The Global Conservation Program

Achievements and Lessons Learned from 10 Years of Support for Threats-based Conservation at a Landscape and Seascape Scale

Glover's Reef Living Seascape:

Safeguarding Marine Resources and Rural Livelihoods in Belize

WILDLIFE CONSERVATION SOCIETY

Glover's Reef Living Seascape

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Key Achievements, Impacts and Lessons Learned Attained with GCP Funding

The Glover's Reef Living Seascape (GRLS) project aims to conserve the outstanding biodiversity and natural beauty of Glover's Reef Atoll, the first coral reef site to be adopted under the WCS Living Landscapes Program[1] and included in the WCS/USAID GCP-II portfolio of conservation sites. The main objective of this project has been the development and implementation of a multi-partner conservation strategy to reduce the key threats to the atoll's biodiversity. Since its inception in 2003, the project has had numerous successes and made a positive impact at this globally significant seascape.

1 The Living Landscapes Program develops and tests threats-based, highly participatory and wildlife-focused strategies to resolve the conflicts between people and wildlife that threaten important wild places and the biodiversity they support.

Glover's Reef Living Seascape, Project Highlights

- **Participatory Threats Assessment.** The Glover's Reef Advisory Committee and other local experts completed a participatory spatial assessment of human activities in 2004. This process laid the foundation for the project, identifying the four main threats to Glover's Reef: overfishing; coral bleaching; coral damage; and nutrient/pesticide pollution. Activities to conserve the productivity and diversity of the atoll and sustain local incomes have reduced these threats through the implementation of high-priority interventions that are feasible, measurable and cost-effective.

- **Seascape Species Selection.** With input from international and local experts, and endorsed by an Advisory Committee of stakeholders, a suite of seven Seascape Species was chosen: hawksbill turtle; Nassau grouper; osprey; star coral; Caribbean reef shark; queen conch; and black-spined sea urchin. These focal species provide the lens through which interventions are planned and form the basis of the monitoring program to measure the effectiveness of the conservation interventions undertaken at the site.

Box 1: Belizean Government Enacts Sweeping New Laws to Protect its Coral Reefs and Fisheries

In April 2009, the Belizean Ministry of Agriculture and Fisheries enacted a far-reaching new set of regulations to place parrotfish, Nassau grouper and other species under new protection. The Wildlife Conservation Society's research and conservation work has helped inform these new laws, which will better protect Belize's extensive coral reefs. The changes in regulations are as follows:

1. The first new law will protect parrotfish and other grazers (such as doctor and surgeon fish), which studies have shown keep algal growth in check, thus encouraging more coral growth. In years past, fishers did not target grazing fish, catching mainly snappers and groupers instead. However, as these species declined, fishers have turned to the next tier of the food web, namely the herbivores and, in particular, parrotfish. WCS catch data show that parrotfish are now the most commonly caught fish on Glover's Reef. Protection of parrotfish and other grazers is expected to encourage coral growth, thereby increasing the percentage of live coral cover on the reef.

2. The second new law will set minimum and maximum size limits in order to protect the Nassau grouper, which is listed as an endangered species by IUCN and has suffered dramatic declines in Belize. Although fishers usually bring in their catch as fillets, the new rules also require that all Nassau grouper be brought back to the dock whole, ensuring correct identification; all other fish species can still be brought in as fillets, as long as they retain a patch of skin to allow for species identification.

3. The third new law bans spearfishing within marine reserves. Spearfishing is the main method used to take grazing fish, Nassau grouper, and other groupers and has caused severe declines of these species.

4. The new laws also change the zoning regulations for South Water Caye and Sapodilla Cayes marine reserves to include "no take" areas closed to fishing. This includes the Pelican Cayes area, which is known as a biodiversity hotspot for rare sponges and tunicates (a type of marine animal that includes sea squirts). Although these marine reserves were declared in 1996 and form part of a World Heritage Site, they have not been off-limits to fishing until now.

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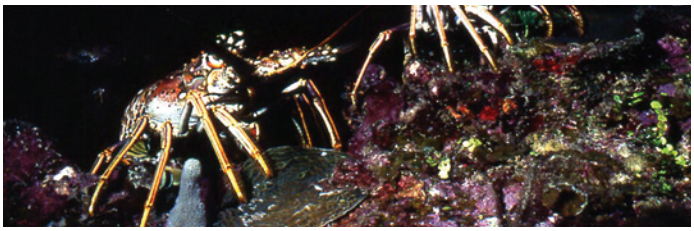
• **Revitalized Glover's Reef Advisory Committee.** GCP-supported training workshops gave the virtually dormant Glover's Reef Advisory Committee (GRAC) new life, transforming it into a revitalized committee with strongly-attended quarterly meetings which encourage active participation. The GRAC recognized the need for increased fishing community representation, and adjusted its membership accordingly; furthermore, it now provides significant input to fisheries and marine reserve policy, advising the Marine Reserve's management and the Fisheries Department on critical issues. In practice, having the GRAC act as a co-manager of the reserve provided the necessary catalyst for the Fisheries Department to develop an enforcement policy[2], and led to a recommendation for limiting fishing access on the atoll to traditional fishers[3]. In fact, the Fisheries Department has encouraged the GRAC to assume even more responsibility. The revitalization of the committee allowed it to become an effective mechanism for genuine stakeholder participation in resource management and to provide a successful example of involvement in management to other marine reserve advisory committees along the nation's coastline.



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2 Illegal nighttime fishing became a main concern in FY06, and the committee helped to draft an enforcement policy for the Fisheries Department's consideration. The recommended enforcement policy was taken up by the Department; a draft policy was prepared, reviewed by enforcement personnel within the Department and submitted to the Fisheries Administrator for endorsement.

3 Members also recognized that a reduction in fishing effort is necessary to achieve sustainability on the atoll; to this end, GRAC recommended that the Fisheries Department introduce a limit on the number of fishing licenses issued for Glover's Reef. In FY08, the recommendation to limit fishing access on the atoll to traditional fishers was accepted; in January 2008, the Department began issuing special licenses only to fishers who had a previous record of fishing on the atoll. This license program suffered a glitch when a member of the executive committee of one of the fishing co-operatives objected to the special license program, leading the Fisheries Department to put the program on hold until further consultation with stakeholders (which is currently underway). Nevertheless, the Fisheries Department is still very supportive of the idea and says that it plans to reinstitute the issuing of special licenses at Glover's even though there is currently no date set for it to start.

• **The Fisheries Catch Data Collection Program.** The establishment of a catch and effort data collection system for the atoll at the inception of the project was critical in informing fisheries management. This program involves local fishers concerned about the poor state of the fishery in the collection of catch data, thereby encouraging their involvement in the sustainable management of their own fishery[4]. The results of this catch data collection program indicate that fishers tend to take mainly juvenile groupers, leading to discussions with officials at the Fisheries Department on the possibility of implementing size-limit restrictions for the species. The data also revealed that parrotfish are the most commonly caught species on the atoll, a cause for concern as they are important herbivores which keep the coral reefs clean of algal growth. (See Box 1 for significant biodiversity and livelihoods conservation successes resulting from these activities.)

• **Conservation Seascapes.** The Human and Biological Seascape models were generated and then Conservation Seascapes were developed for each of the seven Seascape Species. These models were approved by the GRAC and local experts, and they formed the basis of the conservation strategy for the atoll. This planning approach ensured that both human aspects and ecological attributes were taken into account in the strategy's development, increasing the likelihood that the management measures implemented will be the most acceptable and successful in the long-term.

• **Long-term Atoll Monitoring Program (LAMP).** Begun in October 2004 and conducted in partnership with Marine Reserve staff, LAMP collects fishery-independent size information on several commercially-fished species (spiny lobster, queen conch, Nassau grouper, black grouper, hogfish, mutton snapper, queen triggerfish and parrotfish). Results are shared with the Fisheries Department and presented at national and international marine science meetings. One of the major findings was that 18% of legally-sized conch were juveniles with no flared lip that had not yet reproduced. An indication of the success of this program is that the Fisheries Department is considering revising the regulations on conch size limits in light of this information.

4 This program involved the participation of over 60 fishers from Sarteneja and Hopkins in FY06, and over 100 fishers in FY08.

• **Alternative Livelihood Activities.** Funds from WCS and the GEF Small Grants Programme's COMPACT (Community Management of Protected Areas for Conservation) project to SWEET (Sarteneja Wildlife, Environment and Ecotourism Team), a local Sarteneja NGO, supported tour-guide training provided to fishers. COMPACT provided funds for additional training in fly fishing and small business management. WCS supported follow-up training to improve skills in: computer literacy, giving presentations, developing strategic plans, creating a tourism development plan for the village, project reporting, accounting and evaluation. This allowed for institutional strengthening of SWEET, the Sarteneja Tour Guide Association and the Sarteneja Fisherman Association.

