exploit the seabird colonies for their survival (White et. al. 2000). Based on the timing of visits as it relates to the phenology of particular colonies, a single visit by people unaware of the needs of seabirds can destroy an entire year's production. Even researchers visiting islands are often unaware of the needs of seabirds and that visitations during the heat of the day will cause eggs and chicks to cook under the tropical sun and to be exposed to predators.

This scenario is made more grim by the fact that there has never been a complete inventory of the seabirds of the Bahamas and there are no long range studies that show population trends. Some nesting sites suspected to be of paramount importance, not just to the Bahamas but to the entire region, have not been inventoried, and many have not been visited by biologists at appropriate breeding seasons for many decades. Assessments made during the last 15 years (Schreiber and Lee 2000) show that earlier inventories (van Halewyn and Norton 1984, Sprunt 1984) erred in over-estimating populations. Additionally, populations of a few species have declined dramatically during the last fifteen years. Because the local populations are often small and condensed, the potential for rapid disappearance of the remaining nesting colonies is alarming. Because of their modest reproductive output, the ability of tropical seabirds to colonize or recolonize areas once extirpated is minimal, and may not even be an option. Recent information shows that, in some areas, seabirds rarely move between breeding islands (Schreiber and Schreiber 1988). There are far too

many examples of massive losses of seabirds from tropical island groups around the world (Steadman 1985, 1989, 1995, Wragg and Weisler 1994) and local extirpations and declines from specific islands in the Bahamas and West Indies (Sprunt 1984, Steadman et al. 1984, van Halewyn and Norton 1984, Schreiber and Lee 2000).

Present day diversities and densities of the Bahamian marine avifauna will be difficult to retain because of the ecological imbalance and rapid development. This difficulty is amplified by the disjunct nature of the important breeding sites in the country. Steps should be taken immediately to protect the key sites described in this report. Local inventories of these and other sites of potential importance are greatly needed, but this data gathering should be coordinated across the entire West Indies and southeastern United States so that the status of regional populations can be understood. Population assessment within the United States is rather complete, while that in the West Indies is at best sketchy. Nonetheless, the importance of having compatible monitoring programs can not be overstated. Coordinating local inventories and long term protection is difficult enough within the Bahamas. In the region, the number of independent political units is large (including mainland margins of the Caribbean, 28 different nations govern the region) and languages, currencies, and levels of communication vary throughout. Thus, while further inventory and international coordination are needed, these needs do not justify delaying the protection of key sites which we know to be important to nesting seabirds. Because we have knowledge of the majority of key nesting sites, their protection can proceed independently of detailed monitoring studies.

Sprunt (1984) reviews the specific problems facing seabirds in the Bahamas. He discusses direct exploitation of birds and eggs, incidental takes (fishing), competition with commercial fisheries, pollution and poisoning, habitat destruction and disturbance, and natural and introduced predators. To this list we would add overgrazing and erosion from feral live stock and invasion of exotic plants. The latter two problems result in the alteration of nesting sites, which in extreme cases results in colony abandonment. Sprunt (1984) also provided information on a marked decline in the historic populations of Brown Boobies and Magnificent Frigatebirds. For Brown Boobies, he noted the loss of thousands of nesting pairs and a 64% decline at one colony in the 1900s. For the frigatebirds, he reports the total loss of three colonies, one containing many thousands of pairs. The loss is apparently the result of these larger birds being used as a food source. Declines of the smaller species certainly occurred but remain undocumented. White

et al. (1999) documented further decline of Brown Boobies and Magnificent Frigatebirds at one of these sites.

Seabirds provide a valuable, natural ecotourism resource if they and the tourists can both be properly managed. Also, as top-level predators of marine food chains, these birds provide us with a valuable yardstick to monitor the general health of oceanic systems. For example, seabirds collected off the North Carolina coast (many of which nest in the Bahamas) have been used to document baseline mercury loads in the tissues of 27 species (Whaling et al. 1980), and the growing incidence of plastic ingestion by pelagic species (Mosser and Lee 1992). Yet, within the region we know little about key foraging areas or seasonal variation of surface productivity and how they relate to the locations of successful seabird colonies. Coastal development and source pollution in wetlands in the Bahamas is damaging marine nursery grounds. Some sea birds feed in these nursery grounds, but more importantly, these areas support early developmental stages of key prey species, contributing to the productivity of oceanic habitats. Destruction of these wetlands, and the disruption of the natural processes which support them, will not only severely harm marine bird populations, but will also harm the marine-related economies of the country.

