REEF CHECK

Mesoamerican Reef Alliance

ICRAN-MAR Project

Sustainable Fisheries Component:

Community-based ecological and socio-economic monitoring

CORAL REEF HEALTH MONITORING RESULTS

MEXICO – BELIZE – GUATEMALA – HONDURAS

USAID FROM THE AMERICAN PEOPLE — UNITED NATIONS FOUNDATION — ICRAN International Coral Reef Action Network

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INTRODUCTION

Reef Check Program

Reef Check is the most widely used coral reef monitoring protocol. The techniques are simple to learn and the data are scientifically robust. Reef Check data (and projects) are managed by the Reef Check Foundation, which is an international marine conservation organization based in Los Angeles, California with offices in the Philippines, Indonesia, the Dominican Republic and Australia and teams in over 80 countries and territories.

The Reef Check program brings together community groups, government departments, academia and business partners to:

- *Educate* the public about the coral reef crisis;
- *Create* a global network of volunteer teams to regularly monitor and report on reef health;
- *Scientifically investigate* coral reef ecosystem processes;
- *Facilitate* collaboration among academia, NGOs, governments and business;
- *Stimulate* local community action to protect remaining pristine reefs and rehabilitate damaged reefs worldwide using ecologically sound and economically sustainable solutions.

By involving local people in community-based monitoring, Reef Check serves as the first step in attracting participation in coral reef management activities. In several cases, this has facilitated the creation of well-managed MPAs.

At the international level, Reef Check (RC) serves as the community-based component of the Global Coral Reef Monitoring Network (GCRMN) and collaborates on regular status reports. Reef Check is a member of the International Coral Reef Initiative (ICRI) and International Coral Reef Action Network (ICRAN). Reef Check provides data to and is developing interactive reef monitoring data management systems with ReefBase, the global database of coral reef information. Regional and national Reef Check training programs are offered throughout the world each year. The Reef Check monitoring program is completely volunteer, however training and management activities are often supported by private donations, grants from foundations, the United Nations and other national and international agencies including the US Agency for International Development and the National Oceanic and Atmospheric Administration.

In addition to collecting a wealth of valuable data from coral reefs around the world, Reef Check has received national and international environmental awards for its conservation efforts and has raised public understanding of the global coral reef crisis and the potential solutions to the problems faced by coral reefs and the people who depend on them. For more information about Reef Check activities, please refer to the Reef Check website: **www.reefcheck.org**.

ICRAN-MAR: Sustainable Fisheries Component

The Sustainable Fisheries Initiative: aims to develop best practice guidelines for key fisheries, and positively influence their long-term sustainability by cooperating with the companies that control market share to promote sustainable fisheries. Previous work with lobster fisheries will guide efforts for best practices work, and the creation of specific environmental guidelines for sustainable lobster fishing, as well as grouper and conch fisheries. Community exchanges will be held to promote the transfer of skills and lessons from demonstration areas to target communities. Trainings will also be held in alternative income generation.

The community-based fishery management will be improved through development of appropriate partnerships with the private and public sector. 'Best practice' guidelines will be promoted for fisheries management and partnerships will be developed with major international seafood buyers and local seafood buyers.

Community-based ecological and socio-economic monitoring was implemented to support community assessment and monitoring of their progress in resource management. Local institutions were selected as centers for ecological and socioeconomic monitoring (complementary to GEF/MBRS monitoring program) using as criterion to be ICRAN demonstration sites, have viable populations of fishing resources and local people with a medium level of developed participation. And training was provided in socio-economic and natural resource monitoring and management techniques for local residents, especially fisherfolk, who are now capable of assessing managed and unmanaged areas. Existing monitoring manuals were published in Spanish and English.

Reef Check Work plan Objectives and Activities

Sub-Result 2.2 Community-based ecological and socio-economic monitoring implemented to support community assessment and monitoring of their progress in resource management.

Activities:

- Communities were established as centers for RC ecological and socioeconomic monitoring to complement the new GEF/MBRS monitoring program.
- Training was provided in socio-economic and natural resource monitoring and management techniques, so that local residents, especially fisher folk can

monitor their own resources and contribute data to the regional and global biophysical and socio-economic assessment, which will be completed within this framework.

Indicators of success:

- Local institutions supported and prepared to serve as RC ecological and socioeconomic centers
- At least 60 community members from the Tourism and Fisheries Industries in Mexico, Belize, Guatemala, and Honduras were trained in RC monitoring methodology
- All results from the monitoring already conducted can be found in our on-line database free of charge at http://datamanagement.reefcheck.org/.

METHODS

Reef Check Protocol

Site Selection

One goal of Reef Check is to determine the widespread extent of human impacts on coral reefs. For this reason, Reef Check teams that can only survey one site should survey the "best" site they have access to (i.e. sites least likely to have been affected by human impacts, fishing, pollution etc). Such a site should have high living hard coral cover, and dense fish and mobile invertebrate populations.

In addition, we would also like information on the geographic distribution of human impacts on all reefs. For groups willing and able to survey multiple sites, we would suggest choosing two or more additional sites that are representative of moderate and heavy human impacted reefs. By doing so, it will be possible to construct a more complete picture of the extent and distribution of human threats, and why some reefs are more vulnerable to these threats than others.

If you are trying to locate appropriate sites for Reef Check monitoring and the underwater horizontal visibility is 10 m or more, a “manta tow” can be used to survey large sections of reef quickly. This procedure involves slowly towing an observer, using a mask and snorkel, on a rope behind a small boat. A specially designed “manta board” with handholds and a writing slate attached can be constructed for this purpose.

When selecting sites it is helpful to first map the reef area you are interested in. This will help you to identify the different reef zones or habitats (e.g. reef flat, reef crest, reef slope. The next step is to decide where you want to survey. If you compare one survey with another in a subsequent year it is important that both surveys were conducted in the same reef zone. That is, you should not compare data from a survey of the outer reef crest with those from a lagoon.

For teams capable of long-term monitoring of multiple sites, another useful approach is to use a sampling design that includes sites inside and outside of a Marine Protected Area (MPA). With sufficient surveys (3 to 5 outside and 3 to 5 inside), it will be possible to show how effective the protected area is and to distinguish if reef health improves over time. If improvement in reef health can be shown, this may serve as a valuable case study of a successful MPA and help coral reef managers replicate this effort elsewhere.

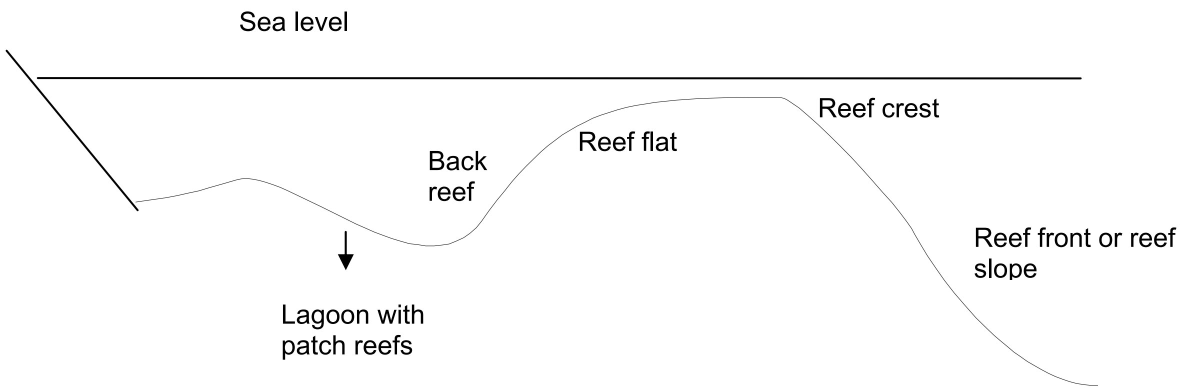

Figure 1. Diagram of reef zones. Reef Check volunteers selecting their sites should keep all transects in the same reef zone or habitat if results from these surveys are to be compared with one another or collated.

With all site selection, however, it is important to remember that a survey is only a sample of the coral reef environment. The site selected for the Reef Check should be representative of the reef area. If you are interested in the health of an entire reef, you will need to set up a number of Reef Check survey sites at a number of locations.

The survey transects should be placed seaward of the reef crest on the outer slope, parallel to shore. In lagoons, the transects may be placed on the inner reef slope (back reef). It is very important to describe the physical setting of the site and its position in relation to obvious human influences on the Site Description Form. This assures that data comparisons will be made between similar reef settings.

Basic Design

The goal is to survey two depth contours, 3 m and 10 m below chart datum (*lowest low tide*). However, on many reefs, the highest coral cover will not be found at these exact depths. Therefore, choose the depth contour with the highest coral cover within the following ranges: Shallow (2 - 6 m depth), Mid-reef (>6 - 12 m depth). The transect should be laid at a constant depth within these ranges. If you select 2 m depth for your shallow transect, the whole transect should be at 2 m depth. Note that the tide should be taken into account, particularly for the shallow transect.

Along each depth contour, four 20 m long segments are surveyed to make up one transect. The segments should follow the designated depth contour one after the other. However, segment start and end points **must** be separated by a minimum of a 5 m gap. The distance between the start of the first segment and end of the last segment is 20 + 5 + 20 + 5 + 20 + 5 + 20 = 95 m. The 5 m gaps are necessary to ensure independence between samples, which is important for statistical analyses.

We recommend using single 100 m or two 50 m fiberglass measuring tapes available from hardware and survey equipment supply stores or from Reef Check Foundation. The depth contours were chosen for practical reasons of time and safety. Reefs in many areas are not suitable for a survey at both depths. In this case, just survey one depth contour. At some reefs, it may be necessary to deploy the transects perpendicular to the reef edge or crest, i.e. following spurs or ridges. In such areas, teams may prefer to survey individual 20 m transect segments located within the specified depth contours. Since fiberglass tapes can break, it may be useful to have a second tape available as a back up.

