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1. GENERAL INFORMATION

Title of the project

BAhamas: a Coral reef Hope spot (BACH)

Proponent

Department of Biology, University of Padova, Italy

People involved in the project

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2. PROJECT OUTLINE

Synopsis

Coral reef ecosystems are in serious decline from multiple threats, putting in jeopardy the services that these ecosystems provide to people. In 2000, the Bahamian government initiated the process of developing a network of marine protected areas (MPAs) with the goal of setting aside about 20% of their coastal marine environment. Recent studies demonstrated that marine communities of Bahamas MPAs are healthy, being able to contrast the invasion of invasive ambush predators.

This project aims to increase the public awareness on the need to preserve coral reefs, indicating how the insightful policy of Bahamas government in establish a network of MPAs is actually making of the Bahamas reefs a worldwide model, an *hope spot* for marine biodiversity. By recording the presence, abundance and behavior of two fish species, one of which affected by alien species invasion in unprotected areas, we intend to set an easy tool to advertise the healthy status of Bahamas marine environments. Non-professional scientists, such as university students, diving centers, tourists will be involved in snorkel surveys. In 2013 the information will be collected in the most successful Bahamas marine protected area, the Exuma Cays Land and Sea Park, by a marine biologist of the University

of Padova with the support of two university students, from Italy and Bahamas. In the following years, in accordance with the Bahamas institution in charge of marine conservation and tourism development, additional surveys could be conducted in both protected and unprotected areas. In this second set of surveys, local diving centers, schools, and tourists will be involved.
The results will be presented in popular conferences, popular articles, tourism brochure, schools, as well as the advertising media of television, radio, and internet.

Background

The importance of healthy coral reefs for the sustainability of the wider ecosystem and for maintenance of viable recreational, fisheries, and tourism activities is widely accepted (Hughes et al. 2003). The ''ecological'' solution most actively promoted by the natural science community for improving the health of coral reefs is to create networks of marine reserves or no-take areas (National Research Council 2000, Palumbi 2002, Lubchenco et al. 2003). Indeed, such networks offer the best hedge against overfishing within a biogeographic region by connecting egg and larval dispersal and juvenile and adult migration paths. Networks also enhance opportunities to build scientific understanding of complex marine ecosystems by protecting interdependent populations from extractive activities. Last, but not least, networks of reserves preserve critical habitat and allow low-impact activities like ecotourism to thrive. The public interest in marine conservation may play a fundamental role in sustaining the establishment of protected areas. This is why, in addition to the traditional advertising media of television and radio, as well as the internet, is critical to try to get the public, both foreign visitors and local residents, involved in evaluating the effects of marine protection in properly managed areas.

The Bahamas is a model setting, a sort of "hope spot" of coral reef conservation, to increase public attention to the invaluable positive effects of the establishment of a network of marine reserves. The Bahamas, an archipelago of more than 3000 islands and cays spanning more than 600 miles, is home to extensive coral reefs and marine resource-dependent communities in terms of direct (commercial and subsistence fishing) and indirect (tourism, including recreational fishing and diving) contributions to household livelihoods. Here, in 1959, the first marine reserve in the Caribbean was established: the Exuma Cays Land and Sea Park (managed by the Bahamas National Trust). Over the next 25 years, as

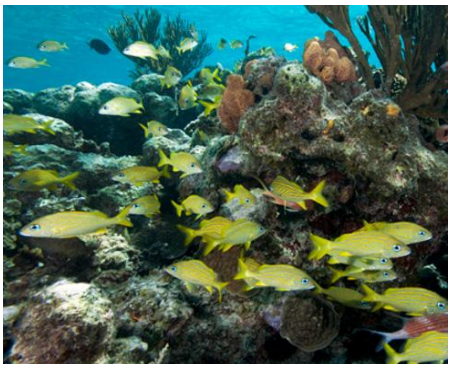
pressure on the fisheries and other marine resources in the Exuma islands increased, the Bahamas made the park a "no-take zone", i.e. a Marine Protected Area that prohibits extractive activities. Then, in recognition of the importance of the marine environment and in step with management trends globally, in 2000, the Commonwealth of the Bahamian planned a pioneering efforts to establish the world's first networks of "no-take" MPAs (Stoner et al. 1999). In 2002, additional MPAs were created as national parks, under the management of the Bahamas National Trust, with the intent to protect 20% of costal marine habitat. The positive outcome of this environmental policy has been documented by several analyses, published in the most prestigious scientific journals (see for instance the results of the Bahamas Biocomplexity Project http://bbp.amnh.org/website/products.html).

