South Florida/Caribbean Network

National Park Service
Inventory and Monitoring Division

Standard Operating Procedure RF03

Field Data Collection—Version 2.0

Please cite this as:

South Florida/Caribbean Network. 2025. Field Data Collection—Version 2.0. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—RF03. South Florida/Caribbean Network, Palmetto Bay, Florida

Information within SOP RF03 is based on:

CRCP. 2024. National Coral Reef Monitoring Program (NCRMP) Reef Visual Census (RVC) Fish Survey Protocols for the U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, U.S. Virgin Islands. NOAA Coral Reef Conservation Program. 22 pp. doi: 10.25923/1y7h-cf65

Purpose

This standard operating procedure (SOP) describes the methodology used by participants to collect reef fish visual census (RVC) monitoring data. The goal of the fish community surveys is to collect and report information on species composition, density, size, abundance, and derived metrics (*e.g.*, species richness, diversity) using the RVC method in a stratified random sampling design on hardbottom habitats.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
3/24/2020	Mike Feeley	Removed use of Secchi disc.	No longer used.	2.0
3/24/2020	Mike Feeley	Removed count on non-reef habitat.	A fish count is completed only on hardbottom habitats.	2.0
3/24/2020	Mike Feeley	Removed 2 sets of replicate fish counts.	Only 1 set of fish counts is required.	2.0
3/24/2020	Mike Feeley	Size of primary unit	Reduced from 200 x 200 m to 50 x 50 m grid	2.0
3/24/2020	Mike Feeley	Removed anchoring approach for small teams.	2 paired dive teams no longer used for fish counts.	2.0
3/24/2020	Mike Feeley	Removed water quality information log.	Water quality is recorded on subset of sites by NCRMP.	2.0
3/24/2020	Mike Feeley	Updated Field/Boat Log.	Combined dive and boat logs.	2.0

Contents

Page

Equipment 4
Sequence of Events in the Field 4
Navigating to the Sample Site (Primary Sample Unit) 5
Benthic Team 7
Observations Made in the Field 9
Field Forms 9
Field/Boat Log 9
Fish/Habitat Data Sheet 10
Collecting Fish Data 12
Sample-Specific Data 15
Habitat Data 15
U.S. Caribbean Habitat Types (Kendall et al. 2001) 16
Florida and the Dry Tortugas: Four Main Habitat Types 17
Site Characteristics: Additional Data Collected 17
Site Photographs 20
Post-Collection Data Sheet and Logs Processing 20
Literature Cited 21
Appendix A. Species Codes for Florida and U.S. Virgin Islands Reef Fish 22
Appendix B. Habitat Information Sheets 36
Appendix C. Printable Data Sheets 42

Equipment

Each diver will be equipped with a data sheet and underwater slate, pencil(s), dive watch, and reference measuring tool (a marked PVC "t-stick" consisting of a 1 meter (3.3 feet [ft]) shaft marked at 10-centimeter [3.9 inches {in}] intervals and 30 centimeter [11.8 in] cross-piece marked at 1 centimeter [0.4 in] intervals – Figure 1). The reference tool/t-stick is referred to as an All-Purpose Tool or APT. In addition to the APT, divers may use tools such as a ruler affixed to a clipboard or slate, measuring tape, or gradations marked directly on a clipboard or slate. Preferably, at least one diver will also be equipped with a digital camera for habitat documentation and to record images for subsequent verification or identification of fish or invertebrates, as necessary.

Each dive team will be equipped with a reel and line. Attached to the line is a surface buoy/dive flag and GPS unit used to record the sampling location of the buddy pair. This setup is unique for each boat and will be used by the diver teams to mark the site for surface support, to mark a starting point for the dive teams, and to verify site location with the allocated site. The time displayed on each diver's watch is set to within ±15 seconds of the local time as indicated on the GPS unit.

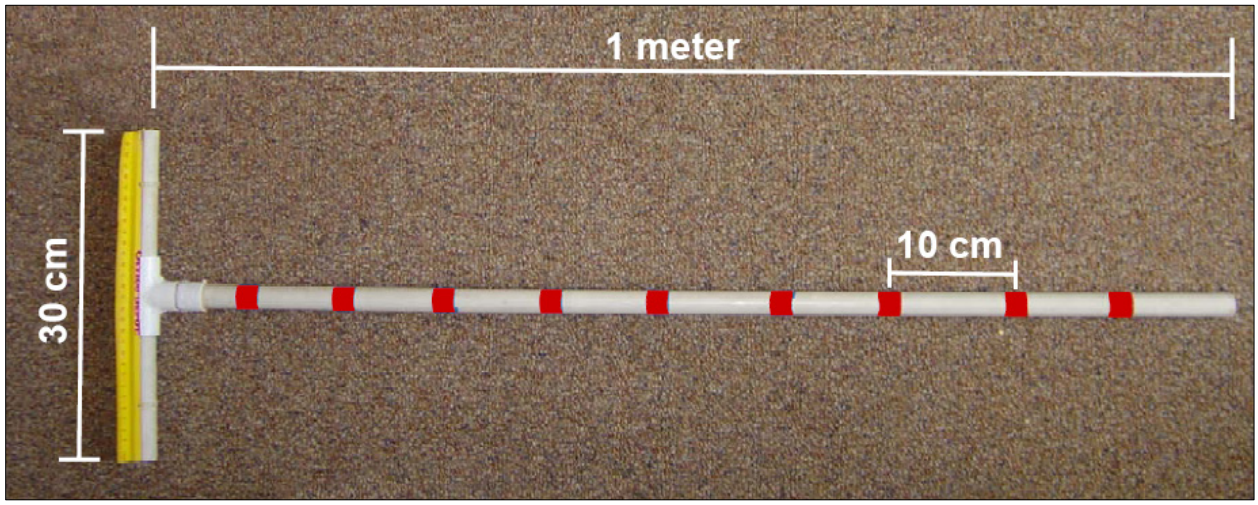


Figure 1. The RVC All Purpose Tool (APT) used as a reference device for measuring habitat vertical relief, estimating fish lengths, and estimating the location of the center and outer edge of the sample cylinder.

Sequence of Events in the Field

Sampling teams should survey sites within the same vicinity each sampling day to minimize travel times and maximize sampling efficiency. Teams will strive to sample sites across multiple habitat types each day to avoid temporal biases in fish-habitat characterizations that could arise by sampling multiple sites within 1–2 habitat types on a given day. It is also advised to work from deep to shallow sites throughout the day's sampling period for diver safety and time management purposes (i.e. consideration of required surface intervals and no decompression dive time limits).

Navigating to the Sample Site (Primary Sample Unit)

Sample sites are located using a vessel-mounted or hand-held GPS unit. The vessel uses the location coordinates of the centroid of the grid cell to first navigate to the sample site. Upon arrival at the sample site (PSU), the team will attempt to determine (e.g., via interpretation of depth finder display, surface water color) if benthic habitat within the grid cell is reef habitat. If there is enough hardbottom available, the dive team will enter the water near the centroid or where the vessel detects hard-bottom habitat within the grid cell. The main objective is to get the divers safely on habitat within the selected grid cell. Upon descent, if the benthic habitat is not hardbottom reef habitat, or if the depth exceeds dive operating limits (100 ft or 30.5 meters [m]), the divers will abort the dive and note this on the Field/Boat Log. Another site from the alternate site list within the same stratum will be selected to replace the survey. The alternate site does not need to be surveyed the same day as the original primary-selected site. Field procedures are designed to avoid selection bias of survey locations by divers.

Diver Deployment, Descent, and Location of Survey Sites (Secondary units)

At each sample site, one replicate or set of paired surveys occurs. Each team's unique GPS and dive flag numbers are recorded on the daily Field/Boat log (Figure 2). Care and effort are made to deploy survey divers within the target primary sample unit. Primary sample units are square grid cells 50 meters (164 ft) on each side. The latitude-longitude site positions provided in the annual RVC survey plan mark the center (centroid) of the targeted primary sample units. The GPS unit used for vessel navigation should have waypoints stored for each RVC site listed in the annual plan. Vessel distance from a given stored waypoint can be used to determine that the sampling occurs within the targeted primary sample unit. The distances to the edge of the targeted primary unit from the centroid waypoint is less than 25 meters (82 ft) in a north, south, east, or west direction; or less than 35.4 meters (116.1 ft) in a northeast, northwest, southeast or southwest direction.

Once the boat is in position, divers are deployed and maintain visual contact with each other throughout the entire census. As the dive team enters the water, the boat captain or their designee will use a GPS (boat mounted or hand-held) to mark a waypoint of the surface float/flag and record the coordinates, in decimal degrees, on the Field/Boat log. **The waypoint is only marked after the divers have safely descended.**

Date:

Supervisor's Boat Log

Divemaster:

Page _____ of _____

Date	DOD	Site ID	Station	Team	Diver	O2%	PSI IN	TIME IN	Flag #	Actual Dive		TIME OUT	PSI OUT	Comments
										Depth	BT			

DOD= # dive of day

Figure 2. The Field/Boat Log form includes survey site information as well as basic dive log information. A printable version is located at the end of this SOP.

Diver deployment can occur either by live boating or anchoring (if permitted), but live-boating is the preferred method. Each buddy team will carry a reel with line attached to a surface buoy and surface GPS unit to record the location of the actual sample. Prior to dive, teams check that the GPS unit is on, as they can be accidentally switched off or batteries depleted. The buddy pair will descend as a team to the bottom and complete individual timed fish surveys on the first reef habitat encountered and return together to the surface at the surface buoy for recovery onto the vessel. If necessary, during descent, divers may swim to appropriate habitat within visible range (e.g., if divers enter the water over sand, they may swim to nearby reef habitat for sampling). If divers enter the water over hardbottom different from that expected, they will still establish cylinders where they were deployed**.**

Consistency in habitat selection is emphasized in training to avoid bias created by preferentially choosing habitat types based on quality or selecting core habitat and/or edge features. If hardbottom is present, the divers will continue with the habitat type assessment and set up the fish survey. If hardbottom is not visible at the site (no hardbottom at all, i.e., continuous sand or seagrass combined with limited visibility), then the dive will be terminated by the dive team and an alternate site from the same stratum will be selected. It is not acceptable for divers to swim around searching for hardbottom or to move from nearby hardbottom to other hardbottom perceived to be of higher quality

or more interesting to survey. The reason for terminating the dive is recorded in the Field/Boat log comments.

Each diver chooses a sampling location within the same stratum such that each diver is within the distance of accepted "dive buddy" separation standards of his/her buddy that water conditions allow. Under optimal visibility conditions, the distance between dive buddies will be approximately 15 meters (49.2 ft; Figure 3). The reel is secured to the bottom and serves as a starting point to measure the radius of the sampling cylinder (i.e., 7.5 meters [24.6 ft]), using the APT as a visual aid to measure visibility, as a point of reference (e.g., edge of cylinder) during data collection and as a point of return for both divers following data collection. If conditions allow (i.e. shallow depth or not much current), less scope in the dive reel line will result in a more accurate GPS coordinate mark.

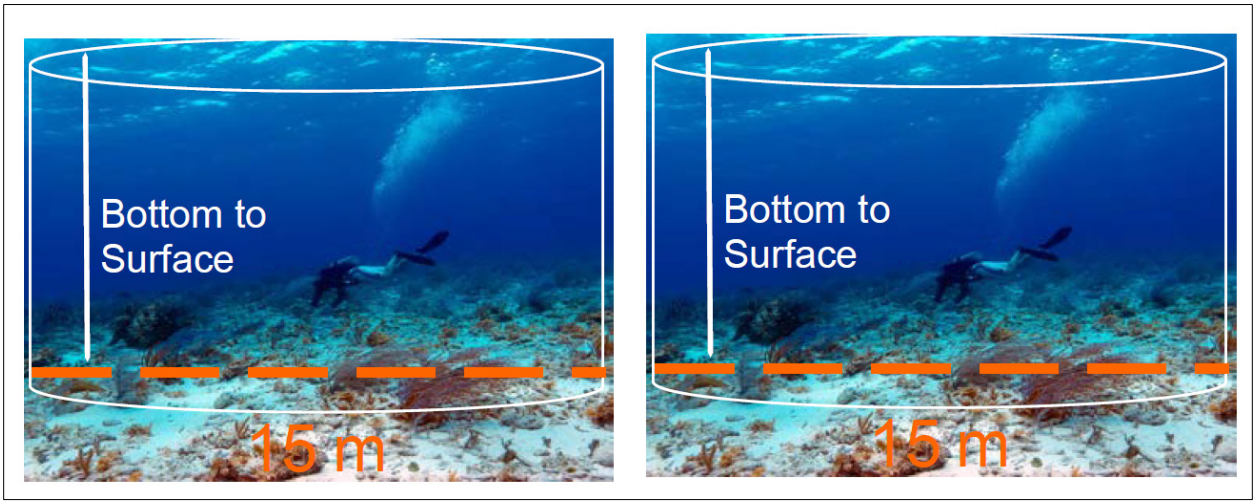


Figure 3. Example of two survey cylinders indicating optimal cylinder placement. The dive teams surface buoy will be tied to the bottom in between both cylinders.

