BBP in Brief

A Newsletter of the Bahamas Biocomplexity Project

Produced by the American Museum of Natural History's Center for Biodiversity and Conservation (AMNH-CBC)

Issue 2
April, 2004

Welcome...

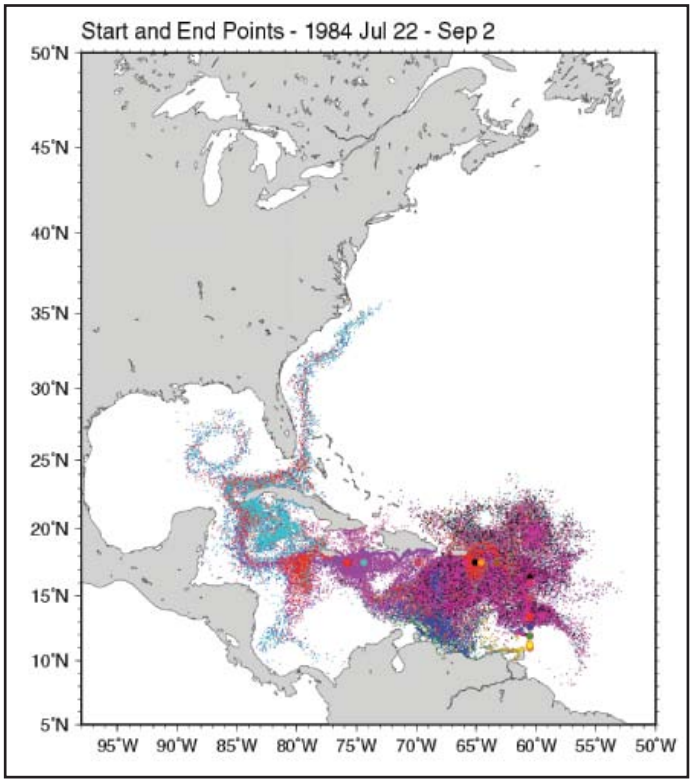
This is the newsletter of the Bahamas Biocomplexity Project, or "BBP," also available at http://bbp.amnh.org/bbpinbrief/. Here you can learn about the activities and progress of the BBP team and its partners. We welcome your submissions about research progress, upcoming field plans, meetings, or any other information you feel would be of interest to project partners. Submissions for consideration in future newsletters may be made to Kate Holmes (kholmes@amnh.org) or Christine Engels (cengels@amnh.org).

In this Issue:

Connectivity Between The Bahamas and the Greater Caribbean

Donald B. Olson (University of Miami–RSMAS) and Dan Brumbaugh (AMNH-CBC)

The BBP Connectivity Working Group is studying how the Bahamian archipelago is ecologically connected with the rest of the Caribbean, as well as how internal parts of the archipelago are linked to each other. The degree of such connections, including how much they vary over time, plays a pivotal role in understanding the functions of a network of MPAs in The Bahamas. In particular, the performance of an MPA network for fisheries will largely depend on whether reproduction and replenishment of populations tends to be fairly local, or whether larvae are dispersed widely by current patterns.



Simulated dispersal of particles released from different points in a circulation model of the Atlantic. The large colored dots along the Greater and Lesser Antilles indicate different release points for sets of 5000 particles, with the correspondingly colored cloud of particles indicating the distribution after 40 days. Note that only a few particles enter Bahamian waters in the western and southeastern reaches. © D. Olson

Almost all of the Bahamian marine fauna are also found throughout at least portions of the insular Caribbean Sea (bounded by South and Central America to the south and west, and the Greater and Lesser Antilles to the north and east). The Bahamas and the Florida coast represent the northernmost outpost for these species (with the exception of the small island of Bermuda), though certain species' distributions differ somewhat among subregions of the greater Caribbean. Given that one objective of many MPAs is to protect populations in order to build or simply sustain fisheries stocks, what is the importance of ecological connectivity to the design of MPA networks? Fundamentally, wide-scale connections are important to fisheries management because of the traditional argument that fisheries, whether measured at maximum sustainable yield (MSY) or some more conservative measure, rely on ecosystem surpluses. In other words, individuals taken from the wild will not harm the long-term productivity of populations because either the exploited numbers are less than what could cut into the local reproductive output of the population, or the exploited portion is downstream and distant from the reproductive source. For example, if juvenile lobsters in Florida waters originate from the insular Caribbean, then they are all surplus, at least up to the point that their removal does not disrupt the supply of larvae to lobster populations further downstream or some important local ecosystem functions. In this case of supply to downstream sites, a network of MPAs may be warranted to provide a series, analogous to stepping stones, of upstream refuges for breeding populations. If, however, local reproduction is important for the Florida population, then it is important to maintain a local breeding stock. Creating individual MPAs in Florida (in

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A typical drogue used by oceanographers. This drogue, hanging at a depth of 15 meters and attached to a radio transmitter, ensures that the drifter assemblage tracks shallow ocean currents rather than surface winds. © D. Olson

this case, lobster reserves) is one mechanism for achieving this. The outcome depends strongly on whether the species in question is present due to distant or local sources.

