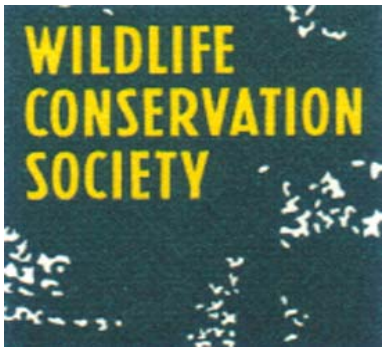
Field Protocol for Monitoring Coral Reef Fisheries Resources in Belize



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I. WHY MONITOR MARINE FISHERIES RESOURCES?

Marine fisheries resources are among the most valuable natural resources in Belize and in many Caribbean countries. This resource is renewable, but several factors are crucial for **sustainable**, **long-term harvesting** of the resource into the future. There are several strategies for harvesting marine fisheries. For example, in the northern Pacific, fishermen harvest most of the populations of squid and salmon each year, after a period in which all the adults reproduced at the same time (termed **semelparous** reproduction). This type of mass harvesting is possible because the adults will die soon after reproducing, and so each generation is discrete. However, most species in tropical seas have a different life history in which generations in a population overlap in time. Only some individuals reach maturity each year but they can reproduce many times through their life span (termed **iteroparous** reproduction). Therefore, unlike north Pacific fishermen, Belizean fishermen must harvest **selectively** – taking only a limited proportion of the population each year. If too much of the population is harvested in one year, the entire fishery may collapse economically and the species may be driven to extinction. Marine fisheries regulation and monitoring are necessary to ensure that fisheries resources in Belize remain sustainable.

II. HOW ARE MARINE FISHERIES RESOURCES MONITORED?

Monitoring of marine species that are targeted in commercial fisheries is aimed at maintaining **viable populations**. In a viable population:

i) the habitats needed by the species are preserved in an optimal state for providing food and shelter

ii) the adults are allowed to reproduce at least once in their life span

iii) all juveniles are allowed to grow to maturity before being killed

iv) the unharvested portion of the population is kept large enough to maintain genetic diversity.

A simple count of the target species will not provide enough data to draw any conclusions or make any management decisions. To monitor and analyze the viability of a fished population, the minimal data that must be gathered include: the number of animals in each **size class** of the population, the number of adults that are reproducing, and any major changes in habitat quality from that required by the species. These data must be gathered at regular intervals using standardized methods in order to construct a data **time series**. Analysis of these data time series can reveal trends on whether the population is increasing, decreasing, or stable, so that management decisions on fishing quotas, length of season, and regulations can be modified to make the fishery both profitable and sustainable.

The most complete protocol for monitoring fisheries resources is a combination of the following two methods:

1) Fishery Monitoring

Direct fishery monitoring involves subsampling the fishermen's catch or landings. This is accomplished by posting researchers on board fishing vessels to sample the catch from various fishing methods (diving, traps, trawls). Researchers take data on what species are caught, the sizes of animals, reproductive status, and the proportion of the catch that meets the fishery "legal size" criteria. These data can be supplemented by information from the export market of the fishing cooperatives. However, export data alone is not adequate to monitor the status of any fishery.

2) Fishery-independent Monitoring

This type of monitoring involves sampling of habitats of the target species. Researchers use diving surveys, trapping, remote video, or experimental techniques (e.g. mark-recapture sampling) to get direct estimates of a population in its natural habitat. This type

of monitoring is the most intensive in terms of labor, manpower, and cost, but generally yields the best data. Additionally, fishery-independent monitoring in **marine protected areas** where fishing is prohibited is important for comparing the impacts of fishing and for rapidly detecting changes in a fished population (such as overfishing, reproductive failure, disease outbreaks, etc.).

III. WCS FIELD PROTOCOL FOR MONITORING CORAL REEF FISHERIES

The aim of this WCS-sponsored project is the fishery-independent monitoring of target species in and around marine protected areas of Belize. This protocol was developed in 1996 to monitor the spiny lobster and queen conch fisheries in the Glover's Reef Marine Reserve. It was expanded in 2000 to include monitoring of important finfish species.

1. Sampling

Sampling is based on timed surveys to visually locate and estimate several parameters. Timed surveys are used because they yield quantitative estimates and require minimal equipment. Surveys are conducted for exactly 0.5 or 1 hour in one particular habitat, such as coral reef or seagrass beds. The **catch-per-unit-effort (CPUE)** is then recorded as the number of animals encountered per hour of sampling. The CPUE can be converted to **density per unit area** of habitat after measuring the average distance along a transect or area of reef covered by a researcher during the time period (0.5 or 1 hour).

