



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)

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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 or Christine Engels (bbp.in.brief@amnh.org).

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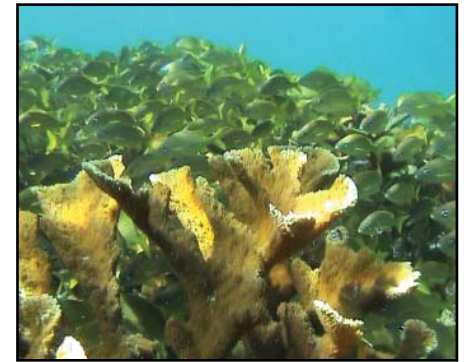
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Examining Patterns of Species and Habitat Diversity Across The Bahamas

Alastair Harborne (University of Exeter)

The Habitat Working Group has mapped the distribution of habitats at six sites in the Bahamas Archipelago (Andros, Bimini, Abaco, Exumas, San Salvador, and South Caicos). At each site we have assessed fish communities (using underwater visual censuses) and benthic communities (using video analysis) in each habitat type present. One of the aims of collecting these data is to study how a habitat type differs in the number of species and the abundance of each species at different sites. For example, how does the fish community structure differ between a forereef area in Andros and one in the Exumas? And how does the coral community change from one site in San Salvador to another 5 km north on the same reef? And are the changes different if you consider a reef habitat compared to a seagrass bed? These questions are important when designing networks of marine reserves. By working inside and outside the Exuma Cays Land and Sea Park, we can accurately quantify how such reserves may affect community structure. Furthermore, by collaborating with other BBP working groups (particularly the Connectivity and Social Working Groups) we are trying to explain the patterns across the archipelago in terms of movement of larvae, fishing pressure, and other differences among sites such as depth, wave exposure, and the presence of mangroves. These findings will provide unique insights into why you see the species you do when diving at different sites in The Bahamas.



Schools of french grunt were commonly seen moving through reefs with staghorn coral off South Caicos island. K. Holmes © AMNH-CBC

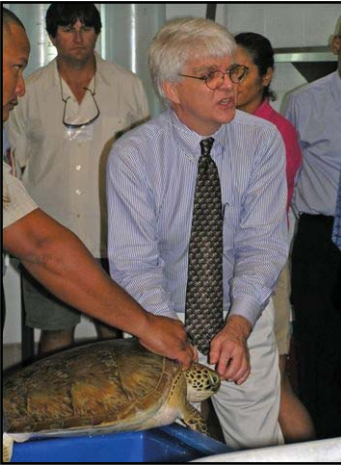
The Habitat Working Group is also attempting to combine habitat maps with the data on species distributions to generate novel ways of examining coral reefs. A habitat map might show where there is a large number of different habitats but each of those habitats might be home to a fairly similar group of species. For biodiversity conservation, it could be better to protect areas that have lots of habitats with very different groups of species (e.g., an area with mangroves, a seagrass bed, and a forereef). Using specially designed software, we are able to make maps of habitat (or "beta") diversity that identify "hot spots" of habitat diversity. Such maps are useful for management, but we are also seeking to understand the maps by statistical modelling. Early findings indicate that, for example, habitat diversity is particularly influenced by water depth and wave exposure. Further analyses will provide more insight into what decisions can help with the establishment of effective marine protected areas.

Sea Turtle Conservation Strategy Workshop

Lynn Gape (Bahamas Natural Trust), Alan Bolten, and Karen Bjorndal (University of Florida)

The Bahamas National Trust (BNT), in partnership with the Bahamas Department of Marine Resources (formerly the Department of Fisheries), the Archie Carr Center for Sea Turtle Research of the University of Florida, The Nature Conservancy, the College of The Bahamas, and the Atlantis Resort, held a Sea Turtle Conservation Strategy Workshop in January 2006. Director of Marine Resources Michael Braynen and U.S. Ambassador John Rood opened the workshop by stating the need for protection of these endangered species and remarking on the opportunities for partnership between The Bahamas and the United States to protect and conserve these animals. The focus of the three

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Alan Bolten explaining techniques of sea turtle catch and release.
© K. Bjorndal

day workshop was to develop a conservation strategy for sea turtles in The Bahamas and an implementation plan for the strategy. Workshop attendees included a range of stakeholders, including representatives of government agencies, educational institutions, and non-governmental conservation organizations that are active within The Bahamas. The goal for the strategy is to provide a plan to further sea turtle population recovery in Bahamian waters that will, in turn, enhance healthy marine ecosystems for the benefit of the Bahamian people. The workshop was facilitated by Karen Bjorndal and Alan Bolten of the University of Florida, who serve as Scientific Advisors to the BNT and have conducted sea turtle research at Union Creek Reserve (Inagua, Bahamas) for over 25 years. Participants in the workshop considered and prioritized threats to sea turtle populations and identified major conservation actions needed to conserve sea turtles in The Bahamas. The Atlantis Resort's Water Features Department made possible a hands-on demonstration of turtle tagging and measuring on the first day of the workshop.

