Coral Restoration in Old Providence Atoll, Seaflower MPA, after Beta Hurricane: A Joint Work among Scientists, Technicians and Fishermen

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ABSTRACT

Old Providence atoll is part of the San Andres Archipelago and constitutes the central section of the SeaFlower marine protected area (MPA), one of the largest MPA in the Americas. This elongated atoll covers an area of 255 km^2 and has well developed reef habitats, including an extensive barrier reef (35~ km^2) as well other leeward, windward and lagoonal environments. Among the seven major habitat types identified, coral cover and coral species richness is highest at coral patches. Fish biomass is also high in coral patches, with larger biomass composed mainly by herbivores, thus representing one of the most productive and complex habitat types. Unfortunately, high water temperatures registered in 2005 resulted in coral bleaching and other coral disease such as white plague, particularly at coral patches. Stressed corals in Old Providence suffer additional damages due to the Hurricane Beta, which crossed its northern end in October 27-28, 2005. Beta was a category one hurricane with 110 km/hour (70 mph) sustained winds and 989 mb of atmospheric pressure. As a consequence, around 20% of the coral colonies at lagoonal coral patches, in the first 5 m depth, were dislodged and fractured and subjected to erosion and up-side down positioning. CORALINA, the MPA manager, with the support of the Ministry of Environment, contracted trained personnel as well as recreational divers and artisanal fishers to conduct a rapid assessment on coral damages and perform coral restoration actions following techniques learned from the Florida Keys National Sanctuary Personnel. A total of 186 coral colonies along seven miles we re-attached and have been monitored every two months. Results have been used in several education activities conducted by CORALINA. This project illustrates the benefits of having trained personnel, the support of the local community and the importance of share experiences with students, all three important aspects needed for MPA implementation.

KEY WORDS: Coral restoration, hurricane impacts, MPA management actions.

Restauración de Corales en el Atolón de Old Providence, AMP Seaflower, Después del Paso del Huracán Beta: un Trabajo Conjunto entre Científicos, Técnicos y Pescadores

El atolón de Old Providence es parte del archipiélago de San Andrés y constituye la sección central del área marina protegida (AMP) SeaFlower, una de las mayores AMP en las Américas. Este atolón elongado cubre una área de 255 km^2 y tiene arrecifes coralinos bien desarrollados, incluyendo una extensa barrera arrecifal (35~ km^2), y otros ambientes protegidos, expuestos y lagunares. Entre los siete principales hábitats que han sido identificados, la cobertura de coral y la riqueza de especies de coral es mayor en el hábitat de parche de coral. La biomasa de peces es también alta en los parches de coral, y se compone principalmente por peces herbívoros; por lo tanto representan uno de los hábitats más productivos y complejos. Desafortunadamente, las altas temperaturas registradas en el 2005 resultaron en el blanqueamiento de corales y otras enfermedades, como la plaga blanca. Los corales ya estresados sufrieron un daño adicional debido al paso del huracán Beta, el cual cruzó el extremo norte de la plataforma entre el 27 y 28 de Octubre, 2005. Beta fue un huracán categoría uno, con vientos sostenidos de 110 km/hora (70 mph) y una presión atmosférica de 989 mb. A consecuencia, cerca del 20% de las colonias de coral de los parches de coral de la laguna arrecifal, en los primeros 5m de profundidad, se desprendieron y fracturaron quedando sujetos a la erosión y volcamiento. CORALINA, agencia manejadora del AMP, con el apoyo del Ministerio del Ambiente, se contrató personal entrenado, buzos recreativos y pescadores artesanales para hacer una evaluación rápida de los daños y adelantar acciones de restauración de coral aplicando técnicas aprendidas del personal del Santuario Nacional de los Cayos de la Florida. Un total de 186 colonias de coral a lo largo de 7 millas fueron re-adheridos y han sido monitoreados cada dos meses. Los resultados de este proyecto han dio divulgados en las actividades de educación ambiental de CORALINA. Este proyecto ilustra la importancia de tener personal entrenado, de contar con el apoyo de la comunidad local y de compartir conocimientos y experiencias con estudiantes, todos aspectos necesarios para la implementación de la AMP SeaFlower.