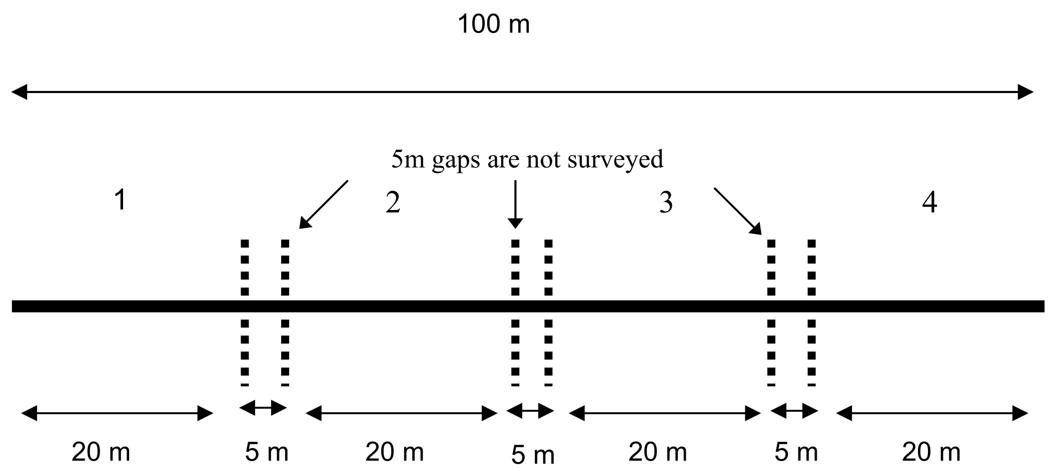

Figure 2. Diagram of a transect line. This 100 m line is divided into four 20 m segments with a 5 m gap in between them to ensure sample independence.

Four types of data are recorded and are later transferred to standard Reef Check Data Forms (Appendices A-D). Ecological and Socio-Economic data is collected as follows:

1) **Site Description**. Anecdotal, observational, historical, location and other socioeconomic data is recorded on the Site Description Form. These data are extremely important when we interpret global correlations.

2) **Fish belt transect**. Four 5 m wide (centered on the transect line) by 20 m long segments are sampled for fish species typically targeted by fishermen, aquarium collectors and others. Fish seen up to 5 m above the line are included. This is the first survey to be performed.

3) **Invertebrate belt transect**. The same four 5 m wide by 20 m long segments as used for the fish belt transect are sampled for invertebrate species typically targeted as food species or collected as curios. Reef impacts are also counted along this line.

4) **Substrate line transect**. The same transect line as the fish and invertebrate belt transects is used, but this time, points are sampled at each 0.5 m interval along the tape to determine the substrate types on the reef.

Reef Check surveys may be replicated, as needed depending on the purpose of the monitoring. Three to five surveys on one reef will provide results useful for management. For more details on long-term monitoring, please refer to Chapter 6.

Site Description Instructions

The Site Description helps us put the other survey data into context – it is therefore essential in helping us interpret what we see underwater. The Site Description Form (Appendix A) can be completed before or during the survey with only one completed per site. It is helpful if one team member is given the responsibility of completing the form with the help of other team members.

Please use the information below (also found on the Site Description Field Guide on the Reef Check CD) to complete this form as it helps to keep our data standardized. Please also mark one response for each question. **Blanks will be interpreted as missing data or unknown.**

Data Collected:

Country, State/Province, City/Town:
Please be as descriptive as necessary and if you are located on an island, please record appropriately. (Example: Country: ***Australia*** State/Province*:* ***Queensland*** City/Town: ***Cairns***)

LATITUDE/LONGITUDE:
Record the coordinates in degrees, minutes, seconds. If you record the coordinates in a format other than degrees, minutes, and seconds (e.g. degrees, minutes; degrees), please indicate this on the Site Description Form. Make sure to note the units required for specific fields (i.e. distance from shore in **meters**; distance from nearest river in **km**; population size **x1000**, i.e. write in 15 for 15,000). Please record the compass direction of the transect line in relation to these fixed coordinates. For more details on the use of GPS and maps, see the end of this chapter.

IMPACTS

Indicate if the site is sheltered or exposed and if there have been recent coral damaging storms. It is important to provide the date of the storm if known. Please estimate the overall anthropogenic impact at your site and indicate if siltation is a problem.

The following definitions should be used to fill out the Site Description Form.

BLAST FISHING
None ---
Low — Known blast fishing in area, but no evidence seen or heard during survey
Med — Blast crater observed anywhere on reef, no blasts heard during survey
High — One or more blasts heard during survey and/or blast crater on transect
POISON FISHING
None ---
Low — Less than one incident per month
Med — More than one incident per month, but less than one per week
High — One incident a week or more

NET AQUARIUM FISHING
None ---
Low — Less than one fisherman/collector trip per month
Med — More than once per month, but less than once per week
High — Once a week or more

COLLECT INVERTEBRATES FOR FOOD
None ---
Low — One fisher collects less than once per week
Med — Multiple fishers collect more than once per week, but less than daily
High — Daily collection by multiple fishers

COLLECT INVERTEBRATES FOR CURIO* SALES
None ---
Low — One fisher collects less than once per week
Med — Multiple fishers collect more than once per week, but less than daily
High — Daily harvest by multiple fishers
* A curio is something that is collected to be admired as an object but not eaten.

TOURIST/VISITOR DIVING/SNORKELING (PEAK SEASON AVERAGE PER DAY)
None ---
Low — 1-5 individuals per day
Med — 6-20 individuals per day
High — More than 20 individuals per day

SEWAGE POLLUTION (OUTFALL OR BOAT)
None ---

Low — Sewage, irregular or rare discharge and > 500 m away
Med — Source of discharge > 100 m but < 500 m from transect
High — Source of discharge < 100 m from any point on transect

INDUSTRIAL POLLUTION
None ---
Low — Source greater than a 500 m distance
Med — Source between a 100 and 500 m distance
High — Source less than a 100 m distance

COMMERCIAL FISHING (FISH CAUGHT FOR FOOD TO SELL, NOT INCLUDING LIVE FISH RESTAURANT TRADE)
None ---
Low — Less than once per month
Med — Less than once a week and more than once a month
High — Once a week or less

FISHING FOR THE LIVE FOOD FISH RESTAURANT TRADE
None ---
Low — Less than one fishing trip per month
Med — Less than one fishing trip per week and more than once per month
High — One fishing trip per week or less

ARTISANAL/RECREATIONAL FISHING (MAINLY FOR LOCAL CONSUMPTION)
None ---
Low — Less than one fishing trip per week
Med — More than one fishing trip per week, but less than daily
High — Daily fishing trips

LIST THE NUMBER OF YACHTS/MOTORBOATS TYPICALLY PRESENT WITHIN 1 KM OF THE REEF
None ---
Few — 1-5 per day
Med — 6-10 per day
Many — More than 10 per day

PROTECTION
Indicate if the area has any sort of protection from human usage (legal or otherwise), the level of protection and if this protection is enforced. Please check the listed activities that are banned at your site.

TEAM MEMBERS

IMPORTANT: Please record the name of the Team Scientist your team works with, even if they do not participate in this survey. In addition to the name of the person recording the data and the team leader, please list the names and nationalities of all team members

Fish Belt Transect

The fish belt transect is the first survey completed because fish can easily be disturbed by divers. If you are doing repeated fish surveys, try to do them at a standard time e.g. between 9 and 10 am. In any case, it is important to note the time you conducted the survey on the datasheet. After the transect has been deployed, the divers should wait 15 minutes in a location away from the transect before starting the survey. This waiting period is necessary to allow fish to resume normal behavior after being disturbed by the divers deploying the transect. The maximum height above the transect to record fish is restricted to 5 m in the water column. This can be estimated as two body lengths including outstretched arms and fins.

Each diver assigned to count fish swims slowly along the transect counting the indicator fish. The diver then stops every 5 m, and then waits one minute* for indicator fish to come out of hiding before proceeding to the next 5 m stop point. The fish are counted while swimming and while stopped along the entire length of each 20 m transect. This is a combined timed and area restricted survey: four segments x 20 m long x 5 m wide = 400 m^2. As with each of the surveys, there are four 5 m gaps where no data are collected. At each depth contour, there are sixteen "stop-and-count" points, and the goal is to complete the entire 400 m^2 belt transect in one hour.

Remember, a note should be made of any sightings of what are now becoming rare animals such as manta rays, sharks and turtles, but if these are off-transect records, they should be recorded at the bottom of the data sheet under "Comments

Indicator fish

The indicator fish have been selected because they are typically shot out of reefs by spearfishing, removed as targets of cyanide fishing, and caught using hand-lines. Size minimums have been placed on two families of food fish **(> 30 cm for Grouper, > 20 cm for Parrotfish**). **Grouper and parrotfish smaller than these limits are not counted.** Given these limits and the magnifying effect of the water, divers should practice estimating sizes before attempting the fish surveys. When practicing, a measured 2.5 m colored wire or 2 cm diameter PVC pipe can be used to help estimate the 5 m belt transect width, however these tools can be difficult to carry in a current, and may scare some fish. Another method is to lay a 5 m wide line perpendicular to the start of each 20 m segment to help you to continuously re-adjust your estimates of width. A final method is to measure yourselves from your fin tips to you finger tips and use your body length lying horizontal in the water to help judge the width.

To practice estimating fish lengths, first make color copies of each fish picture of the correct size on large transparencies (used for overhead projectors) and tether these in the water column. A small fishing weight can be tied on to a hole made in the bottom edge of the transparency and a float can be attached to the top of the transparency so that it will float upright. A series of these photos can be set out along a test transect. A more basic method is to make 20 and 30 cm sticks, 1 cm in diameter and set them out on the reef in a similar manner with a weight and float. If your slate is marked with a rule, this also can be help you to estimate the 20 and 30 cm distances. **For each Grouper counted, a size estimate should be given in the specified section of the datasheet. Record size classes as 30-40 cm, 41 – 50 cm, 51-60 cm etc.**

We recommend that one diver records fish on each side of the transect at the same time, that is the buddy pair work together, both counting, one on each side handling a 2.5 m wide belt. Alternatively, one diver may conduct the survey for the whole 5 m belt. It is imperative that divers communicate with each other to avoid double counting fish that may swim across the transect line. Tally the fish on the slate using a vertical tick mark for each fish observed and after each four fish, draw a horizontal line through the four, thus creating easily counted groups of five next to the correct name and under the appropriate column (Figure 8). It is crucial to remember to keep the counts for each of the four segments of the transect separate and to avoid double counting by communicating with your buddy.