Regional surveys should be conducted in fishing grounds and in marine protected areas on at least a quarterly basis (three times per year) in order to construct a statistical time series. If possible, surveys should be conducted February, June, and October. The **GPS** coordinates of sampling sites and current **weather conditions** should be recorded.

2. Measurements

2.A. Spiny lobster *Panulirus argus*

(and other reef lobster species including *Panulirus guttatus*, *Syllarides nodifer*, *S. aequinoctialis*, *Parribaccus antarcticus*)

Spiny lobsters (and other lobster species that may be incidentally fished) are surveyed on coral reef habitat. Large juveniles and adults use reef habitat for shelter and feeding; smaller size classes use seagrass and macroalgal habitats (that cannot be visually surveyed). All crevices are searched, using an underwater flashlight if necessary. **Patch reefs** are searched by swimming crossing patterns across the whole reef structure. **Forereef habitats** (spur-and-groove, wall, etc.) are surveyed with each diver covering 5-m wide transects along a single depth strata (3, 10, or 20 m deep) for the survey time period. A variety of reef habitats and depths should be surveyed in each region.

Lobsters are measured for size, sexed, and checked for egg masses, without capturing the animal if possible. When a lobster is found, it is approached slowly to be observed and measured.

- To determine the sex of adults: Adult males are distinquished by having the **third pair of walking legs** that are much longer than all other legs. Adult females have **swimmerets with frilly tips** under the **abdomen ("tail")**. If it is an adult female, the ventral side of the abdomen is checked visually to determine if it is carrying an **egg mass**, attached to the swimmerets.
- To measure size: Its **carapace ("head") length** is estimated by laying a marked stick over the dorsal side. The carapace is measured to the **nearest cm**, from the posterior end of the carapace to the space between the eyes (figure 1).

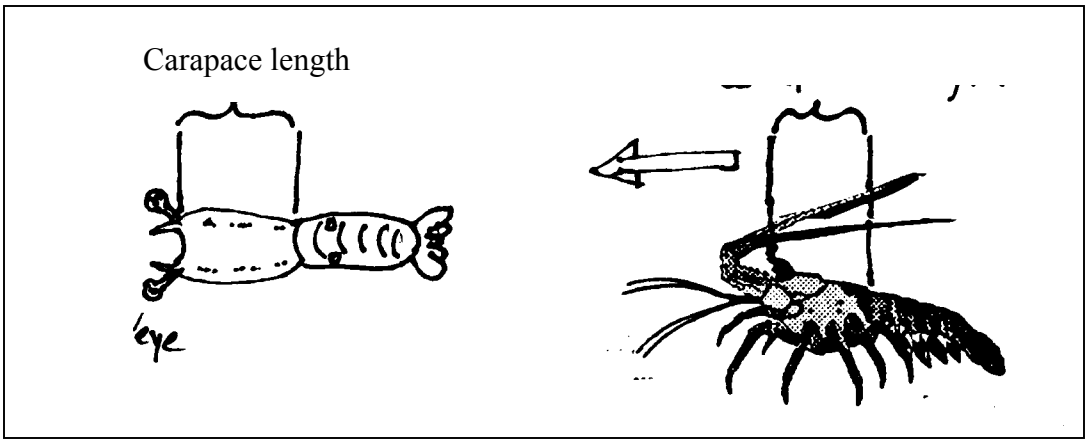

Figure 1. Measurements of spiny lobster carapace length.

2.B. Queen conch *Strombus gigas*

Queen conch are surveyed in **sand-algal flats and seagrass beds**, as well as near shallow **patch reef** habitat (with spiny lobster sampling protocol above). In sand-algal and seagrass habitats, density surveys are conducted along straight-line belt transects that are 2 m wide by 50 m long. A 50-m measurement tape is laid along the substrate, and conch are counted along 1 m on either side of the tape. The time that surveys take should also be recorded for calculation of CPUE.

Conch are measured for size and checked for egg-laying activity.

- To measure size: **Shell length** is measured in cm from the tip of the spire to the notch opening (figure 2). Mature conch stop increasing in shell length, but the **shell lip** starts to widen. Therefore, the lip width and thickness must be measured to estimate age or weight in mature conch. The width of the shell lip opening and the thickness of the shell lip are measured.
- To check for egg-laying activity: Mature females may be observed laying an egg mass, which is a kidney-shaped mass consisting of small tubules with eggs. Egg-laying activity or the presence of egg masses nearby should be recorded.