With the goal of addressing how populations within The Bahamas are connected to ones outside, the Connectivity Working Group has attempted to quantify the origin of near surface waters in the vicinity of The Bahamas. The observational tools used include satellite imagery, surface drifters, and an analysis of the waters themselves in terms of their temperature and salinity. The satellite data on sea surface temperature and ocean color (a measure of phytoplankton biomass in the open ocean and as well as the sea floor in shallow bank areas) provides information on the flows out of the Caribbean through the Yucatan Channel and into the Florida Current and some idea of the flows through the Providence Channel. There is also a fairly extensive dataset of satellite-tracked drifters that documents the through-Caribbean flow as well as the flow to the east of The Bahamas. Each drifter includes a radio-transmitting unit tied to a surface buoy which is attached to a fabric cylinder called the drogue (see photo, above). The drogue drops 15 meters below the surface so that the buoy moves with the water's currents at that depth. In addition to these oceanographic data, the group is using simulations of dispersing particles in a numerical circulation model of the Atlantic in order to investigate the possible pathways that larval animals might take to disperse from the insular Caribbean into The Bahamas (see map, page 1).

Results to date suggest that only the southern and eastern Bahamas below San Salvador Island are connected ecologically to the northern Antilles, unless there are periodic flow reversals northward through the Windward Passage (as has been suggested but not well documented). A stronger connection between The Bahamas and the insular Caribbean occurs through the Gulf Stream, but this influence seems to only introduce Caribbean waters to the northwestern edges of the Grand and Little Bahama Banks. These patterns are partially consistent with morphological and genetic patterns in the sharknose goby (*Elacatinus [Gobiosoma] evelynae*) presented by Taylor and Hellberg in a 2003 *Science* article. The connectivity group is currently working on further genetic sampling on queen conch (*Strombus gigas*), spiny lobster (*Panulirus argus)*, land crabs (*Cardisoma guanhumi* and *Gecarcinus lateralis*), staghorn coral (*Acropora cervicornis*), and bonefish (*Albula vulpes*). The Connectivity Working Group results suggest that the Bahamian archipelago is largely divided into two regions with somewhat different connections to the Caribbean. The next step is to understand in finer detail the connections within The Bahamas themselves.

Studies of Seafood Consumption and Tourism Activities

Wendy Wood and Joy Hazell (University of Miami – RSMAS)

University of Miami Master's students Joy Hazell and Wendy Wood spent the last six months living in The Bahamas, working on projects supervised by Liana Talaue-McManus, one of the BBP's collaborators within the Social Science Working Group. Joy studied seafood consumption patterns of both Bahamians and visiting tourists. Locals and tourists were surveyed in Nassau, Abaco, and Exuma. In addition, Joy conducted exploratory research on waste generation and sewage management in Nassau.

Wendy examined tourism activities, such as diving and boating, which may influence the design and sustainability of marine protected areas (MPAs) in The Bahamas. Land-based divers were surveyed in Nassau, and "live-aboard" divers (those who eat and sleep in a boat during diving expeditions) from Bimini and Exuma were polled to gather data from three different locations, including the Exuma Cays Land and Sea Park. The surveys explored divers' expectations and assessment of dive sites in The Bahamas, as well as their willingness to pay for maintaining MPAs.

Talaue-McManus and her students aim to provide estimates of seafood consumption, waste generation, and marine-based tourism activities as inputs to both conceptual and quantitative models for designing and evaluating potential MPA networks in The Bahamas. Furthermore, they hope the information will provide scientific bases for developing more eco-friendly policies in The Bahamas.