While the number of endangered and threatened species of seabirds in the Bahamas and the West Indies paints a rather bleak picture, there are several important regional conservation efforts which have been successful. Gochfield et al. (1994) review case studies of four successful management programs: 1) Culebra, a Caribbean national Wildlife Refuge managed from Puerto Rico, 2) Desecho, an island off Puerto Rico where exotic mammals are being eradicated, 3) Jamaica, with a successful seabird management program, and 4) Aruba, where enforcement of existing wildlife laws, colony patrols and positive media coverage have allowed important larid colonies to recover. Barbuda, after a training program for wardens and tour guides, has set up a very successful ecotourism program for their Magnificent Frigatebird colony. These regional programs each serve as successful models that can be used in the Bahamas. Consultation with the countries that have carried out successful programs could assist the Bahamas in developing conservation plans. The main point, however, is that with reasonable protection, predator management, and educational programs for the people associated with seabird colonies, seabird populations rebound. In the Bahamas, a number of key conservation programs are now in place. Some of the country's marine bird fauna is protected

within the Exuma Cays Land and Sea Park, Conception Island, Pelican Cays Land and Sea Park, Peterson Cay National Park, Tilloo Cay National Reserve, and Inagua National Park. Additionally there are a number of wild bird reserves which protect nesting seabirds. Nonetheless, a number of important sites remain unprotected and these are addressed below.

In the last few years, a number of regional studies have been published that will prove valuable in directing management efforts of Bahamian seabirds. In addition to the species summaries provided in Schreiber and Lee (2000), studies have been conducted on tropicbirds (Lee and Wlask-McGehee 1998) and island-by-island inventories are presented for the West Indies (Lee and Walsh-McGehee 2000) and for the Bahamas and Turks and Caicos (Walsh-McGehee et al. 1999). Haney et al. (1999) provide information on Bridled Terns, and Mackin (in press) has presented some preliminary results of his studies of Audubon's Shearwaters in the Exumas.

The following is a list of seabird breeding areas in the Bahamas that we believe deserve protection. The list is based on the following criteria:

- 1) The desire to protect representative populations of all species of seabirds that breed in the Bahamas.
- 2) The protection of key sites that harbor massive assemblages of seabirds.
- 3) Priority protection for regional endemics and globally rare species.
- 4) Protection of colonies with potential interest to ecotourism.

This list does not include parks and other areas where seabirds are already afforded protection. This list is incomplete because current information is not available for such island groups as the Ragged Islands, Berry Islands, and cays northwest of Abaco. Species known to nest at each site are listed; bold type indicates priority species with conservation concerns.

Cay Sal Bank

Double-headed Cays - **Audubon's Shearwater, Bridled Tern, Sooty Tern, Brown Noddy.**

Damas Cays - **Aududon's Shearwater, Bridled Tern, Sooty Tern, Brown Noddy.**

Andros

Grassy Creek Cays - **White-tailed Tropicbird, Bridled Tern, Sooty Tern, Brown Noddy.**

Washerwoman Cays - **Audubon's Shearwater, Bridled Tern, Sooty Tern, Brown Noddy.**

New Providence

Goulding Cay - **Bridled Tern**, Sooty Tern, Brown Noddy.

Eleuthera

Great Oyster Pond - **Double-crested Cormorant**.

Little San Salvador

Goat Cay, Tee Cay & Long Rocks - **White-tailed Tropicbird, Roseate Tern, Bridled Tern**, Sooty Tern, Brown Noddy.

Cat Island

Fernandez Bay Cays - **Bridled Tern**.

San Salvador

Graham's Harbour and Manhead Cay - **Audubon's Shearwater, White-tailed Tropicbird, Brown Booby, Red-footed Booby, Magnificent Frigatebird, Roseate Tern, Bridled Tern**, Sooty Tern, Royal Tern, Brown Noddy.

Cays in interior lakes - **Double-crested Cormorant**, Gull-billed Tern, Least Tern, Laughing Gull.

Pigeon Creek Cays - **Audubon's Shearwater**, several tern species likely.

Rum Cay - **White-tailed Tropicbird, Roseate Tern, Bridled Tern**, Least Tern, Gull-billed Tern, Laughing Gull.

Long Island

Galliot Cay - **Roseate Tern**, Sandwich Tern.