All of the fish to be counted within these fish belt transects are listed below. Photographs for the Caribbean, Indo-Pacific and Hawai'i regions are included in Appendix E. Other regions (Arabian Gulf and Red Sea) are available separately from Reef Check HQ.

Common Name	**Scientific Name**
Nassau Grouper (>30 cm)	*Epinephalus striatus*
Butterflyfish	Chaetodontidae
Other grouper (>30 cm)	Serranidae
Snapper	Lutjanidae
Grunts/Sweetlips/Margates	Haemulidae
Parrotfish (>20 cm)	Scaridae
Moray eel (any species)	Muraenidae

Invertebrate Belt Transect

When the fish belt transect is complete, the invertebrate team can then carry out the belt transect survey for invertebrates using the same belt transect that was used for the fish survey. Each belt transect is 5 m wide (2.5 m on either side of the transect line). The total survey area is 20 m x 5 m = 100 m^2 for each segment and 400 m^2 for one complete transect of 4 segments for each depth contour, (800 m^2 per complete survey including the two depths). The invertebrate survey is similar to the fish survey, however, the diver does **not** need to stop every 5 m but each diver should swim slowly along the transect counting the indicator invertebrates.

It is best to adopt the face down, feet up position to ensure all parts of the transect are explored. It is extremely important to look in cracks and under large coral heads and overhangs to search for cryptic species such as lobster and banded coral shrimp. But do not pick up or move rocks or coral heads to look under them. We recommend that Buddy #1 records invertebrates on the left side of the transect while Buddy #2 surveys the right side. There are many other ways to perform this survey, each with its own advantages. Feel free to use the method that works best for you and your team.

All of the organisms to be counted within the invertebrate belt transects are listed below and photographs for your region are given in Appendix E. It is the responsibility of the Reef Check Trainer and Team Scientist to ensure that their team members are sufficiently prepared to identify the animals before surveys begin. See the section on Training in Chapter 2.

Common Name	**Scientific Name**
Pencil urchin	*Eucidaris* spp.
Flamingo tongue	*Cyphoma gibbosum*
Triton	*Charonia variegata*
Gorgonian (sea fan, sea whip)	
Long-spined black sea urchin	*Diadema*
Banded coral shrimp	*Stenopus hispidus*
Lobster (spiny and slipper/rock)	Malacostraca (Decapod)
Sea Egg/Collector urchin	*Tripneustes* spp.

Coral Disease/Bleaching, Trash and Coral Damage

Each team records the level of bleaching and the presence of coral disease, trash and coral damage in the survey area. Corals that are still alive, but bleached should be recorded as live coral (HC) on the line transect. If bleaching is present, two estimates are made. First, teams estimate the percentage of all corals on the transect that are bleached. Second they estimate the mean percent of each individual colony that is bleached. For example, the estimate might be 30 out of 100 corals (30%) along the transect are bleached but of the colonies bleached, the mean level of bleaching per colony is 80%. Please also indicate the date when bleaching started and maximum water temperature if known in the "Comments" section. Coral disease is noted as present or absent and the type of coral disease should be noted in the comment box (if identified). Note that many diseases are difficult to identify without a high level of training. All cases of suspected coral disease should be compared with the Reef Check ID cards and confirmed by the Team Scientist and if you have a camera – please take a photo. Indicate yes or no in the appropriate box on the data sheet and note the percentage of coral in the segment with disease. Trash is separated into general and fish nets/traps, while coral damage is separated into boat/anchor, dynamite, and other. Damage and Trash should be rated as the following: None = 0; one piece/damage per transect any type is Low = 1; two to four pieces/damage per transect is Medium = 2; and more than four pieces/damage is High = 3. It is important to put zeros in these fields if there is no bleaching, disease, trash or coral damage noted.

For the belt transects, team members are encouraged to look in holes and under overhangs to detect organisms, such as lobster and especially banded shrimp, that may be hiding.

Line Transect Instructions

When the invertebrate belt transect is almost completed, the next buddy pair can begin the line transect. We use a "point sampling" method for the substrate survey because it is the least ambiguous and fastest method and is easily learned by non-scientists. It involves recording the substrate type that lies directly below the tape at 0.5 m intervals i.e. at: 0.0 m, 0.5 m, 1.0 m, 1.5 m etc. up to 19.5 m (40 data points per 20 m transect segment).

To minimize bias, it is important to use a plumb line, which is a 5 mm diameter metal nut or other small metal object (e.g. a fishing weight) tied to a 1.5 m length of string. The weight is dropped at each sampling point and it lands on only one substrate type, which is recorded. This minimizes potential bias in what is counted, especially in cases where the tape is hanging above the substrate and swinging back and forth with the surge. Note, do not use fishing line for the plumb line as it will tangle easily. Use woven nylon or cotton string.

A 1.5 m plumb line is wrapped around the wrist and the plumb "bob" or weight is lowered quickly to the bottom. The diver records the type of substrate directly where the weight touches the bottom.

There is a space for each point sample result on the Field Line-Transect Sheet. Input the substrate category abbreviations in the appropriate space on the data sheet. Each segment must have a total of 40 entries for the computer data sheet to automatically calculate results and charts. Therefore ensure that EVERY box is completed when you conduct your survey.

There are many cases when the substrate type may be ambiguous. Please use the following guidelines to identify substrate types for Reef Check. Note that these may differ from other definitions with which you are already familiar.

Reef Check Guidelines For Categorizing Substrate Types

Hard Coral (HC): Live coral including bleached live coral. Also include fire coral (*Millepora*), and in the Indo-Pacific, blue coral (*Heliopora*) and organ pipe coral (*Tubipora*) because these are reef builders.

Soft Coral (SC): Include zoanthids, but not sea anemones (the latter go into "Other"). Sea anemones do not occupy space in the same manner as zoanthids or soft corals, which can compete with hard corals. In the Atlantic, this category is for zoanthids.

Recently Killed Coral (RKC): The aim is to record coral that has died within the past year. The coral may be standing or broken into pieces. RKC appears fresh and white *or* with corallite structures still recognizable (i.e. their structure is still complete/not yet eroded). Please write the estimated percentage of RKC that is the result of bleaching at the bottom of the data sheet.

Nutrient Indicator Algae (NIA): The aim is to record blooms of algae that may be responding to high levels of nutrient input. In 2006, the NIA definition was changed to include all algae except coralline, calcareous (such as *Halimeda*) and turf. Turf algae are defined as being shorter than 3 cm. When turf algae are present, record the substrate directly beneath the algae and note this in the Comments section.

Sponge (SP): All sponges (but no tunicates) are included. The aim is to detect sponge blooms that cover large areas of reef in response to disturbances.

Rock (RC): Any hard substrate whether it is covered in e.g. turf or encrusting coralline algae, barnacles, oysters etc. Rock also includes dead coral that is more than about 1 year old, i.e. is worn down so that few corallite structures are visible, and covered with a thick layer of encrusting organisms and/or algae.

Rubble (RB): Includes rocks between 0.5 and 15 cm diameter in the longest direction. If it is larger than 15 cm it is rock, if it is smaller than 0.5 cm it is sand.

Sand (SD): Particles smaller than 0.5 cm. In the water, sand falls quickly to the bottom after being dropped.

Silt/Clay (SI): Sediment that remains in suspension if disturbed. Note that these are practical definitions, not geotechnical. Often, silt is present on top of other indicators such as rock. In these instances, silt is recorded if the silt layer is thicker than 1 mm or covers the underlying substrate such that you cannot observe the color of what is underneath. If the color of the underlying substrate can be discerned, then the contact will be counted as the underlying substrate NOT silt.

Other (OT): Any other sessile organism including sea anemones, tunicates, gorgonians or non-living substrate.

RESULTS

Fish Abundance

Data on the abundance of Butterfly fish species reflect similar results for all MAR countries during the fours years of the study, with the exception of Mexico during 2005 that showed a rapid increase from the previous year. Butterfly fish are present in most reefs in the Caribbean and in other part of the world are heavily collected for the aquarium trade, which is not the case for the MAR (see figure 3).

Results from all MAR countries showed a significant low abundance of groupers larger than 30 cm, suggesting heavy fishing pressure in the area for that economically important group. We found grouper abundance to be much lower than 1 fish per 100m^2 of reef. Grouper are predatory fish that control herbivore fish on reefs, in their absence, smaller fish tend to be more abundant of not targeted by fishing as well (see parrotfish data further in this report) (see figure 4).

Grunts abundance was found to be greater than other fish groups during the surveys, Mexico having the greatest abundance of grunts along with Belize. Unlike higher order fish, grunts tend not to be as heavily targeted by fishing as e.g. grouper and are also controlled by other fish species targeted by fishing, this allows grunt populations to flourish in the absence of predatory fish (i.e. Grouper) (see figure 5).

Moray eel population was found to be normally low in all reefs surveyed (less than 1 per 200 m^2). Smaller moray eels are targeted by aquarium collectors, and larger ones are targeted by fishing in the Caribbean and other parts of the world (see figure 6).

The Nassau grouper was once a commercially viable species, especially in the NW Wider Caribbean. Now due to intense fishing pressure, its populations have been decimated throughout its range. This scenario is clearly shown in results obtained from the surveys conducted for the ICRAN-MAR project, in which our volunteers found 1 or less Nassau grouper per 200 m^2, a very low abundance compared to past decades (see figure 7).

Parrot fish population results obtained during the implementation of ICRAN-MAR project were found to be relatively normal when compared to other regions of the world. Parrotfish are key controllers of algae that could potentially overgrow corals in their competition for space coverage (see figure 8).

Even though, fishing also heavily targets snappers, their population in the MAR countries seems to reflect some normally when compared to other areas of the region (see figure 9).

Invertebrate Abundance

Banded coral shrimp results showed no particular trend from the surveys conducted for the MAR countries. Their abundance shows similar numbers to other reef sites of the Wider Caribbean. Banded Coral Shrimp are heavily targeted for aquarium collectors in the Pacific, and not so in the Caribbean (see figure 10).

