ANNEX D - BIOPHYSICAL BASELINE MONITORING METHODS

The GCRMN baseline scientific monitoring methods provide a basic framework for existing and developing monitoring programs to contribute data that support a regional understanding of status and trends of Caribbean coral reefs. The purpose of these methods is to collect data that will contribute to our understanding of the processes that shape coral reefs and to provide actionable advice to policy makers, stakeholders, and communities. In order to achieve these goals, the GCRMN community seeks to collect comprehensive and inter-comparable data that build from a modern scientific perspective of reef monitoring.

METHODS

The GCRMN methods have been developed to provide a systematic snapshot of the ecosystem health of coral reefs and, when repeated through time, insight into temporal trends in reef condition. Based on the conclusions of a retrospective analysis of trends in reef health over the past decades, GCRMN members have agreed that there is great value in coordinating and standardizing future monitoring efforts. To date, Caribbean regional monitoring efforts often collect non-overlapping types of data about coral reefs, or the efforts use non-comparable methods for describing similar parts of the reef ecosystem. The goal of this document is to define a set of data and data collection techniques that will be used by Caribbean GCRMN members. These methods reflect long-standing, vetted scientific protocols and provide a compromise between practical applicability and ease of comparison between existing methods and long-term datasets.

The GCRMN methods describe six elements of the coral reef ecosystem – (1) abundance and biomass of key reef fish taxa, (2) relative cover of reef-building organisms (corals, coralline algae) and their dominant competitors, (3) assessment of coral health and (4) recruitment of reef-building corals, (5) abundance of key macro-invertebrate species, and (6) water quality. These elements provide an overview of the current condition of the coral reef ecosystem as well as an indication of likely future trajectories. GCRMN recognizes that by collecting information about these elements across multiple locations, with regular re-sampling through time, it will be possible to more knowingly describe the status of coral reef health in the Caribbean and to assess the effectiveness of local and regional management efforts.

These methods are designed to provide a basic and regional summary of reef health. Importantly, the elements that are included for GCRMN monitoring are not all-inclusive, and many partner members may be interested in collecting more detailed or spatially expansive data. However, the GCRMN methods should be viewed as a minimum set of measurements to provide a reliable snapshot of reef condition – data elements should not be selected individually but instead will be collected in sum. Given the inherent complexity of reef processes, a multi-dimensional description of coral reef health is essential to provide a coherent ‘baseline’ of coral reef condition in a dynamic and changing world.

Training, standardization, and calibration

A series of references and support tools are to be produced to assure that the GCRMN methods are well-understood by partners and that the data generated are robust. This document (Annex E) provides an overview of the methodology along with references to supporting documents. In addition, a number of products are intended for production to supplement this document, including – (i) a species identification guide, providing images and descriptions of taxonomic groups to be used for recording fish and benthic data, (ii) a series of instructional videos, intended to visually 'walk through' the implementation of each set of methods, and (iii) an online portal for discussion and consultation, providing a pathway for partners to troubleshoot methodological or reporting concerns. Pending resource availability, the GCRMN group will implement (iv) occasional local training workshops, intended to get partners together to exchange knowledge in the field setting and to perform cross-checks and calibration of data collection protocols.

Design of local monitoring

The GCRMN baseline monitoring methods have been developed to enable partners to describe the status and trends of specific locations in a manner that is directly comparable across geographies. As such, the design of the monitoring protocols must be founded on consistency within locations and standardization across locations. Operational definitions of the spatial design of GCRMN monitoring are provided here.

A monitoring effort may partner with the GCRMN community if they provide a reliable description of a coral reef location in the Caribbean region. A *location* is defined as the characteristic reporting unit, and the *location* has a bounded geographic range, representing somewhere between 5 to 100 km of coastline. For example, an island with a total coastline of 78 km may opt to define their *location* as the coral reefs spanning the entire coastline of the island. In contrast, if an island has 1000s of km of coastline with coral reefs, the partner will define a specific section of the coast as the *location*. The definition of a *location* is expected to follow from the needs of each partner, for example representing regions of important historical or ecological significance. The partner, however, should begin monitoring only after the specific boundaries of a *location* have been defined.