Tourist diving among sharks off New Providence. © W. Wood

Collaborations in Studying, Learning, and Practicing Stream Restoration

Albrey Arrington (University of Alabama) and Craig Layman (Yale University)

Tropical estuaries—coastal water bodies where fresh and salt water mix—are critical nursery grounds for numerous species, including many that are important commercially (such as Nassau grouper) and recreationally (such as bonefish). In The Bahamas, while estuarine creeks are dominant features on most of the Islands, they remain poorly studied (especially relative to coral reefs) despite their essential role in supporting species that are critical to economic livelihood and cultural heritage (e.g. queen conch). Since 1999, Albrey Arrington and Craig Layman have coordinated a research program aimed at increased understanding of these systems and the critical ecological roles they play. Through hundreds of hours of fish surveys, they have compiled extensive information on numerous fish species that utilize these systems (more than 110 species identified to date). This work has been conducted with direct involvement of people of The Bahamas, ranging from the training of local high school students in field surveys to town meetings informing concerned citizens of their findings.

Students examining the health of an estuarine creek in Andros. © A. Arrington

In 2003, Arrington initiated a class through the Bahamas Environmental Research Center on Andros for students of the College of The Bahamas (which runs the center) and of the University of Alabama that focused on establishing a database on the health of estuarine creeks and how people can (and have) impacted them. For instance, roads have been constructed across the mouths of many estuaries, limiting natural water exchange and preventing movement of fish and invertebrates in and out of the systems. In 2003, the class began quantifying these adverse effects, a project that will continue during the annual class this May. This work is intended to culminate in restoration projects in multiple target estuaries where tidal flow will be restored through installation of culverts or bridges. College of The Bahamas students will be able to track changes in restored estuaries over time, evaluate the best ways to achieve restoration goals, and monitor the health of these critical systems.

The Bahamas Marine Mammal Survey Reaches Out to the Community

Dianne Claridge (Bahamas Marine Mammal Survey)

Watching dolphins is one of the many camp activities. © P. Church

The Bahamas Marine Mammal Survey (BMMS) is a team of scientists, students, and volunteers conducting research and educational programs on dolphins and whales in Abaco. We conduct field studies with Earthwatch Institute volunteers, coordinate stranding response, and offer internships for Bahamian students, as well as lectures and field trips for schools. Our goals are to increase scientific knowledge, and through public education contribute to the conservation of marine mammals in The Bahamas. Field studies are funded primarily by an annual field grant from Earthwatch Institute, and our Adopt-A-Dolphin program, while outreach and other programs are supported by corporate grants and individual donations.

BMMS launched two new exciting community outreach programs in Abaco during 2003: the Great Abaco Whale Fest and the Sandy Point Environmental Camp. The Whale Fest, held at the end of March, is a multi-day marine mammal educational and fundraising event, which includes a 5K and 2.5K Whale Walk/Run in Sandy Point; an Open House at the BMMS Research Centre with educational displays, games, and demonstrations; a wild dolphin tour; a live Auction; and lectures and wildlife films. The Sandy Point Environmental Camp (SPEC) was initiated in summer 2003 to increase our community outreach effort for Bahamian primary school children. SPEC's mission is to educate children about their local environment and conservation issues through fun, creativity, and experiential education. We targeted children who would not otherwise have exposure to environmental education or the opportunity to learn outdoor adventure skills. Twelve children completed the Camp and are well on their way to becoming environmental stewards in their community. For 2004, BMMS is actively seeking funding to expand the initial program into three diverse environmental camps reaching 30 children. For more information about our programs, please contact us at (242) 366-4155 or email us at bmms@oii.net or info@bahamaswhales.org.

Fully-Protected Marine Reserves Exhibition, a Partnership Outreach Effort

Shenique A. Albury

During the month of April, the *Community-Based Conservation for Bahamian Marine Protected Areas and Critical Marine Habitats* project will be displaying a public exhibition comprised of a series of panels explaining fully-protected marine reserves and how they are designed. Eight life-size murals will depict marine ecosystems, while a montage of photos will illustrate fishing and other marine scenes, as well as the cultural prominence of marine life in The Bahamas. Historical and present day footage of reefs will also be shown to emphasize the need for protection of Bahamian marine resources. While supplies last, viewers will receive T-shirts with the slogan "Fully-protected marine reserves, more food on your plate, more money in your pocket."

Exhibit panel illustrating a Bahamian coral reef. © E. Carey

The exhibition will be held April 19-24, 2004 in the Mall at Marathon in New Providence. The target audience is the general public but emphasis is on secondary school students since a significant portion of the exhibition's content is reflected in the national high school curriculum for biological sciences. It is expected that after viewing the exhibition, students and the general public alike will have a greater understanding of no-take marine reserves and the process of establishing a network of reserves. This exhibition is supported by The Bahamas Department of Fisheries, the Bahamas Reef Environment Educational Foundation (BREEF), and The Nature Conservancy who are partnering to cooperate in the Department's initiative to establish a national network of fully-protected marine reserves. The partnership concentrates on raising awareness of communities about scientific information on how marine reserves work and the roles community members can play in the establishment and management of marine reserves. After the exhibition is displayed in Nassau, Project Coordinator Shenique Albury plans to take it to each of the Family Islands involved in this project, including Abaco, Bimini, the Berry Islands, Eleuthera, Exuma, Long Island, South Andros, and San Salvador.