A captain and two-person dive team are the minimum crew required for field work, for both boat and diving safety. However, a four-person dive team (two rotating teams of two divers) for small boat operations is recommended and can greatly increase sampling efficiency. When an odd number of divers are present, divers rotate teams at each sample site so that each diver remains at the surface at every third sample site.

Benthic Team

If a benthic team is diving with the fish team, **all** dive teams enter the water as close to the same time as possible. Benthic Assessment (i.e., Line Point-Intercept) and Coral Demographics surveys are currently collected at all sites in the U.S Virgin Islands and at a subset of fish sites in Florida. At sites that require both fish and benthic surveys, a team of two benthic divers can be deployed simultaneously with the two-diver fish team and they establish the benthic transect on the appropriate habitat with minimal interference with the fish surveys (Figure 4). However, benthic and fish surveys do not have to occur at the same time if, for example, the number of available qualified staff or boat space is a limiting factor. Refer to *Assessment of Coral Reef Benthic Communities in the U.S. Virgin Islands* and *Assessment of Coral Reef Benthic Communities in the Florida Reef Tract* and select the

Documentation tab for benthic protocols (Coral Demographics and Line Point-Intercept) for the USVI (US Caribbean) and Florida respectively. The benthic team will set up adjacent to the cylinders and lay out a 15-meter (49.2 ft) transect tape using the surface buoy tie-off location for the anchor point of the belt transect if possible ("X" in Figure 4). Benthic teams can swim to nearby hardbottom if it is patchy where the RVC is established, and if they remain in visual contact with the RVC divers and the surface float.

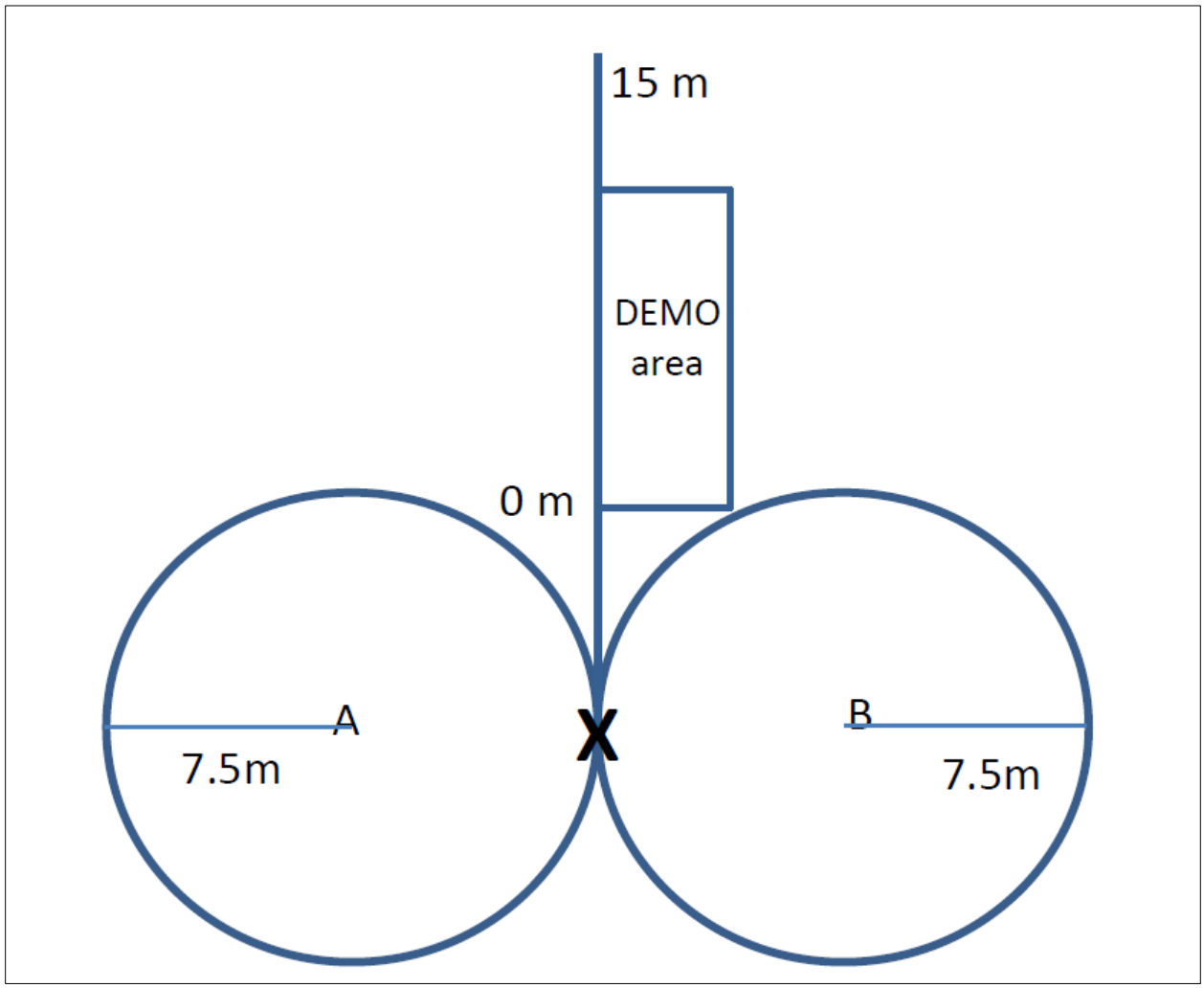


Figure 4. Suggested arrangement of fish and benthic survey areas on continuous hardbottom. A and B represent the position of the two fish diver replicate surveys. X represents the location of the tie off for the surface buoy and anchor point for the 15-meter (49.2 ft) benthic survey belt transect tape.

Observations Made in the Field

RVC diver responsibilities include collecting site, fish, benthic cover, topographic information, and site photos. The flow of RVC data collection occurs in four phases: (1) Pre-dive, (2) Fish counting/measuring, (3) Site/benthic/topographic assessment and (4) Post-dive (Figure 5). Data are recorded on two data forms: the Field/Boat Log and Fish/Habitat data sheet. Data on the Field/Boat Log is recorded at the surface by a surface support worker/diver during the pre-dive period. All the site information at the top of the Fish/Habitat data sheet is also recorded prior to the dive. The fish and habitat data are collected and recorded underwater at the sample site by the divers. Before ascending, divers check their datasheet for completeness and fill in any missing information.

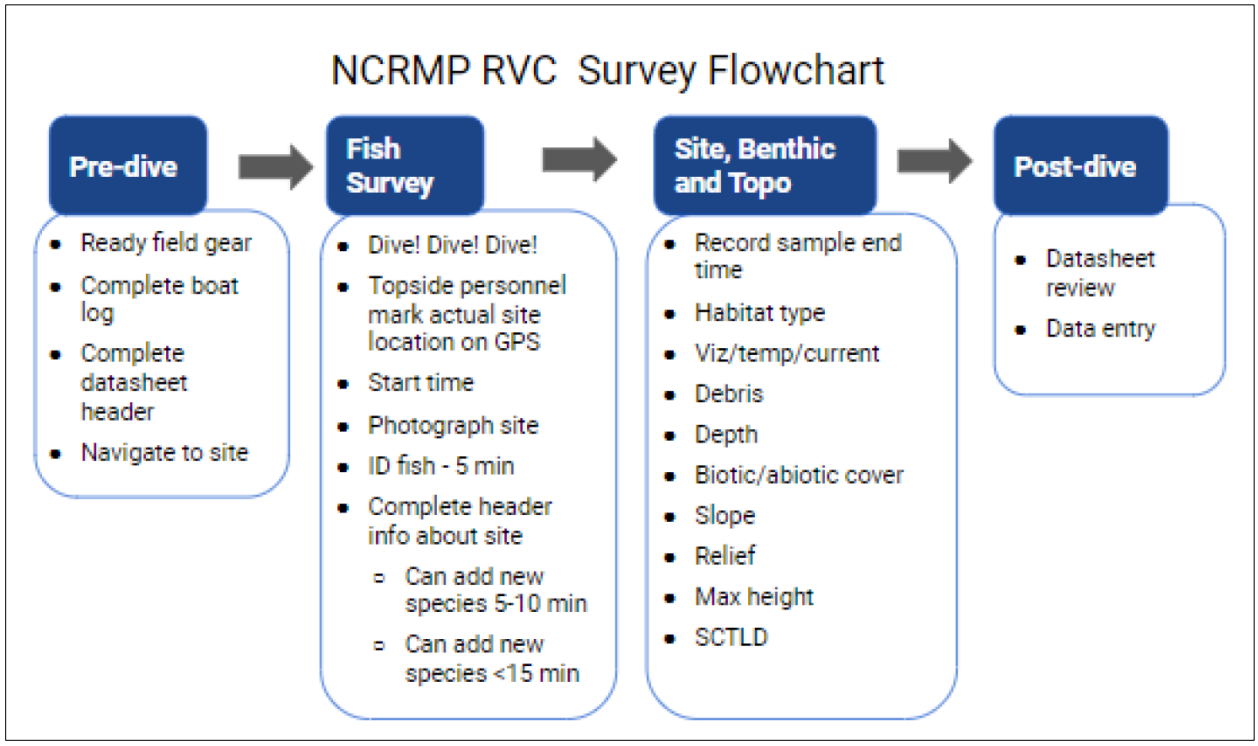


Figure 5. Reef fish visual census (RVC) sequence of events.

Field Forms

Field/Boat Log

The Field/Boat Log (Figure 2) serves as a record of where, when and by whom sites were sampled each day (a printable version of the form is included at the end of this SOP). Two lines of data (one for each replicate pair of surveys) is recorded for each sample site. The Field/Boat log also records dive log related information including oxygen percentage (O_2%), tank PSI in, time in, bottom depth and bottom time, time out, tank PSI out, and divemaster name. The following survey information is also recorded on the form:

a. Date: The month/day/year of the survey.

b. Dive of day (DOD): The cumulative survey number (i.e., 1, 2, 3…). This number will be the same for each of the two lines of data recorded for each diver at each site.

c. Site ID: This is a four-digit code listed on the sample site list. This number will be the same for each of the two lines of data recorded for each diver at each site.

d. Station: The designation of each "team" of replicate fish divers in the primary sampling unit. In the current sampling design, this will always be 1.

e. Team (Team member assignment): Letter code identifying the type of survey data being collected by the diver within their dive team. Codes are assigned to diver positions within the team and type of data collected; therefore, diver team codes could change by station as divers potentially rotate.

    a. Fish (A/B) – A two-diver fish team consists of a Diver A and Diver B.

    b. Benthic (J/X) – The diver collecting Benthic Assessment data is assigned the code'J'; the diver collecting Demographic data is assigned 'X.'

f. Time in: The time at the beginning of dive.

g. Flag #: Each dive team has a numbered dive flag with a uniquely numbered, attached GPS unit; the GPS number is used to subsequently match the GPS position with the recorded survey start time collected by each dive team.

h. Comments: Any additional information judged to be important by the surface data collector (e.g., notation of a specific camera used by a diver, or presence of coral disease) may also be entered. The waypoint number from the boat mounted/handheld GPS of the position of the surface vessel when divers entered the water or the team's location (latitude and longitude) is recorded in decimal degrees.

Fish/Habitat Data Sheet

Fish and habitat data are entered on the Fish/Habitat Data Sheet (Figure 6; a printable version of the data sheet is included at the end of this SOP). Prior to each dive, divers enter their name (name of observer/diver), name of dive buddy, Field ID, data manager and date on the data sheet. The field ID is the four-digit site ID, station ID and team letter assignment combined (ex. 12001A; Site 1200, Station 1, Team A):

FIELD ID = [(SITE ID) + (STATION ID) + (TEAM letter)]

After entering the water and confirming the site can be surveyed (i.e., hardbottom), the diver records the dive and sample start times (time of beginning of dive and time of beginning of data collection, respectively; Figure 6). Each diver then begins collection of fish, habitat, and sample-specific data as described in the following section.