PALABRAS CLAVES: Restauración de coral, impacto de huracanes, acciones de manejo en AMP

INTRODUCCION

Last October 27-28, 2005, the category one hurricane Beta crosses the Old Providence and Santa Catalina insular shelf with sustained winds of 110 km/h (70 mph) and an atmospheric pressure of 989 milibars. As a direct consequence, the well developed coral reefs present in the area were upside down and suffered coral dislodgments, colony fractures, and to up 25% increase in recent coral mortality depending on their spatial location, with higher values seen in shallow coral patches at the northern section of the insular (Taylor et al. in press). Prior to the hurricane impact, corals reefs were affected by white plague and bleaching believed to be caused by an extended period of elevated water temperature. In fact, between May and October 2005 weekly temperature in surface waters registered on average 30 ˚C.

This paper describes the actions taken by CORALINA in order to develop a coral restoration project, and constitutes only one of the several aspects conducted in order to initiate an intensive ecosystem recovery actions which significantly affected not only the marine environment, but in addition all coastal and terrestrial ecosystems. In doing so, CORALINA personnel supported by artisanal fishers, military personnel and students transferred knowledge and experience in coral restoration techniques initially received from scientists at the Florida Keys National Marine Sanctuary (FKNMS). Successful results presented here are showing a clear example of a functional networking in MPA implementation, technological transfer, and the importance of national and international cooperation.

STUDY AREA

Old Providence and Santa Catalina is one of the atolls that comprise the San Andres archipelago in the Western Caribbean which belongs to Colombia. This archipelago was recognized by UNESCO as the Seaflower Biosphere Reserve in 2000, and in 2005 Old Providence and Santa Catalina were included within the multiple use Seaflower MPA as its central section. The Seaflower MPA extends over 65,000 km2, with the central section representing 20%, however the insular shelf is only 255 km^2.

The platform of Old Providence and Santa Catalina is elongated and covered by well developed coral reefs in which seven different habitat types (coral crest, coral patches, fore reef, leeward reefs, gorgonian plains, sea grass and sands/silts) and three waves regimes (leeward, wind ward, lagoonal) has been identified (Marquez 1997, Díaz et al. 2000). Live coral coverage varies from 1 to 38% depending on the site, with the coral patches and leeward reefs having maximum species richness (Friedlander et al. 2003). Algae cover in the shelf is high compared with San Andres, despite increases in number of sea urchins regularly monitoring with CARICOMP protocol (García y Pizarro 2002, Herrón 2004). The Hurricane Beta crosses the insular shelf on its northern section from east to west (Figure 1).

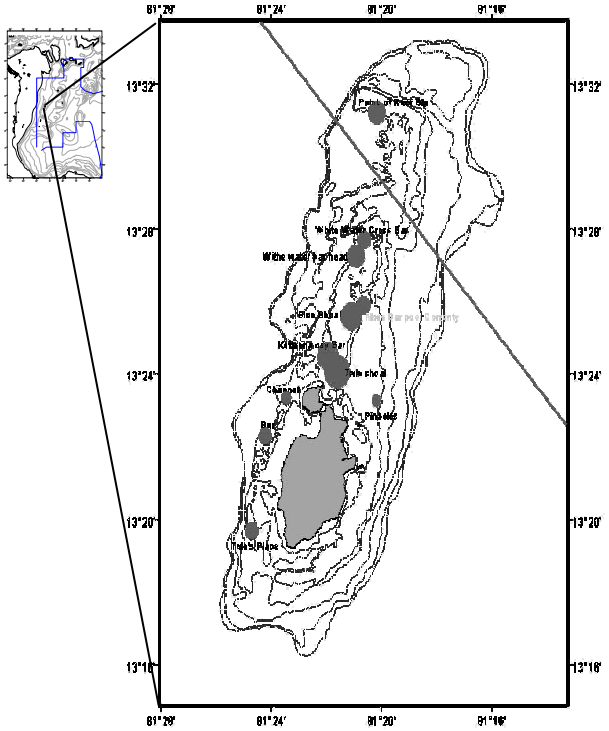

Figure 1. Old Providence and Santa Catalina insular shelf illustrating the proximately Beta hurricane pathway in Oct, 2005. Rapid assessment on recent coral mortality surveyed at 11 sites across the shelf (scaled solid circles). Large circles represent up to 20% in coral mortality, small circles represent minimum of 5% increases in recent coral mortality. Sites on the northern section of the shelf were subjected to coral restoration. Scale 1:100.000.