• **New Monitoring Programs.** During FY07, new monitoring programs were launched for two of the Seascape Species: the hawksbill turtle[5] and long-spined black sea urchin (*Diadema*)[6]. The hawksbill monitoring program involves tagging and tissue sample collection on a regular schedule of thrice-yearly in-water turtle surveys, and fosters a close working relationship with reserve staff. Monitoring of *Diadema*, an extremely important herbivore at Glover's Reef, involved the formation of a long-term partnership with a professor from the University of Belize.

• **Management Planning Framework for the Glover's Reef Marine Reserve.** Weak management, insufficient planning guidelines, and lack of sustainable financing were identified as contributing to the loss of the atoll's biodiversity. Three documents were prepared to directly address these factors: (1) a revised management plan with six components (natural resource management, research and monitoring, community participation, public use, infrastructure, and administration); (2) a business plan, which outlines straightforward actions to make the Marine Reserve more financially sustainable; and (3) a document entitled *Best Practices for the Cayes*[7], which complements the overall management plan and addresses concerns such as vegetation clearance, impact of activities on nesting sea turtles, waste disposal, and energy use with the goal of encouraging eco-friendly practices in this vulnerable area. Coastal development is a major threat to all marine ecosystems, thus a user-friendly pamphlet based on the best practices document was prepared for wide distribution, to guide development on other Belizean cayes as well.

• **Halting the Decline of the Nassau Grouper.** A monitoring program for the Glover's Reef Nassau grouper spawning aggregation at Northeast Point was established, in partnership with staff from the WCS station and the Marine Reserve. Fishers who formerly fished this area were hired to assist with the monitoring. In response to the alarmingly low counts of spawning Nassau grouper at Northeast Point, and declining numbers of spawning groupers nationwide, the National Spawning Aggregation Working Group (with WCS as secretariat) drafted several recommendations for additional measures to be instituted. These included the introduction of a moratorium on the fishing of Nassau grouper and a ban on spearfishing within marine reserves. Fishers represented in the Working Group expressed support for the measures proposed[8], which were submitted to the Ministry of Fisheries. (The resulting legislative success is described in Box 1.) Additionally, the group spearheaded a public outreach campaign to raise awareness about the urgent need for protection of this species and focused efforts to improve spawning site enforcement by reserve staff. If strengthened enforcement is maintained, it is hoped that the recent trend of increasing counts of Nassau grouper at Northeast Point will continue.

5 Anecdotal reports had indicated the presence of juvenile turtles but very little nesting on the cayes. The results of the in-water surveys confirmed that the atoll provides important foraging habitat for this highly endangered species and supports a large population of juveniles. An additional success of this project was the recruitment of two resort owners on the atoll to assist in the monitoring of hawksbill nesting activity on their islands.

6 *Diadema* experienced a die-off throughout the Caribbean in the early 1980s; this project monitors its comeback. If it is able to recover to its former densities at Glover's Reef, it is hoped that higher coral cover on the atoll will result.

7 The participatory approach of including the GRAC and landowners was key to bringing landowners on board and enhancing their willingness to adopt proposals for the conservation of cayes which are healthy enough to support the biodiversity and livelihoods that depend upon them.

8 For example, at one GRAC meeting, a Sarteneja fisherman committee member reported that Sarteneja fishers would be willing to stop fishing for Nassau grouper if they were granted special licenses to fish the atoll.

- **Assessment of Glover's Reef Osprey Population.** The ospreys found in Belize are a non-migratory race of the species (*Pandion haliaetus ridgwayi*), which is believed to number only 100-150 pairs of birds. WCS's osprey expertise permitted a first assessment of the osprey population at Glover's Reef. The osprey, one of our Seascape Species, nests primarily in trees on the cayes and feeds in the atoll lagoon, thus bridging both terrestrial and marine environments. Plans for future work include: monitoring the population at Glover's over the coming years; refining Conservation Seascapes for the species; and contributing to the body of knowledge on this unique endemic Caribbean species.

- **GCP Partner Collaboration.** WCS collaborated with international partners on several activities. In the Spawning Aggregation Working Group, for example, working closely with The Nature Conservancy (TNC) was vital to the development of the database, the Nassau grouper posters and the broadcasting of the TV spot (the broadcasting costs were shared by WCS, TNC and the World Wildlife Fund [WWF]). WWF led a nationwide monitoring program to assess reef health, using the AGRRA (Atlantic and Gulf Rapid Reef Assessment) methodology; WCS contributed to the effort by monitoring 15 sites on Glover's Reef.

- **The Conservation Strategy for the GRLS.** A Conservation Strategy for Glover's Reef was completed, a major accomplishment that represents the successful planning and implementation of many activities during five years of the project. The Strategy was developed in a very participatory manner, is viewed as a product of the Glover's Reef Advisory Committee (GRAC), and has received endorsement from the Fisheries Department. The expectation is that the Strategy will be adopted and implemented over the next few years, leading to improved management at Glover's Reef and, ultimately, to the conservation of the Seascape Species and the wealth of biodiversity that they represent.

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GCP Program Background

The goal of the Wildlife Conservation Society's Biodiversity Conservation at the Landscape Scale (BCLS) Program is to ensure conservation of biological diversity in regions of global importance, using a landscape- (or seascape-) and species-based approach. For the past 10 years, the WCS Living Landscapes Program (LLP) has been developing and testing wildlife-focused strategies to resolve the conflicts between people and wildlife that threaten biodiversity found in these important wild places. The LLP-developed Landscape/Seascape Species Approach (LSA) is threats-based and highly participatory; it promotes conservation of landscapes (and seascapes) by focusing efforts on key animal species found within that landscape/seascape. The conservation of these Landscape Species offers a focused and cost-effective way to retain a full complement of biodiversity and overall ecological integrity.

While WCS recognizes the integral role that protected areas play within national biodiversity conservation plans, we also realize that parks and reserves are seldom sacrosanct and are always embedded in larger, human-dominated landscapes. Regardless of how large or small a protected area may be, the plants and animals it contains are often threatened by human resource use, whether directly or indirectly. Therefore, the management of parks and reserves cannot occur in isolation from the surrounding landscape; rather, management plans must take into account where and how human activities conflict with biodiversity conservation as well as where conservation activities might adversely impact human welfare. As human populations continue to expand, the incentive for over-exploiting natural resources within and outside protected areas will increase and, therefore, the need for biodiversity conservation tools that address human-wildlife conflict will become even more important. In our efforts to conserve Landscape Species that frequently move beyond protected area boundaries, we recognize that parks and reserves must be integrated into the broader landscape, a landscape in which, realistically, people will continue to exploit natural areas and wild species to meet their socio-economic needs.

The Wildlife Conservation Society's BCLS Program was designed to ensure biodiversity conservation in a selection of globally significant sites, by identifying actions to conserve Landscape Species and by increasing the capacity of local and national organizations to implement such actions. Over the course of Cooperative Agreement LAG-A-00-99-00047-00, the WCS GCPII/USAID portfolio has included 7 sites:

- **Glover's Reef Living Seascape** (Belize)
- **Greater Madidi Landscape Conservation Area** (Bolivia)
- **Ndoki-Likouala Landscape Conservation Area** (Republic of Congo)
- **Greater Yasuní-Napo Moist Forest Landscape Conservation Area** (Ecuador)
- **Maya Biosphere Reserve Living Landscape** (Guatemala)
- **The Eastern Steppe Living Landscape** (Mongolia)
- **Southern Sudan Transboundary Living Landscape** (Southern Sudan)

Location, Global Importance and Key Threats to this Seascape

The Glover's Reef Living Seascape project works to conserve the outstanding biodiversity and natural beauty of Glover's Reef Atoll (see Figure 1). The atoll is located within the southern portion of the Belize Barrier Reef[9], considered by many to be the most pristine in the Western hemisphere. Glover's Reef, 30 miles off the coast of Belize and one of only four atolls in the Atlantic, possesses the greatest range of reef types in the Caribbean Sea. The atoll's spur and groove outer reef encircles a shallow, protected lagoon that is dotted with more than 800 patch reefs and supports an extraordinary amount of biological diversity. This lagoon provides nursery and feeding habitats for at least three species of sea turtles, eight species of sharks and rays, more than twenty species of aggregating reef fish and numerous species of coral. One of the Caribbean's

9 The Belize Barrier Reef is part of the largest coral reef system in the Western Hemisphere, the Mesoamerican Barrier Reef.