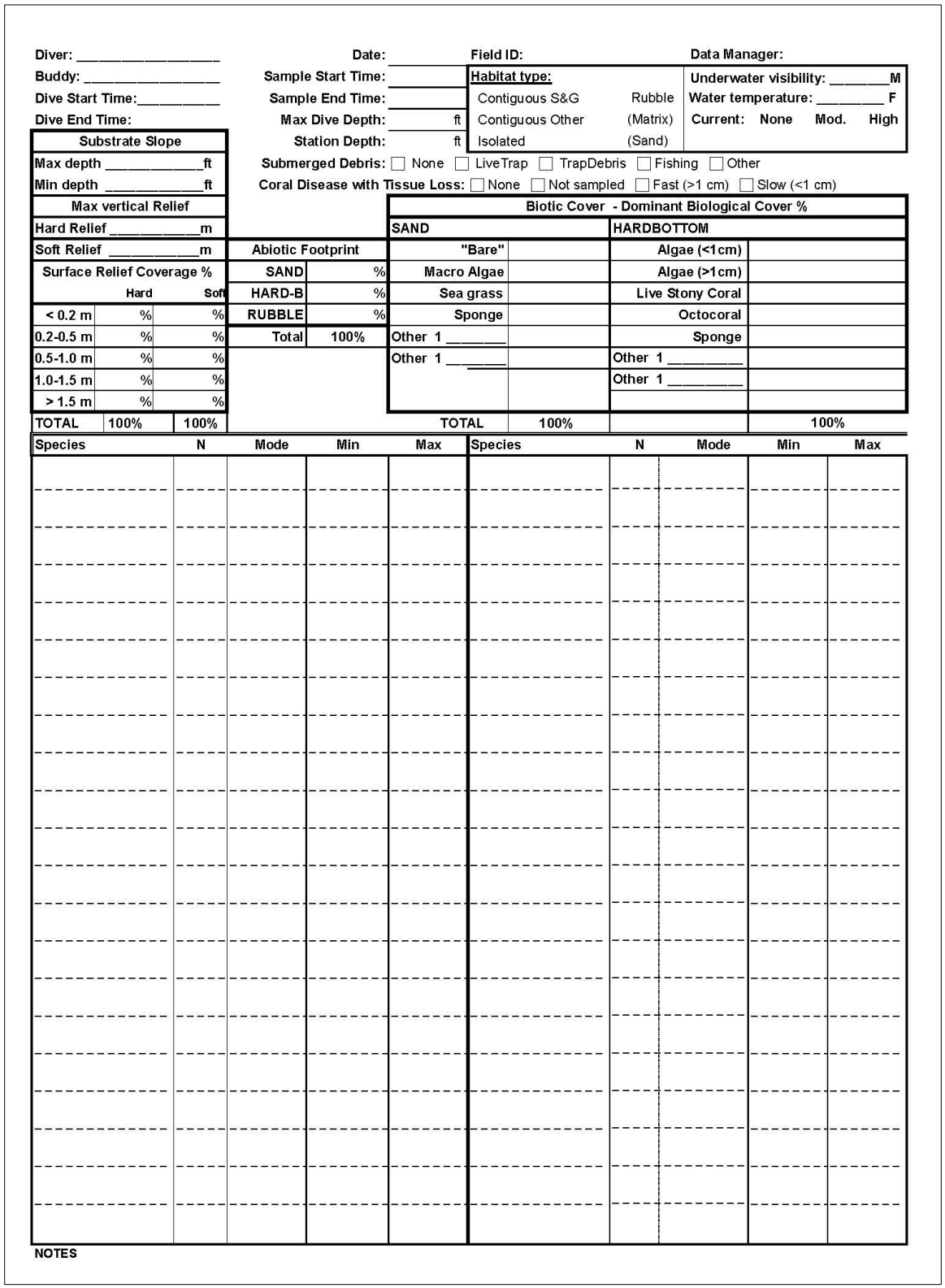


Figure 6. The Fish/Habitat underwater data sheet. Printable versions for Florida and the U.S. Virgin Islands are found at the end of this SOP.

Collecting Fish Data

The Reef fish Visual Census (RVC) methodology is modified from Bohnsack and Bannerot (1986) and occurs with the diver remaining at a fixed site. Fish are surveyed within an imaginary cylinder centered on the diver and extending from the reef substrate to the limits of vertical visibility, usually the surface (Figure 7). The diver first estimates and enters the visibility on the datasheet, as this information is needed to establish the cylinder. If horizontal visibility is greater than or equal to 7.5 meters (24.6 ft), then the radius of the cylinder will be 7.5 meters. If the horizontal visibility is less than 7.5 meters but greater than 5 meters (16.4 ft), the diver will move slightly from the middle to fully observe fish within the area needed to fulfill the 7.5-meter cylinder. The distance between divers is the same as the maximum visibility at those distances and thus the degree of overlap could be calculated from that value if necessary. The APT is used to mark the initial midpoint with the handle pointing in the direction of the diver's buddy. In reduced visibility conditions, the diver's cylinders may overlap to the degree needed to maintain visual buddy contact. If the horizontal visibility is less than 5m, then further data collection will not occur, and the dive is terminated. Additionally, if bottom currents are strong enough that it is difficult to maintain a stationary position, the dive is immediately terminated.

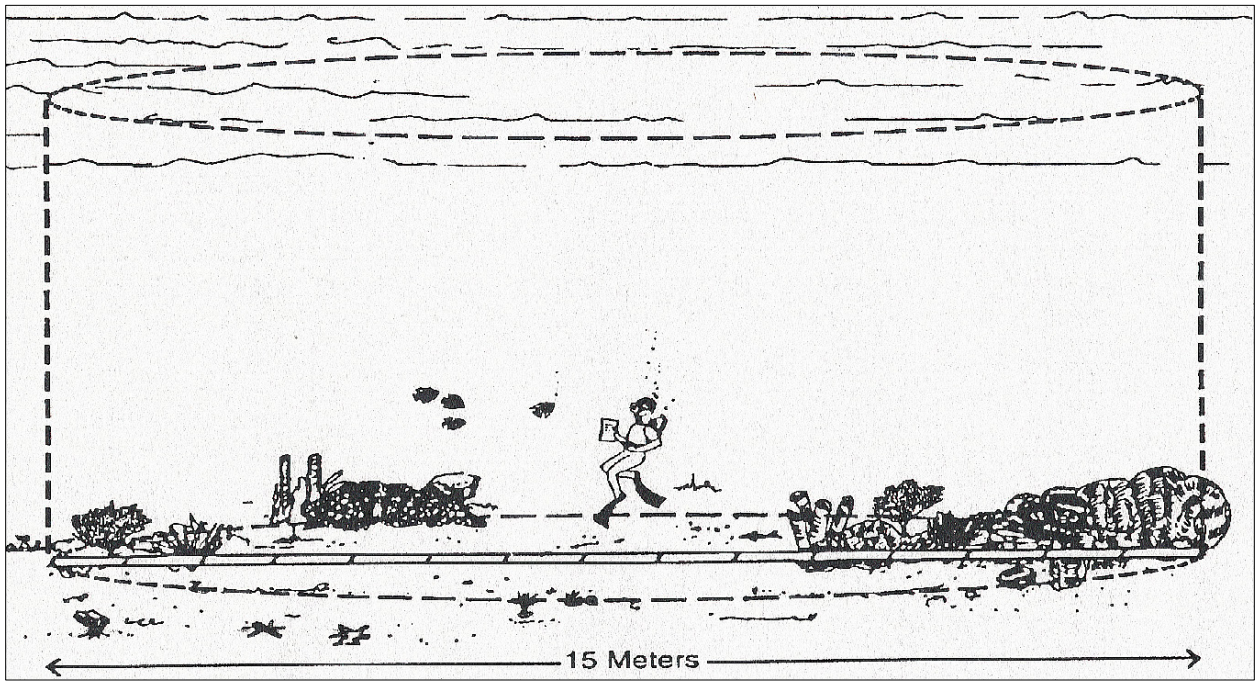


Figure 7. Conceptual diagram of a RVC diver within 7.5 meter (24.6 ft)-radius survey cylinder (Figure from Rogers et al. 1994).

Once horizontal visibility has been assessed and the appropriate cylinder radius has been established, the RVC survey begins. Each diver establishes a fixed point on the bottom to serve as the center of their sample cylinder, and hover above the point (maintaining neutral buoyancy) to avoid damaging the benthic habitat. During the survey, the reference measurement tool (APT) is also used to aid in

measuring habitat vertical relief and to estimate fish lengths. To the extent that conditions permit, the diver remains at the center of the survey cylinder for the entirety of the fish data collection portion of the survey.

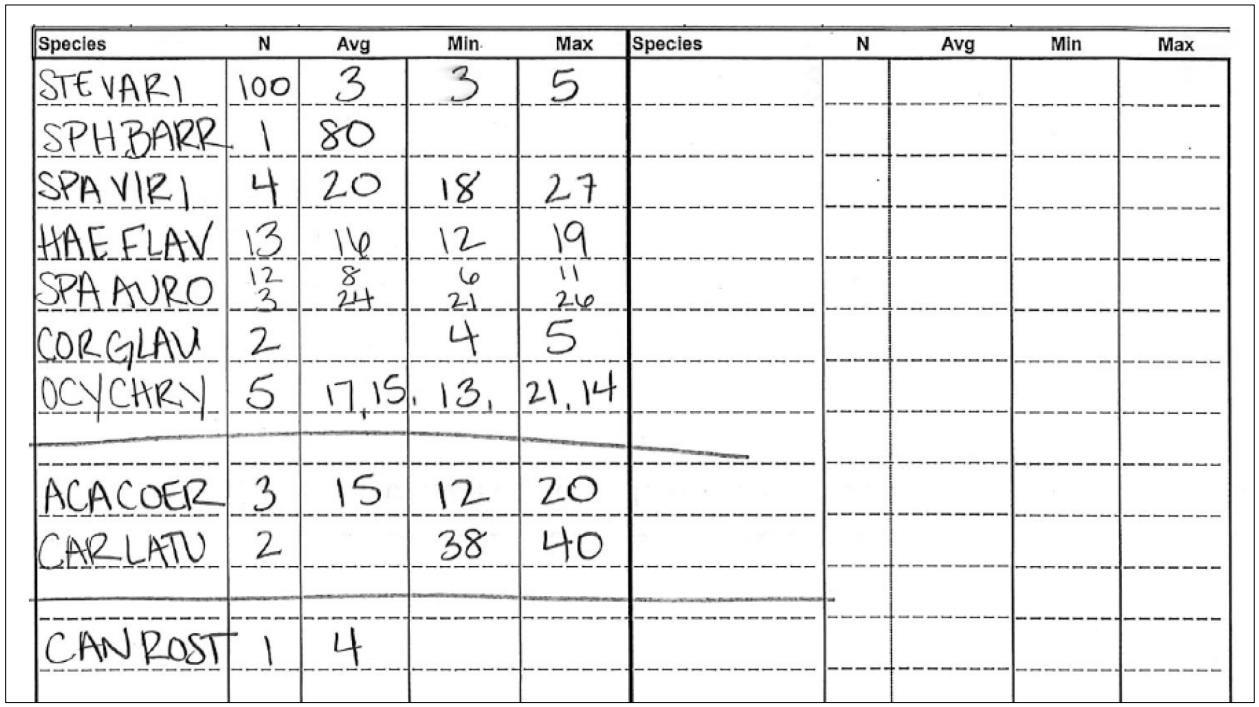
Divers record the sample start time on the Fish/Habitat Data Sheet and begin a timed count, using the stopwatch function on the diver's watch to keep track of time. For a five-minute period, divers record all fish species observed; this is the minimum standardized time that is dedicated to recording fish species. Fish species may be recorded by writing the common name, scientific name or species code (Appendix A). During this period, divers rotate their position (while remaining above the imaginary fixed point) to ensure that all portions of the cylinder are surveyed. The diver treats the survey as if they are taking an instantaneous "snapshot in time" of all species they observe in the cylinder during the initial 5-minute period. For species with few individuals (e.g. angelfishes, Great Barracuda [*Sphyraena barracuda*], and Hogfish [*Lachnolaimus maximus*]) or for highly mobile species (e.g., sharks and jacks), individuals are enumerated, and their sizes are estimated when first observed. Highly mobile species such as jacks, sharks or skittish species may swim in and out of the cylinder while a diver is in the identifying phase of the survey and can be enumerated and sized when observed.

After five minutes have elapsed, data are collected by each diver on the abundance ("N" column in Figure 6) and sizes for each species. Individual fork lengths are recorded for the following species: all groupers, snappers, lionfish, and Hogfish. A complete list of these important commercial and recreational species is included in Table 1. When 10 or less individuals of any of these species are present in a survey, individual lengths for all individuals will be recorded on the datasheet using the "Mode," "Min" and "Max" columns for individual fish sizes. When more than 10 individuals of any of these species are present, data are collected by each diver on the abundance ("N" column) and mode, minimum and maximum lengths ("Mode," "Min" and "Max" columns in Figure 6). For all other species, abundance ("N" column) and mode, minimum and maximum fork lengths ("Mode," "Min" and "Max") are recorded. If only one individual of a species was observed, the estimated length is entered in the "Mode" field. If two or three individuals were observed, enter each estimated length in the "Min" and "Max" fields (2) or "Min," "Mode" and "Max" fields (3). When entering lengths for three fish, make sure the "Mode" field contains the size in between or equal to the minimum and maximum sizes. Some species, parrotfish in particular, have individuals that may have bimodal size groups. The diver may estimate the mode, minimum, and maximum sizes of each group (e.g. juveniles and adults) when possible. This provides a greater resolution of the community structure of these species. For example, the Redband Parrotfish (*Sparisoma aurofrenatum*) commonly has groups of juveniles and adults intermixed. In this situation, juvenile sizes would be recorded on one line as described above and on a second line the sizes of adult Redband Parrotfish would be recorded. If appropriate, single or paired outlier sized individuals may also be entered separately.