Sea turtles face ever-increasing threats in The Bahamas and throughout the western Atlantic Ocean as human populations grow, coastal areas are developed, and marine habitats are degraded. Successful management and conservation of sea turtles in The Bahamas would benefit from an archipelago-wide effort based on a strategic approach.



Coastal Awareness: If Not Us...Who?...If Not Now...When?

Coastal Awareness Committee

The Coastal Awareness Committee of The Bahamas, a group of stakeholders from the private and public sectors with an interest in promoting the sustainable development of The Bahamas, has organized several events for this year's month-long national initiative.

First, April was declared "Coastal Awareness Month in The Bahamas" by Dr. Marcus Bethel, Minister of Energy and the Environment. A coastal awareness supplement, prepared by the Committee, ran in Bahamian newspapers in early April and called for public participation at the month's events and alerted the public to the main threats

to the coastal environment of The Bahamas, which include: pollution, climate change, invasive species, habitat destruction and over-harvesting of marine resources. A national church service celebrating the coast took place on April 2 at Zion Baptist Church and was broadcast live on ZNS television. The Coastal Awareness National T-shirt Day on April 7 welcomed all Bahamians to wear a T-shirt showing their support for protecting the coast.

Other events included an educational marine exhibition at the Marathon Mall and a national science and art competition. Mr. Earlston McPhee of the Ministry of Tourism and Chairperson of the National Coastal Awareness Committee stated that the purpose of the competition was to "involve the youth of The Bahamas in dialoguing and identifying environmental challenges from within their immediate surroundings and proposing possible solutions to improve and/or solve problems. We are all in this together and as our motto states 'If not us...who? If not now...when?'" Field trips to Dolphin Encounters on Blue Lagoon Island and Dive Stuart Cove were also arranged to provide students, particularly in urban areas of New Providence, with an opportunity to learn about protecting the coasts and enjoy the marine wonders of The Bahamas. The events culminated with a dune restoration initiative at Orange Hill Beach, New Providence on April 30. Beach clean-ups and other Coastal Awareness activities were also organized on the islands of Abaco, Andros, Bimini, Eleuthera, Exuma, and San Salvador.



Students from C.V. Bethel Sr. High School preparing to snorkel as part of Coastal Awareness Month.

For more information on Coastal Awareness Month please contact Earlston McPhee at 356-6967/63/38.

Society for Conservation Biology, 20th Annual Meeting Conservation Without Borders – San Jose, California, USA.



The Society for Conservation Biology's annual meeting will take place in San Jose, California June 24 - 28, 2006. A primary objective of this year's meeting is to transcend real and perceived boundaries of ecology, sociology, politics, and human behavior that impede conservation science and its application. Major topic areas will range from partnerships with private landowners to marine and freshwater conservation and transboundary conservation. For more information and to register visit www.conbio.org/2006.

BBP Publication Highlights

Dan Brumbaugh, Kate Holmes (AMNH-CBC), and Claire Paris (University of Miami-RSMAS)



Cover of *Science*, with a composite picture of diverse larvae. © AAAS

Several BBP peer-reviewed research articles have been published in books and journals in the last few months, bringing the total to date to more than 15 – including recent publications in *Proceedings of the National Academy of Sciences of the U.S.A.*, *Ecological Applications*, *Biological Conservation*, and *Advances in Marine Biology*. Many of these are available via the BBP website's publication page, <http://bbp.amnh.org/website/publications.html>. Several more articles are in press and many more are in various stages of preparation.

In January of this year, two BBP articles were published in *Science*. The first, “Fishing, trophic cascades, and the process of grazing on coral reefs” (abstract available via the URL above), reported on the potential effect on corals of protecting fishes inside Caribbean marine reserves. Since reserves are marine protected areas that ban fishing, discussions about tropical marine reserves generally focus on their effects on reef fishes and fisheries while the effects of reserves on coral communities are much less clear. In fact, some scientists have speculated that by allowing predatory fish such as Nassau grouper to flourish, a marine reserve might inadvertently harm reefs by depressing the numbers of herbivorous fishes, such as parrotfish, which could then allow seaweed to flourish and outcompete corals.