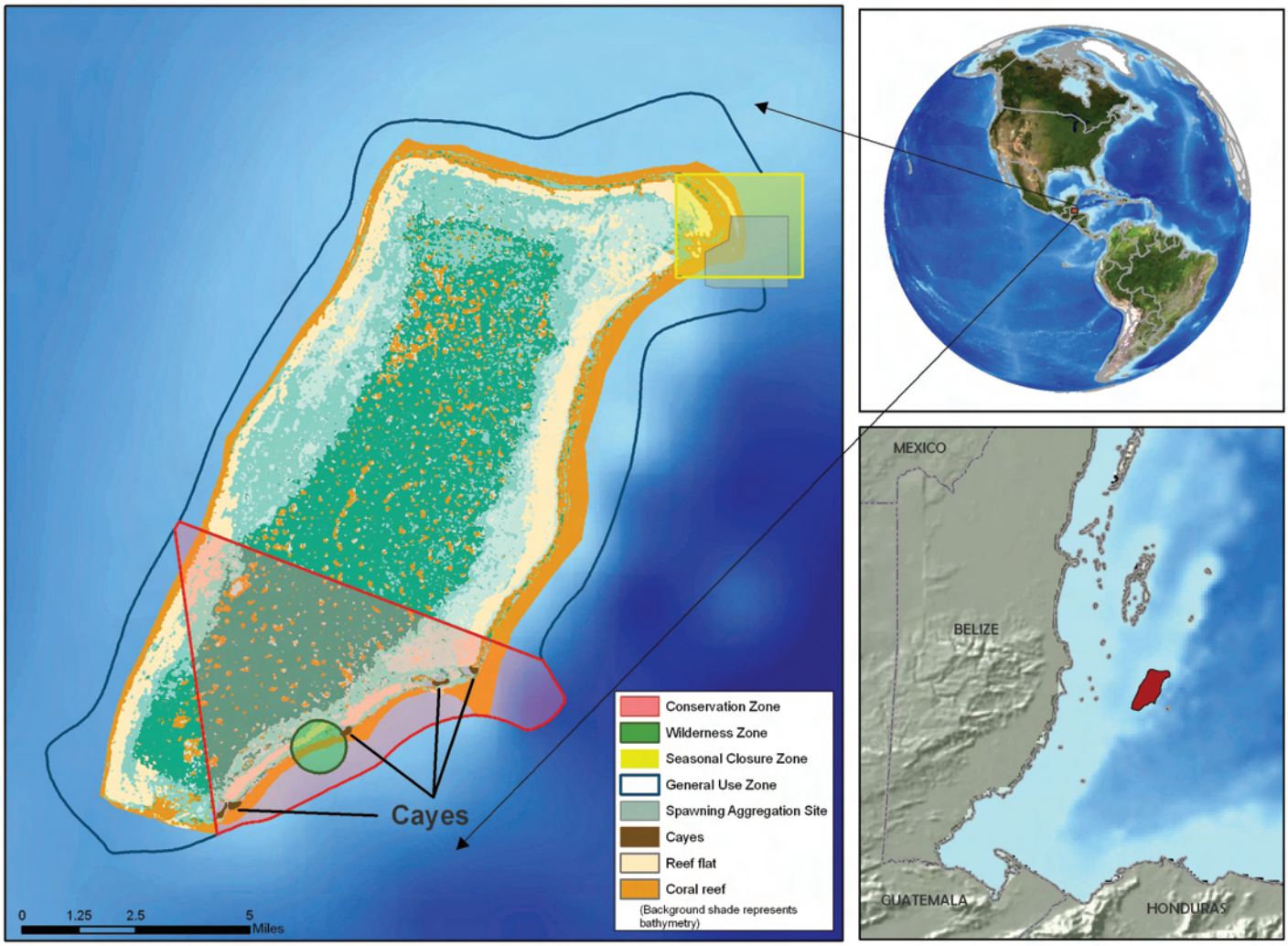

Figure 1. The Glover's Reef Living Seascape.

largest remaining Nassau grouper spawning aggregations, a spectacular biological phenomenon that has cultural and economic importance, still occurs in the northeastern corner of the Atoll. Such aggregations are severely threatened across the Caribbean.

Due to its biological and ecological importance, Glover's Reef Atoll has emerged as a priority for long-term conservation and it was the first coral reef site to be adopted under the WCS Living Landscapes Program. The atoll is the third-largest marine reserve in Belize – with an area of almost 36,000 hectares – and was declared a World Heritage Site in 1996. Despite this protection, Glover's Reef Atoll is threatened directly and indirectly by human activities which occur both on-and off-site. A participatory threats assessment (described in later sections) revealed that the four main direct threats to Glover's Reef are overfishing, coral bleaching, coral damage and pollution (due to both nutrients and pesticides).

The Wildlife Conservation Society's Historic and Current Roles in this Seascape

The Wildlife Conservation Society (WCS) began its involvement in Belize during the early 1980s, and by 1987 began planning the creation of the Glover's Reef Marine Reserve. The reserve was intended to maintain ecological processes, preserve genetic diversity, maintain natural areas for education and research, and provide social and economic benefits through sustainable fishing activity and ecologically sensitive tourism and recreation, by means of informed management of species and their habitats. In 1993, Glover's Reef was declared a Marine Reserve by the government of Belize, but WCS recognized that establishing the Marine Reserve was not, in itself, enough to protect and conserve the amazing habitats and species found there. Therefore, WCS made a commitment to the region by purchasing Middle Caye, one of the six sand cayes within the reserve, and opening the Glover's Reef Research Station (GRRS) there in 1997. The shared mission of WCS and the GRRS is to promote the long-term conservation and management of the Belize Barrier Reef by means of in-situ research, cooperative management, training and education through its service as both the marine reserve headquarters and a platform for cutting-edge research in effective conservation management.

The Living Landscapes Program of WCS developed the Landscape Species Approach as a method for conserving biodiversity at a Landscape Scale by facilitating the development and prioritization of conservation interventions. A Conservation Strategy for Glover's Reef was developed using the LSA adapted for the marine environment (i.e. the Seascape Species Approach) and describes the actions required to address the main threats to the conservation of Glover's Reef.

WCS's Approach to Threats-based Conservation at a Seascape Scale

The conservation and sustainable use of the marine resources of the Glover's Reef Atoll is the overall program goal. To achieve this goal using the Seascape Species Approach (SSA), the planning steps shown in Figure 2 were completed.

The first step in the process was the identification of the main threats present in the seascape, so that actions to mitigate these could be developed. In February 2004, a participatory workshop to spatially assess human activities in the area allowed the Glover's Reef Advisory Committee (GRAC) and other local experts to work together to reach consensus on the main issues facing Glover's Reef. During this process, participants listed each threat under one of four main categories: habitat loss; species depletion; pollution; or the introduction of non-native species. Then, to prioritize the identified threats, each participant was asked to vote for the three listed factors that they considered to be the biggest threats.

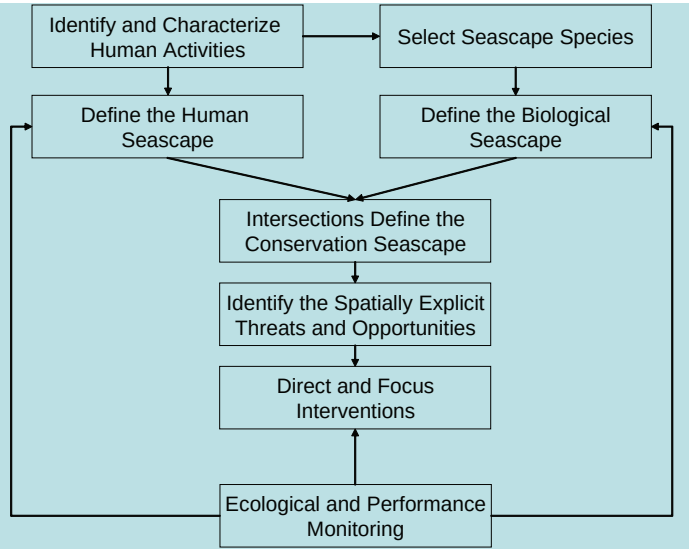

Figure 2. Seascape Species Approach flow chart.

As a result of this prioritization process, the four main direct threats to Glover's Reef were identified as:

- **Overfishing**;
- **Coral Bleaching**;
- **Coral Damage**, caused by divers or snorkelers and anchors; and
- **Nutrient and Pesticide Pollution**, from agricultural/aquacultural runoff.