Table 1. Complete list of important commercial and recreational fish species that are individually sized.

Scientific name	Common name	Scientific name	Common name
Cephalopholis cruentata	Graysby	*Mycteroperca phenax*	Scamp
Cephalopholis fulva	Coney	*Mycteroperca tigris*	Tiger Grouper
Dermatolepis inermis	Marbled Grouper	*Mycteroperca venenosa*	Yellowfin Grouper
Epinephelus adscensionis	Rock Hind	*Lachnolaimus maximus*	Hogfish
Epinephelus drummondhayi	Speckled Hind	*Lutjanus analis*	Mutton Snapper
Epinephelus flavolimbatus	Yellowedge Grouper	*Lutjanus apodus*	Schoolmaster
Epinephelus guttatus	Red Hind	*Lutjanus buccanella*	Blackfin Snapper
Epinephelus itajara	Goliath Grouper	*Lutjanus cyanopterus*	Cubera Snapper
Epinephelus morio	Red Grouper	*Lutjanus griseus*	Gray Snapper
Epinephelus niveatus	Snowy Grouper	*Lutjanus jocu*	Dog Snapper
Epinephelus striatus	Nassau Grouper	*Lutjanus mahogoni*	Mahogany Snapper
Mycteroperca acutirostris	Western Comb Grouper	*Lutjanus synagris*	Lane Snapper
Mycteroperca bonaci	Black Grouper	*Ocyurus chrysurus*	Yellowtail Snapper
Mycteroperca interstitialis	Yellowmouth Grouper	*Pterois volitans*	Red Lionfish
Mycteroperca microlepis	Gag	–	–

Concurrent with the species enumeration and length estimation described above, new species that are observed after the initial five-minute observation period and until completion of all data collection are also recorded, as are estimates of their abundance and minimum, mode, and maximum lengths. These species are noted on the Fish/Habitat Data Sheet as having been observed “Between 5 and 10 minutes” or “After 10 minutes,” depending on the time elapsed at time of observation. The diver draws a line on their datasheet under the initial 5-minute list and a second line under the 10-minute list. The first pencil-drawn horizontal line across the data sheet is the 5–10 minute line; the second pencil-drawn horizontal line across the data sheet is the after 10-minute line. If an individual or individuals of a species observed in the initial five-minute observation period is observed after data on the abundance, mode, minimum and maximum fork lengths for that species have been recorded, the diver excludes these individuals from the count and continues recording only new species data. The fish count is over when all fish have been identified, counted and sized (i.e. new fish species may still be recorded after the 10-minute mark). Figure 8 illustrates an example of how fish data are recorded on the datasheet during an RVC survey.



Species	N	Avg	Min	Max	Species	N	Avg	Min	Max
STEVAR1	100	3	3	5					
SPHBARR	1	80							
SPAVIR1	4	20	18	27					
HAEFLAV	13	16	12	19					
SPAAURO	12 3	8 24	6 21	11 26					
CORGLAU	2		4	5					
OCYCHRY	5	17, 15,	13,	21, 14					
ACACOER	3	15	12	20					
CARLATU	2		38	40					
CANROST	1	4							

Figure 8. Example of how fish observations of numbers and size (including the mode, minimum and maximum or individual size) are hand recorded on the RVC Fish/Habitat underwater data sheet during an RVC survey.

Sample-Specific Data

Following fish data collection, the following sample-specific data are recorded on the Fish/Habitat data sheet: water temperature, current speed (None, Mod, or High), maximum dive depth, and station depth (bottom depth at the diver's survey location). The horizontal visibility will have been measured and recorded prior to the RVC survey.

Habitat Data

Following the sample-specific data collection, habitat data are collected and recorded on the Fish/Habitat data sheet.

Habitat type: chosen from the following categories (circle one on the Fish/Habitat data sheet). While at the surface, after the dive, the diver discusses with their buddy, and benthic team members if applicable, and they try to come to a consensus. If a consensus is not achieved, divers note that in the Field/Boat Log comments. **NOTE: habitat types are different in Florida and the U.S. Virgin Islands (Appendix A and Appendix B in SOP RF01 *Statistical Sampling Design—Version 2.0* (SFCN 2025).** An example of target habitats is illustrated in Figure 9.

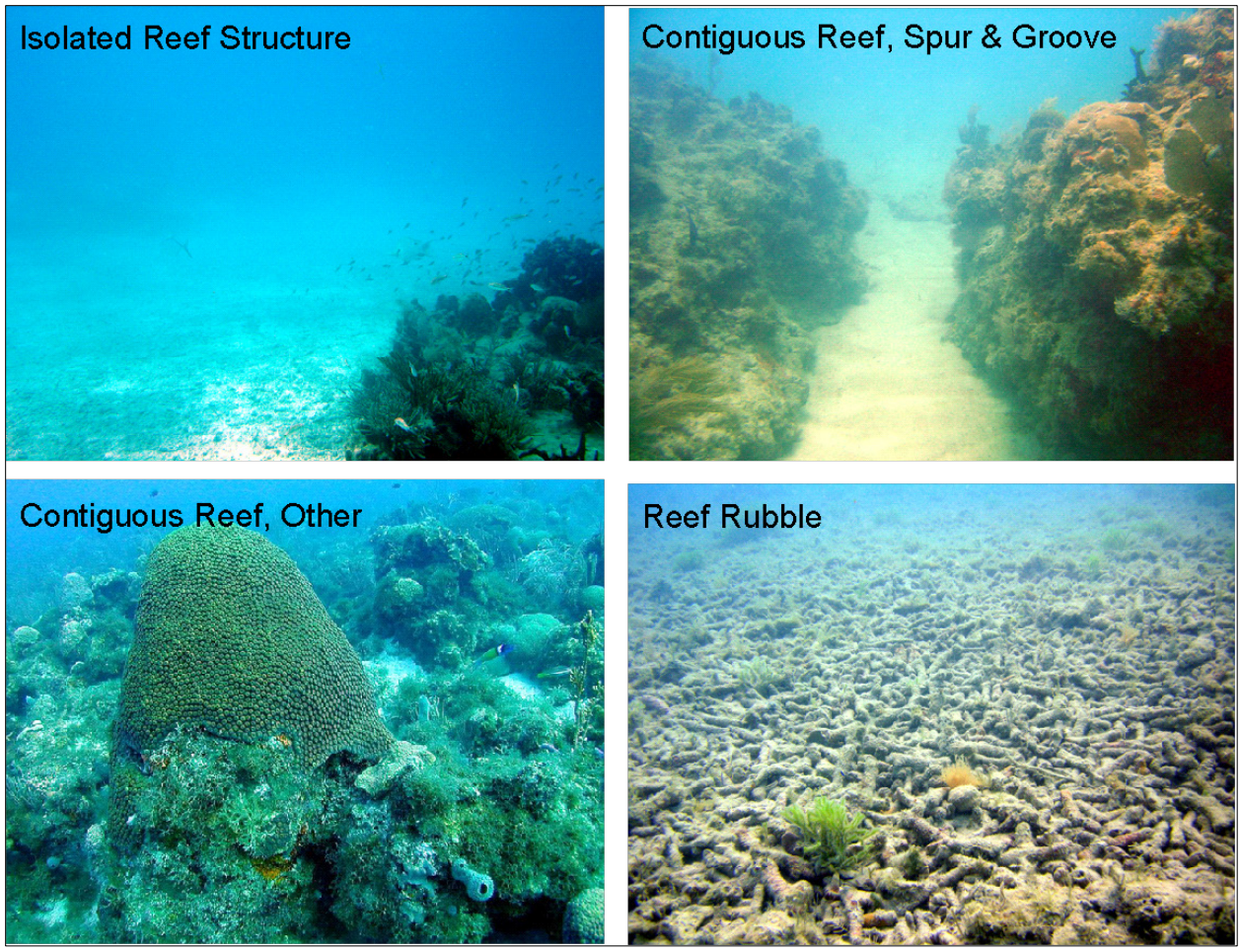


Figure 9. Example photos of target habitats.

U.S. Caribbean Habitat Types (Kendall et al. 2001)

Aggregate reef: Continuous, high-relief coral formation of variable shapes. Examples of aggregate reefs include fore reef, fringing reef, shelf edge reef, and spur and groove reef.

Bedrock: Exposed bedrock contiguous with the shoreline. May be colonized or uncolonized (often covered by a thin sand veneer with sparse coverage of biota).

Patch reef: Coral formations that are isolated from other coral reef formations by sand, seagrass or other habitats. Can be an individual patch reef or aggregate patch reefs.

Pavement: Flat, low-relief, solid carbonate rock. May be colonized or uncolonized (often covered by a thin sand veneer with sparse coverage of biota).

Scattered coral/rock in sand: Primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually (i.e., smaller than individual patch reef).

Florida and the Dry Tortugas: Four Main Habitat Types

Contiguous Spur & Groove: A continuing reef structure with well-defined spur (hardbottom) and groove (sand channel) formations. Can be low or high relief spur and groove.

Contiguous Other: Contiguous low relief hardbottom.

Isolated: Larger reef formations that are isolated by sand, seagrass or other habitats. Examples include patch reefs, rocky outcrops, and pinnacles.

Rubble: Scattered rocks and small isolated coral heads in sand or seagrass.

Note: Matrix and Sand are legacy categories and will no longer be used.

Site Characteristics: Additional Data Collected

Water temperature, Visibility and Current: temperature (nearest °F), visibility (nearest m) at the bottom, and water current estimated by divers for each paired survey; categories as follows: None (none), Mod. (diver is able to stay in same position with a gentle kick), High (diver struggles to stay in same position).

Substrate Slope: the maximum and minimum depths (nearest ft) within the sample cylinder. These values refer to the maximum and minimum depths on the imaginary plane underlying the sample cylinder. If there is a slope these depths will be different (Figure 10).

Max Vertical Relief: the maximum vertical relief (nearest m) within the sample cylinder of both hard (e.g., coral structure, coralline spur, rocky outcrop) and soft (e.g., octocorals, sponges and macroalgae) substrate (Figure 10). These values should not be zero, unless a flat hardbottom substrate.

Surface Relief Coverage for Hard Vertical Relief (e.g., coral structure, coralline spur, rocky outcrop and sand): the estimated percentages (nearest one percent) of hard relief that fall into the following categories (all values in meters): < 0.2, 0.2–0.5, 0.5–1.0, 1.0–1.5, and > 1.5 meters (< 0.7, 0.7–1.6, 1.6–3.3, 3.3–4.9, and > 4.9 ft). These values will sum to 100% (Figure 10).

Surface Relief Coverage for Soft Vertical Relief (e.g., octocorals, sponges and algae): the category (< 0.2, 0.2–0.5, 0.5–1.0, 1.0–1.5, and > 1.5 meters) representing the average vertical relief of all soft relief is indicated by writing “100%” by that category (Figure 10).