Collector urchins were found in low abundance, but given that they are mostly found in seagrass areas, these results can be assumed normal. In some Caribbean countries they are collected for food. They are a key herbivore in tropical marine ecosystems, and their effects on algae control can be substantial (see figure 11).

Lobster abundance estimates show a clear impact from fishing pressure; none of the MAR countries showed abundance lower than 1 lobster per $100m^2$. Given the high visitation rates by tourist, lobsters, as in many other areas of the world, have been decimated to satisfy and ever increasing demand for seafood (see figure 12). The lobster fisheries in MAR countries are targeting areas farther away from human habitation and in deeper water.

The long Spine Black Sea Urchin (*Diadema*) populations suffered a region-wide die off due to a disease that was quickly spread around the late 80s. Results from this study show evidence of the *Diadema* urchin coming back to the region. They are one of the main herbivores on the reef, and their presences ensures the control of algae (see figure 13).

Pencil urchin abundance estimates show no particular trend during the Reef Check surveys during ICRAN-MAR. They are harvested in some areas for the curio trade (e.g. for wind chimes). With the exception of Honduras results, Pencil urchin abundance was low and normal. As the other species of urchin present on the reef, Pencil Urchin also come out at night to graze on the algae surrounding their location (see figure 14).

Like elsewhere in the region, Triton snail abundance were found to be very low during the surveys for the ICRAN-MAR. Tritons are collected for food, similar to conch, and for their decorated shell as curio (see figure 15).

Substrate Composition

Bottom coverage results showed that the reefs in the MAR countries seem to be dominated mainly by rock, live coral or algae; which is a common pattern for reefs in the region. Estimates of coverage by bare rock showed a slow decline during 2006 and 2007, probably as a shift in the coverage by the other co-dominating components (see figure 16).

Rubble coverage usually fluctuates as shown in during this study as their dynamics are dominated by the frequency and intensity of storms and other biological stressors in the area. Rubble formation after the sudden effect of storms or slow bioeroders usually is followed by the consolidation of loose material back into rock (see figure 17).

Bottom coverage by sand was found to be between 5-20% of reefs in the MAR countries, with a couple of exception in Mexico (2004) and Honduras (2006) .The Sand category consists of loose particles smaller than 0.5 cm (see figure 18).

Even smaller particles are classified as Silt, and usually cover the bottom of reef areas to a lesser extend than sand, when compared to seagrass areas. Bottom coverage by Silt was found to be less than 2% in most cases during the ICRAN-MAR project (see figure 19).

Data from these surveys in the MAR countries suggest low recent mortality of corals. Recently Dead Coral coverage estimates reflects corals that have died within that year, probably as a result of coral damaging storms and the 2005/6 bleaching event (see figure 20).

Live Coral cover ranged from 10-30% of the bottom. Data shows no particular trend in all MAR countries with the exception of Belize, which showed stable results during the four years of data (see figure 21).

Data from Mexico and Belize show a steady increase of algae coverage of the bottom. Although in higher percentages, Honduras data shows no trend over the years of this study. Algae coverage usually increases as a response in lack of herbivore action or nutrient inputs from land (see figure 22).

Soft coral coverage results indicate some stabilization in most of the MAR countries, having higher percentage levels in Honduras and Guatemala. Soft corals in the Caribbean are represented by zoanthids (ie. *Palithoa*); due to the fact that true soft corals only exist in the Pacific (see figure 23).

Lastly, Sponge coverage data shows no particular trend in all MAR countries (see figure 24).

FIGURES

Fish Abundance

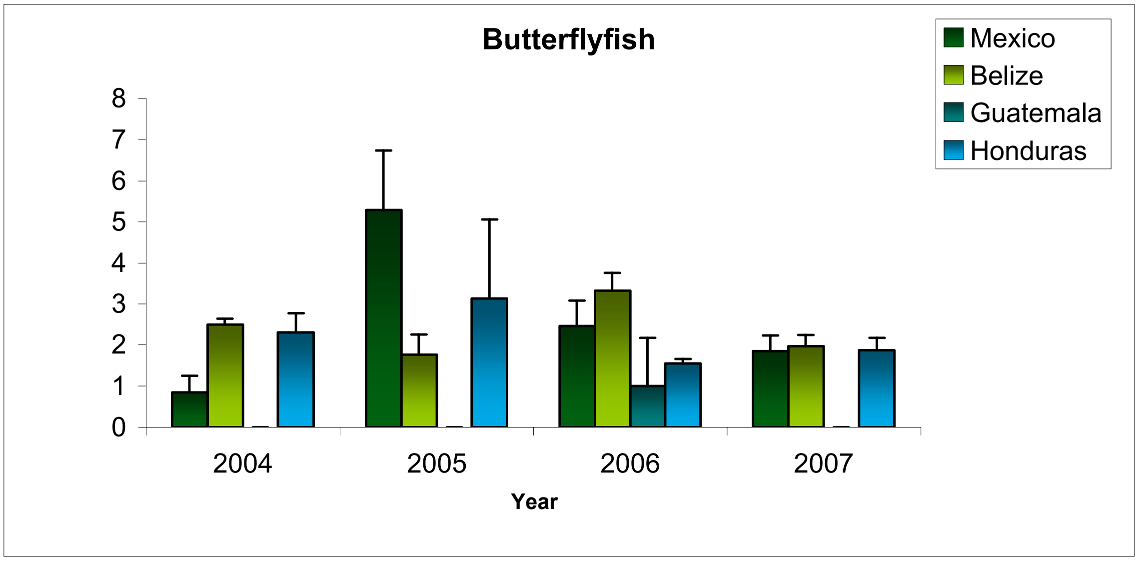

Figure 3. Butterfly fish abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

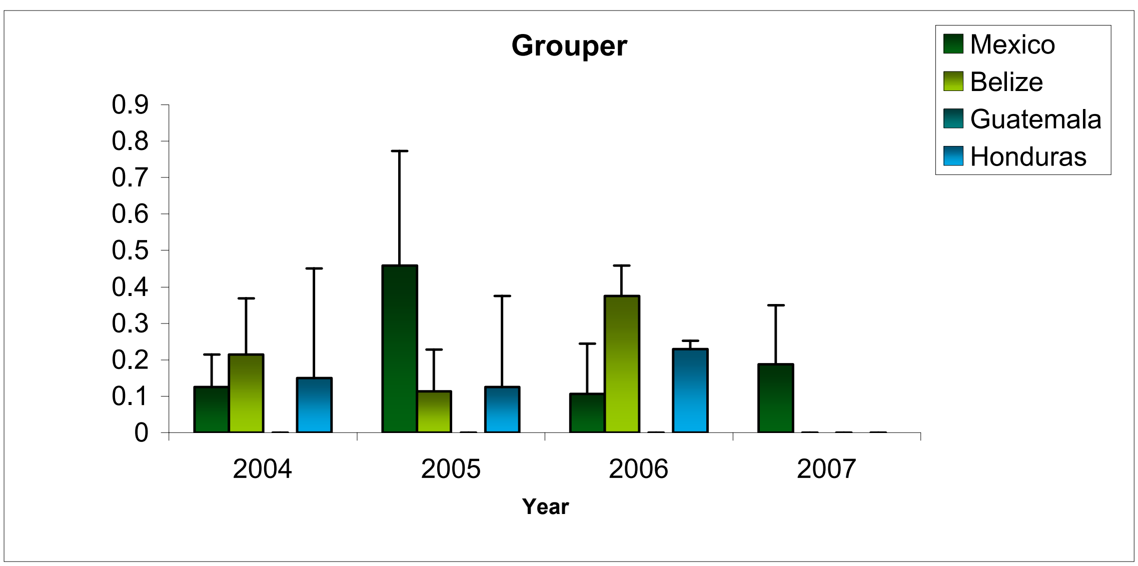

Figure 4. Grouper abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

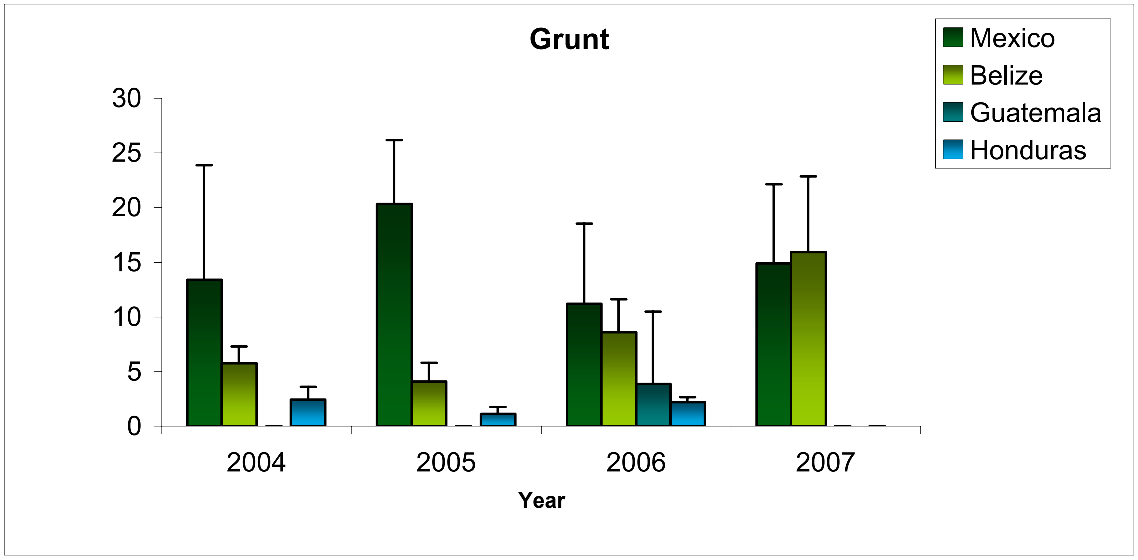

Figure 5. Grunts abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per $100m^2$.