Other threats include: algal growth (which inhibits the growth of corals); hurricane damage (as with coral bleaching, this is exacerbated by the impacts of global climate change); dredging; potential oil exploration; and introduced species on the cayes (such as rats, dogs and cats). Of particular concern is the nutrification and high turbidity of the Atoll's lagoon due to the aforementioned run-off from the mainland and inappropriate development on the cayes with its associated threats to the ecosystem, which include run-off (such as untreated sewage), as well as turtle and bird nesting site damage.

The next step involved the production of hand-drawn maps to create a spatially explicit picture of where the threats were occurring. The participants were divided into four groups and each group was responsible for mapping one of the four main threats. The maps were later digitized using geographic information system (GIS) software and the final product was developed, as shown in Figure 3. These human activity maps, or Human Seascapes, highlight the specific locations where each threat occurs and where management actions may need to be implemented. Each group also completed a card for each mapped threat to describe its status: its severity and urgency; when it occurs; whether it has changed since 2000; and the time that would be required for recovery. This information was fed into the focal species selection process described subsequently.

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Workshop participants 'voting' on the most important threats

Finally, the participants considered the potential root causes for each activity which directly threatens biodiversity. Each of these indirect threats, or contributing factors, generally falls into one of the following categories: management capacity; resource use; or policy/law. For instance, in the case of overfishing, the root causes were identified as lack of enforcement and an increase in the number of fishers (exacerbated by the lack of alternative livelihoods).Other contributing factors include, for example: lack of unanimous stakeholder support for the marine reserve; insufficient information for strategic conservation management; and lack of long-term conservation financing.

To reach the overall program goal the project developed three specific medium-term objectives, or conservation targets. These include:

- Restoration of viable populations of spawning fish, including Nassau grouper
- Achieving a successful and well-functioning marine reserve
- Restoration of coral reefs/maintaining the reefs' health and diversity

A conceptual model based on the information from the participatory threats assessment was created to explicitly demonstrate how the identified threats adversely affect the targets (whether directly or indirectly) and which interventions are necessary to remove or reduce these threats and achieve the desired outcomes. The Glover's Reef Conceptual Model (Figure 4) clearly illustrates the links between interventions (in yellow), indirect and direct threats (in gold and pink), and the conservation targets (in green). Later, to allow for explicit wildlife-focused conservation management, the conservation targets shown in Figure 4 were further refined. (The threats and interventions described in the Conceptual Model are listed in terms of their IUCN classification in Tables 1 and 2.)

The Seascape Species Approach assumes that the conservation of a well-chosen suite of Seascape Species will lead to the conservation of all biodiversity in the seascape, allowing humans to better co-exist with wildlife by adopting management practices that avoid or minimize conflicts with nature. The goal of the species selection process is to identify a suite of wildlife that collectively represents the entire seascape, forming an effective "conservation umbrella" for all of the

Figure 3. Hand-drawn maps, produced by participants at the human activities assessment workshop, are shown in the insets. The resulting digitized maps show the potential threat from coral bleaching (left) and unsustainable fishing (right).

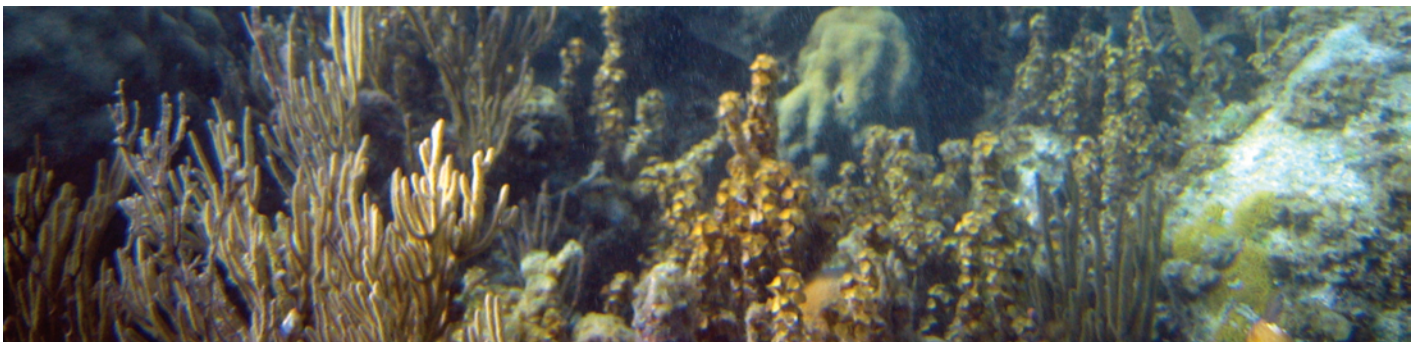

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Table 1. IUCN-CMP Unified Classification of Direct Threats (from the Glover's Reef Conceptual Model shown in Figure 4).

IUCN Classification	Direct Threat(s)
5.4: *Fishing and Harvesting Aquatic Resources*	• Unsustainable Fishing
6.1: *Recreational Activities*	• Direct Physical Damage by Boats, Divers, and Snorkelers
7.3: *Other Ecosystem Modifications*	• Nutrification and High Turbidity
9.1: *Household Sewage and Urban Wastewater*	• Sewage Discharge
9.3: *Agricultural and Forestry Effluents*	• Runoff from Mainland Watersheds
11.1: *Habitat Shifting and Alteration*	• Excessive Algal Growth • Climate Change (Bleaching, Acidification and Hurricane Damage)
11.4: *Storms and Flooding*	• Climate Change (Hurricane Damage)

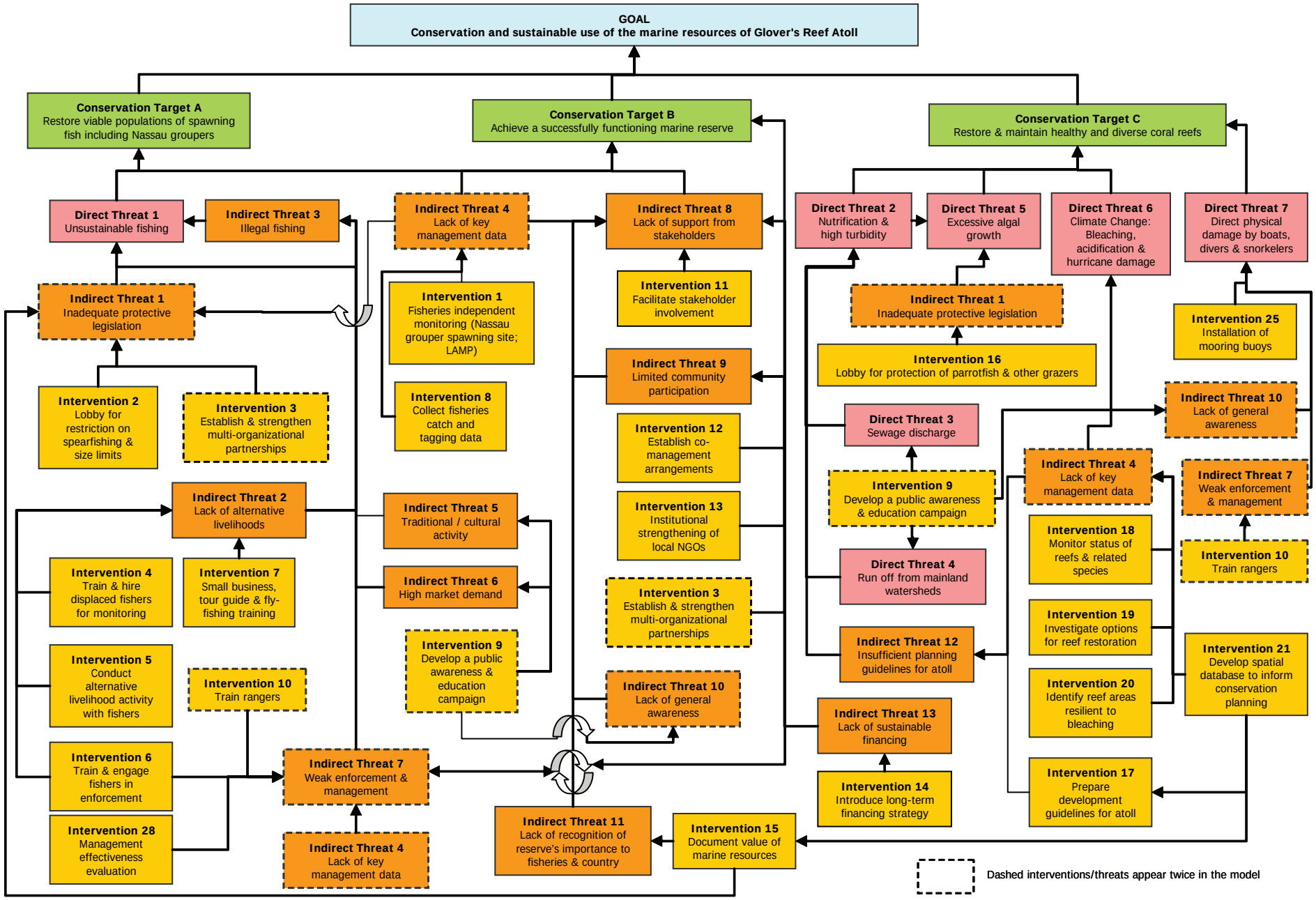

Figure 4. Conceptual model for the Glover's Reef Living Seascape.