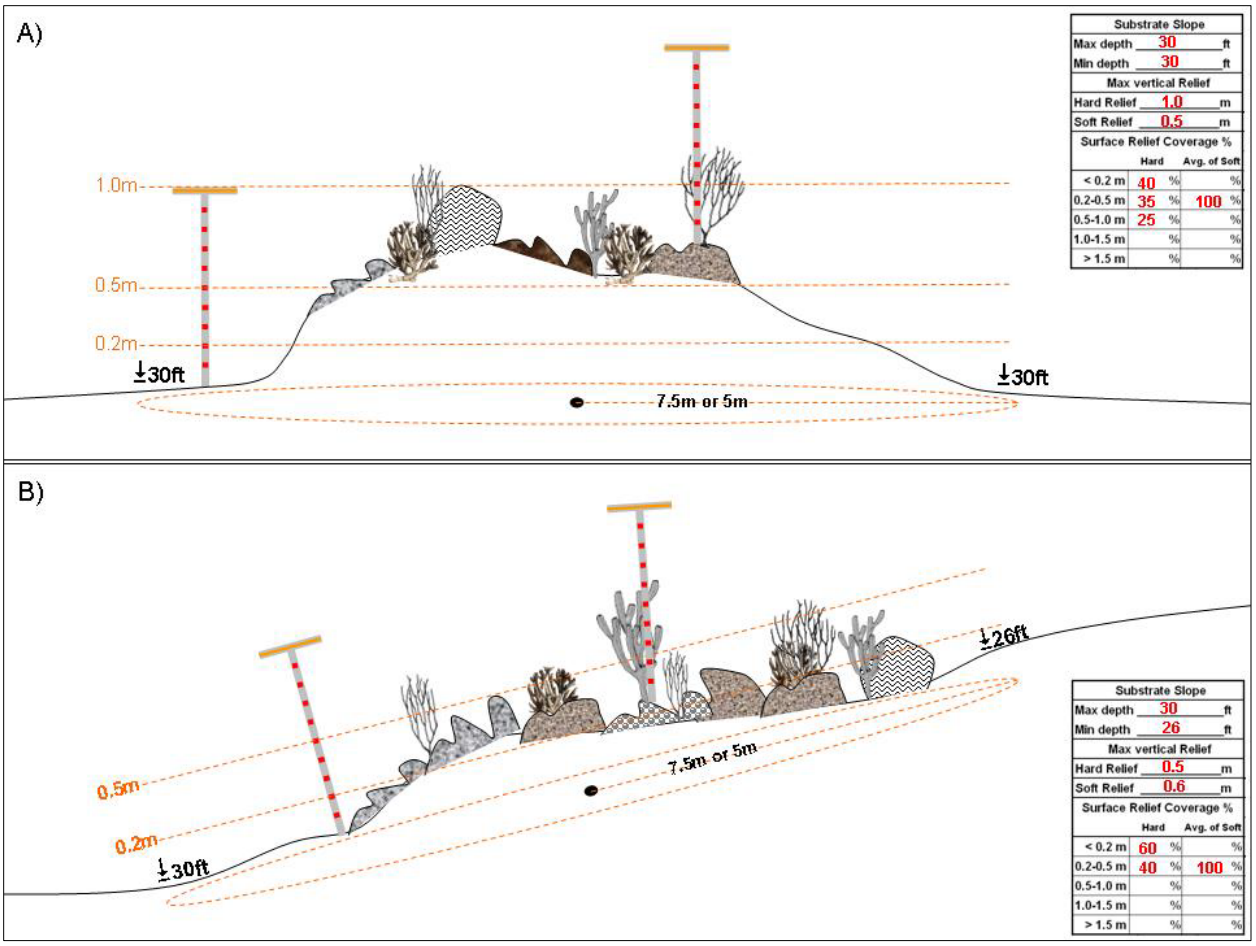


Figure 10. Diagram showing how to measure substrate slope, max vertical relief, and surface relief coverage. If there is NO slope then Max Depth = Min Depth (A). If there is a slope, then Max Depth > Min Depth (B). Soft Relief is measured from base of attachment to maximum height. Surface relief coverage (%) for the hard substrate components (e.g., coral structure, coralline spur, rocky outcrop and sand) is estimated by determining the percentages of the cylinder area that occupy the following vertical height categories (all values in meters): < 0.2, 0.2–0.5, 0.5–1.0, 1.0–1.5, and > 1.5 meters (< 0.7, 0.7–1.6, 1.6–3.3, 3.3–4.9, and > 4.9 ft). Average surface relief coverage (%) for soft substrate components (e.g., octocorals, sponges and algae) is estimated as the vertical height category within the cylinder representing the average vertical relief of all soft substrate components in the cylinder (including macroalgae). This is indicated by writing "100%" in that vertical relief category (figure from Brandt et al. 2009).

Abiotic Footprint: The estimated percentage (nearest one percent) of the cylinder comprised of sand, hardbottom and rubble. These percentages will sum to 100%. Sand is defined as coarse biogenic or oolitic sand (grain sizes typically between 0.5–5 mm) and finer silt sized particles (< 0.2 mm). Sand is considered the substratum when sediment depth is 2–3 centimeter (0.8-1.2 in) in depth or greater. It excludes a surface "dusting" of sediment particles overlying a consolidated substrate. Rubble ranges from coarse gravel (> 5 mm) to unconsolidated and moveable rocks (e.g. dislodged and moveable coral fragments). This category differs from consolidated hardbottom because of its loose and moveable nature. Consolidated hard-bottom includes solid, consolidated lithogenic or biogenic

substratum, including living and dead coral, and non-coral hard-bottom. Areas covered by seagrass are coded as sand, since the biotic "grass" is growing in the abiotic sand substrate.

Biotic Cover:

a. SAND: The estimated percentage (nearest one percent) of the sand substrate that corresponds to the following categories: bare, growth of macroalgae, growth of seagrass, growth of sponges, and other (e.g., *Sargassum*; see Appendix B for more examples). These values will sum to 100%. See preceding section for sand definition.

b. HARDBOTTOM: While looking at an aerial, canopy view of the cylinder, the estimated percentage (nearest one percent) of the hardbottom substrate covered with algae < 1 centimeter (0.4 in) height (e.g., turf algae, *Lobophora*), macroalgae > 1 centimeter height (e.g., *Halimeda, Dictyota*), live coral (e.g., *Millepora*), octocoral, sponge, and other (e.g., *Palythoa*, *Cliona,* cyanobacteria; see Appendix B for more examples). These values will sum to 100%.

Submerged Debris: Indicate if live fishing traps, trap debris, fishing gear (line, etc.) or other man-made debris is present.

Coral Restoration: This notes the presence of coral restoration (i.e., outplanting) evident at the survey site or within the RVC survey cylinder. Restoration or outplanting may be indicated by epoxy or cement at the base of corals along with tagged corals and by the species (e.g., Acroporids). If the diver suspects restoration but is unsure, then 'Unknown' should be checked and if there is no evidence 'None' should be checked.

Coral Disease with Tissue Loss – Stony Coral Tissue Loss Disease (SCTLD) is prevalent in Florida and the U.S. Caribbean. This header field provides site-level observations on the presence of recent mortality and associated coral tissue loss related to disease, an indicator for SCTLD.

- None—no disease with tissue loss is observed at the site.
- Not Sampled—diver did not include this measurement in their survey.
- Fast (> 1centimeter [0.4 in])—fast (acute) tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of recent mortality (uncolonized dead skeleton) is > 1 centimeter in width/diameter. This fast (> 1 centimeter) rate of disease spread can be indicative of SCTLD.
- Slow (< 1 centimeter)—slow (sub-acute) tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of recent mortality is < 1 centimeter in width/diameter.

Note: Divers will record any comments relative to the sampling or conditions encountered.

Following fish and habitat data collection, sample end time is recorded, and divers ensure that all sections on the Reef/Habitat data sheet are completed. Dive end time is recorded after all data have been collected and immediately prior to dive ascent.

Site Photographs

Photos will include the RVC survey area for general site characterization. Additional photos may include divers conducting surveys, unique features, and species for ID purposes. In Florida, one diver in each two-diver buddy team will take pictures. In the U.S. Caribbean, benthic and fish teams often dive together, and the benthic assessment diver will take pictures.

a. Station Documentation: at least five photographs per station

    i. Take one photograph of station and logistic information at the top of the datasheet prior to taking any photographs of the site. The station name, date, time and heading information must be clear and legible in the photograph.

    ii. Take four site photographs at the four cardinal compass headings (i.e. 0°, 90°, 180° and 270°) or four distinct directions.

    iii. Additional photographs may be taken of anything unusual (e.g., rare fish, bleached or rare corals), for species identification purposes, unique site features or other divers to document work.

b. Agencies will maintain one photo directory annually for each region. All photos (datasheet and directional) from a survey are stored in an individual folder with the filename: *PSU#_fish* or *PSU#_benthic*. The agency directory is sent to the NOAA data manager who maintains a master file on the NOAA SEFSC server of all RVC site photos organized by region and year.

Post-Collection Data Sheet and Logs Processing

Once all data collection has been completed underwater, divers ascend to the surface immediately adjacent to their surface dive flag and wait for the research vessel to approach. Immediately upon returning from a dive, initial QA/QC includes discussions between buddy teams to ensure agreement on variables such as habitat type, bottom current, and other important variables. Datasheets are exchanged between divers for review by checking for completeness and legibility. **A diver cannot review their own datasheet**. This is a small but important step for finding and fixing errors that may have been written on the datasheet. Data sheets and logs are maintained in a secure area aboard the research vessel. Once on land, data sheets and Field/Boat Logs are rinsed with fresh water, dried and scanned. Copies of Fish/Habitat Data Sheets are redistributed to data collectors for data entry. The Field/Boat Log is redistributed to the data manager. Copies (electronic or paper) of all data sheets are made before redistribution to data collectors and managers in case of loss of original data sheets. These copies are maintained in a single storage location.

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Appendix A. Species Codes for Florida and U.S. Virgin Islands Reef Fish

Table 2. Species codes for Florida and U.S. Virgin Islands Reef Fish.

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
ABU SAXA	*Abudefduf saxatilis*	sergeant major
ACA ASPE	*Acanthemblemaria aspera*	roughhead blenny
ACA BAHI	*Acanthurus bahianus*	ocean surgeon
ACA CHAP	*Acanthemblemaria chaplini*	papillose blenny
ACA CHIR	*Acanthurus chirurgus*	doctorfish
ACA COER	*Acanthurus coeruleus*	blue tang
ACA MARI	*Acanthemblemaria maria*	secretary blenny
ACA POLY	*Acanthostracion polygonia*	honeycomb cowfish
ACA QUAD	*Acanthostracion quadricornis*	scrawled cowfish
ACA SOLA	*Acanthocybium solandri*	wahoo
ACA SPE.	*Acanthurus sp.*	surgeonfish species
ACA SPIN	*Acanthemblemaria spinosa*	spinyhead blenny
ACR CERV	*Acropora cervicornis*	staghorn coral
ACR PALM	*Acropora palmata*	elkhorn coral
AET NARI	*Aetobatus narinari*	spotted eagle ray
AHL EGMO	*Ahlia egmontis*	key worm eel
ALB VULP	*Albula vulpes*	bonefish
ALE CILI	*Alectis ciliaris*	African pompano
ALP AFER	*Alphestes afer*	mutton hamlet
ALU MONO	*Aluterus monoceros*	unicorn filefish
ALU SCHO	*Aluterus schoepfii*	orange filefish
ALU SCRI	*Aluterus scriptus*	scrawled filefish
ALU SPE.	*Aluterus sp.*	filefish species
AMB PINO	*Amblycirrhitus pinos*	redspotted hawkfish
ANC LYOL	*Anchoa lyolepis*	dusky anchovy

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
ANI SURI	*Anisotremus surinamensis*	black margate
ANI VIRG	*Anisotremus virginicus*	porkfish
ANT OCEL	*Antennarius ocellatus*	ocellated frogfish
ANT SPE.	*Antipatharia sp.*	black coral species
APO AURO	*Apogon aurolineatus*	bridle cardinalfish
APO BINO	*Apogon binotatus*	barred cardinalfish
APO MACU	*Apogon maculatus*	flamefish
APO PHEN	*Apogon phenax*	mimic cardinalfish
APO PSEU	*Apogon pseudomaculatus*	twospot cardinalfish
APO QUAD	*Apogon quadrisquamatus*	sawcheek cardinalfish
APO TOWN	*Apogon townsendi*	belted cardinalfish
ARC PROB	*Archosargus probatocephalus*	sheepshead
ARC RHOM	*Archosargus rhomboidalis*	sea bream
AST GUTT	*Astroscopus guttatus*	northern stargazer
AST PUNC	*Astrapogon puncticulatus*	blackfin cardinalfish
AST SPE.	*Astrapogon sp.*	cardinalfish species
AST STEL	*Astrapogon stellatus*	conchfish
ATH STIP	*Atherinomorus stipes*	hardhead silverside
AUL MACU	*Aulostomus maculatus*	Atlantic trumpetfish
BAL CAPR	*Balistes capriscus*	gray triggerfish
BAL SPE.	*Balistes sp.*	triggerfish species
BAL VETU	*Balistes vetula*	queen triggerfish
BLE SPE.	blenny species	blenny species
BOD PULC	*Bodianus pulchellus*	spotfin hogfish
BOD RUFU	*Bodianus rufus*	Spanish hogfish
BOL BOQU	*Bollmannia boqueronensis*	white-eye goby
BOT LUNA	*Bothus lunatus*	peacock flounder
BOT OCEL	*Bothus ocellatus*	eyed flounder
BRO BARB	*Brotula barbata*	Atlantic bearded brotula