Exuma Cays

Allen's Cays - **Audubon's Shearwater**.

Elizabeth Harbor Cays and Rocks - **Roseate Tern, Bridled Tern**, Gull-billed Tern, Least Tern, Laughing Gull, Sandwich Tern, Sooty Tern, Brown Noddy.

Mira Por Vos - **Audubon's Shearwater, Brown Booby, Bridled Tern**, Sooty Tern, Brown Noddy.

Plana Cays - **Audubon's Shearwater, White-tailed Tropicbird**, Sandwich Tern.

Great Inagua

Conchshell Point - **White-tailed Tropicbird**

Other locations (some possibly within park) - **Brown Pelican**, Royal Tern, Neotropic Cormorant, Laughing Gull, Sandwich Tern, Gull-billed Tern, Least Tern, Royal Tern, Sooty Tern.

Little Inagua - **White-tailed Tropicbird, Roseate Tern**, Least Tern.

Mayaguana

Booby Rocks - **Brown Booby**, several terns likely.

Cay Verde - **Audubon's Shearwater** (?), **Brown Booby, Magnificent Frigatebird, Bridled Tern**, Laughing Gull, Sooty Tern, Brown Noddy.

Cay Lobos - **Roseate Tern**, Least Tern, Sandwich Tern, Sooty Tern.

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BAHAMIAN SEABIRDS	NP	GB	AB	BE	BI	AN	EL	EX	CT	SS	LO	CR	RG	MA	GI	CS
Audubon's Shearwater			?			B		C		C		B	?			C
<i>Puffinus lherminieri</i>						X	?	D	A	C	A	A	?		B	
White-tailed Tropicbird			B													
<i>Phaethon lepturus</i>										C		B		B		
Brown Booby																
<i>Sula leucogaster</i>										A						
Red-footed Booby																
<i>Sula sula</i>																
Brown Pelican (W. I. Race)															C	
<i>Pelecanus occidentalis occidentalis</i>																
Double-crested Cormorant (Bahama race)							?			C						
<i>Phalacrocorax auritus heuretus</i>									?							C
Neotropic Cormorant	A															
<i>Phalacrocorax brasilianus</i>										B		B				
Magnificent Frigatebird			?													
<i>Fregata magnificens</i>													B			
Laughing Gull		X						C	C			B	B			
<i>Larus atricilla</i>																
Gull-billed Tern	A								B	B	B	B		?	B	
<i>Sterna nilotica</i>																
Royal Tern						B	A		B	B	B					B
<i>Sterna maxima</i>																
Sandwich Tern						C	A	B			B	C	B		C	
<i>Sterna sandvicensis</i>																
Roseate Tern	?		B	B		B	C	C	B	B	X		B			
<i>Sterna dougallii</i>					X	B	C	C	B	C	C	B	B		C	B
Least Tern	A	X														
<i>Sterna antillarum</i>						B	B	C	B	B	B	B	B	B	A	B
Bridled Tern	B	B	B	B	B	B	B	C	B	B	B	B	B	B	A	B
<i>Sterna anaethetus</i>						D	E	D	B	C	C	C	C	C	C	D
Sooty Tern	C		C	C	C	D										
<i>Sterna fuscata</i>																
Brown Noddy	C			C	C	C	D	D	B	C	D	C	C	C	B	D
<i>Anous stolidus</i>																

Locations. NP = New Providence and its offshore cays; GB = Grand Bahama and its offshore cays; AB = Abaco and its offshore cays including cays northwest of Abaco;

BE = The Berry Islands; BI = The Bimini; AN = Andros, its offshore cays, the Joulter Cays, Big Green Cay, and nearby rocks; EL = Eleuthera, its offshore cays, Schooner Cays, Finley Cay; EX = The Exumas; CT = Cat Island, its offshore cays, and Little San Salvador; SS = San Salvador, its offshore cays, Rum Cay, and Conception Island;

LO = Long Island and its offshore cays; CR = Crooked and Acklins Islands, their offshore cays, Samana Cay, Plana Cays, Mira Por Vos, and Hogsty Reef; RG = The Ragged Island Range, Cay Verde, Cay Santo Domingo, and Cay Lobos; MA = Mayaguana and its offshore cays; GI = Great and Little Inagua; CS = The Cay Sal Bank.

Number of Breeding Pairs. A = 1-10; B = 11-100; C = 101-1,000; D = 1,001-10,000; E = 10,001+; X = Breeding confirmed, number unknown.