Table 2. IUCN-CMP Unified Classification of Conservation Actions ("Interventions"), from the Glover's Reef Conceptual Model (Figure 4).

IUCN Classification	Interventions
2.1: *Site/Area Management*	• Establish Co-Management Arrangements • Fisheries Independent Monitoring • Collect Fisheries Catch and Tagging Data • Monitor Status of Reefs and Related Species • Installation of Mooring Buoys • Develop Spatial Database to Inform Conservation Planning • Prepare Development Guidelines for the Atoll • Management Effectiveness Evaluation
2.3: *Habitat and Natural Process Restoration*	• Investigate Options for Reef Restoration • Identify Reef Areas Resilient to Bleaching • Prepare Development Guidelines for the Atoll
3.1: *Species Management*	• Fisheries Independent Monitoring • Collect Fisheries Catch and Tagging Data • Monitor Status of Reefs and Related Species
4.2: *Training*	• Train Rangers • Small Business, Tour Guide and Fly-Fishing Training • Train and Engage Fishermen in Enforcement • Train and Hire Displaced Fishers for Monitoring
4.3: *Awareness and Communications*	• Facilitate Stakeholder Involvement • Establish Co-Management Arrangements • Institutional Strengthening of Local NGOs • Develop a Public Awareness and Education Campaign
5.1: *Legislation*	• Lobby for Restriction on Spearfishing • Lobby for Nassau Grouper Size Limit Restrictions • Lobby for Protection of Parrotfish and Other Grazers
5.2: *Policies and Regulations*	• Prepare Development Guidelines for the Atoll
5.3: *Private Sector Standards and Codes*	• Installation of Mooring Buoys
5.4: *Compliance and Enforcement*	• Train Rangers • Train and Engage Fishers in Enforcement
6.1: *Linked Enterprises and Livelihood Alternatives*	• Train and Hire Displaced Fishers for Monitoring • Conduct Alternative Livelihood Activity with Fishers • Train and Engage Fishers in Enforcement • Small Business, Tour Guide and Fly-Fishing Training
6.3: *Market Forces*	• Document Value of Marine Resources
6.5: *Non-Monetary Values*	• Document Value of Marine Resources
7.1: *Institutional and Civil Society Development*	• Institutional Strengthening of Local NGOs
7.2: *Alliance and Partnership Development*	• Establish Co-Management Arrangements • Establish and Strengthen Multi-Organizational Partnerships • Facilitate Stakeholder Involvement • Introduce Long-term Financing Strategy
7.3: *Conservation Finance*	• Introduce Long-term Financing Strategy

biodiversity in the seascape. Seascape Species typically require large, ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems. Their requirements in time and space make them particularly susceptible to human alteration and use of natural ecosystems. The rationale is that, by focusing on a well-chosen suite of complementary species that depend on the full range of major habitats and are impacted by the key threats, all the ecosystems within the seascape will be conserved and the associated threats addressed. Focusing on a suite of Seascape Species therefore allows a project to efficiently allocate scarce resources, by using wildlife to define and conserve a functional seascape and focusing conservation actions on this subset of biodiversity.

The selection of the suite of Seascape Species for Glover's Reef involved several steps:

Step 1: Experts familiar with the seascape supplied a comprehensive list of species of interest, and a habitat list, based on published data on the marine habitats of Glover's Reef, was developed. Next, the experts contributed and revised data on five selection criteria for each potential Seascape Species: its area requirements; the heterogeneity or variety of habitats it requires; its vulnerability to human activities or threats; the ecological functions it performs; and its socioeconomic significance.

Step 2: Local and international experts attended a one-day workshop in April 2004 to review and further refine the Seascape Species selection data, using the Species Selection decision support software developed by LLP[10].

Step 3: The experts' workshop continued for a second day, and GRAC members were invited to join the group. The experts described the process and presented the preliminary results of the species selection to committee members for their review and approval. GRAC members saw the value of focusing attention on a small set of species, which more efficiently effects conservation. A final suite of six Seascape Species (hawksbill turtle, Nassau grouper, osprey, star coral, Caribbean reef shark and queen conch) was confirmed, as was the addition of the black-spined sea urchin due to its keystone status as an important herbivore in coral reef communities.

Step 4: Participants created draft maps of the distribution of each of the seven Seascape Species, a process that benefited greatly from the firsthand knowledge of the GRAC members. The initial maps, or Biological Seascapes, were later refined by information gleaned from scientists, GRLS monitoring data and published papers.

Once Seascape Species were selected, the general conceptual model for Glover's Reef was further broken down into 3 sub-models to allow for more detailed definition of the threats, their contributing factors and associated interventions. Each sub-model corresponds to a Seascape Species category – those which are commercially exploited (Nassau grouper, Conch, and Caribbean Reef Shark), land-linked (the two species, Hawksbill Turtle and Osprey, that nest on cayes) or benthic (Star Coral and Black-spined Sea Urchin). The first sub-model mainly deals with the direct threat of overfishing. The second sub-model describes the main threats to animals which rely on terrestrial habitat, such as habitat loss, introduced species and predation on the islands. The benthic species are most affected by the direct threats of climate change (coral bleaching, acidification and hurricane damage), disease, nutrification and direct physical damage (caused by boats, divers and snorkelers).

A conceptual model clearly illuminates what needs to be done and why, keeping the focus on reducing the key threats and achieving conservation objectives. However, such a model is, by necessity, very dynamic, requiring review and revision over time. Monitoring programs, based on this model, determine the program's effectiveness in making progress towards the ultimate vision and assist with decisions on where, when and how to adapt management activities.

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Ospreys, a caye-dependent Seascape Species

10 This software is designed to rank the species according to the five selection criteria and to suggest a suite of species. The suggested suite includes the most highly-ranked species that are complementary in terms of the habitat/management zones that they use and the threats which impact them.

Implementing Conservation at a Seascape Scale: Overcoming Challenges, Grasping Opportunities and Managing Adaptively

Having explicitly defined the key threats to the GRLS and selected a suite of Seascape Species impacted by these threats, the focus then shifted to threat abatement. By addressing limiting factors to conservation across the Glover's Reef seascape it was possible to secure some remarkable successes, all the while adapting to the dynamically changing conservation context. The implementation of conservation interventions at Glover's Reef involved three major approaches: addressing policy issues and forming government partnerships; managing the Protected Area; and implementing conservation in the broader Belizean context.

Policy Issues/Government Partnerships

The Glover's Reef Advisory Committee identified the need for stronger enforcement; in fact, discussions on this issue have dominated their meetings. Most fishers consider illegal fishing to be the most critical threat to the atoll's resources, and the majority interviewed called for more patrols and better enforcement of the laws. These discussions highlighted the need for the Fisheries Department to develop a formal enforcement policy. During the management effectiveness evaluation, many valid recommendations were made in relation to enforcement. They range from the demarcation of the reserve's boundaries to the training of reserve rangers to the addition of patrols and increased penalties for infractions.

Long-term Atoll Monitoring Program (LAMP) data from 2004 to 2006 show that 18% of conch that were of legal size for harvest – those greater than 7 inches in shell length – were not sexually mature (their shells did not have a flared lip). Thus, a significant number of immature conch are being legally removed from the population without being given a chance to reproduce at least once. The presence of a flared lip is a much more accurate sign of sexual maturity than is size; therefore the legislation should be changed to allow harvesting of only those conch that have flared lips. This recommendation is currently under consideration by the Fisheries Department.