A GCRMN partner must complete sufficient sampling in order to provide a statistically robust description of a *location*, and the unit of replication within the *location* is called the site. A *site* is defined as a particular spot on a map where surveyors will get into the water to collect monitoring data. A *site* can be considered operationally as a 'dive site' or 'monitoring station', and will be reported based upon its geographic coordinates (latitude and longitude). Individual *sites* should be selected randomly from across the location, thereby faithfully (and without bias) representing the variation in the coral reefs across the location. The GCRMN required level of effort is 20 or more *sites* per location. This level of effort is informed by a statistical power analysis considering the ability of the data to detect a 5% change in coral cover between sampling intervals (e.g., a change from 20% to 15% coral cover). Figure 1 demonstrates that by sampling at least 20 *sites* per location, there will be a 50% chance of documenting such a change of 5% in coral cover. Note that the statistical power increases greatly at the number of

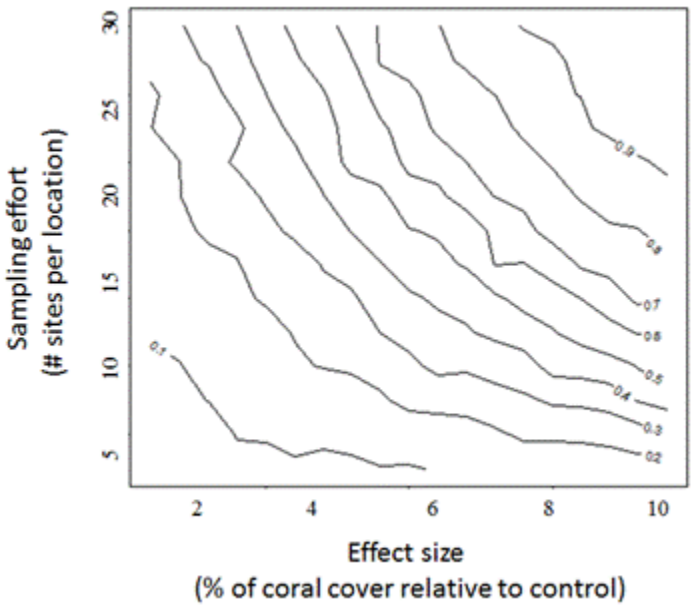

Figure 1. Results of a statistical power analysis for considering sampling effort for GCRMN reef monitoring. The contours in the graph represent the probability (power, or 1-β) that a reef survey with a particular amount of effort (y-axis; number of sites surveyed) reveals a change in coral cover of a particular effect size (x-axis; absolute difference in percent cover cover). For example, a survey sampling 20 sites will reveal a 2% change in coral cover approximately 20% of the time, a 5% change 50% of the time, and a 10% change 80% of the time. The survey assumes sampling 75 photoquadrats per site with 25 points assessed per photograph.

sampling intervals increase (i.e., with increased sampling through time). As such, these considerations of statistical power should be viewed as a guide for selection of sampling effort rather than as a strict statement of statistical results that are to be expected from a real, long-term monitoring campaign.

All sampling sites used for GCRMN monitoring efforts will be limited to a subset of reef habitats. In order to maximize comparability across the region, GCRMN data will be collected solely from forereef habitats at depths ranging from 8-15 m. Importantly, this constraint disallows contribution of data from backreefs, lagoons, and deep reef habitats. However, if GCRMN partners have local interests in monitoring these (or other) coral reef habitats in their region, they are encouraged to apply the same methods. By using comparable methods, there will be greater future opportunities to consider cross-comparisons within and among regions, as data become available. A fundamental goal of GCRMN is to increase standardization of data collection for monitoring, thereby increasing the ability of the management and research community to better understand regional patterns of change in coral reef into the future.