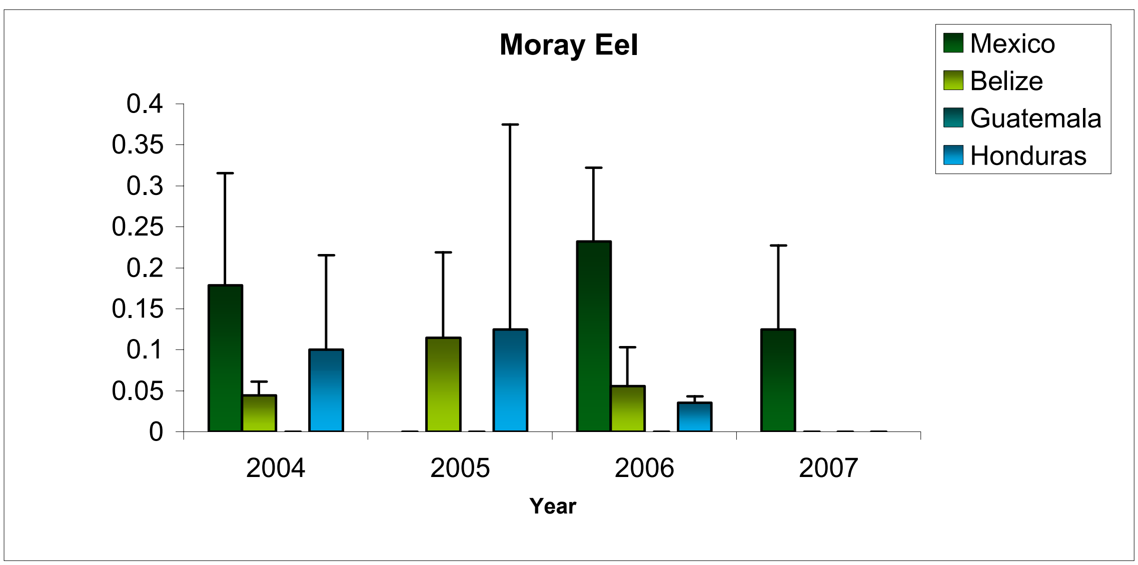

Figure 6. Moray Eel abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per $100m^2$.

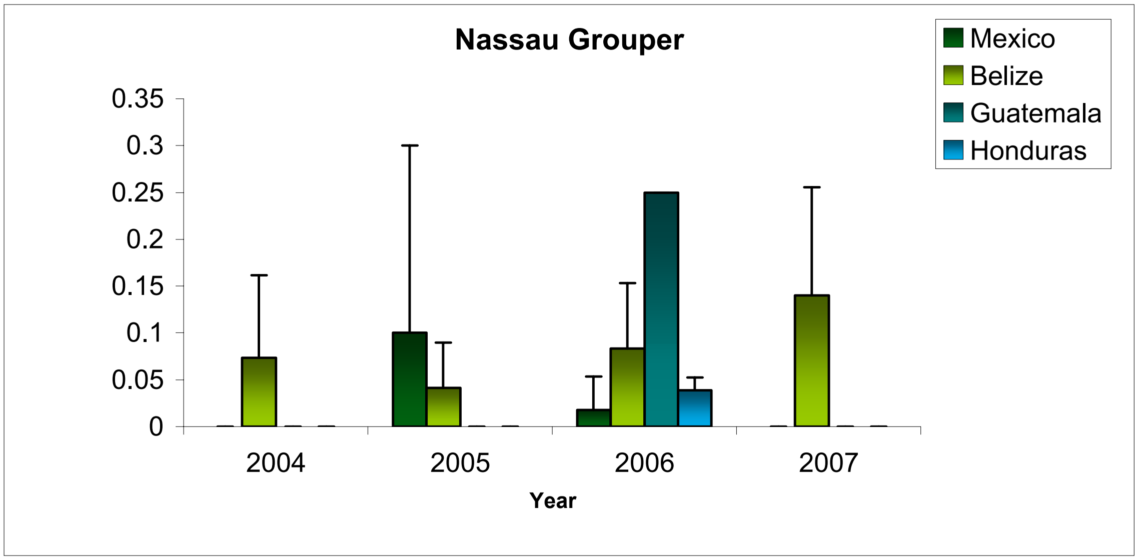

Figure 7. Nassau Grouper abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

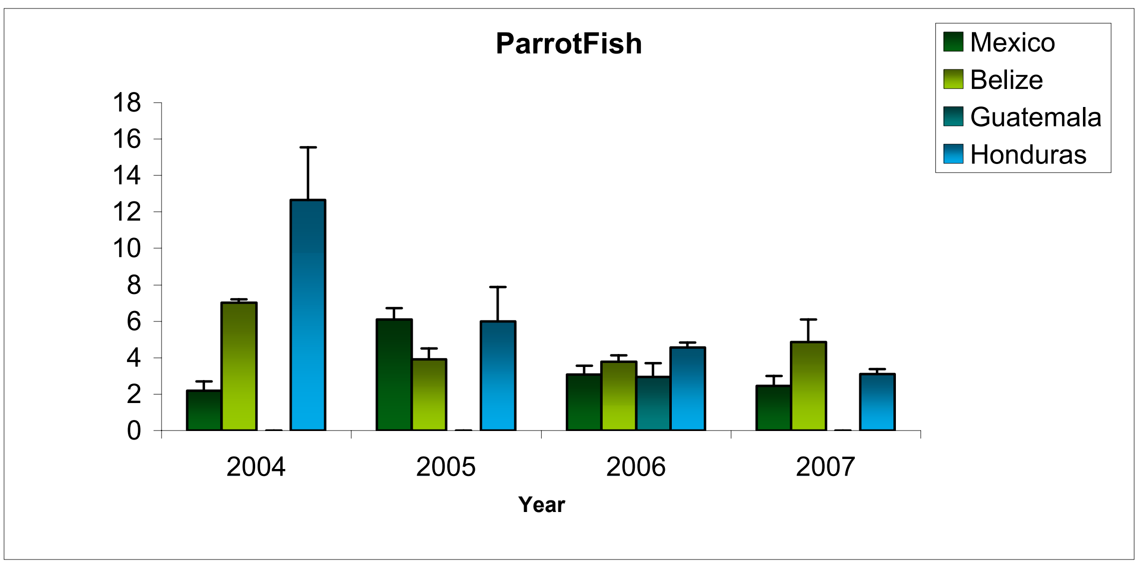

Figure 8. Parrotfish abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m2.

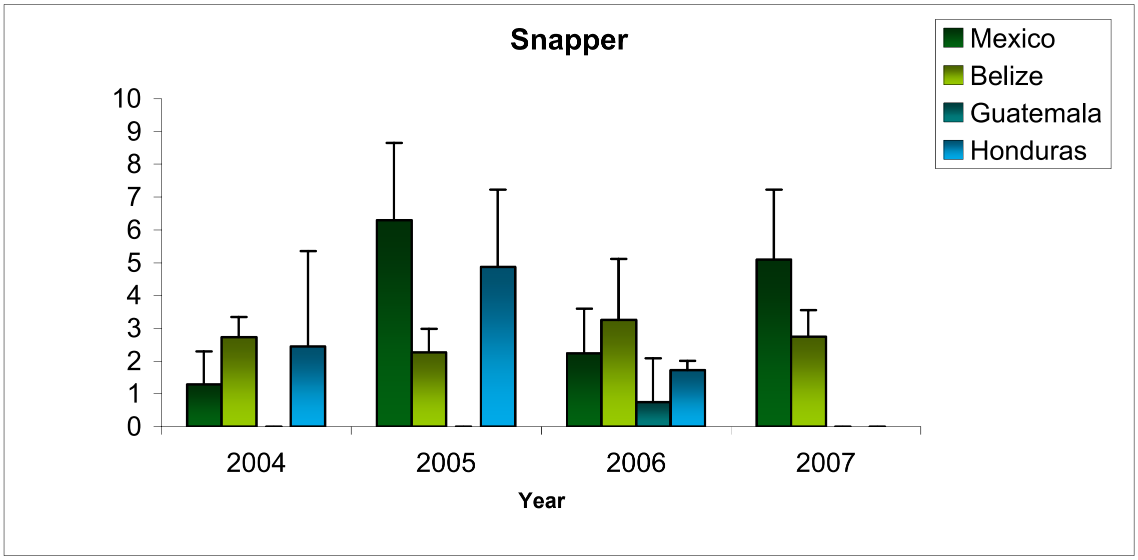

Figure 9. Snapper abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per $100m^2$.

Invertebrates Abundance

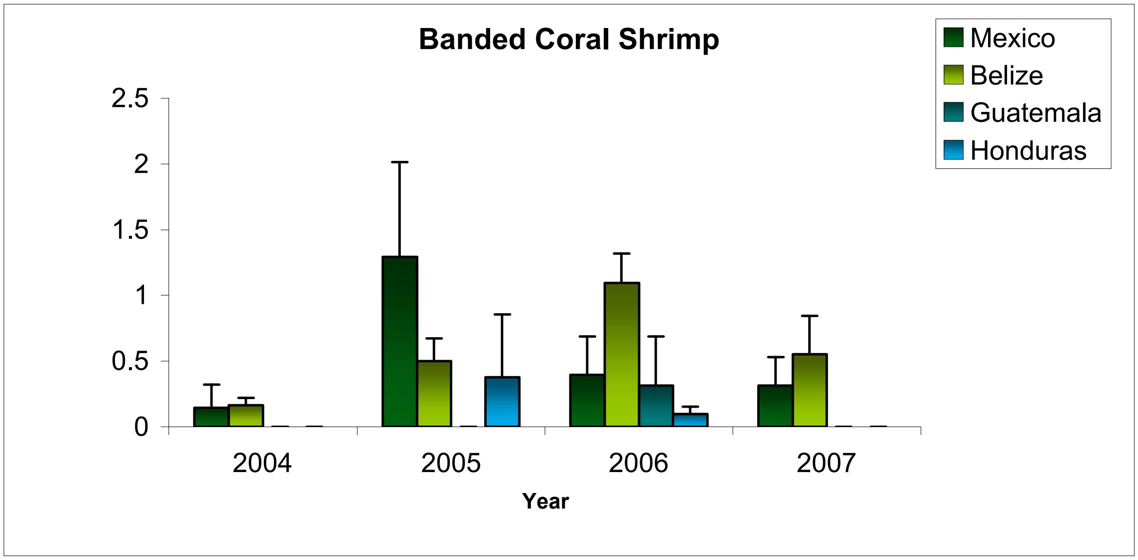

Figure 10. Coral Banded Shrimp abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