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
CAL BAJO	*Calamus bajonado*	jolthead porgy
CAL CALA	*Calamus calamus*	saucereye porgy
CAL NODO	*Calamus nodosus*	knobbed porgy
CAL PENN	*Calamus penna*	sheepshead porgy
CAL PROR	*Calamus proridens*	littlehead porgy
CAL SPE.	porgy species	porgy species
CAN MACR	*Cantherhines macrocerus*	whitespotted filefish
CAN PULL	*Cantherhines pullus*	orangespotted filefish
CAN ROST	*Canthigaster rostrata*	sharpnose puffer
CAN SUFF	*Canthidermis sufflamen*	ocean triggerfish
CAR BART	*Caranx bartholomaei*	yellow jack
CAR CRYS	*Caranx crysos*	blue runner
CAR FALC	*Carcharhinus falciformis*	silky shark
CAR HIPP	*Caranx hippos*	crevalle jack
CAR LATU	*Caranx latus*	horse-eye jack
CAR LEUC	*Carcharhinus leucas*	bull shark
CAR LIMB	*Carcharhinus limbatus*	blacktip shark
CAR LUGU	*Caranx lugubris*	black jack
CAR PERE	*Carcharhinus perezii*	reef shark
CAR RUBE	*Caranx ruber*	bar jack
CAR SPE.	*Caranx sp.*	jack species
CEN ARGI	*Centropyge argi*	cherubfish
CEN UNDE	*Centropomus undecimalis*	common snook
CEP CRUE	*Cephalopholis cruentata*	graysby
CEP FULV	*Cephalopholis fulva*	coney
CHA CAPI	*Chaetodon capistratus*	foureye butterflyfish
CHA FABE	*Chaetodipterus faber*	Atlantic spadefish
CHA LIMB	*Chaenopsis limbaughi*	yellowface pikeblenny
CHA OCEL	*Chaetodon ocellatus*	spotfin butterflyfish

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
CHA SEDE	*Chaetodon sedentarius*	reef butterflyfish
CHA STRI	*Chaetodon striatus*	banded butterflyfish
CHI ANTE	*Chilomycterus antennatus*	bridled burrfish
CHI SCHO	*Chilomycterus schoepfii*	striped burrfish
CHR ATHE	*Chriodorus atherinoides*	hardhead halfbeak
CHR CYAN	*Chromis cyanea*	blue chromis
CHR ENCH	*Chromis enchrysura*	yellowtail reeffish
CHR INSO	*Chromis insolata*	sunshinefish
CHR MULT	*Chromis multilineata*	brown chromis
CHR SCOT	*Chromis scotti*	purple reeffish
CLE PARR	*Clepticus parrae*	creole wrasse
COR DICR	*Coryphopterus dicrus*	colon goby
COR EIDO	*Coryphopterus eidolon*	pallid goby
COR GLAU	*Coryphopterus glaucofraenum*	bridled goby
COR LIPE	*Coryphopterus lipernes*	peppermint goby
COR PERS	*Coryphopterus personatus*	masked goby
COR PUNC	*Coryphopterus punctipectophorus*	spotted goby
COR SPE.	*Coryphopterus sp.*	goby species
CRY ROSE	*Cryptotomus roseus*	bluelip parrotfish
CTE SAEP	*Ctenogobius saepepallens*	dash goby
DAS AMER	*Dasyatis americana*	southern stingray
DEC MACA	*Decapterus macarellus*	mackerel scad
DEC PUNC	*Decapterus punctatus*	round scad
DER INER	*Dermatolepis inermis*	marbled grouper
DIA ANTI	*Diadema anitillarum*	long-spined urchin
DIO HOLO	*Diodon holocanthus*	balloonfish
DIO HYST	*Diodon hystrix*	porcupinefish
DIO SPE.	puffer species	puffer species
DIP ARGE	*Diplodus argenteus*	silver porgy

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
DIP FORM	*Diplectrum formosum*	sand perch
DIP HOLB	*Diplodus holbrookii*	spottail pinfish
DOR MEGA	*Doratonotus megalepis*	dwarf wrasse
ECH NAUC	*Echeneis naucrates*	sharksucker
ECH NEUC	*Echeneis neucratoides*	whitefin sharksucker
ELA BIPI	*Elagatis bipinnulata*	rainbow runner
ELA EVEL	*Elacatinus evelynae*	sharknose goby
ELA HORS	*Elacatinus horsti*	yellowline goby
ELA MACR	*Elacatinus macrodon*	tiger goby
ELA OCEA	*Elacatinus oceanops*	neon goby
ELA RAND	*Elacatinus randalli*	yellownose goby
ELA SAUC	*Elacatinus saucrum*	leopard goby
ELA SPE.	shark species	shark species
ELA XANT	*Elacatinus xanthiprora*	yellowprow goby
ELO SAUR	*Elops saurus*	ladyfish
EMB BAHA	*Emblemariopsis bahamensis*	blackhead blenny
EMB PAND	*Emblemaria pandionis*	sailfin blenny
EMM ATLA	*Emmelichthyops atlanticus*	bonnetmouth
ENC NIGR	*Enchelycore nigricans*	viper moray
ENN ALTI	*Enneanectes altivelis*	lofty triplefin
ENN BOEH	*Enneanectes boehlkei*	roughhead triplefin
EPI ADSC	*Epinephelus adscensionis*	rock hind
EPI DRUM	*Epinephelus drummondhayi*	speckled hind
EPI FLAV	*Epinephelus flavolimbatus*	yellowedge grouper
EPI GUTT	*Epinephelus guttatus*	red hind
EPI ITAJ	*Epinephelus itajara*	goliath grouper
EPI MORI	*Epinephelus morio*	red grouper
EPI NIVE	*Epinephelus niveatus*	snowy grouper
EPI STRI	*Epinephelus striatus*	Nassau grouper

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
EQU LANC	*Equetus lanceolatus*	jackknife-fish
EQU PUNC	*Equetus punctatus*	spotted drum
EUC ARGE	*Eucinostomus argenteus*	spotfin mojarra
EUC GULA	*Eucinostomus gula*	silver jenny
EUT ALLE	*Euthynnus alletteratus*	little tunny
FIS TABA	*Fistularia tabacaria*	bluespotted cornetfish
GER CINE	*Gerres cinereus*	yellowfin mojarra
GIN CIRR	*Ginglymostoma cirratum*	nurse shark
GNA THOM	*Gnatholepis thompsoni*	goldspot goby
GOB DILE	*Gobiosoma dilepis*	orangeside goby
GOB SPE.	goby species	goby species
GRA LORE	*Gramma loreto*	fairy basslet
GYM FUNE	*Gymnothorax funebris*	green moray
GYM MILI	*Gymnothorax miliaris*	goldentail moray
GYM MORI	*Gymnothorax moringa*	spotted moray
GYM NIGR	*Gymnothorax nigromarginatus*	blackedge moray
GYM SAXI	*Gymnothorax saxicola*	honeycomb moray
GYM VICI	*Gymnothorax vicinus*	purplemouth moray
HAE ALBU	*Haemulon album*	margate
HAE AURO	*Haemulon aurolineatum*	tomtate
HAE CARB	*Haemulon carbonarium*	caesar grunt
HAE CHRY	*Haemulon chrysargyreum*	smallmouth grunt
HAE FLAV	*Haemulon flavolineatum*	French grunt
HAE MACR	*Haemulon macrostomum*	Spanish grunt
HAE MELA	*Haemulon melanurum*	cottonwick
HAE PARR	*Haemulon parra*	sailors choice
HAE PLUM	*Haemulon plumierii*	white grunt
HAE SCIU	*Haemulon sciurus*	bluestriped grunt
HAE SPE.	*Haemulon sp.*	grunt species

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
HAE STRI	*Haemulon striatum*	striped grunt
HAL BIVI	*Halichoeres bivittatus*	slippery dick
HAL CAUD	*Halichoeres caudalis*	painted wrasse
HAL CYAN	*Halichoeres cyanocephalus*	yellowcheek wrasse
HAL GARN	*Halichoeres garnoti*	yellowhead wrasse
HAL MACU	*Halichoeres maculipinna*	clown wrasse
HAL PICT	*Halichoeres pictus*	rainbow wrasse
HAL POEY	*Halichoeres poeyi*	blackear wrasse
HAL RADI	*Halichoeres radiatus*	puddingwife
HAR HUME	*Harengula humeralis*	redear sardine
HAR JAGU	*Harengula jaguana*	scaled sardine
HEM BRAS	*Hemiramphus brasiliensis*	ballyhoo
HEM SIMU	*Hemiemblemaria simula*	wrasse blenny
HET CRUE	*Heteropriacanthus cruentatus*	glasseye snapper
HET LONG	*Heteroconger longissimus*	brown garden eel
HIP EREC	*Hippocampus erectus*	lined seahorse
HOL ADSC	*Holocentrus adscensionis*	squirrelfish
HOL BERM	*Holacanthus bermudensis*	blue angelfish
HOL CILI	*Holacanthus ciliaris*	queen angelfish
HOL RUFU	*Holocentrus rufus*	longspine squirrelfish
HOL SPE.	squirrelfish species	squirrelfish species
HOL TOWN	*Holocanthus sp.*	townsend angelfish
HOL TRIC	*Holacanthus tricolor*	rock beauty
HYP BERM	*Hypleurochilus bermudensis*	barred blenny
HYP CHLO	*Hypoplectrus chlorurus*	yellowtail hamlet
HYP GEMM	*Hypoplectrus gemma*	blue hamlet
HYP GUTT	*Hypoplectrus guttavarius*	shy hamlet
HYP HARR	*Hypoatherina harringtonensis*	reef silverside
HYP HYBR	*Hypoplectrus hybrid*	hybrid hamlet

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
HYP INDI	*Hypoplectrus indigo*	indigo hamlet
HYP NIGR	*Hypoplectrus nigricans*	black hamlet
HYP PUEL	*Hypoplectrus puella*	barred hamlet
HYP SPE.	*Hypoplectrus sp.*	hamlet species
HYP TANN	*Hypoplectrus tann*	tan hamlet
HYP UNIC	*Hypoplectrus unicolor*	butter hamlet
INE VITT	*Inermia vittata*	boga
IST PLAT	*Istiophorus platypterus*	sailfish
JEN SPE.	*Jenkinsia sp.*	herring species
KYP SECT	*Kyphosus sectatrix*	Bermuda chub
LAB BUCC	*Labrisomus bucciferus*	puffcheek blenny
LAB FILA	*Labrisomus filamentosus*	quillfin blenny
LAB GOBI	*Labrisomus gobio*	palehead blenny
LAB KALI	*Labrisomus kalisherae*	downy blenny
LAB NIGR	*Labrisomus nigricinctus*	spotcheek blenny
LAB NUCH	*Labrisomus nuchipinnis*	hairy blenny
LAB SPE.	*Labrisomid sp.*	labrisomid blenny species
LAC BICA	*Lactophrys bicaudalis*	spotted trunkfish
LAC MAXI	*Lachnolaimus maximus*	hogfish
LAC TRIG	*Lactophrys trigonus*	trunkfish
LAC TRIQ	*Lactophrys triqueter*	smooth trunkfish
LAG RHOM	*Lagodon rhomboides*	pinfish
LIO EUKR	*Liopropoma eukrines*	wrasse basslet
LIO MOWB	*Liopropoma mowbrayi*	cave basslet
LIO RUBE	*Liopropoma rubre*	peppermint basslet
LUT ANAL	*Lutjanus analis*	mutton snapper
LUT APOD	*Lutjanus apodus*	schoolmaster
LUT BUCC	*Lutjanus buccanella*	blackfin snapper
LUT CYAN	*Lutjanus cyanopterus*	cubera snapper

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
LUT GRIS	*Lutjanus griseus*	gray snapper
LUT JOCU	*Lutjanus jocu*	dog snapper
LUT MAHO	*Lutjanus mahogoni*	mahogany snapper
LUT SPE.	snapper species	snapper species
LUT SYNA	*Lutjanus synagris*	lane snapper
MAL AURO	*Malacoctenus aurolineatus*	goldline blenny
MAL GILL	*Malacoctenus gilli*	dusky blenny
MAL MACR	*Malacoctenus macropus*	rosy blenny
MAL PLUM	*Malacanthus plumieri*	sand tilefish
MAL TRIA	*Malacoctenus triangulatus*	saddled blenny
MAL VERS	*Malacoctenus versicolor*	barfin blenny
MAN BIRO	*Manta birostris*	giant manta
MEG ATLA	*Megalops atlanticus*	tarpon
MEL NIGE	*Melichthys niger*	black durgon
MEN MERC	*Menippe mercenaria*	Florida stone crab
MIC CARR	*Microgobius carri*	Seminole goby
MIC CHRY	*Microspathodon chrysurus*	yellowtail damselfish
MIC MICR	*Microgobius microlepis*	banner goby
MIT SPE.	*Mithrax species*	spider crab species
MON CILI	*Monacanthus ciliatus*	fringed filefish
MON TUCK	*Monacanthus tuckeri*	slender filefish
MUL MART	*Mulloidichthys martinicus*	yellow goatfish
MUR RETI	*Muraena retifera*	reticulate moray
MYC ACUT	*Mycteroperca acutirostris*	western comb grouper
MYC BONA	*Mycteroperca bonaci*	black grouper
MYC INTE	*Mycteroperca interstitialis*	yellowmouth grouper
MYC MICR	*Mycteroperca microlepis*	gag
MYC PHEN	*Mycteroperca phenax*	scamp
MYC TIGR	*Mycteroperca tigris*	tiger grouper