Each GCRMN partner will complete a comprehensive sampling of their location (or locations, for partners with more reef area and sufficient capacity) at least *once per year.* Annual sampling of sites within locations will assure that temporal change within and among locations can be documented. In order to avoid any potential error due to seasonal variation in reef composition (e.g., algal blooms, fish spawning), sampling will be completed in the same season, and highly recommended to be completed in the same month, each year.

METHODS OUTLINE

The methods that follow are organized into three sections, labeled as *highly recommended*, *recommended*, and *required*. The *highly recommended* method is the one that provides the most rigorous and comparable data for current and future applications. In many cases, this method provides higher resolution for archiving reef condition, and thus enables more detailed explorations of reef health today and into the future. The *recommended* method is the basic approach that provides the essential information defined by GCRMN, and uses a common and consistent field approach. The *required* methods are a collection of viable approaches for collecting the essential information while not using the recommended method. Methods considered under the description 'required' are those that provide information that is broadly comparable to the recommended methods, though differ in key aspects that prevent detailed comparisons of the data. The required methods should be used only in cases where the local GCRMN partner has an established monitoring program, and thus changing methods may compromise the legacy and consistency of the local effort.

1. Abundance and biomass of key reef fish taxa

Core information to collect – The goal of data collection for the fish taxa is to characterize the key species of economic and ecological importance. In total, ***the core data to collect are the density and size structure of all species of snappers (Lutjanidae), groupers (Serranidae), parrotfish (Labridae – Scarinae), and surgeonfish (Acanthuridae)***. These species are among the principal food fishes among Caribbean small-scale fisheries, as well as being critical species for maintaining reef ecosystem health. Note that collecting information on both density and size structure is required to estimate the biomass of each species by using known length-to-weight relationships published for all fish species. Additionally, it is recommended to record the presence of sensitive species (e.g., sharks, rays) or important invasive species (e.g., lionfish).

Beyond the core information, *it is highly recommended to provide estimates of the density and size structure of all fish species* within the survey area. Such high resolution estimations of the fish assemblage provide the core information (snappers, groupers, parrotfish, and surgeonfish), while also providing fundamental information about other members of the fish assemblage that may serve important roles in fisheries (e.g., barracuda and grunts) or ecosystem maintenance (e.g., damselfish) that will be further considered or discovered in the years to come.

Highly recommended – The GCRMN highly recommended method for estimating the density of coral reef fishes is similar to the Atlantic and Gulf Rapid Reef Assessment (AGRRA) – http://www.agrra.org/method/methodhome.html . All fish present (of all species) are counted within a belt transect (30m length x 2m width), with the survey time limited to approximately 6 minutes per transect. At each site, 5 transects are surveyed and the data are pooled to provide an average estimate of the density and size structure of all fishes at the site.

Recommended – If the taxonomic expertise is limited among the survey team, it is recommended to follow the same modified AGGRA protocol, but to estimate the density and size structure of only the core species (snappers, groupers, parrotfish, and surgeonfish).

Required – It is required for contribution to the GCRMN database that the core information about the fish assemblage (including estimates of density and biomass) is collected using a vetted and comparable field method. Acceptable protocols are the stationary point count and belt transects (of different dimensions to the AGGRA protocol). Note that the specifications of these protocols are often variable, and GCRMN members should strive to achieve standardization of methods whenever possible.

2. **Relative cover of reef-building organisms and their dominant competitors**

Core information to collect – The goal of data collection for the assessment of benthic environment (i.e., corals, algae) is to document the relative cover of reef-building, stony corals and their dominant competitors. As such, ***the core data to collect is the percent of the reef bottom that is covered by stony corals, gorgonians, sponges, and various types of algae (turf algae, macroalgae, and crustose coralline algae)***. The stony corals and some of the calcifying algae are the dominant taxa that build the coral reef structure, while the turf and some macroalgae can compete with reef-builders and thereby limit growth of the reef structure.