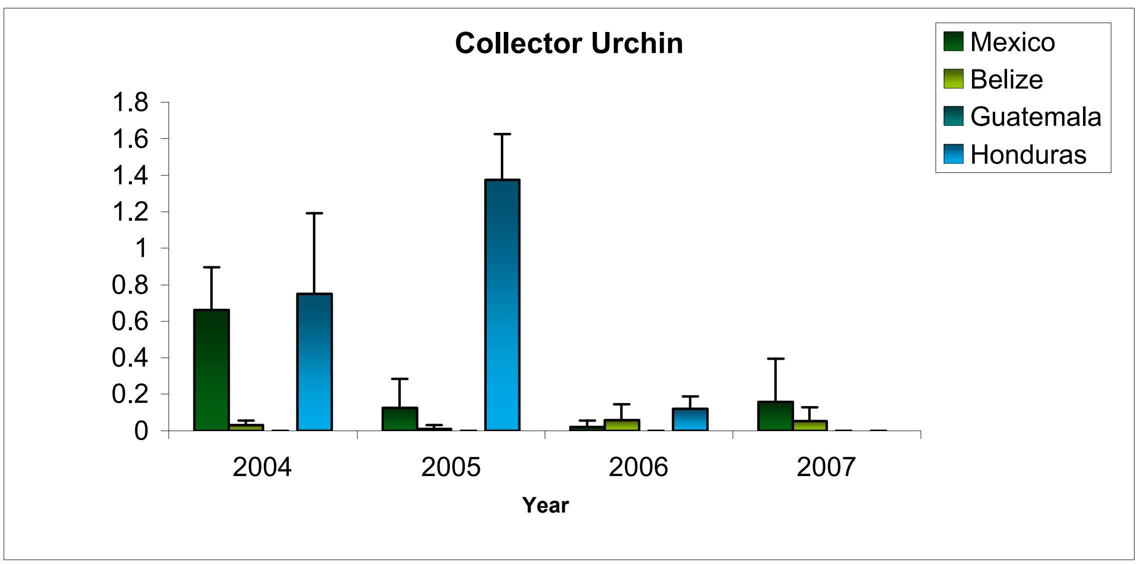

Figure 11. Collector Urchin abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

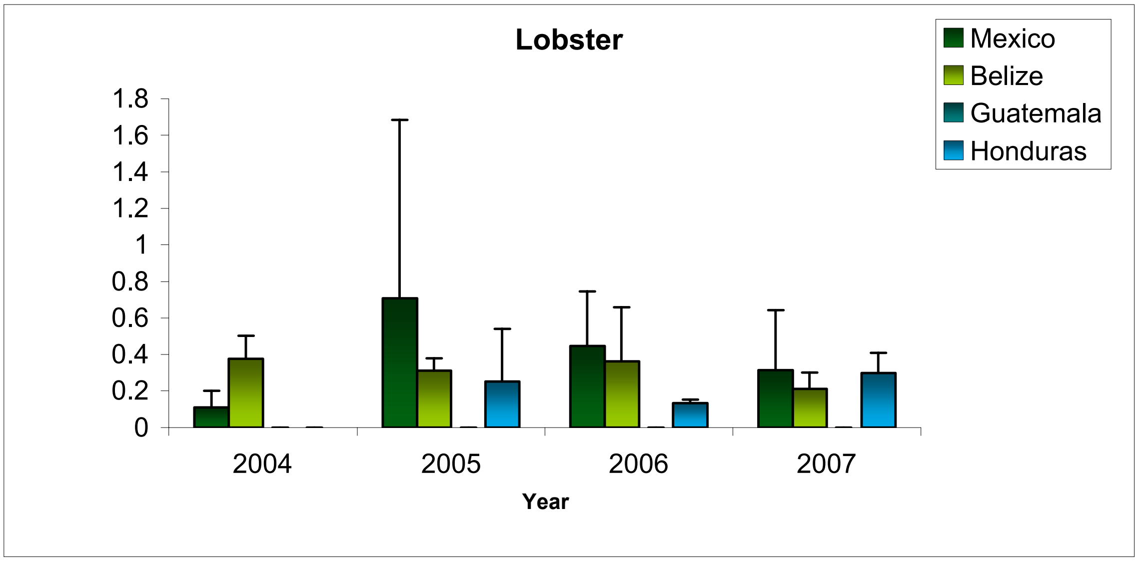

Figure 12. Lobster abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

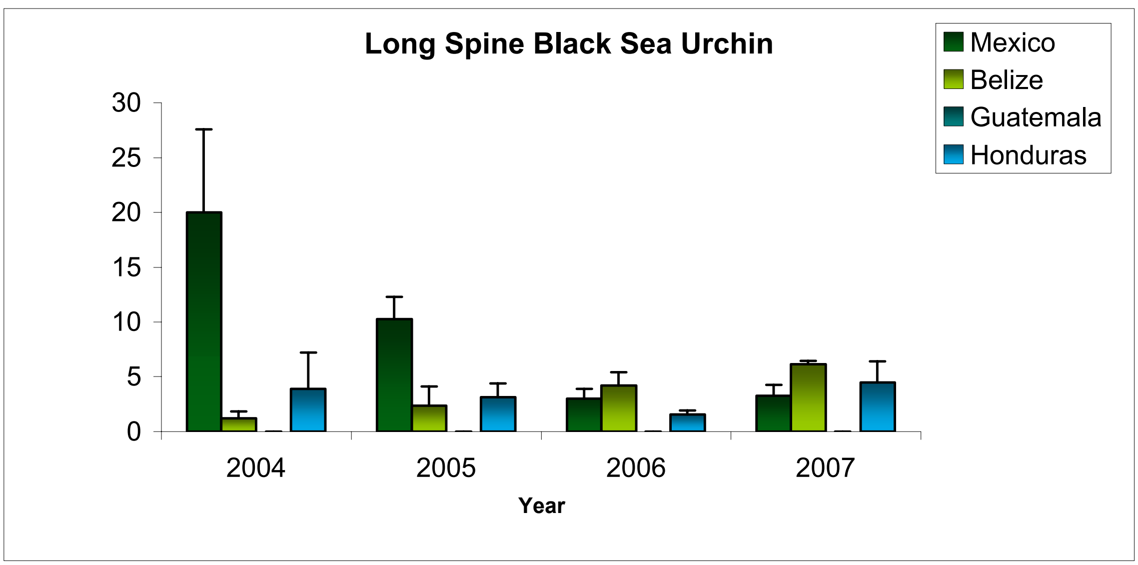

Figure 13. Long Spine Black Sea Urchin (*Diadema*) abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per 100m^2.

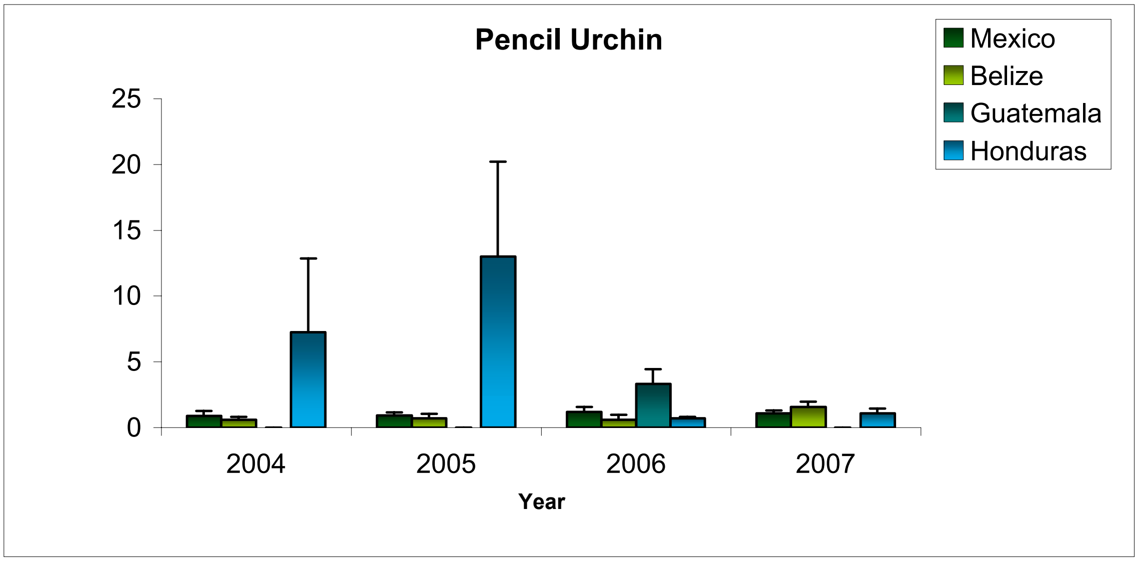

Figure 14. Pencil Urchin abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per $100m^2$.

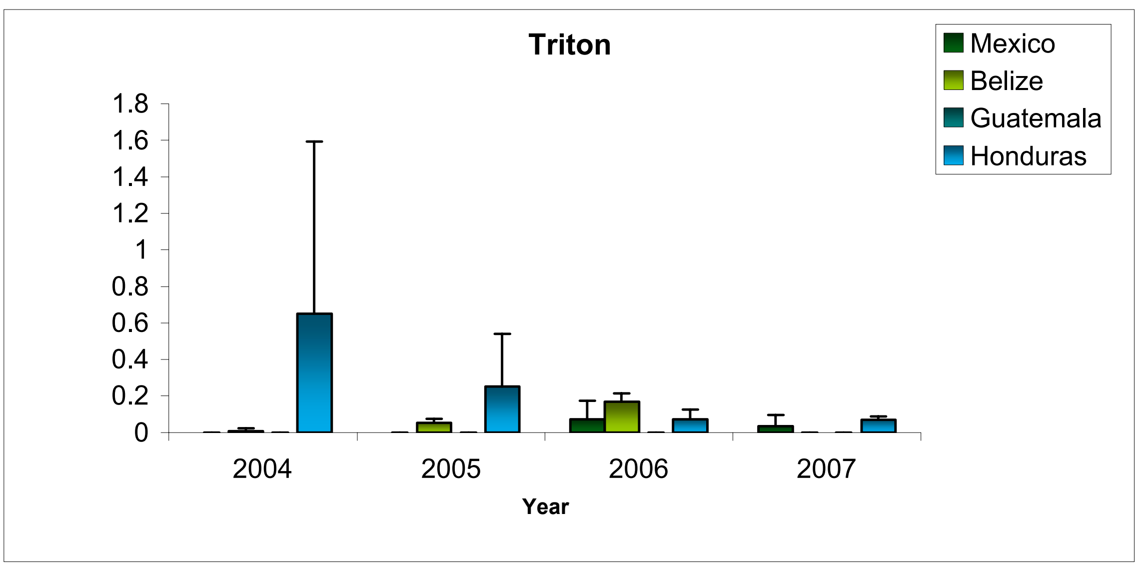

Figure 15. Triton abundance during the ICRAN-MAR project in Mexico, Belize, Guatemala and Honduras between 2004 and 2007. Bars represent the mean number of individuals per $100m^2$.