A Conference to Share Scientific Knowledge of Abaco and the Bahamian Environment

Friends of the Environment

Abaco parrot at the entrance of a ground nest. © R. Gnam

This past January over 90 people gathered in Marsh Harbour for the First Abaco Science Alliance Conference sponsored by Friends of the Environment, a non-profit, non-governmental organization based on Abaco. The conference attracted people from Nassau and Abaco, and from as far away as Oregon and Quebec. Keynote Speaker Livingston Marshall, a Consultant and Science Advisor to the Office of the Prime Minister, spoke of the importance of the environment to the economic future of The Bahamas. Fourteen presenters covered a wide range of topics on research carried out in and around the Abacos. It was clear that these individuals are deeply concerned about The Bahamas and Abaco in particular. The first speaker, Ethan Freid, told of picking up eight large bags of trash during his work investigating and documenting plant diversity in the 20,500 acre Abaco National Park. Researchers Serge Lariviere, Caroline Stahala, and Jaime Collazo, reported on threats to the Bahama Parrot on Abaco. Due to the recent introduction of racoons and the fact that the parrot nests only in the ground, extensive reduction of the parrot population is feared. Scientist, David Smith, noted that certain species of insects living in aquatic communities could serve The Bahamas as environmental indicators, metaphorically similar to how canaries once served to indicate degrading air conditions in coal mines, but only if we improve our understanding of Bahamian insect biodiversity. Another presenter, Stephen Thompson reported on his study of blue holes, the natural water filled sinkholes found in the limestone that makes up much of The Bahamas and which can be found both inland or offshore within the reefs. Thompson, who first began studying the offshore blue holes of Abaco seventeen years ago, recently found that they have been "trashed." Of the four blue holes studied, he believes two are salvageable, one is questionable, and the damage to the fourth is irreversible. Immediate action is needed to save Abaco's blue holes. Keith Tinker, Director of the Antiquities, Monuments and Museums Corporation of The Bahamas, stressed the importance of alliances between government and non-governmental organizations in the protection and preservation of Bahamian cultural resources. He called for an alliance of researchers to allow for the widest possible dissemination of research findings. Several Abaconians who attended the meeting remarked that they had not been aware of all of the scientific work being conducted on the island, and stressed the importance of sharing this information broadly. By all accounts, the conference was a huge success. Details can be obtained from the Friends of the Environment's office, (242) 367-2721.

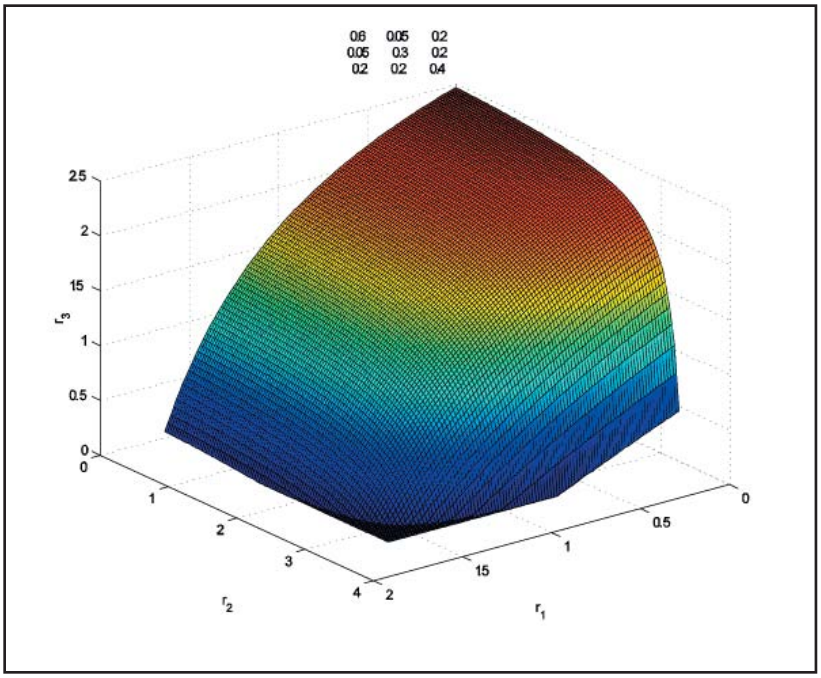
Modeling Marine Protected Areas – Populations, Persistence, and Economics