Bahamas MPAs are playing an important role as replenishment areas for species that are exploited in surrounding waters. For instance, the concentration of queen conch, *Strombus gigas*, inside the Exuma Park has been estimated to be 31 times greater than outside the Park. Spiny lobster, *Panulirus argus*, spawned in the Park appear to be repopulating areas around Cat Island – 70 miles away. Fish communities within marine reserves are very different from those outside of reserves, showing a higher abundance of large top predators — like snappers, groupers and barracudas. The population of Nassau grouper, *Epinephelus striatus*, an high valuable species for local commercial fishery, fall in the top 1% of all Caribbean sites (Mumby et al. 2011). In addition, grouper predation appears to act as a biocontrol of the invasive species (Mumby et al. 2011), allowing the structure and function of marine ecosystems, included in the MPA network, to remain mostly unaffected by alien species threats. The case of the invasion of the world's most ornate fishes, the Indo-Pacific lionfish, *Pterois volitans/miles*, of the Bahamas habitats is, if needed, a perfect example of the primary role of MPAs network in preserving marine ecosystems.

Lionfish released from aquaria in Florida a decade ago (Betancur et al. 2011) produced, over the last five years, an invasion of unparalleled speed and magnitude, involving much of the Caribbean (Schofield 1999). What makes the invasion of these species important is their voracious appetite for small fishes (Albins & Hixon 2008; Côté & Maljkovic´ 2010) combined with their ability to invade multiple habitats, ranging from the outer margins of reefs to sheltered mangrove lagoons (Barbour et al. 2010). These ambush predators consume a wide variety of native fish and invertebrate species at high rates, and are well defended from predation by venomous fin spines (Green et al. 2011; Hoegh-Guldberg et al. 2003). In

unprotected Caribbean areas, lionfish abundance increased rapidly between 2004 and 2010, by which time lionfish comprised nearly 40% of the total predator biomass with a dramatic decrease on the biomass of their 42 local prey fishes (Green et al. 2011). However, recent surveys along a chain of Bahamian reefs, including the region's most successful marine reserves, showed that protected habitats suffer the lowest effects of lionfish invasion. For instance, in Exuma Cays Land and Sea Park, where grouper biomass is abundant, lionfish biomass is 7-fold reduced compared to unprotected reefs (Mumby et al. 2011). Moreover, in protected areas the 42 small-bodied local fish species consumed by lionfish do not show significant signs of decline (Green et al., 2011). Some of these species, such as gobies and wrasses, are very common also in shallow water and can be spotted by snorkelling. Thus a control of their presence and abundance, a sign of environmental viability, can be easily performed in snorkel surveys and, through the involvement of students and tourists, may be used as a tool to increase public awareness on the effectiveness of the "Bahamas hope spot".





Exuma Cays Land and Sea Park

Aims

This project is aimed at increasing public interest in coral reef conservation highlighting the success of Bahamian protection policy. The ultimate goal is the advertising of Bahamas as an *hope spot* for coral reef biodiversity.

To accomplish this aim, non-professional scientists (i.e. students, tourists, diving centers, etc.) will be lead, under the coordination of marine biologists and Bahamas National Trust, to personally evaluate the positive effects of the Bahamas's network of MPAs. The sampling activities and their results will be spread in public conference, both in Italy and Bahamas, popular science articles and tourist brochure.

Description and sampling design

Snorkel surveys are widely used to monitor fish populations and to estimate both relative and total abundance (Slaney and Martin 1987). Snorkeling can also be used to assess fish distribution, presence/absence, species behavior, and habitat use. Because fish are not handled and disturbance is minimized, this technique is especially useful for sampling rare or protected stocks. Last, but not least, snorkel surveys can be performed also by briefly trained volunteers, non-professional scientists.

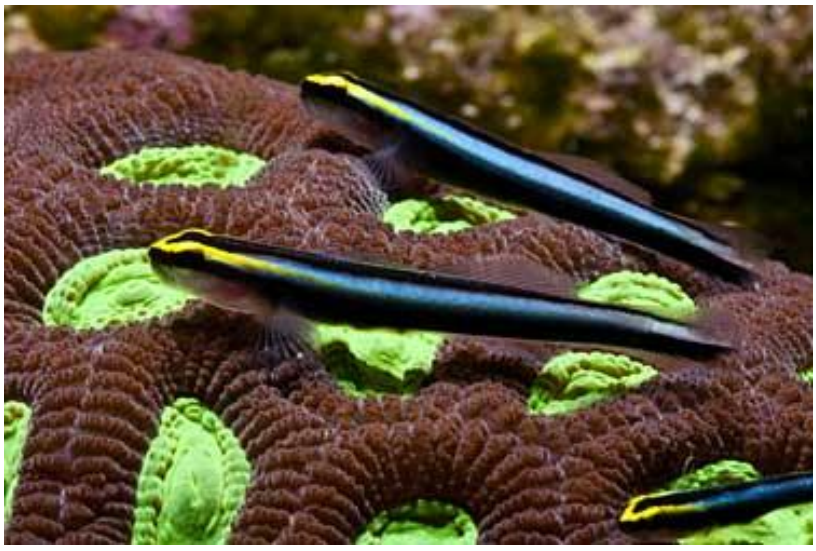
The project will focus the attention on two fish species, chosen on the basis of the most recent scientific results (Green et al. 2011; Mumby et al. 2011), as indicators of environmental condition. One species, the bluehead wrasse *Thalassoma bifasciatum* is directly affected by of lionfish invasion, while the other, the sharknose goby (or cleaner goby) *Elacatinus evelynae*, does not suffer lionfish presence.

a) The bluehead wrasse belongs to the wrasse family (Labridae); it is native to the coral reefs of the Caribbean Sea, where is one of the commonest and more abundant fish species. Like many other wrasse species, the bluehead is a protogynous sequential hermaphrodite: individuals may begin life either as males or females, but females can change sex later in life and function as males (Warner & Robertson 1972). Young/small females and males are yellow and white in color, often with black lateral stripes and occasionally dark vertical bars. This coloration is known as the

Bluehead wrasse. a) Initial Phase (IP); b) Terminal Phase (TP).