Substrate composition

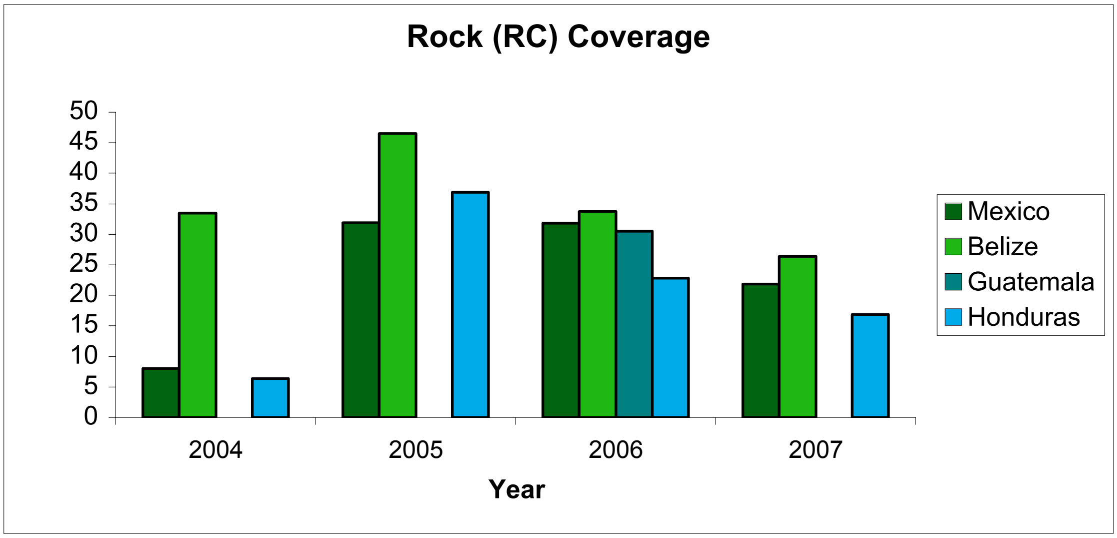

Figure 16. Rock coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

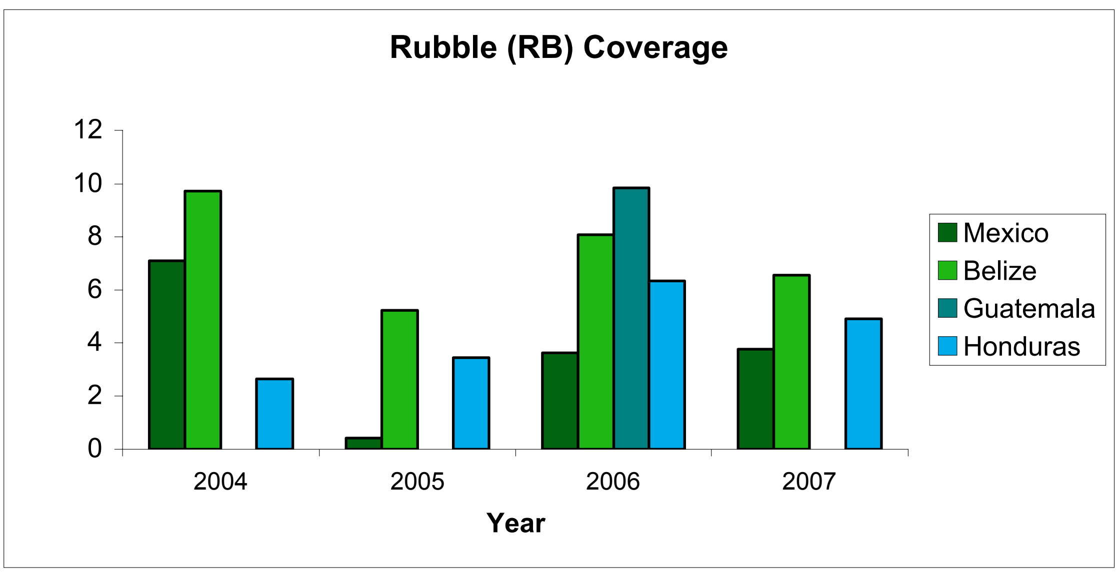

Figure 17. Rubble coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

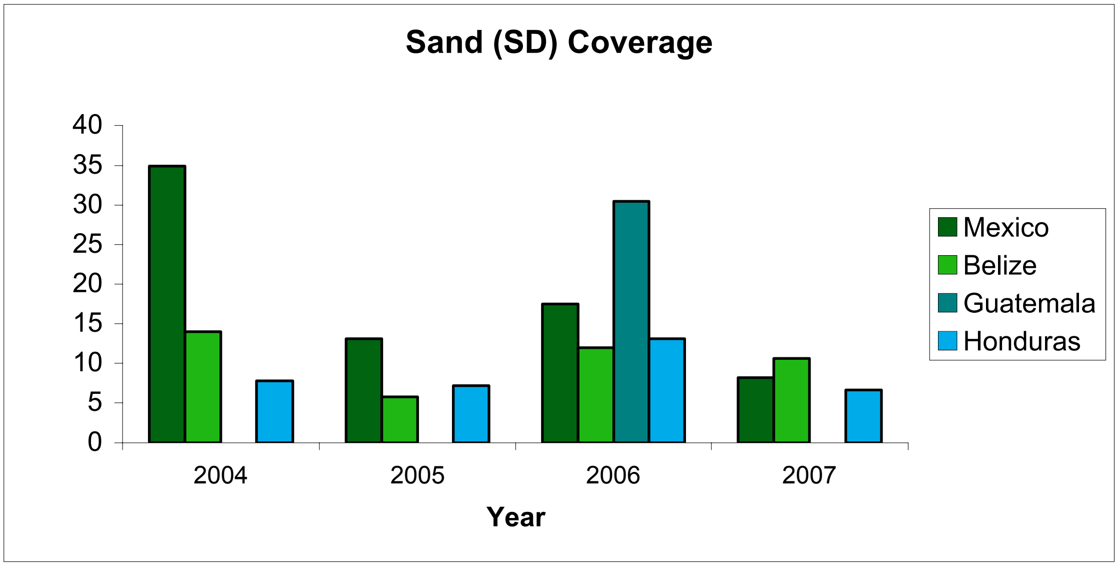

Figure 18. Sand coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

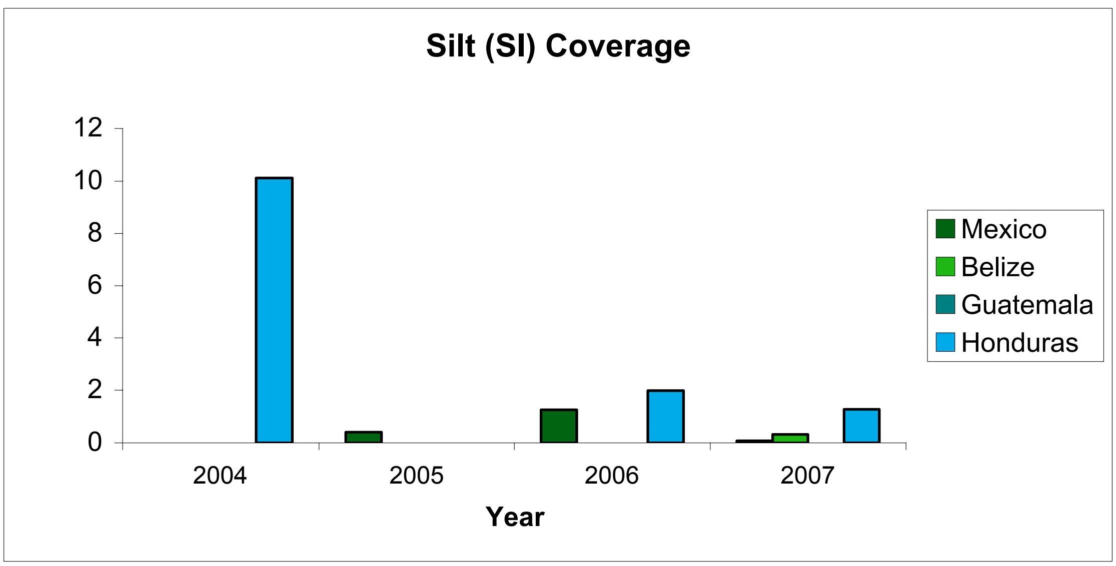

Figure 19. Silt coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

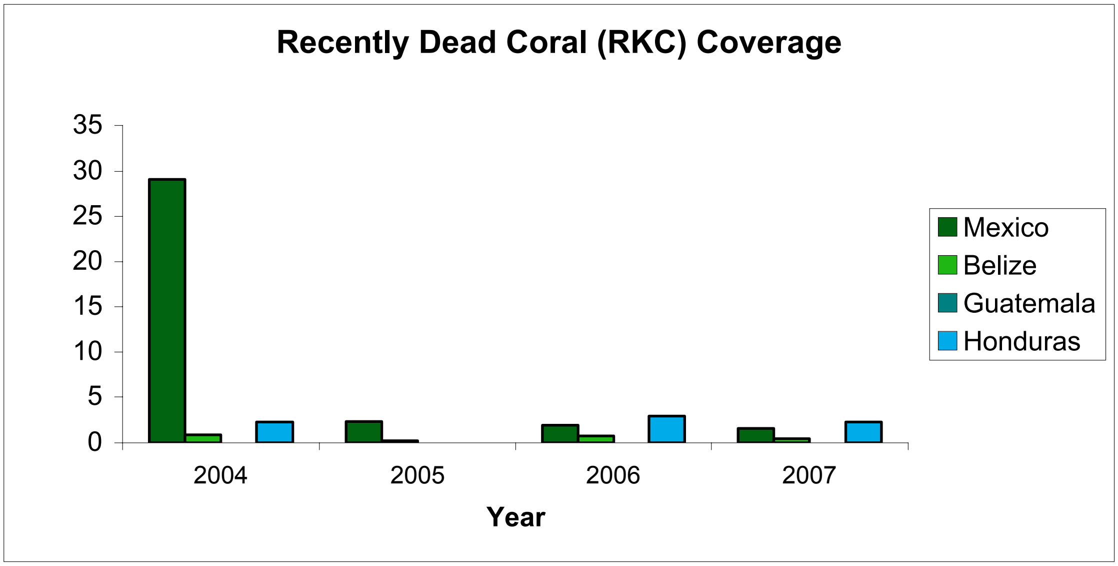

Figure 20. Recently Dead Coral coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