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ANNUAL MEETING AND WORKSHOP
Bahamian Field Station, San Salvador, The Bahamas
10-12 November 2000

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CBSG Workshop and Training Processes

Information on capabilities of the Conservation Breeding Specialist Group (CBSG/SSC/IUCN)

Introduction

There is a lack of generally accepted tools to evaluate and integrate the interaction of biological, physical, and social factors on the population dynamics of threatened species and populations. There is an urgent need for tools and processes to characterize the risk of species and habitat extinction, on the possible impacts of future events, on the effects of management interventions, and on how to develop and sustain learning-based cross-institutional management programs.

The Conservation Breeding Specialist Group (CBSG) of IUCN's Species Survival Commission (SSC) has 10 years of experience in developing, testing and applying a series of scientifically based tools and processes to assist risk characterization and species management decision making. These tools, based on small population and conservation biology (biological and physical factors), human demography, and the dynamics of social learning are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management.

Our Workshop processes provide an objective environment, expert knowledge, and a neutral facilitation process that supports sharing of available information across institutions and stakeholder groups, reaching agreement on the issues and available information, and then making useful and practical management recommendations for the taxon and habitat system under consideration. The process has been remarkably successful in unearthing and integrating previously unpublished information for the decision making process. Their proven heuristic value and constant refinement and expansion have made CBSG workshop processes one of the most imaginative and productive organizing forces for species conservation today (Conway 1995).

Integration of Science, Management, and Stakeholders

The CBSG PHVA Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biologi-

cal information, but is dependent on actions of humans living within the range of the threatened species as well as established national and international interests. There are characteristic patterns of human behavior that are cross-disciplinary and cross-cultural which affect the processes of communication, problem-solving, and collaboration: 1) in the acquisition, sharing, and analysis of information; 2) in the perception and characterization of risk; 3) in the development of trust among individuals; and 4) in 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach agreement on needed conservation actions, collaboration needed, and to establish new working relationships.

Frequently, local management agencies, external consultants, and local experts have identified management actions. However, an isolated narrow professional approach which focuses primarily on the perceived biological problems seems to have little effect on the needed political and social changes (social learning) for collaboration, effective management and conservation of habitat fragments or protected areas and their species components. CBSG workshops are organized to bring together the full range of groups with a strong interest in conserving and managing the species in its habitat or the consequences of such management. One goal in all workshops is to reach a common understanding of the state of scientific knowledge available and its possible application to the decision-making process and to needed management actions. We have found that the decision-making driven workshop process with risk characterization tools, stochastic simulation modeling, scenario testing, and deliberation among stakeholders is a powerful tool for extracting, assembling, and exploring information. This process encourages developing a shared understanding across wide boundaries of training and expertise. These tools also support building of working agreements and instilling local ownership of the problems, the decisions required, and their management during the workshop process. As participants appreciate the complexity of the problems as a group, they take more ownership of the process as well as the ultimate recommendations made to achieve workable solutions. This is essential if the management recommendations generated by the workshops are to succeed.

Participants have learned a host of lessons in more than 100 CBSG Workshop experiences in nearly 40 countries. Traditional approaches to endangered species problems have tended to emphasize our lack of in-

formation and the need for additional research. This has been coupled with a hesitancy to make explicit risk assessments of species status and a reluctance to make immediate or non-traditional management recommendations. The result has been long delays in preparing action plans, loss of momentum, dependency on crisis-driven actions or broad recommendations that do not provide useful guidance to the managers.

CBSG's interactive and participatory workshop approach produces positive effects on management decision-making and in generating political and social support for conservation actions by local people. Modeling is an important tool as part of the process and provides a continuing test of assumptions, data consistency, and of scenarios. CBSG participants recognize that the present science is imperfect and that management policies and actions need to be designed as part of a biological and social learning process. The Workshop process essentially provides a means for designing management decisions and programs on the basis of sound science while allowing new information and unexpected events to be used for learning and to adjust management practices.

Workshop Processes and Multiple Stakeholders

Experience: The Chairman and three Program Officers of CBSG have conducted and facilitated more than 100 species and ecosystem Workshops in 40 countries including the USA during the past 6 years. *Reports from these workshops are available from the CBSG Office.* We have worked on a continuing basis with agencies on specific taxa (e.g., Florida panther, Sumatran tiger) and have assisted in the development of national conservation strategies for other taxa (e.g., Sumatran elephant, Sumatran tiger, Indonesia). Our *Population Biology Program Officer (Dr. P. Miller)* received his doctoral training with Dr. P. Hedrick and has experience with the genetic and demographic aspects of a range of vertebrate species. He has worked extensively with *VORTEX* and other population simulation models.