METHODS

Within a cooperative work that CORALINA is conducting with the FKNMS, local scientists and technicians received training in coral restoration methods in July, 2005, just before the Hurricane Beta. Restoration techniques Learnt by CORALINA personnel were then transferred to artisanal fishers and students establishing a working team who were able to quickly initiate a short term coral recovery actions. The technique consisted basically in colony re-attachment using Portland cement, type 2. CORALINA technicians improved the technique by siting the coral colonies on an external structure made of iron bars and wire to support those colonies lacking enough surface area to appropriate re-attachment.

A total of 186 coral colonies of medium size ranging from 15 to 65 cm in diameter were re-attached in six of the 11 sites initially inspected having shallow coral patches ($\leq$ 8 m) located on the northern section of the insular shelf with a mean of 16 (SD=8.8) coral colonies per site (Table 1, Figure 1). To facilitate future inspections, each colony was marked with plastic/aluminum once recovered, and GPS coordinates for each site was registered. Restoration took place the first two weeks in February 2006, or three

months after the hurricane impact.

Data on initial coral condition was measured one month after the hurricane and again at the time of recovery. Partial measurements on percent of recent mortality, bleaching and colony size (long and width axis) were also conducted in April and July, 2006 in order to assess success of the restoration work.

RESULTS

Reattachment of the coral colonies was successful in 100% of the cases, cement and external frames were quickly colonized, not being possible to be identified three months after restoration. Recovered corals belonged to four species, form which 42% were loved, montanius star or boulder star (*Montastrea* complex), 33% brain (*Diploria* sp.), 17% mustard hill (*Porites porites*), 4% were lettuce (*Agaricia* sp.), 3% Massive starlet (*Siderastrea siderea*) and the remaining 2% were *Millepora* sp.

As reported by Taylor et al. (in press), coral recent mortality at the northern section of the insular shelf was estimated in 20% in December, 2005, and only 10% at the most northern end of the shelf. Similar values were estimated in February 2006, at the of the restoration. Despite not having statistically significance, there was a trend in reducing recent mortality of recovered corals, diminishing to 18% (SD=18) in April 2006 and to only 2% (SD=4) in July 2006. Similarly, bleaching affected restored corals in 11% (SD=12) in February 2006 and to 9% (SD=9) and 8% (SD=8) in July 2007.

Additional coral mortality, not related with the hurricane, began to be observed seven months after the hurricane, mortality seen not only in recovered colonies, but also on several colonies and several species at the shallow patch recovered sites. New and low coral mortality impacts might be associated again with high water temperatures, having similar values to those measured in 2005 (mean of 29.5, SD=1.5). Similarly, significant reduction in fleshy algae due to strong currents and winds, by July 2006, had grown to the levels seen prior to Beta hurricane (mean coverage around 30 to 50%, depending on the site).

Unfortunately, large coral colonies (≥ 1 m in diameter) in good health prior to the Beta impact and found upside down were not recovered due to lack of appropriate size lift bags. Those colonies are exhibiting low and progressive levels of bleaching, are not yet under monitoring to evaluate their performance.

CORALINA's rapid response to restore environmental impacts caused by Beta hurricane was possible because of dedication and participation from a wide variety of stakeholders such as artisanal fshers, navy personnel, Old Providence and Santa Catalina department of planning and developing, high school and university students, National Parks Division and the Minister of Environment, housing and Development. This is a clear example on how MPA implementation needs to look not only to restrictions, but also to promote recovery of ecosystem functioning and services.

DISCUSSION

Satisfactory results on coral restoration achieved with this project demonstrated the importance to have a functional MPA networking which allowed to have trained personnel on key issues at the time when most needed. Initial training and permanent assessment from the Florida Keys

Table 1. Sites characteristics where coral restoration took place. For site location see Figure 1.