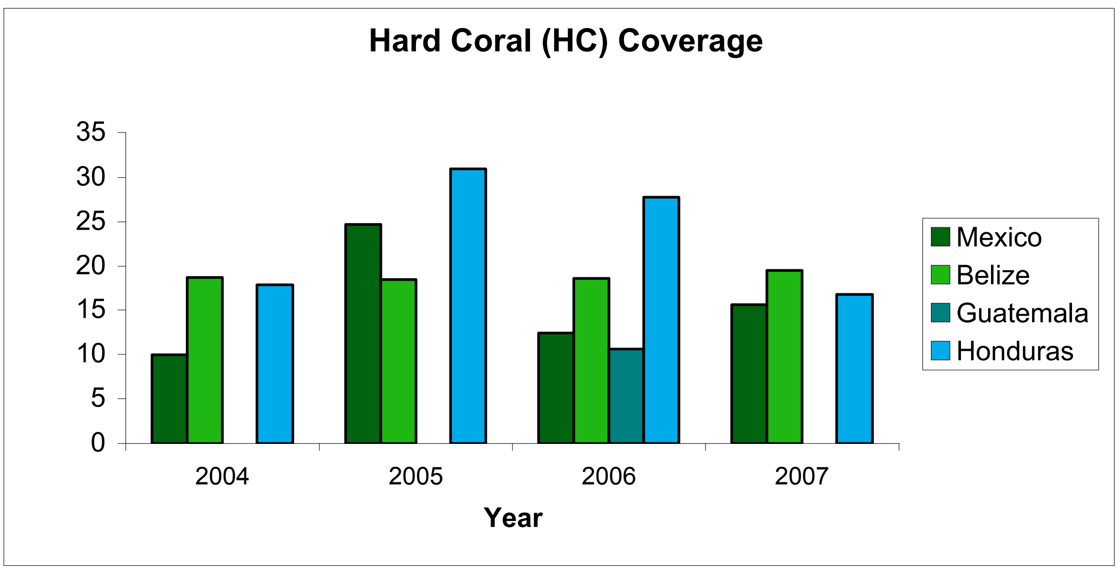

Figure 21. Hard Coral coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

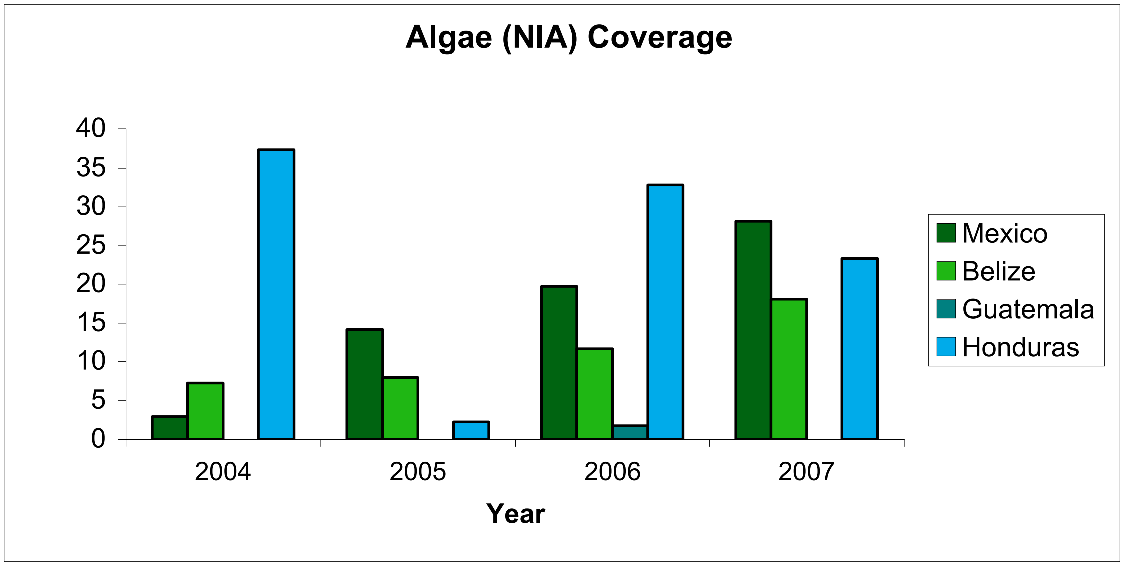

Figure 22. Algae coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

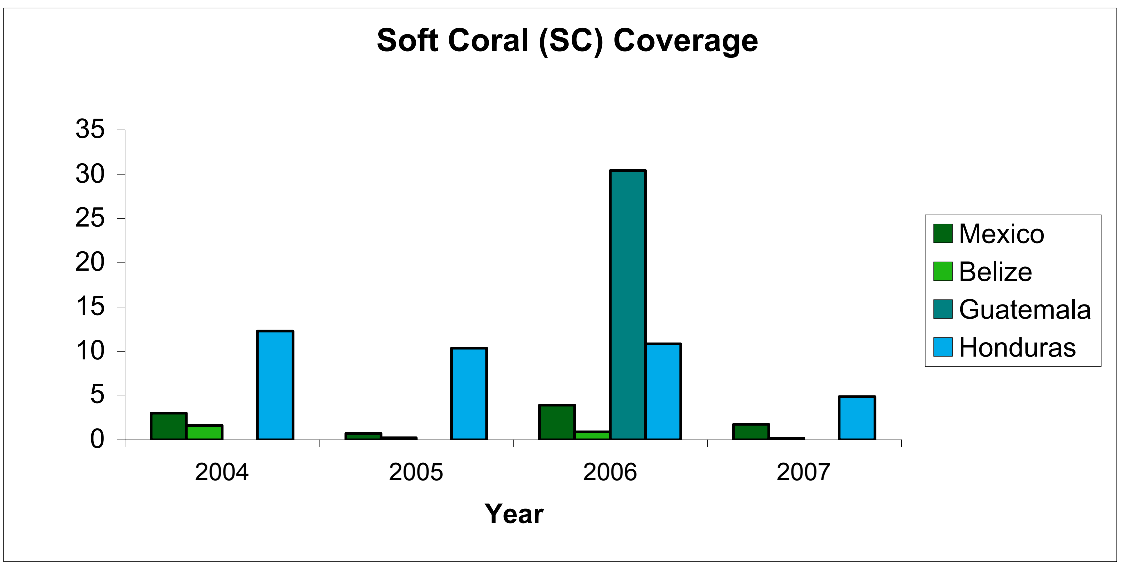

Figure 23. Soft Coral coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.

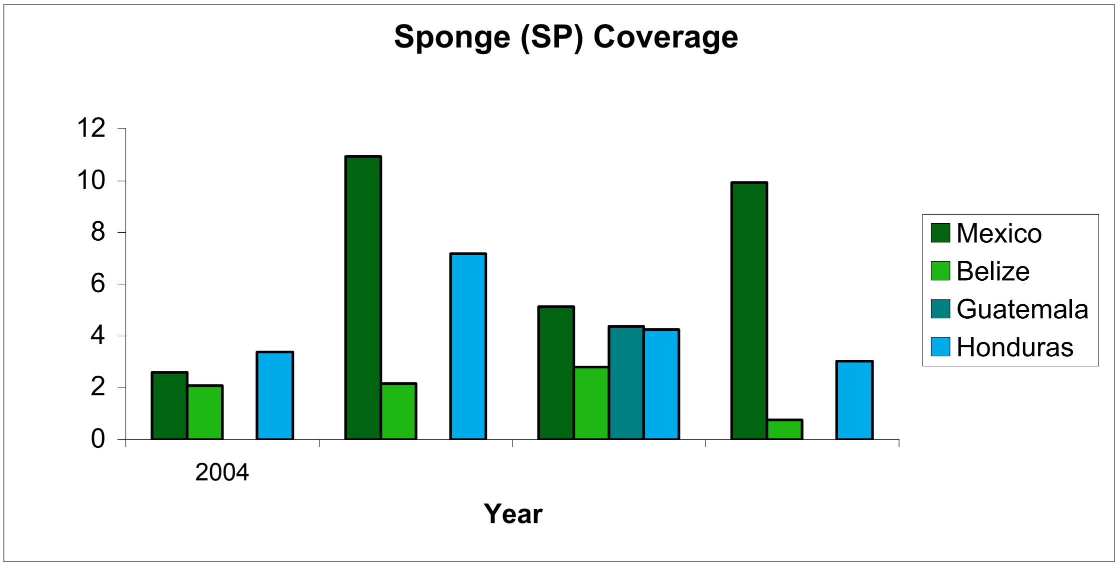

Figure 24. Sponge coverage of the bottom between 2004 and 2007 in Mexico, Belize, Guatemala and Honduras. Bars represent the percentage coverage by the substrate category.