BBP scientists, however, found that parrotfish, far from being wiped out, are prospering because the reserve that allows predator populations to thrive also allows for the recovery of large parrotfish. Although smaller species of parrotfish are negatively affected by the accumulation of predators inside a Bahamian reserve, larger parrotfish species survive long enough to outgrow the groupers' mouth size while also benefiting from the reserve's fishing prohibition. Since larger parrotfish eat much more seaweed than smaller individuals, the net effect inside the reserve is a doubling of the grazing intensity, leading to a four-fold reduction in the amount of seaweed on the reef. In addition to demonstrating some of the surprising complexity of ecological interactions on coral reefs, this research provides the first demonstration of how the establishment of marine reserves in the Caribbean can help reduce seaweed, thereby facilitating the potential recovery of corals on reefs.

The article was accompanied by a perspective, “Complexities of coral reef recovery” (by coral ecologist Ove Hoegh-Guldberg) in the same issue of *Science*, and generated a great deal of press – including coverage in *The New York Times*, *The Times* (U.K.), *The Economist*, *The Independent*, *Nature*, *Scientific American*, and *The Bahamas Naturalist and Journal of Science*; on National Public Radio's *Talk of the Nation's Science Fridays*; and in online reports of the Discovery Channel, National Geographic, and the BBC.

In the other recent BBP *Science* article, “Scaling of connectivity in marine populations” (originally published electronically in *Science Express* on December 15, 2005; abstract available via the URL above), BBP scientists estimated, for the first time, typical dispersal distances for multiple species of coral-reef fishes, mapped out networks of ecologically relevant larval exchange (i.e., levels that are needed to sustain a population) between coral-reef patches, and distinguished hypothetical populations across the wider Caribbean.

They did this using a new high throughput biophysical modeling system that allows highly efficient simulations of dispersing larvae. Such virtual larvae – representing spawning productions of trillions of eggs – were released from 260 50-km local population patches and tracked as they dispersed according to realistic hydrodynamics, species-specific early life-history traits, and larval demographic factors. Because these simulations were run with equal numbers of larvae from each reef, without taking into account the current health of the coral reef ecosystem (i.e., areas that have been heavily overfished or have experienced the loss or degradation of coral reef habitat), the researchers essentially modeled pristine populations. By integrating physical and biological processes, such as realistic renditions of ocean circulation, adult spawning, and larval behavior for a variety of species, they explored how larval exchange of reef fishes would operate in the absence of pervasive human impacts. An improved understanding of these “undisturbed” connectivity patterns should help in designing effective conservation measures to maintain or restore natural levels of biodiversity and ecosystem function.

Results indicate that most larvae settle at 10-100 km from the spawning site depending on seascape structure (the geomorphology, oceanographic regimes, and natural patchiness of habitats) and certain larval traits such as time in the plankton, patterns of larval vertical migration, and the degree of active settlement. The study illustrates that the maintenance of locally breeding populations depends both on larvae self-recruiting to their patches of origin and subsidies of larvae from outside the local area, emphasizing the critical aspect of small-scale ecological networks. Further, the results reveal distinct regions of demographic isolation. For example, The Bahamas region, including the Turks and Caicos islands, stands out as an isolated enclave, with relatively high levels of internal recruitment and strong interconnectedness, limited larval exchange with the northern central Cuban shelf, and virtually no exchange with other regions of the Caribbean. This finding is important for Bahamian resource management as it suggests the opportunity for managers to influence and capture the potential ecological benefits from marine reserves and other forms of spatial management across the country.

In addition, the researchers found that regional patterns in demographic connectivity matched published genetic data for neon gobies and elkhorn coral. At the wider spatial scale of the Caribbean region, the conservation of such genetic diversity may also require taking connectivity into account during conservation planning, including the use of networks of marine protected areas (MPAs) across gradients of genetic variability. Beyond helping with MPA network design, other applications of the study's modeling approach include simulations of the spread of invasive species, and tools for dealing with ongoing impacts from climate change.

The printed article made the cover of *Science*, with a composite picture of diverse larvae, and was backed up by an additional perspective, “Staying connected in a turbulent world” (by marine ecologist Bob Steneck) in the same issue.