Site Name	Site code	No. Colonies	No. Species	Mean colony Length	Mean colony Width
Blue shoal	BSH	12	3	28	22
Channel shoal	CHS	16	4	27	22
Katalina key bar	KKB	4	3	32	27
Catalina key east	KKE	17	5	26	18
Point of big reef 1	PR1	15	3	24	21
Point of big reef 2	PR2	14	2	31	23
Socky drum 1	SD1	40	5	29	21
Socky drum 2	SD2	22	6	40	24
White bar head1	WBH	17	5	31	22
Wshite bar head2	WSH	15	4	39	30
Twin shoal	TSH	14	2	30	25

National Marine Sanctuary gave local MPA managers the confidence to conduct this field project and to innovate in the use of local materials and technique modifications. Networking combined both national and international participation increasing probabilities of success not only in overcoming losses generated with this category one hurricane, but in addition to be able to translate MPA planning into actions.

Perhaps the success of this project laid not only in the broad participation of MPA users from the local community, which indeed resulted critical to meet goals and objectives, but also in allowing the people to express their ideas, analyze and make decisions on appropriate methods, and invite them to actively be part of the solutions affecting islands ecosystems. This co-management approach is the beginning of a new approach CORALINA is taken to manage the Seaflower MPA.

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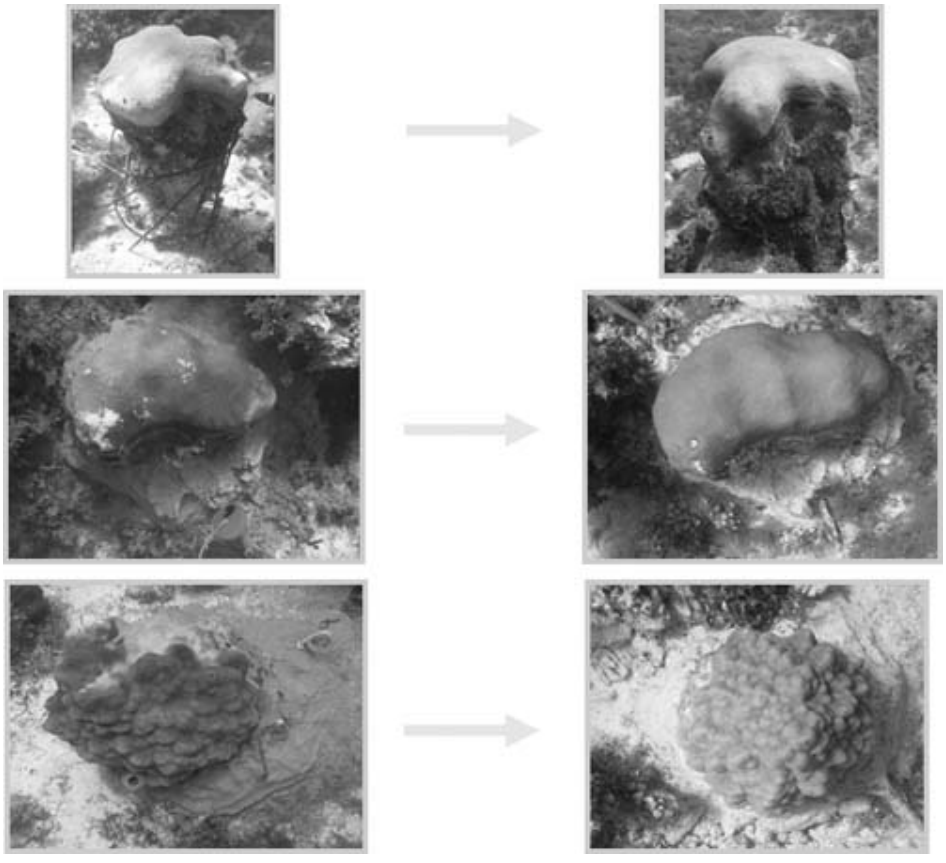

Figure 3. Underwater pictures on selected coral colonies showing coral recovery in four months after coral recovery actions. All pictures taken by Giovanna Peñaloza.

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