The Nassau grouper is a long-lived species[11] which does not reach sexual maturity for approximately 7 years and at a relatively large size. The life history and behavior of Nassau grouper make this species particularly vulnerable to overfishing. Although the species was once the most commonly landed species of reef fish throughout the tropical western Atlantic region, it is now commercially extinct in many locations and listed as Endangered by the IUCN. As Nassau grouper numbers decline in Belize, additional management measures are necessary to enable the population to recover. Research on Nassau groupers indicated that they do not reach sexual maturity until about 45 to 50 cm (18 to 20 inches) in length and, furthermore, that it is the largest female groupers that are the most fertile and produce the most eggs. Therefore, WCS staff recommended that legally caught Nassau grouper should be between 20 and 30 inches, standard length; the minimum length established to ensure that an adult grouper is allowed to reproduce at least once, and the maximum size set to encourage greatest egg production. These recommendations were successfully passed into Belizean law (see Box 1).

Spearfishing of several fish species, such as Nassau grouper and parrotfish, has led to overfishing. Research on Nassau grouper at Glover's Reef revealed that fishing mortality was occurring at an unsustainable level (14% per annum mortality) for this species, mainly due to spearfishing. Spearfishing is highly selective and can quickly decimate a fish population as fishers target the largest fish. Curious species or those (like the Nassau grouper) that hide in holes or rocks are particularly easy to approach and catch. Glover's fisheries catch data show that the majority of Nassau groupers are presently caught by spearfishing. Furthermore, the majority of those caught are juveniles, which indicates a loss of adults in the population. Because WCS scientists recognized the threat posed by spearfishing, they recommended that spearfishing be forbidden within the boundaries of marine reserves. This proposal, too, has met with resounding success (see Box 1).

Coral reef monitoring programs in Belize have revealed that coral cover has significantly decreased while fleshy algae cover has increased, to the extent that many of the reefs are now dominated by algae. For instance, while live coral cover of the patch reefs at Glover's Reef

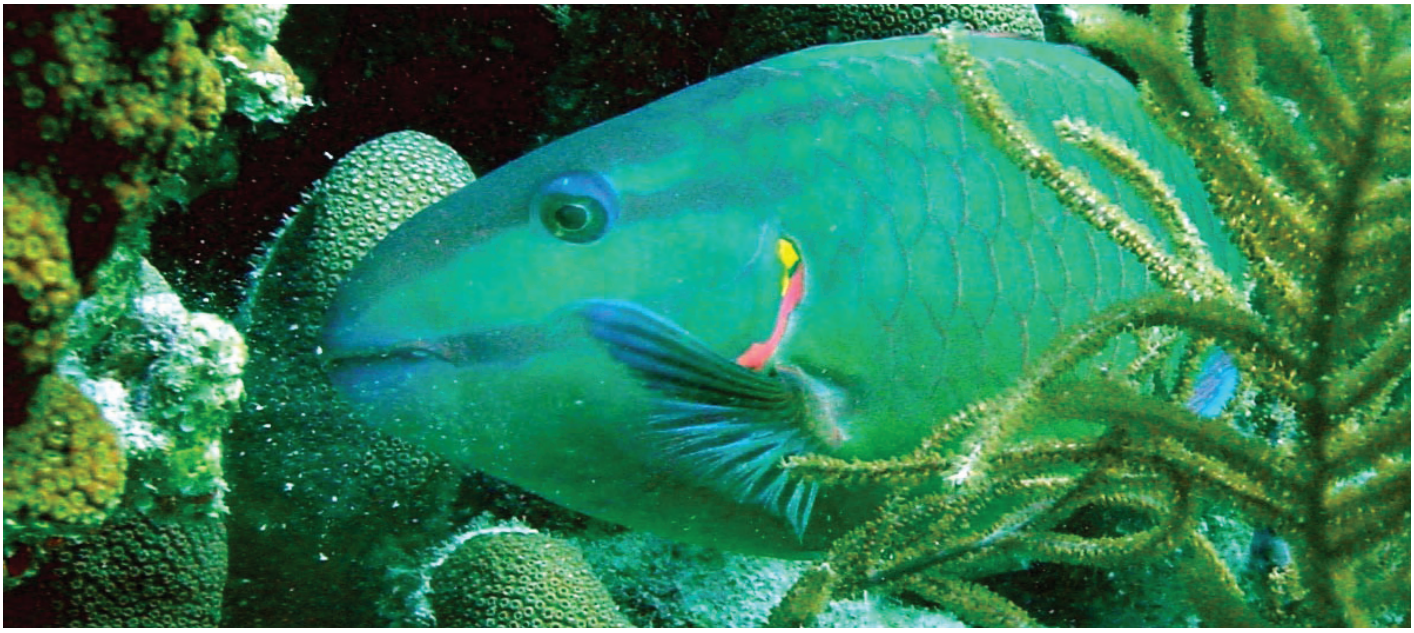
11 The oldest recorded Nassau grouper was 29 years old.

in 1970 was 80%, recent monitoring results showed that live coral cover is only 8% and algal cover is 15.6%. The exact reason for this change is unclear, but it is likely due to a combination of factors that have shifted the balance in favor of algal growth. These factors include: increases in sedimentation and nutrients as a result of run-off due to poor agricultural and aquaculture practices; uncontrolled coastal development including the clearance of mangroves; dredging and waste disposal; coral bleaching and other diseases causing coral mortality; and the die-off or over-fishing of important reef herbivores, such as *Diadema* and parrotfish, which keep algal cover in check.

The protection of parrotfish, which are so important in maintaining a healthy reef, is essential to reverse declining coral cover, by ensuring that an adequate level of algal grazing occurs. Scientific research[12] emphasizes the critical need to preserve the grazing role of parrotfish in the Caribbean coral reef community. Reefs are highly sensitive to parrotfish exploitation and, with the current low numbers of *Diadema*, it becomes particularly important to ensure the highest possible level of grazing by parrotfish if reefs are to remain stable and resilient. Fisheries catch data from Glover's show that large numbers of parrotfish are being caught (they are the second most important type of fish being exploited). Nevertheless, the socioeconomic survey that WCS conducted in Sarteneja, Dangriga and Hopkins in 2006 showed that the majority of fishers in these communities supported the protection of parrotfish, highlighting their understanding of the importance of this species to reef health. WCS's recommendation that parrotfish and other grazers be protected has met with resounding success (see Box 1).

As more fishers have entered the fishery at Glover's Reef over the years, fishing pressure on limited marine resources has increased substantially. The GRLS program's socioeconomic surveys indicate that many fishers from Sarteneja and Hopkins feel that there are too many fishers operating on the atoll. Many of the traditional fishers have complained that opportunistic fishers exploit Glover's only during the opening of the lobster and conch season, reaping the benefits of the reserve even though they often fish illegally and tend not to feel any management responsibility towards the reserve. To reduce the current, unsustainable level of fishing effort, the GRAC has recommended that entry be limited to licensed traditional fishers, as specified in the current reserve regulations. The Fisheries Department is considering implementing this measure in 2009, using the records of all fishers who have fished the site as the starting point for capping numbers.

12 See, for example, Mumby, P.J., A. Hastings and H.J. Edwards. 2007. Thresholds and the resilience of Caribbean coral reefs. *Nature* **450**: 98-101.



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The Stoplight Parrotfish, one of Glover's Reef's many resident species

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Nassau Grouper, a Seascape Species

Protected Area Management

No-take zones were originally created to sustain atoll-based fisheries, but their success requires both the enforcement of 'no-take' rules and a high level of voluntary compliance by fishers (which is only possible if they are aware of the location of the boundaries of these zones). A high priority for the reserve management team, therefore, is the installation of marker buoys that clearly demarcate the Conservation Zone, Wilderness Zone, and the Spawning Aggregation Marine Reserve to reduce illegal fishing (Indirect Threat #3), which exacerbates the current levels of unsustainable fishing (Direct Threat #1).

Increased nutrients in terrestrial run-off (Direct Threats #2-4) can lead to algal cover domination of the reefs at Glover's (Direct Threats #5). Even though Glover's Reef is located relatively far offshore and is generally considered oceanic rather than coastal, run-off can reach the atoll following extreme events (e.g., hurricane Mitch in 1998), causing turbid waters that are high in nutrients. An additional contributor to nutrient increase is sewage run-off from the cayes themselves. Preliminary water quality studies carried out in 2005 showed high levels of nutrients in two locations, both near cayes; such increases may be linked to development on the cayes. For instance, the levels of DIN (dissolved inorganic nitrogen) were 8.2 times higher in 2005 than in 1991. High levels of DIN are associated with eutrophication and macroalgal blooms and, therefore, the threat posed by nutrient run-off must be addressed.