Workshop to Review *Treasures in the Sea: Our Bahamian Marine Resources*

Lynn Gape (Bahamas National Trust)

The Bahamas National Trust (BNT), in partnership with the American Museum of Natural History's Center for Biodiversity (CBC), held a workshop on March 29, 2006 designed to bring together educators and stakeholders to review *Treasures in the Sea: Our Bahamian Marine Resources*. This educational resource is being developed for teachers of grades 3 to 6 with activities highlighting some of the major fishery resources of The Bahamas: queen conch, crawfish, and Nassau grouper.

Participants reviewed the resource and made constructive comments on how to improve its draft components. Educators also worked out a strategy to pilot the activities in the classroom. Meg Domroese, Outreach Manager of the CBC, commented, "The work today far exceeded our expectations. We were able to review all of the activities and the participants had excellent suggestions to assist us in the final drafting process."

Treasures in the Sea has been a true collaborative effort. Educators and stakeholders have come together and have been working very hard to create a uniquely Bahamian resource for students and educators. The *Treasures* working group is indebted to the Ministry of Education, Science and Technology curriculum coordinators who have assisted them in reviewing the activities for curriculum relevance. *Treasures in the Sea* is expected to be completed in early 2007.



Participants to the March workshop included representatives from the Ministry of Education, Science and Technology, BREEF, Friends of the Environment, the Department of Marine Resources, the BEST Commission, The Nature Conservancy, and representatives from public and private schools.
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The BBP at the American Association for the Advancement of Science's Annual Meeting

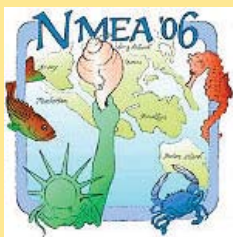
Dan Brumbaugh (AMNH-CBC)



St. Louis' famous Gateway Arch on a cold winter day during the 2006 meeting of the AAAS.
K. Holmes © AMNH-CBC

On February 20, 2006, the BBP was the focus of a symposium at the annual meeting of the American Association for the Advancement of Science (AAAS) held in St. Louis, Missouri. Entitled "Coral Reef Ecosystems and People in The Bahamas: Practical Applications of Biocomplexity Science," the AAAS symposium showcased research progress to date from diverse BBP working groups and related outreach and educational efforts (see link at <http://bbp.amnh.org/website/outreach.html>). Presenters representing the BBP and partners included Dan Brumbaugh, Steve Palumbi, Fiorenza Micheli, Kenny Broad, Rich Stoffle, Alan Hastings, and Karen St. Cyr, who spoke on behalf of the Bahamas Ministry of Education, Science and Technology, the Bahamas National Trust, and other educational collaborators. In addition to highlighting the state of discrete connectivity, ecological, social, modeling, and educational components, the symposium demonstrated several cross-cutting and integrative results, and mapped out additional integrations that are in various stages of development.

The response to the symposium was good and we made several new contacts with the science-news media. Perhaps more importantly, the symposium provided an important internal milestone and momentum for BBP to conduct and communicate its original, integrative research on marine seascapes and their conservation. Since we are currently exploring options for future BBP sessions, symposia, or workshops, please feel free to contact Dan Brumbaugh with any suggestions (bbp.in.brief@amnh.org).



National Marine Educators Association A City of Islands! – New York City, New York, USA

This year's National Marine Educators Association annual conference will be held July 15-21 and hosted by the New York State Marine Educators Association. Following the meeting's theme, presenters will discuss how they are working to address major ocean literacy themes through diverse educational activities. Marine scientists will also be presenting their work through a "Research in Action" track. For more information and to register visit <http://nysmea.org/con06/>.

The Bahamas Naturalist and Journal of Science



The Bahamas Naturalist and Journal of Science is the only publication that deals primarily with Bahamian science and environmental topics. It is produced twice yearly. Subscriptions are \$40 a year, but Bahamas National Trust (BNT) members receive a 20% discount. The journal represents a merger of *The Bahamas Naturalist*, produced sporadically by the BNT since 1975, and *The Bahamas Journal of Science*, published continuously by Media Enterprises since 1993. This publication is produced independently as a contribution to public education. Views expressed by the authors are not necessarily those of the publisher or the BNT. For information on how to subscribe or to become a BNT member, contact BNT at bnt@batelnet.bs.

BBP Collaborators and Partners



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 education and decision-making.

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