Highly recommended – The GCRMN highly recommended method for estimating the cover of key taxa on the reef benthos is the photoquadrat method. This approach depends upon taking digital photographs of the reef surface in standardized quadrat areas (0.9m x 0.6m). Photographs are taken along each of the 5 transect lines set for counting fish, with 15 images captured per transect line (i.e., one image taken at every other meter marker on the transect tape). In total, 75 benthic photographs will be collected at each site (5 transect lines x 15 photographs per line).

Data are captured from the images through post-processing by a trained observer. On each image, 25 points are identified in random locations across the image. The benthic type under each point is classified into a standardized benthic category including key species (and some broader groups) of corals and algae (see Table 1). Image processing software is freely available to support the image post-processing (e.g., Coral Point Count).

Recommended – If taxonomic expertise is limited in the survey team or time is limited for detailed post-processing, it is recommended to collect the images as above but to follow one of two options for post-processing – (i) identify points in the images to coarse functional groupings (principally stony coral, gorgonian, sponges, turf algae, macroalgae, crustose coralline algae; complete list is available in Table 1), or (ii) solicit support from a partner within the GCRMN for high-resolution image post-processing.

Required – It is required for contribution to the GCRMN database that the core information be collected using a standardized and reliable method. Given that some programs may have a long-standing approach using an alternative (but generally comparable) method, or that a potential member may not have access to digital cameras, alternatives are available (though not preferred) to provide the core data. In particular, *in situ* estimation of benthic cover may be collected using field assessment of quadrats (collected in sufficient quantity) or using line-point-

intercept methods (estimated over sufficiently long and replicated transects). Note that the specifications of these protocols are often variable, and GCRMN members should strive to achieve standardization of methods whenever possible.

3. **Assessment of coral health**

Core information to collect – The goal of data collection for assessing coral health is to document ***the prevalence of disease in stony corals***. Disease prevalence is a metric describing the proportion of coral that shows signs or pathologies of any disease. Because of the challenges associated with defining the boundaries of individual coral colonies, the GCRMN core information reports coral disease prevalence as the proportion of replicated benthic areas (e.g., photoquadrats) that have diseased corals. Note that while this simplified method does not capture many elements of coral disease ecology, like species- or size-specificity of disease incidence, this is a useful approach for collecting standardized and inter-comparable data describing coral health.

Highly recommended / Recommended – The GCRMN highly recommended method for estimating disease prevalence in corals depends upon use of the photoquadrats collected following the highly recommended (and recommended) methods for benthic cover assessment. Data will be recorded as the proportion of images collected that contain a coral with any disease pathology. For example, if there are four colonies in a particular photoquadrat and any of these colonies shows signs of disease, this image would be tagged as "with disease". The number of images that are "with disease" is divided by the total number of images (15 per transect) to generate a proportional estimate of disease prevalence.

Required – It is required for contribution to the GCRMN database that the core information of proportion of defined areas of substrate that have some coral disease. If the survey team is not depending upon the use of photoquadrats, then *in situ* approaches must be used. A surveyor will lay a quadrat (0.5 – 1.0 m^2) at every other meter of a transect line used for benthic cover assessment. Identically to the Recommended methods, the surveyor will record whether or not the quadrat is "with disease" and the number of these positive disease quadrats will be divided by the total number of quadrats to generate a proportional estimate of disease prevalence.

4. **Coral recruitment**

Core information to collect – The goal of data collection for coral recruitment is to estimate ***the density of young corals that are likely to contribute to the next generation of adult corals*** on the reef. Documenting the early life stages of corals is notoriously challenging, given that many of the smallest coral settlers (e.g., those that recently settled to the reef substrate) are very small and are found in cryptic habitats, such as in cracks or on the hidden surfaces of rocks. As such, this protocol employs an operational definition of coral recruits as those smallest individuals (1.0-4.0 cm^2) that are visible to a diver *in situ*.