Conservation Seascapes (Figure 5), developed by combining the Biological and Human Seascape maps, indicated that the continued existence of the Conservation Zone and the Spawning Aggregation Marine Reserve (see Figure 1) are essential for the conservation and persistence of the seven Seascape Species. This finding reinforced the project's confidence in the current management zone configuration's ability to offer significant protection to these species. However, the maps also highlighted the fact that the present zoning scheme does not protect some prime habitat along the eastern reef upon which hawksbill turtle, Nassau grouper, queen conch, star coral and Caribbean reef shark depend, nor does it protect some important habitat in the northeast corner of the atoll – an area which encourages healthy coral growth due to its increased oceanic water flushing. Thus, in view of these Conservation Seascapes, the project was able to make recommendations for the future adjustment of the Conservation Zone boundary to include more of the

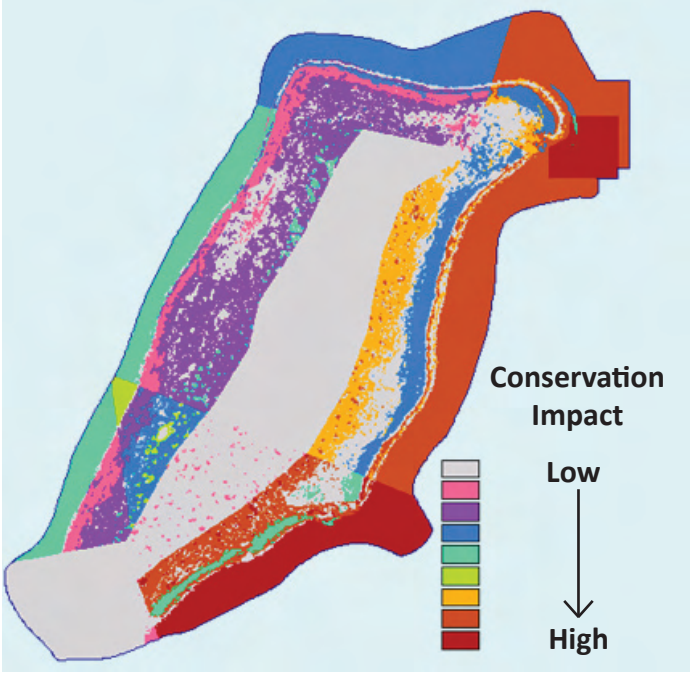

Figure 5. The Conservation Seascape for Nassau Grouper, which illustrates the current and future impact of successful conservation management and highlights the importance of maintaining and improving protection within the no-take zones (see Figure 1) and of the eastern reef connecting these no-take zones.

eastern reef and the northeast portion of the atoll, an extension which should enhance the ability of the atoll to recover healthier populations of the Seascape Species and provide the system with a better chance of recovering from future disturbances such as those linked to global climate change (Direct Threat #6).

The Glover's Reef Living Seascape project has also recommended the deployment of mooring buoys to provide boats with an alternative to throwing their anchors, which causes damage to corals and benthic communities (Direct Threat #7). The GRAC has recommended specific areas on the atoll where mooring buoys are required; installation is proceeding as part of the national mooring buoy project being supported by the National Fish and Wildlife Foundation.

The reproductive activity of Nassau groupers occurs exclusively during the spawning season at specific sites along the barrier reef and atolls; fishing activity that occurs at these spawning sites exploits the species at its most vulnerable stage. Unfortunately, about half of the former spawning sites in the Caribbean no longer exist, and none of these sites have been known to recover once extirpated. Given these constraints, short-term recovery of the spawning site at Glover's Reef is unlikely. However, to encourage recovery in the long-term, the spawning site at Northeast Point has been closed to all fishing for several years. The newly legislated ban on spearfishing in the General Use Zone of Glover's Reef Marine Reserve will provide additional protection for the species (see Box 1 for details).

Caye habitats are important for the survival of several key species, including two Seascape Species, the osprey and the critically endangered hawksbill turtle. The hawksbill turtle, for example, requires vegetated beaches for nesting and laying its eggs. Therefore, as many of these nesting beaches as possible should be protected on the cayes of Glover's Reef. The littoral forest, an important caye habitat critical to the survival of many species of migratory birds, is recognized as Belize's most threatened ecosystem. The mangrove forests are also extremely important, protecting the shoreline from erosion and providing nursery habitat for many marine species; for example, the rainbow parrotfish is a mangrove obligate during its juvenile phase. The forests of the cayes also supply perching and nesting areas for the resident ospreys on the atoll. The remaining vegetation on the cayes should be kept as intact as possible and, where possible, restored by re-planting. The team at Glover's Reef has developed guidelines for the "best practices for the cayes", to help minimize the impact of development activities on these habitats.

Conservation in the Broader Belizean Context

The Glover's Reef Advisory Committee (GRAC) has taken an active role in the management of the marine reserve over the past several years. Committee members intend to continue their proactive role in the reserve; although their terms of reference establish them as a consultative body, the committee often operates under collaborative co-management due to the authority with which the Fisheries Department considers its advice. GRAC's evaluation of the conditions necessary for effective co-management of the reserve identified, inter alia, the need for improved group cohesion, strengthened communication amongst members and coordination amongst stakeholder groups, increased organizational capacity and participation in the legislative decision-making process. As the Committee works toward achieving these conditions, its role in the management of the Glover's Reef Marine Reserve will continue to increase.

Training and education activities have been key interventions and ongoing efforts in this capacity, undertaken at many different levels, are expected to continue. WCS in Belize, working with many local partners, has led training workshops for a wide range of stakeholders – advisory committee members, reserve staff, students, fishers, resort owners, and the concerned public. For example, GRAC members have been trained in conflict resolution, leadership, project management, conducting a meeting and group dynamics; reserve staff have participated in training workshops on monitoring and management methods, such as in the Long-term Atoll Monitoring Protocol (LAMP), spawning aggregation monitoring, in-water sea turtle surveys, socioeconomic surveys, and MPA management effectiveness evaluation; University of Belize marine ecology students have been trained through courses or internships; fishers have been trained in catch data collection methods, monitoring methods and the use of marine radios and GPS units; resort owners have participated in a training session on monitoring the nesting activity

of sea turtles; and scientists have shared the results of research conducted at Glover's Reef at various seminars which were hosted by WCS. Such efforts must be ongoing since new members join the Advisory Committee, reserve staff experience regular turnover and new students constantly enroll. Furthermore, there is a need to strengthen efforts with fishers, particularly in environmental monitoring.

To enhance our training and education activities, WCS has worked with partners to develop educational material, including a brochure for the reserve, newsletters that report on the monitoring results for the spawning aggregation sites, a colorful Nassau grouper poster and a television 'spot' that informs the public of the protected spawning sites and the closed season for the Nassau grouper. Moving forward, the educational aspect of the program should be strengthened and expanded to further increase the awareness and understanding necessary to foster voluntary compliance with the laws.

Socioeconomic surveys have highlighted the particular vulnerability of the Sarteneja fishing community; because of its dependence almost entirely on fishing, the economy of the village suffers as fishing resources decline. Of all the groups in the community, fishers seemed the most interested in developing ecotourism as an alternative economic activity. Partnering with the GEF Small Grants Programme's Community Management of Protected Areas for Conservation (COMPACT), a tour guide training course developed by the Belize Tourism Board was implemented. Twenty-one participants, including 9 fishers and 6 wives or daughters of fishers, completed the course. This training spawned the formation of the Sarteneja Tour Guide Association, a legally registered entity with a core membership of 29 villagers. Tour guide course participants identified the need for training in basic computer skills; this need was subsequently fulfilled by providing computer equipment and computer literacy training to participants from the tour guide training course, to help the newly-trained guides market their services and receive bookings. Future plans include strengthening the alternative livelihoods program and expanding the projects implemented at Sarteneja to the Hopkins fishing community.

Sustainability

A business plan drafted for the Glover's Reef Marine Reserve estimated that the financial sustainability gap – the difference between expenses and revenue – for 2007 would be in the range of BZ$105,000 (USD 52,500). Revenue, generated primarily from reserve entrance fees, is not high enough to cover basic expenses, which run approximately BZ$170,000 (USD 85,000) per annum. The business plan provides multiple suggestions to improve the financing of the reserve's management programs:

- Developing a trust fund, under PACT, that allows other donors to contribute funds for marine protected areas while also allowing greater transparency of the management of reserve fees.
- Engaging a co-management partner to help to raise funds for the reserve.
- Increasing the entrance fee from BZ$10 to BZ$15 and improving fee collection. It was estimated that only 70-80% of the fees were being collected in the past.
- Promoting Glover's Reef Marine Reserve as an ecotourism destination by increasing its visibility via a website (www.gloversreef.org, which has since launched). Also, developing a water taxi service would facilitate transportation to the reserve and further increase visitation rates.
- Investing in a smaller boat with 4-stroke engines to reduce fuel expenditure when conducting patrols and streamline the fee collection process. The reserve has obtained a smaller boat (but without 4-stroke engines) and the streamlining of fee collection is still in process.