Facilitator's Training and Manual: A manual has been prepared to assist CBSG Workshop conveners, collaborators, and facilitators in the process of organizing, conducting, and completing a CBSG workshop. It was developed with the assistance of two management science professionals and 30 people from 11 countries with experience in CBSG Workshops. These facilitator's training workshops have proven very popular with 2 per year planned through 2000 in several countries including the USA. *Copies of the Facilitator's Manual are available from the CBSG Office.*

Scientific Studies of Workshop Process: The effectiveness of these workshops as tools for eliciting information, assisting the development of sustained networking among stakeholders, impact on attitudes of participants, and in achieving consensus on needed management actions and research has been extensively debated. We initiated a scientific study of the process and its long term aftermath four years ago in collaboration with an independent team of researchers (Vredenburg et al. 1999). A survey questionnaire is administered at the beginning and end of each workshop. They have also conducted extensive interviews with participants in workshops held in five countries. *Three manuscripts on CBSG Workshop processes and their effects are available from the team and the CBSG office.* The study also is undertaking follow up at one and two years after each workshop to assess longer-term effects. To the best of our knowledge there is no comparable systematic scientific study of conservation and management processes. *We will apply the same scientific study tools to the workshops in this program and provide an analysis of the results after the workshop.*

CBSG Workshop Toolkit

Our basic set of tools for workshops include: small group dynamic skills; explicit use in small groups of problem restatement; divergent thinking sessions; identification of the history and chronology of the problem; causal flow diagramming (elementary systems analysis); matrix methods for qualitative data and expert judgments; paired and weighted ranking for making comparisons between sites, criteria, and options; utility analysis; stochastic simulation modeling for single populations and metapopulations; and deterministic and stochastic modeling of local human populations. Several computer packages are used to assist collection and analysis of information with these tools. We provide training in several of these tools in each workshop as well as intensive special training workshops for people wishing to organize their own workshops.

Stochastic Simulation Modeling

Integration of Biological, Physical and Social Factors: The Workshop process, as developed by CBSG, generates population and habitat viability assessments based upon in-depth analysis of information on the life history, population dynamics, ecology, and history of the populations. Information on demography, genetics, and environmental factors pertinent to assessing population status and risk of extinction under current management scenarios and perceived threats are assembled in prepara-

tion for and during the workshops. Modeling and simulations provide a neutral externalization focus for assembly of information, identifying assumptions, projecting possible outcomes (risks), and examining for internal consistency. Timely reports from the workshop are necessary to have impact on stakeholders and decision makers. Draft reports are distributed within 3-4 weeks of the workshop and final reports within about 3 months.

Human Dimension: We have collaborated with human demographers in 5 CBSG workshops on endangered species and habitats. They have utilized computer models incorporating human population characteristics and events at the local level in order to provide projections of the likely course of population growth and the utilization of local resources. This information was then incorporated into projections of the likely viability of the habitat of the threatened species and used as part of the population projections and risk assessments. We are preparing a series of papers on the human dimension of population and habitat viability assessment. It is our intention to further develop these tools and to utilize them as part of the scenario assessment process.

Risk Assessment and Scenario Evaluation: A stochastic population simulation model is a kind of model that attempts to incorporate the uncertainty, randomness or unpredictability of life history and environmental events into the modeling process. Events whose occurrence is uncertain, unpredictable, and random are called stochastic. Most events in an animal's life have some level of uncertainty. Similarly, environmental factors, and their effect on the population process, are stochastic - they are not completely random, but their effects are predictable within certain limits. Simulation solutions are usually needed for complex models including several stochastic parameters.

There are a host of reasons why simulation modeling is valuable for the workshop process and development of management tools. The primary advantage, of course, is to simulate scenarios and the impact of numerous variables on the population dynamics and potential for population extinction. Interestingly, not all advantages are related to generating useful management recommendations. The side-benefits are substantial.