Alan Hastings (University of California, Davis)

The BBP's Modeling Working Group has been focusing on theoretical approaches aimed both at understanding how MPAs would contribute to marine population persistence and at integrating biological and economic dynamics. Regarding the persistence analyses, we are developing general conditions that will use information from the Connectivity and the Habitat Working Groups to determine whether existing, proposed, or other potential networks of MPAs are sufficient to ensure the persistence of target species. More specifically, we are trying to understand the role of multiple generations of organisms, connected across a network of MPAs by the dispersal of offspring, in creating persistence of "metapopulations" (that is, populations of populations). Does a metapopulation rely on simple closed loops of adults and their offspring returning repeatedly to the same sites, or are the loops much more complex, with offspring only returning to individual patches many generations later after having ancestral generations hop from place to place in the interim? Our goal, towards which we have made substantial progress, is to quantify and operationalize these concepts. A relatively simple result for a system of three MPAs is illustrated in the graph.

We have also been carefully considering the kinds of features that would make an MPA the best economic solution to the management of a fishery. This work, which uses concepts from optimal control theory, is still in progress. Initial results are very promising, but indicate that over short time horizons, MPAs are not the "optimal" solution, unless a value is explicitly placed on the persistence of the species or fishery beyond the planning period. These models should provide guidance into the kinds of economic and policy considerations that might determine when reserves and other MPAs are good planning and management tools.

Persistence is a key concept in understanding MPAs from a modeling point of view. A population is persistent if it can increase in numbers when rare. This idea can be translated into mathematical conditions for use in the analysis of models, and is the basis of much of the work of the BBP's Modeling Working Group.



A surface illustrating the various combinations of population growth rates (r_1, r_2, and r_3) that, with a set of larval connectivities or dispersal rates among three MPAs, leads to a sustainable MPA network. Each population growth rate, r, varying along an axis, indicates how quickly a population in an individual MPA grows or declines. The small group of numbers above the graph indicates the set of connectivity rates used to calculate this surface. The space above the modeled surface represents the sustainable combination of population growth rates for these connectivities. Although a given MPA may not be sustainable itself (that is, when the growth rate within the MPA is less than one), increases in this rate can lead to sustainability of the overall network. © A. Hastings

BBP General Meeting - May 3-5, 2004
School of Hospitality and Tourism Studies, College of The Bahamas
Nassau, Bahamas

This May, collaborators and partners of the Bahamas Biocomplexity Project will have a general meeting in Nassau to highlight certain dimensions of the project and conduct detailed discussions of ongoing and future research.

On the first day of the meeting (May 3), we are planning to have informative talks open to the public on diverse topics. These include an overview of the entire BBP, discussion of the BBP's cultural anthropological work from the Exumas, a presentation about the importance of ecological linkages among habitats in coral reef ecosystems, and an update on the BBP-Geographical Information Systems work. In addition to these talks, several Bahamian organizations working in environmental management and conservation are being invited to give updates to the BBP and other attendees regarding perspectives and activities relevant to marine conservation in The Bahamas. This day should therefore be of interest to people curious about the BBP as well as current management of Bahamian marine resources. The second and third days of the general meeting will revolve around technical, workshop-based discussions focused primarily on the ongoing development of theory, data analyses, and computer models (e.g., see Alan Hastings article, above) for integration of diverse BBP components. General project management issues will also be discussed. These discussions will be primarily geared for members of the various research working groups, though other observers are welcome. Please contact Kate Holmes (kholmes@amnh.org) for further information.

What is BBP?

The Bahamas Biocomplexity Project (BBP) is a five-year initiative funded primarily by the National Science Foundation to investigate the complex environmental and social factors that affect the design, management, and effectiveness of networks of marine protected areas (MPAs). Researchers involved in the project include oceanographers, biologists, and social scientists from nine institutions working in collaboration with various governmental and non-governmental groups in The Bahamas.

Ultimately, the primary goal of the project is to integrate studies of natural and human processes, leading to a more sophisticated understanding of how individual MPAs work, and how they could work as part of a network throughout The Bahamas and in other coral reef ecosystems. Other important goals include the integration of this research with conservation education and decision-making.

BBP Collaborators and Partners

The College of The Bahamas

The BBP is funded primarily by the National Science Foundation's Biocomplexity in the Environment Program (NSF-BE). This newsletter is made possible through funding from the National Aeronautics and Space Administration (NASA).

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