Importantly, much scientific literature employs the use of standardized substrates (e.g., settlement tiles) for providing a more precise estimate of relative rates of settlement and recruitment. While such efforts are valuable for experimental studies, they are labor-intensive

and prone to methodological bias (e.g., tile type and soaking duration can greatly influence settlement rates). We propose here an observational approach that integrates across natural variability in the environment and offers a relative estimate of the density of corals that are likely to contribute to the next generation of coral adults in the region.

Highly recommended / Recommended – The GCRMN highly recommended method for estimating the density of coral recruits is similar to the AGRRA methods – http://www.agrra.org/method/methodhome.html – though with some specific differences. Coral recruits are defined operationally for this assessment as any stony coral that is greater than 1.0 cm^2 and smaller than 4.0 cm^2. The lower limit of this range is established based on the minimum size that can be observed reliably by a diver *in situ*, while the upper limit is defined as the largest size before the colony will be considered a 'small coral' (*sensu* AGRRA definitions) or sub-adult.

Estimates of coral recruit density are recorded from replicate 25cm x 25cm (625 cm^2) quadrats. A total of 5 quadrats will be surveyed along each of the first 3 transects used for benthic and fish surveys. The coral recruit quadrats will be placed at 2-meter intervals along the transect line, i.e., with the lower corner of the quadrat placed at the following meter marks – 2, 4, 6, 8, and 10 m. The quadrat placement will be repeated comparably on each of the first 3 transects, resulting in a total of 15 quadrats surveys, each 625 cm^2 in area. Within each quadrat, each coral within the target size range (1.0 – 4.0 cm^2) will be recorded to the finest taxonomic level possible (family, genus, or species). Importantly, many of the smaller coral recruits are very difficult to identify to species, even for taxonomic experts, so good judgment must be used to identify to the finest taxonomic level that the observer can confidently assess.

Note that the area of the quadrat used for coral recruits is smaller than that used for benthic cover assessment. The reason for this is that searching for coral recruits is relatively labor-intensive for the observer, as it is necessary to explore the focal area within the quadrat extensively. Especially in quadrats covering areas of high topological complexity, the observer will be required to explore the many surfaces within the region, regardless of orientation (e.g., sides of rocks and under loose fleshy algae).

Required – It is required for contribution to the GCRMN database that the core information of the density of coral recruits be determined. If the survey team does not have the taxonomic training to identify coral recruits with any taxonomic detail (i.e., only recognizing scleractinian, reef-building corals), then a surveyor will simply record the number of coral colonies within the defined size range (1.0 – 4.0 cm^2) within the defined quadrats. A comparable sampling protocol will be used (5 quadrats [625 cm^2] along each of 3 transect lines; total of 15 quadrats).

5. **Abundance of key macro-invertebrate species**

Core information to collect – The goal of data collection for key macro-invertebrate species is to provide an estimate of the density of biologically and economically important species on the reef. There are two principal groups of macro-invertebrates that are targets for data collection,

the sea urchins and the sea cucumbers. ***The core data to collect are the densities of the long-spined sea urchin (*****Diadema antillarum*****), other sea urchins, and all sea cucumbers.***

Many species of sea urchin, especially the historically common long-spined sea urchin (*Diadema antillarum*), are important herbivores on Caribbean reefs with a capacity to control the density of many groups of seaweed. As such, sea urchins can play an important role comparable to that of seaweed-consuming herbivorous fishes. The other key group of invertebrates, the sea cucumbers, includes important fisheries targets in some locations. Many species of sea cucumber are harvested and sold to export markets. The sea cucumbers thus can contribute to local reef-based economies. Estimates of density for these key macro-invertebrate species are valuable for considerations of ecosystem functioning and potential fisheries value.

<u>*Highly recommended*</u> – The GCRMN highly recommended method for estimating the density of sea urchins and sea cucumbers relies on the use of benthic photoquadrats (from ***2. Relative cover of reef-building organisms and their dominant competitors***). The 15 photographs from each of the 5 transect lines (75 photographs total) will be inspected. The number and species identity of each echinoid (i.e., sea urchin) and holothurian (i.e., sea cucumber) will be recorded for each image. The density of these key macro-invertebrate species will be calculated by dividing the total number of sea urchins and sea cucumbers recorded by the product of the number of images (highly recommended as 75) and the size of each photoquadrat (highly recommended as 0.54 m^2 [i.e., 0.6 m x 0.9m]).