- Population modeling supports consensus and instills ownership and pride during the workshop process. As groups begin to appreciate the complexity of the problems, they have a tendency to take more ownership of the process and the ultimate recommendations to achieve workable solutions.
- Population modeling forces discussion on biological and physical aspects and specification of

assumptions, data, and goals. The lack of sufficient data of useable quality rapidly becomes apparent and identifies critical factors for further study (driving research and decision making), management, and monitoring. This not only influences assumptions, but also the group's goals.

- Population modeling generates credibility by using technology that non-biologically oriented groups can use to relate to population biology and the "real" problems. The acceptance of the computer as a tool for performing repetitive tasks has led to a common ground for persons of diverse backgrounds.
- Population modeling explicitly incorporates what we know about dynamics by allowing the simultaneous examination of multiple factors and interactions - more than can be considered in analytical models. The ability to alter these parameters in a systematic fashion allows testing a multitude of scenarios that can guide adaptive management strategies.
- Population modeling can be a neutral computer "game" that focuses attention while providing persons of diverse agendas the opportunity to reach consensus on difficult issues.
- Population modeling results can be of political value for people in governmental agencies by providing support for perceived population trends and the need for action. It helps managers to justify resource allocation for a program to their superiors and budgetary agencies as well as identify areas for intensifying program efforts.

Modeling Tools: At the present time, our preferred model for use in the population simulation modeling process is called *VORTEX*. This model, developed by Bob Lacy (Chicago Zoological Society), is designed specifically for use in the stochastic simulation of the extinction process in small wildlife populations. It has been developed in collaboration and cooperation with the CBSG PHVA process. The model simulates deterministic forces as well as demographic, environmental, and genetic events in relation to their probabilities. It includes modules for catastrophes, density dependence, metapopulation dynamics, and inbreeding effects. The *VORTEX* model analyzes a population in a stochastic and probabilistic fashion. It also makes predictions that are testable in a scientific manner, lending more credibility to the process of using population-modeling tools.

There are other commercial models, but presently they have some limitations such as failing to measure genetic effects, being difficult to use, or failing to model individuals. *VORTEX* has been successfully used in

more than 90 PHVA workshops in guiding management decisions. *VORTEX* is general enough for use when dealing with a broad range of species, but specific enough to incorporate most of the important processes. It is continually evolving in conjunction with the PHVA process. *VORTEX* has, as do all models, its limitations, which may restrict its utility. The model analyzes a population in a stochastic and probabilistic fashion. It is now at Version 8.1 through the cooperative contributions of dozens of biologists. It has been the subject of a series of both published and in-press validation studies and comparisons with other modeling tools. More than 2000 copies of *VORTEX* are in circulation and it is being used as a teaching tool in university courses.

We use this model and the experience we have with it as a central tool for the population dynamic aspects of the Workshop process. Additional modules, building on other simulation modeling tools for human population dynamics (which we have used in 3 countries) with potential impacts on water usage, harvesting effects, and physical factors such as hydrology and water diversion will be developed to provide input into the population and habitat models which can then be used to evaluate possible effects of different management scenarios. No such composite models are available.

CBSG Resources as a Unique Asset

Expertise and Costs: The problems and threats to endangered species everywhere are complex and interactive with a need for information from diverse specialists. No agency or country encompasses all of the useful expert knowledge. Thus, there is a need to include a wide range of people as resources and analysts. It is important that the invited experts have reputations for expertise, objectivity, initial lack of local stake, and for active transfer of wanted skills. CBSG has a volunteer network of more than 700 experts with about 250 in the USA. More than 3,000 people from 400 organizations have assisted CBSG on projects and participated in workshops on a volunteer basis contributing tens of thousands of hours of time. We will call upon individual experts to assist in all phases of this project.

Indirect cost contributions to support: Use of CBSG resources and the contribution of participating experts provide a matching contribution more than equaling the proposed budget request for projects.

Manuals and Reports: We have manuals available that provide guidance on the goals, objectives, and preparations needed for CBSG workshops. These help to reduce startup time and costs and allow us to begin

work on organizing the project immediately with proposed participants and stockholders. We have a process manual for use by local organizers, which goes into detail on all aspects of organizing, conducting, and preparing reports from the workshops. Draft reports are prepared during the workshop so that there is agreement by participants on its content and recommendations. Reports are also prepared on the mini-workshops (working groups) that will be conducted in information gathering exercises with small groups of experts and stakeholders. We can print reports within 24-48 hours of preparation of final copy. We also have CD-ROM preparation facilities, software and experience

References

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