Establishing the economic value (e.g., tourism and fisheries value) of the Marine Reserve's resources is important for justifying its continued management and conservation. WCS partnered with the World Resources Institute to derive the quantitative value of the goods and services provided by the atoll using the fisheries catch data and socioeconomic survey data to inform the process. This valuation demonstrated that a conservative estimate of the atoll's yearly contribution to the economy of Belize in terms of tourism and fishing is US$4.5 – 6.7 million; this far outweighs the cost of reserve management. Given the great value of the Marine Reserve, additional support is required from the government and the tourism industry to increase their investment in the management of these spectacular marine resources.

Measures of Success

The GRLS Project has made significant progress in abating the major threat of overfishing, both at the site itself and at a policy level. On site, WCS has supported the marine reserve in improving its surveillance and enforcement capabilities through ranger training, provision of necessary equipment and assistance with the demarcation of the reserve's boundaries. The GRAC has been successful in its work to formalize an enforcement policy and introduce the concept of limited access for fishers. WCS has provided policy-makers with data that was instrumental to the recent enactment of additional management and protective legislation for parrotfish, Nassau grouper, and other species, including a ban on spearfishing in all marine reserves and minimum and maximum size limits for the Nassau grouper.

Even though the global threat of coral bleaching is extremely difficult to address, efforts to make the reef more resilient are hoped to have positive effects. These efforts include the recent enactment of regulations to protect parrotfish and other grazers, which should lead to an increase in coral recruitment. Implementation of the best practices for development on the atoll's cayes, while important in preserving critical habitats for terrestrial wildlife, will also help to improve water quality, an essential element in maintaining healthy coral reefs. Caye residents and resort owners support voluntary adherence to the best practices guidelines, but WCS will need to continue to work with the relevant authorities to push for mandatory guidelines to be enacted. The best practices guidelines for development on the cayes is being applied in the wider Belizean context.

We have documented signs of recovery in populations of several of our Seascape Species: Nassau grouper spawning aggregation counts at Glover's Northeast Point indicate an increasing trend; the Caribbean reef shark population appears to have remained stable; *Diadema* is showing signs of recovery; the large numbers of juvenile hawksbill turtles bodes well for the recovery of the population at Glover's; and there has been an increase in the number of nesting ospreys due to the provision of new nesting platforms. The percentage of live coral cover is low, however, but it is hoped that the protection of parrotfish and the ban on spearfishing (as well as recovering *Diadema* populations) will gradually restore a more balanced coral reef community that will eventually result in a higher percentage of coral cover. Queen conch also show very low densities; WCS is working to recover this species to more healthy levels through continued participation in a new sustainable fisheries project at Glover's Reef that aims to limit access and set a sustainable catch level for conch.

The monitoring programs that WCS staff have implemented have been very effective, providing key management data that have formed the basis of new legislation (Box 1). WCS's fisheries catch data will be invaluable in informing the new sustainable fisheries project. WCS has also made steady progress implementing alternative livelihoods projects and capacity-building efforts have begun to pay off, with three stronger non-governmental organizations in Sarteneja now managing projects, two of which encourage alternative livelihoods activities for fishers (ecotourism and pig-rearing).

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Hawksbill Turtle, a Seascape Species

Due to government restrictions, it was not possible to finalize a formal co-management arrangement with a local NGO for the Glover's Reef Marine Reserve. However, the GRAC has filled this role exceedingly well with their active participation in the reserve's management and their provision of management recommendations. The Fisheries Department considers GRAC a successful model for improving advisory committees nationally. The lessons learned during the committee's revitalization are currently being used to help revitalize a similar advisory committee for the South Water Caye Marine Reserve.

Due to the successes of the GRLS project, the spectacular resources of Glover's Reef Atoll are being used more sustainably, and its biodiversity is better protected, than they were at the inception of the GCP-II program five years ago. The marine reserve is now functioning better than before, with staff who have benefited from improved training. The Nassau grouper spawning aggregation at Northeast Point has been preserved and new legal measures will help to ensure the recovery of this population. The recently passed regulations protecting parrotfish and other grazers is expected to tip the balance to enhance coral recruitment and growth, supporting the maintenance of a healthy coral reef with increased live coral cover. Bringing about durable changes in the Glover's Reef Living Seascape takes time; WCS is prepared to make the requisite long-term commitment to secure the conservation of this jewel of the Caribbean Barrier Reef System.

Value of the GCP Program

The inception of the GCP program at Glover's coincided ideally with the nascent marine conservation program at the site. The first phase of the GCP program (GCP-I) supported the Living Landscapes Program's development of the Landscape Species Approach, which, once adapted for the marine environment, gave the Glover's Reef Living Seascape project (implemented during GCP-II) a robust basis in sound planning. The availability of this coherent planning framework at the outset resulted in the development of a very cohesive and comprehensive program. The application of the Seascape Species Approach ensured focused and logical progress, which has also led to greater inherent sustainability as activities and projects have been targeted to make the best use of available resources. The WCS Belize Marine Program is confident that this success will act as a catalyst in attracting and leveraging the other sources of funding necessary to continue this important conservation work into the future.

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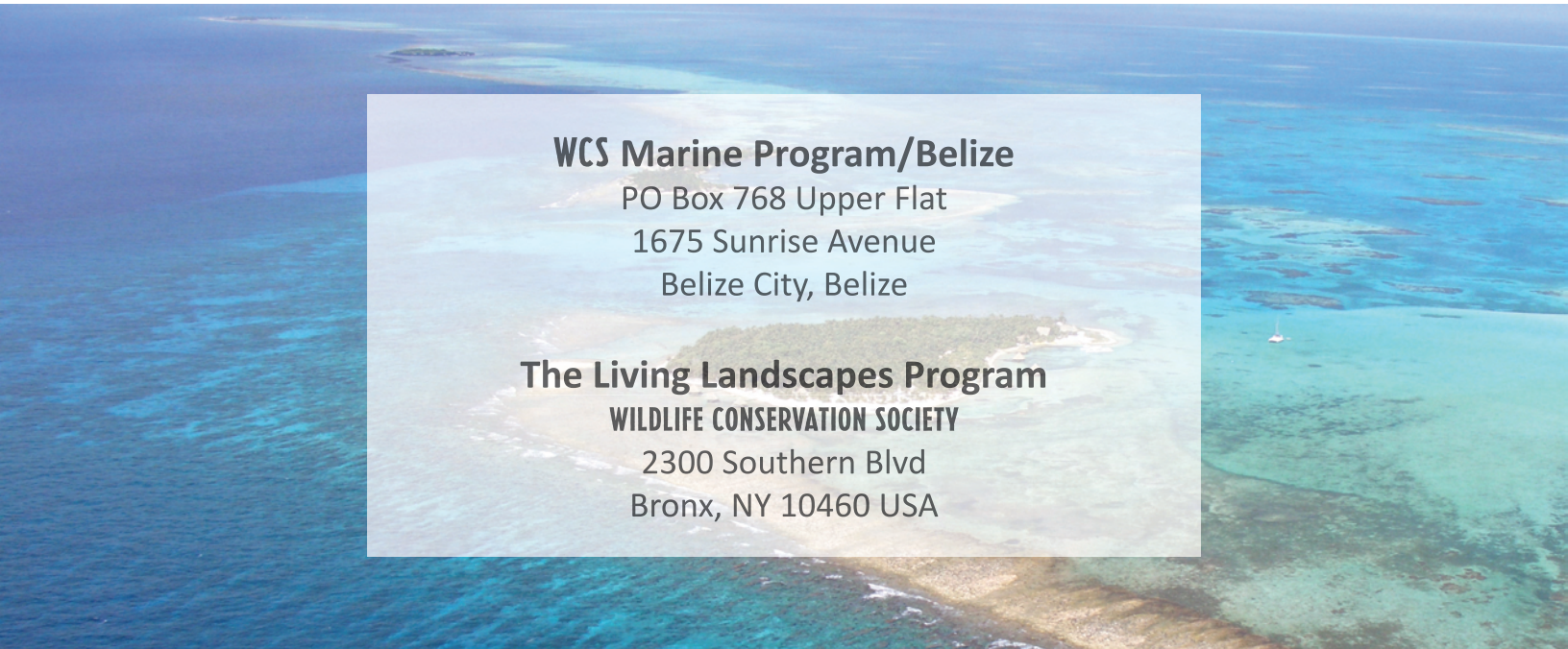

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