<u>*Recommended*</u> – If specific taxonomic expertise is limited in the survey or post-processing team, it is recommended to inspect the images as above but to record the individuals into the following coarse taxonomic categories – (i) *Diadema antillarum*, (ii) other sea urchins, and (iii) sea cucumbers (all species). Given the unique role played by *D. antillarum*, it is essential that the density of this species be estimated specifically and separately from other taxa.

<u>*Required*</u> – It is required for contribution to the GCRMN database that the core information of the density of *Diadema antillarum*, other sea urchins, and sea cucumbers. If the survey team is not depending upon the use of photoquadrats, then *in situ* approaches must be used. A surveyor will lay a quadrat (0.5 – 1.0 m^2) at every other meter of a transect line used for benthic cover assessment. Identically to the *Highly Recommended* and *Recommended* methods, the surveyor will record the number and taxonomic identity (to the finest level possible) of the key macro-invertebrate species. The *in situ* approach will mimic the methods outline in the two *Recommended* categories.

6. **Water quality**

<u>Core information to collect</u> – The goal of data collection for water quality is to provide an estimate of the concentration of particulates in the water column. Water quality is influenced by many factors, ranging from oceanographic delivery of nutrients, algal growth in the water column, terrestrial contribution (e.g., mud and silt), and anthropogenic inputs. As an estimate of the integrated water quality, ***the core data to collect are the depths at which standardized Secchi disks are visible in the surface waters of the reef.*** A standardized and common metric

that captures the basic elements of water quality and has a long history of application is the use of Secchi disks.

Highly recommended / Recommended – The GCRMN highly recommended method for estimating water quality is to deploy regularly a Secchi disk at sites around the study region. The Secchi disk is a black-and-white disk (20 cm in diameter, for the purpose of GCRMN) that is attached to a measured and marked pole, rope, or chain. The disk is lowered into the water from a boat or a diver at the surface until the disk disappears from sight; at this point the measurement on the pole, rope, or chain is recorded. The disk is lowered a bit more, then pulled back up toward the surface slowly. When the disk is visible again, the measurement on the pole, rope, or chain is again recorded. The average of these two measurements is recorded as the best estimate of the distance at which the Secchi disk is visible through the water.

Note that at many tropical locations, the depth of the forereef site will be less than the vertical Secchi depth (e.g., in cases where one can see the reef from the water's surface). In these cases, horizontal Secchi distances can be substituted. In these cases, the Secchi disk will be placed or held at one location, along with the end of a transect tape. An in-water observer will swim away from the disk, pulling the transect tape and will record the distance at which the Secchi disk is no longer visible.

It is *highly recommended* to collect information on water quality at weekly intervals at standardized sites (1-8 total) that are ideally co-located with the benthic sampling sites. It is *recommended* to collect information on water quality at monthly intervals with a comparable spatial distribution. Notably, the frequency of sampling for water quality is much more frequent than the benthic sampling. As such, it is important to consider complementary on-water efforts (e.g., law enforcement and monitoring, partners in recreational dive industry) to support water sampling. Given the relatively low amount of training needed to collect water quality data reliably, there are a broad set of partners that can be engaged to help gather this information consistently.

Required – It is required for contribution to the GCRMN database that the meaningful information of water quality be reported at least annually. In many locations, there are regular programs of water quality monitoring that complement (or often provide higher resolution than) Secchi disk deployments. It is required to report some reliable and consistently-collected form of information about water quality from each GCRMN partner location. Additional types of water quality information include: dissolved oxygen (DO), total dissolved solids (TDS), nutrient concentration analysis, and bacterial sampling.