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
MYC VENE	*Mycteroperca venenosa*	yellowfin grouper
MYR JACO	*Myripristis jacobus*	blackbar soldierfish
NAR BANC	*Narcine bancroftii*	lesser electric ray
NEG BREV	*Negaprion brevirostris*	lemon shark
NEO MARI	*Neoniphon marianus*	longjaw squirrelfish
NES LONG	*Nes longus*	orangespotted goby
NIC USTA	*Nicholsina usta*	emerald parrotfish
NO FISH	no observed fishes	no observed fishes
NO OTHR	no observed other species	no observed other species
OCY CHRY	*Ocyurus chrysurus*	yellowtail snapper
ODO DENT	*Odontoscion dentex*	reef croaker
OGC SPE.	*Ogcocephalus sp.*	batfish species
OLI SAUR	*Oligoplites saurus*	leatherjack
OPH MACC	*Ophioblennius macclurei*	redlip blenny
OPI AURI	*Opistognathus aurifrons*	yellowhead jawfish
OPI MACR	*Opistognathus macrognathus*	banded jawfish
OPI SPE.	*Opistognathus sp.*	jawfish species
OPI WHIT	*Opistognathus whitehursti*	dusky jawfish
ORT CHRY	*Orthopristis chrysoptera*	pigfish
OXY STIG	*Oxyurichthys stigmalophius*	spotfin goby
PAG PAGR	*Pagrus pagrus*	red porgy
PAN ARGU	*Panulirus argus*	Caribbean spiny lobster
PAN GUTT	*Panulirus guttatus*	spotted spiny lobster
PAR ACUM	*Pareques acuminatus*	high-hat
PAR ALBI	*Paralichthys albigutta*	Gulf flounder
PAR BAIR	*Paradiplogrammus bairdi*	lancer dragonet
PAR FURC	*Paranthias furcifer*	Atlantic creolefish
PAR MARM	*Parablennius marmoreus*	seaweed blenny
PAR MARN	*Paraclinus marmoratus*	marbled blenny

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
PAR NIGR	*Paraclinus nigripinnis*	blackfin blenny
PAR UMBR	*Pareques umbrosus*	cubbyu
PEM SCHO	*Pempheris schomburgkii*	glassy sweeper
PHA XENU	*Phaeoptyx xenus*	sponge cardinalfish
POM ARCU	*Pomacanthus arcuatus*	gray angelfish
POM PARU	*Pomacanthus paru*	French angelfish
PRI AQUI	*Pristipomoides aquilonaris*	wenchman
PRI AREN	*Priacanthus arenatus*	bigeye
PRI HIPO	*Priolepis hipoliti*	rusty goby
PRI OPHR	*Prionotus ophryas*	bandtail searobin
PRI PECT	*Pristis pectinata*	smalltooth sawfish
PRO ACUL	*Prognathodes aculeatus*	longsnout butterflyfish
PSE MACU	*Pseudupeneus maculatus*	spotted goatfish
PTE CALL	*Ptereleotris calliura*	blue dartfish
PTE HELE	*Ptereleotris helenae*	hovering dartfish
PTE VOLI	*Pterois volitans*	red lionfish
RAC CANA	*Rachycentron canadum*	cobia
REM REMO	*Remora remora*	remora
RHO AURO	*Rhomboplites aurorubens*	vermilion snapper
RYP MACU	*Rypticus maculatus*	whitespotted soapfish
RYP SAPO	*Rypticus saponaceus*	greater soapfish
SAR AURI	*Sardinella aurita*	Spanish sardine
SAR CORU	*Sargocentron coruscum*	reef squirrelfish
SAR VEXI	*Sargocentron vexillarium*	dusky squirrelfish
SCA COEL	*Scarus coelestinus*	midnight parrotfish
SCA COER	*Scarus coeruleus*	blue parrotfish
SCA CRIS	*Scartella cristata*	molly miller
SCA GUAC	*Scarus guacamaia*	rainbow parrotfish
SCA ISER	*Scarus iseri*	striped parrotfish

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
SCA SPE.	*Scarus sp.*	parrotfish species
SCA TAEN	*Scarus taeniopterus*	princess parrotfish
SCA VETU	*Scarus vetula*	queen parrotfish
SCH BETA	*Schultzea beta*	school bass
SCO CARI	*Scorpaenodes caribbaeus*	reef scorpionfish
SCO CAVA	*Scomberomorus cavalla*	king mackerel
SCO MACU	*Scomberomorus maculatus*	Spanish mackerel
SCO PLUM	*Scorpaena plumieri*	spotted scorpionfish
SCO REGA	*Scomberomorus regalis*	cero
SCY AEQU	*Scyllarides aequinoctialis*	spanish (shovelnose) lobster
SEL VOME	*Selene vomer*	lookdown
SER ANNU	*Serranus annularis*	orangeback bass
SER BALD	*Serranus baldwini*	lantern bass
SER DUME	*Seriola dumerili*	greater amberjack
SER PHOE	*Serranus phoebe*	tattler
SER RIVO	*Seriola rivoliana*	almaco jack
SER SPE.	*Seriola sp.*	jack species
SER SUBL	*Serranus subligarius*	belted sandfish
SER TABA	*Serranus tabacarius*	tobaccofish
SER TIGR	*Serranus tigrinus*	harlequin bass
SER TORT	*Serranus tortugarum*	chalk bass
SLT CONC	Lobster trap-concrete base	Lobster trap-concrete base
SLT DEBR	Lobster trap-debris	Lobster trap-debris
SLT FISH	Lobster trap-fishing	Lobster trap-fishing
SLT NOTF	Lobster trap-not fishing	Lobster trap-not fishing
SLT ROPE	Lobster trap-rope	Lobster trap-rope
SPA ATOM	*Sparisoma atomarium*	greenblotch parrotfish
SPA AURO	*Sparisoma aurofrenatum*	redband parrotfish
SPA CHRY	*Sparisoma chrysopterum*	redtail parrotfish

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
SPA RADI	*Sparisoma radians*	bucktooth parrotfish
SPA RUBR	*Sparisoma rubripinne*	yellowtail parrotfish
SPA SPE.	*Sparisoma sp.*	parrotfish species
SPA VIRI	*Sparisoma viride*	stoplight parrotfish
SPH BARR	*Sphyraena barracuda*	great barracuda
SPH GUAC	*Sphyraena guachancho*	guaguanche
SPH LEWI	*Sphyrna lewini*	scalloped hammerhead
SPH MOKA	*Sphyrna mokarran*	great hammerhead
SPH PICU	*Sphyraena picudilla*	southern sennet
SPH SPEN	*Sphoeroides spengleri*	bandtail puffer
SPH TEST	*Sphoeroides testudineus*	checkered puffer
SPH TIBU	*Sphyrna tiburo*	bonnethead
SPL FEME	SL-female with eggs	SL-female with eggs
SPL FEMN	SL-female no eggs	SL-female no eggs
SPL MALE	SL-male	SL-male
SPL UNKN	SL-unknown sex	SL-unknown sex
SRR SPE.	grouper-sea bass species	grouper-sea bass species
STE ADUS	*Stegastes adustus*	dusky damselfish
STE DIEN	*Stegastes diencaeus*	longfin damselfish
STE HISP	*Stephanolepis hispidus*	planehead filefish
STE LEUC	*Stegastes leucostictus*	beaugregory
STE PART	*Stegastes partitus*	bicolor damselfish
STE PLAN	*Stegastes planifrons*	threespot damselfish
STE SPE.	damselfish species	damselfish species
STE VARI	*Stegastes variabilis*	cocoa damselfish
STR GIGA	*Strombus gigas*	queen conch
STR NOTA	*Strongylura notata*	redfin needlefish
STR TIMU	*Strongylura timucu*	timucu
SYA MICR	*Syacium micrurum*	channel flounder

SPECIES_CD	SCIENTIFIC_NAME	COMMON_NAME
SYN FOET	*Synodus foetens*	inshore lizardfish
SYN INTE	*Synodus intermedius*	sand diver
SYN SCOV	*Syngnathus scovelli*	Gulf pipefish
SYN SYNO	*Synodus synodus*	red lizardfish
THA BIFA	*Thalassoma bifasciatum*	bluehead
TRA FALC	*Trachinotus falcatus*	permit
TYL CROC	*Tylosurus crocodilus*	houndfish
UNK SPE.	unknown species	unknown species
URO JAMA	*Urobatis jamaicensis*	yellow stingray
XYR MART	*Xyrichtys martinicensis*	rosy razorfish
XYR NOVA	*Xyrichtys novacula*	pearly razorfish
XYR SPE.	razorfish species	razorfish species
XYR SPLE	*Xyrichtys splendens*	green razorfish

Appendix B. Habitat Information Sheets

The following pages are habitat information sheets formatted so that they can be printed directly onto sheets of underwater paper for use in the field. For this reason, no page numbers or headings are included (From Brandt et al. 2009).

1st page: Stony Corals

2nd page: Octocorals and Sponges

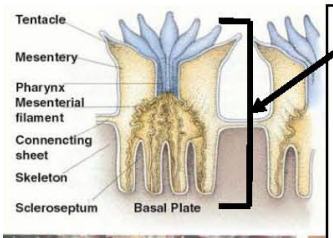
3rd page: Macroalgae, Seagrasses, and Other

4th page: Other (zooanthids), bottom of data sheet organisms, and living vs. bleached vs. recently dead coral identification

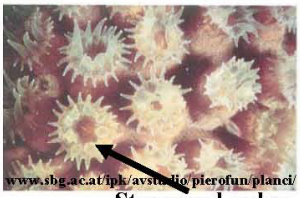
Brandt, M. E., N. Zurcher, A. Acosta, J. S. Ault, J. A. Bohnsack, M. W. Feeley, D. E. Harper, J. H. Hunt, T. Kellison, D. B. McClellan, M. E. Patterson, and S. G. Smith. 2009. A cooperative multi-agency reef fish monitoring protocol for the Florida Keys coral reef ecosystem. Natural Resource Report NPS/SFCN/NRR—2009/150. National Park Service, Fort Collins, Colorado.

STONY CORALS

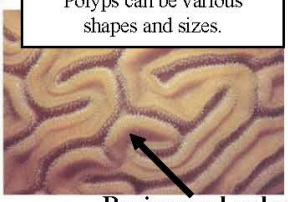
General coral anatomy:



Coral Polyp: A coral colony is made up of genetically identical polyps that are connected. Each polyp is an individual which is essentially a mouth surrounded by tentacles. Polyps can be various shapes and sizes.



Star coral polyp



Brain coral polyp

Stony coral morphotypes:

Massive:







All stony corals are rigid and leave behind reef framework when they die. Polyps vary in size and shape and tentacles are typically retracted during the day (exception is pillar coral – bottom right photo – which feeds during the day)

Branching:

The presence/absence of either species should be noted at the bottom of the data sheet









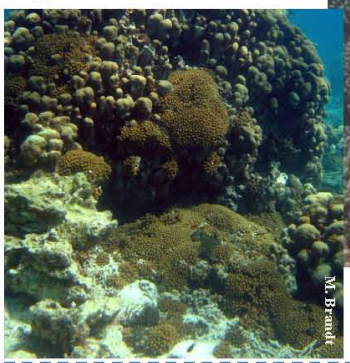
Small encrusting colonies of *A. palmata*. Note the white growing edges and prominent corallites

Leafy, platey:





Finger:





Other stony coral types:

Fire corals

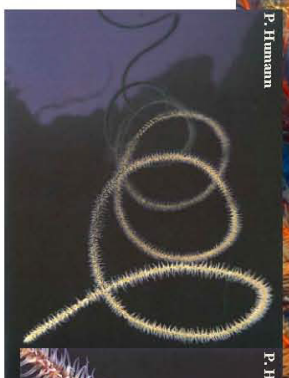




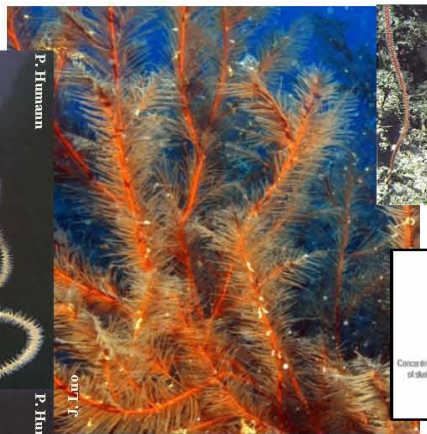


Tend to be orange/tan in appearance with white tips/edges. Stinging polyps look like sharp spines.