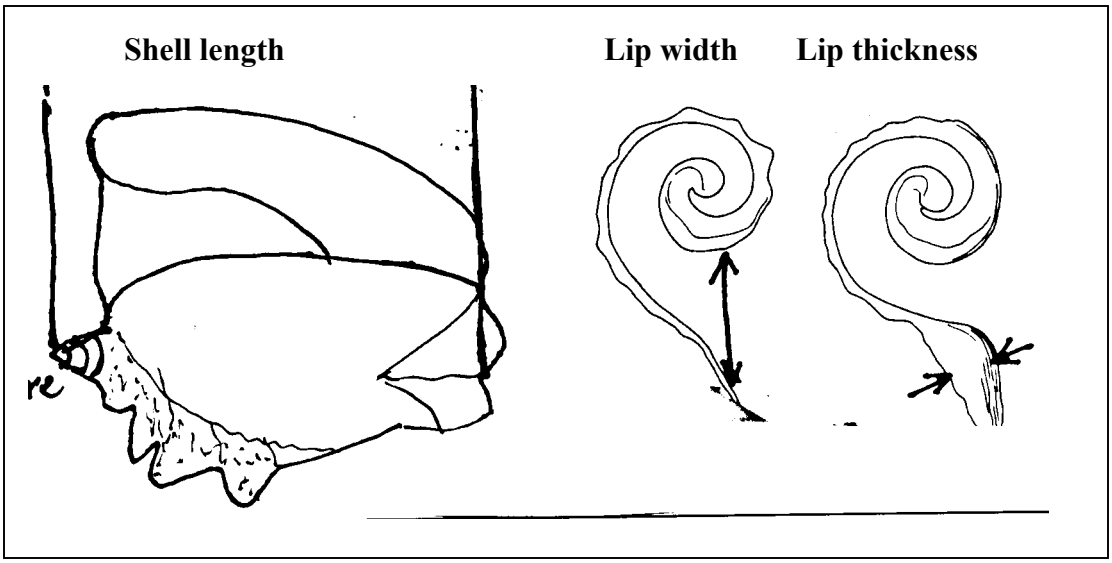

Figure 2. Measurements of queen conch shell parameters.

3.A. Finfish: **Nassau grouper *Epinephelus striatus***
Black grouper *Mycteroperca bonaci*
Hogfish *Lachnolaimus maximus*
Mutton snapper *Lutjanus analis*
Queen triggerfish *Balistes vetula*

Surveys for these fish species are conducted on reef habitat (as in spiny lobster sampling protocol above).

To measure length: Preliminary training must be conducted to orient researchers to visually estimate fish length. Six sticks (painted bright yellow) of varying lengths from 8 cm to 50 cm are randomly placed on a patch reef. Trainees are required to swim to within 5 m of each stick and must estimate the length to the nearest cm. A trainee is qualified for field sampling after that person correctly estimates 5 of the 6 lengths to within +/- 2 cm of the correct value. During field surveys, the length of the target species is estimated from the **tip of the snout** to the **fork of the tail** at a distance of 5 m.

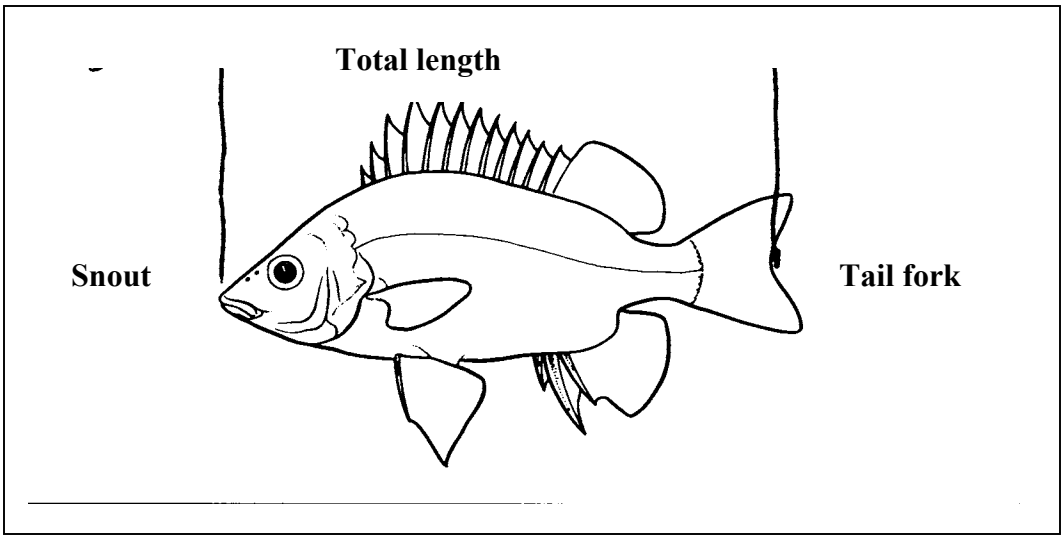

Figure 3. Measurement of finfish length.