Initial Phase (IP). These individuals can rapidly alter the presence or intensity of their yellow color, stripes, and bars, and these color changes appear to correspond to behavioral changes. Large females and some males can permanently change coloration and/or sex and enter the Terminal Phase coloration (TP), which has a blue head, black and white bars behind the head, and a green body. It is this color phase that gives the species its name. Males of this coral reef fish have two modes of reproduction. Large, brightly colored "terminal-phase" (TP) males spawn in bisexual pairs with individual females, while small "initial-phase" (IP) males spawn in groups, with many males releasing sperm in synchrony with the egg released by a single female (Van den Berghe & Warner 1989). Lionfish prey bluehead wrasse smaller then 13 cm (Green et al. 2011) and, as a consequence, where these Indo-Pacific predators are present, a decline in the abundance and spawning frequency of this species is expected compared to sites where lionfish are absent or rare.

b) The sharknose goby is a very small (maximum size: 4 cm long), torpedo-shaped fish. They have dark bodies with iridescent stripes running from the tip of the nose to the base of the caudal fin. They are well-documented cleaner fish, setting up stations where often much larger fish (sometimes even fish which would normally



A pair of sharknose goby

eat the gobies) come to have the gobies eat their small external parasites. Males and females live in monogamous pairs and are strongly site-attached, occupying small cleaning stations on coral heads. Pairs forage together, engaging in cleaning bouts during which ectoparasites, scales and mucus may be removed from the surface of client fish (Arnal et al. 2001). Individuals of this species do not appear to be included in the lionfish diet (Green et al. 2011) and, consequently, their abundance is not expected to differ among similar habitat, in response to the presence of this predator.

We will a organize a simple protocol to record, during snorkel surveys, the: a) abundance of both species and b) bluehead wrasse spawning. The protocol will include information on the number of individual of each species and the size of the area surveyed. Surveys performed in the daytime corresponding to the bleuehead wrasse spawning time (11.00-13.00) will include information on ì) number of TP males, ìì) number of spawning of at least one TP male, ììì) presence/absence of IP group spawning, ìv) number of IP performing group spawning. The comparison of information collected in protected and unprotected reefs is expected to clearly highlight the effectiveness of MPAs in maintaining environmental viability. Indeed we expect that bluehead wrasse will be more abundant, and performing both pair and group spawings, in protected areas. By contrast the sharknose goby abundance, being the species unaffected by lionfish presence, is expected to be similar between protected and unprotected areas.

Time table

The project is organized in two parts.

- The first one will be accomplished in 2013 and will consists of a group of surveys performed in March 2013 in the Exuma Cays Land and Sea Park, the most successful Bahamas MPA. Information on the presence, frequency and behavior of the model species will be conducted by a marine biologist of the University of Padova, supported by two university students, from Italy and Bahamas. The italian team will use as outpost base the Italian boat Jancris.

Deliverables : the results of the two week surveys will be presented:

a) in popular conference, as well as when possible in radio an(d television. These presentation will take advantage of the project acronym (BACH) to drawn attention to the results using specific classic music,
b) popular science articles,
c) a tourist brochure, as well as when possible in radio and television.

- The second part of the project will be organized in following years, in accordance with the institutions involved in the Bahamas marine conservation, i.e. the Bahamas National Trust, the Ministry of Tourism, and the Ministry of the Environment. This part will consist of surveys performed both in protected and unprotected area and will involve local diving centers, hotels, as well as high school and university students. The marine biologists of the Department of Biology of the University of Padova will establish a) a brochure with the description of the species, the project aim, and the data to be recorded for the use of diving centers, schools, etc. and b) a simple form to be filled by the volunteers during the survey.

The results are expected to strongly highlight the high conservation level of MPAs, enhancing the public image of the Bahamas as a coral reef *hope spot* .

The results of these surveys will be advertised in popular conferences, diving centers, schools. However, we believe that it will be the involvement of non-professional scientists that will allow the capillary spreading of the idea that the pioneering Bahamas policy in marine conservation has to be considered as worldwide model to respond to the threats that marine environments are suffering.

If this second part will be realized, considered the massive involvement in the data collection of different types of non-professional scientists, the project will be defined in popular conferences and media ad a "BACH symphony", again taking advantage of the project acronym.

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Padova, May 31st 2012

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