Importantly, the same type of information must be collected at regular intervals in order for the data to be acceptable to the GCRMN partnership. If different forms of data are collected in different years, then there is no capacity to document reliably patterns of change in water quality through time. It is fundamental that the data allow GCRMN partners to follow change in water quality, and this depends upon the application of a consistent methodology through time.

Data entry and reporting

GCRMN partners will use a common database for data entry and archiving. Details of the data entry portal and protocol are forthcoming. The Annex F of the report of Curacao workshop contains a proposal for a model of data management platform.

Table 1 – Categories used for benthic surveys. The GCRMN highly recommended method seeks to record high-resolution taxonomic data, as presented in the detailed categories. If taxonomic expertise is not available (in-house or through collaboration), the recommended and required methods seek to record taxonomic data as presented in the coarse categories.

Coarse categories	Detailed categories
Stony corals	*Acropora cervicornis*
	Acropora palmata
	Acropora prolifera
	Agaricia agaricites
	Agaricia humilis
	Agaricia fragilis
	Agaricia grahamae
	Agaricia lamarcki
	Agaricia tenuifolia
	Agaricia undata
	Colpophyllia breviserialis
	Colpophyllia natans
	Dendrogyra cylindrus
	Dichocoenia stellaris
	Dichocoenia stokesi
	Diploria clivosa
	Diploria labyrinthiformis
	Diploria strigosa
	Eusmilia fastigiata
	Favia fragum
	Isophyllia sinuosa
	Leptoseris cailleti
	Leptoseris cucullata
	Madracis carmabi
	Madracis decactis
	Madracis formosa
	Madracis mirabilis
	Madracis pharensis/senaria
	Manicina areolata
	Meandrina meandrites
	Orbicella annularis
	Orbicella cavernosa
	Orbicella faveolata
	Orbicella franksi
	Mussa angulosa
	Mycetophyllia aliciae
	Mycetophyllia danaana
	Mycetophyllia ferox
	Mycetophyllia lamarckiana
	Oculina diffusa
	Porites astreoides
	Porites branneri
	Porites divaricata
	Porites furcata
	Porites porites
	Scolymia cubensis
	Scolymia lacera
	Siderastrea radians
	Siderastrea siderea
	Solenastrea bournoni
	Solenastrea hyades
	Stephanocoenia michelinii
	Tubastraea aurea
	OTHER corals

Coarse categories (cont.)	Detailed categories (cont.)
Macroalgae/ plants	*Dictyota*
	Lobophora
	Sargassum
	Stypopodium
	Caulerpa
	Halimeda
	Branching and calcareous algae (other than CCA)
	Liagora
	Padina
	Seagrass
	Stypopodium
	Turbinaria
	Wrangelia
	OTHER macroalgae
Turf algae	Grazed or thin turf algae (substrate visible)
	Thick turf algae (substrate not visible)
	Turf algae overgrowing recently dead coral
Cyanobacteria	*Schizothrix*
	Cyanobacterial mats
	OTHER cyanobacteria
Crustose coralline algae (CCA)	Crustose coralline algae (CCA)
Gorgonians	*Gorgonia* spp. (FAN)
	Erythropodium (ENCRUSTING)
	Muricea (ROD)
	Briareum (ROD)
	Plexaura (ROD)
	Plexaurella (ROD)
	Eunicea (ROD)
	Pseudoplexaura (ROD)
	Pterogorgia (ROD)
	Iciligorgia (FEATHER)
	Pseudopterogorgia (FEATHER)
	Muriceopsis (FEATHER)
	OTHER gorgonians
other (invertebrates)	*Chondrilla* spp.
	Cliona spp.
	Other encrusting sponges
	Vase or barrel sponge
	Tube or rod sponge
	OTHER sponges
	Ascidians
	Millepora alcicornis
	Millepora complanata
	Millepora squarrosa
	Stylaster spp.
	OTHER hydrozoans
	Palythoa sp.
	Trididemnum sp.
	OTHER zoanthids
	OTHER (invertebrates)
Sand	sand
Limestone free of overgrowth	Limestone free of overgrowth
Rubble (bare)	Rubble (bare)