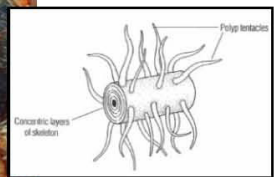
Black corals









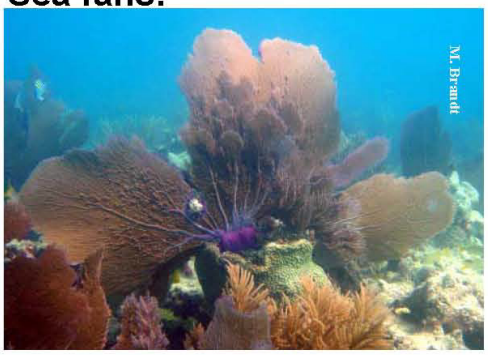


Unlike gorgonians, only tentacles come off of the branches (left close-up and diagram above), giving colonies a pine tree-like appearance. **Note the presence of black coral at bottom of data sheet!**

OCTOCORALS

Octocoral morphotypes:

Sea fans:



Sea rods and plumes:







Encrusting octocorals:

Erythropodium caribaeorum

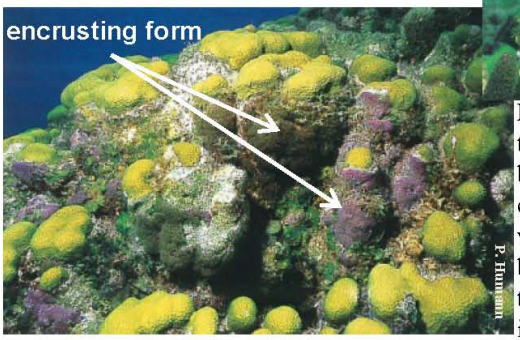


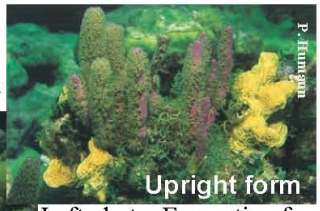




Encrusting gorgonians often look like macroalgae. The two most common species of encrusting gorgonians are *Erythropodium caribaeorum* (left) and *Briareum asbestinum* (below). *Erythropodium* has brown tissue and long tentacles that make it look "hairy". *Briareum* has purple tissue with brown tentacles that also make it look hairy or furry. When the tentacles are retracted the ploys will often be apparent.

Briareum asbestinum

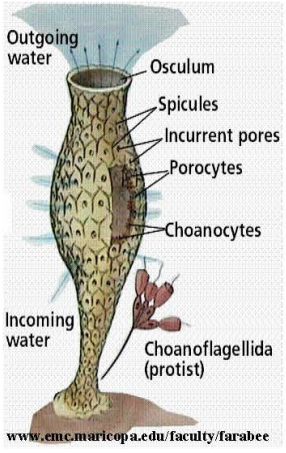




Left photo: Encrusting form is the purple and brown at the bases of the coral colony columns. Top arrow indicates where tentacles are extended, bottom arrow indicates where tentacles are retracted. Yellow is live stony coral.

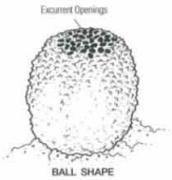
SPONGES

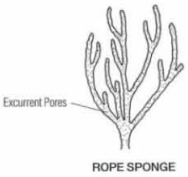
General sponge anatomy:











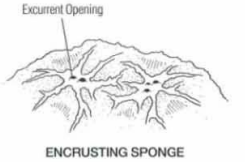




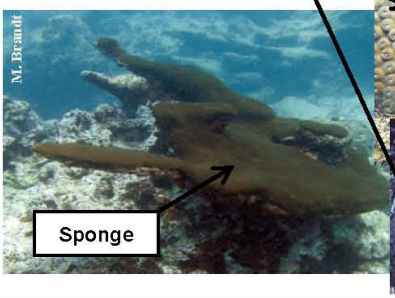


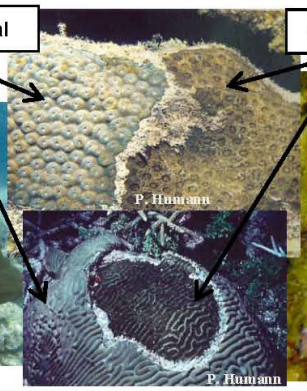


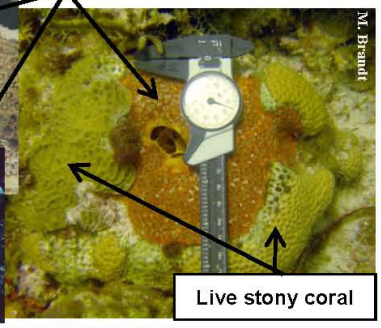




Common encrusting sponges include two species of boring sponges, *Cliona langue* (left) and *C. delitrix* (right). *C. langue* is brown and appears smooth while *C. delitrix* is typically bright red with conspicuous pores and osculums.







MACROALGAE

Macroalgae commonly found on hardbottom substrates:















Crustose coralline algae ("algae <1cm" on data sheets) is only found on hard substrates and is usually red or purple in color:

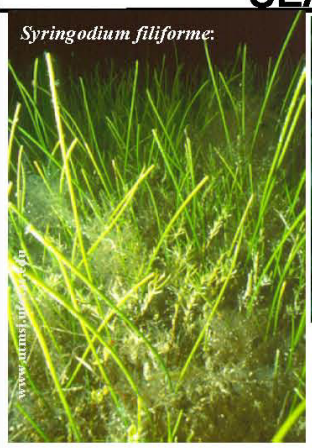




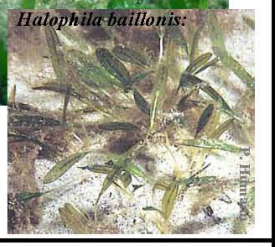




SEAGRASSES





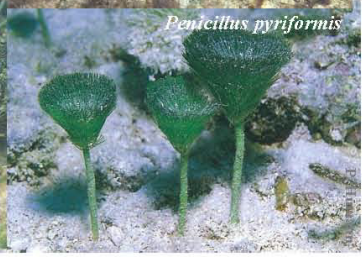


Macroalgae commonly found on sand substrates:









"OTHER": Anemones, Tunicates

Anemones:



Stichodactyla helianthus can occur in dense clusters and may look like stony coral. Look for flimsy edges of individuals.

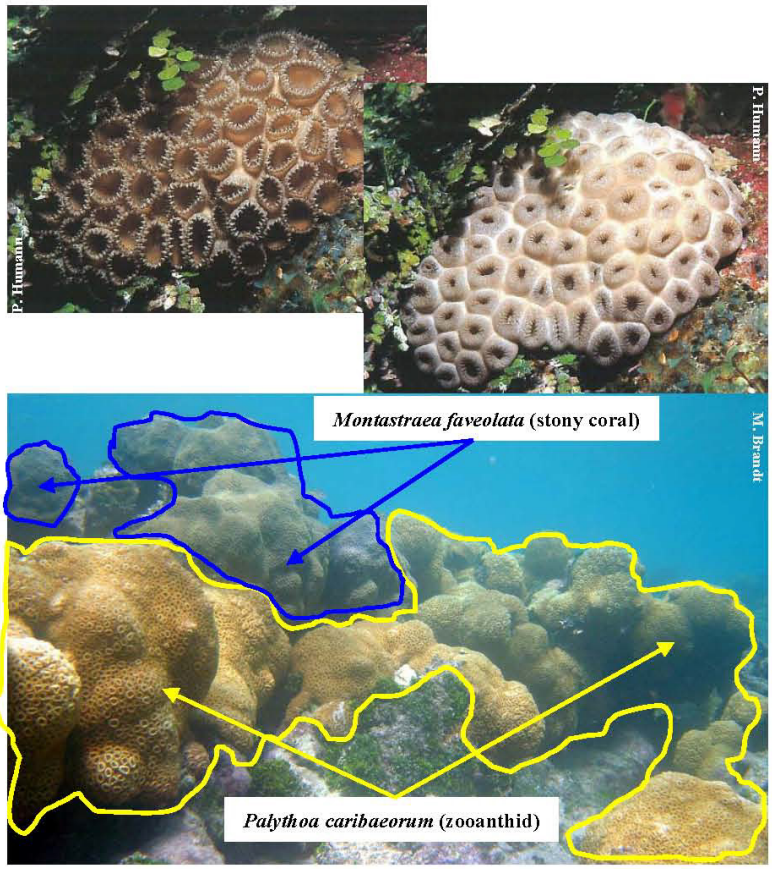
Mat tunicate:



Left photo – *T. solidum* can look like an encrusting sponge, but it is a tunicate! It appears as a green mat with slits.

"OTHER": Zooanthids (*Palythoa*)

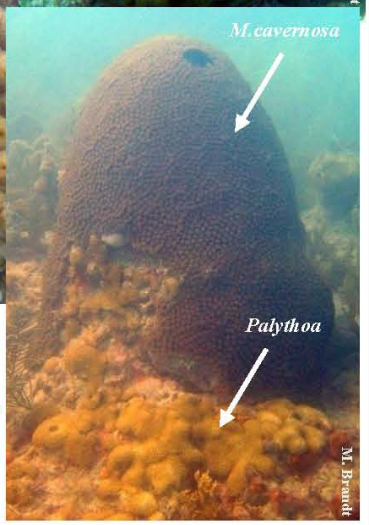
Palythoa caribaeorum **(Order: Zooanthid):**



The polyps of the stony coral *Montastraea cavernosa* (below and right) and the zooanthid *Palythoa caribaeorum* (left) look very similar.



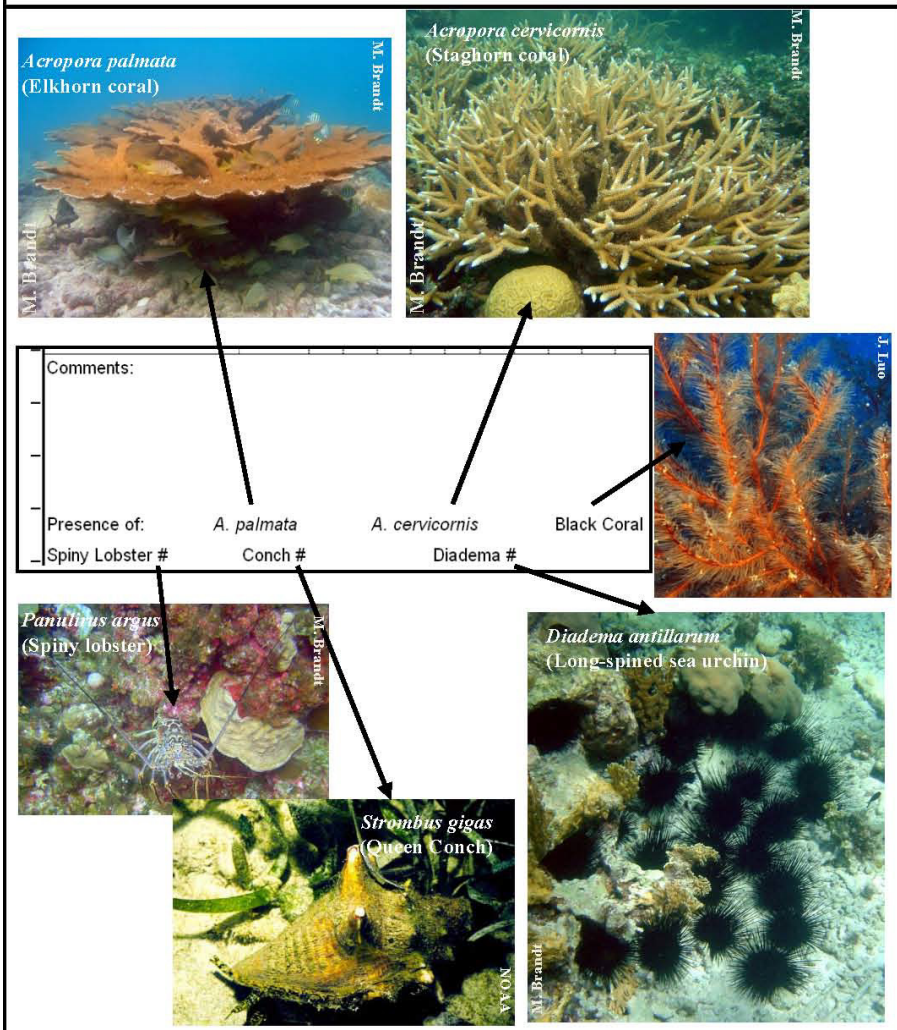




***M. cavernosa*: usually dark in color (unless bleaching). When polyps are open, the mouths are a light color. When touched, the colony feels hard and slimy.**

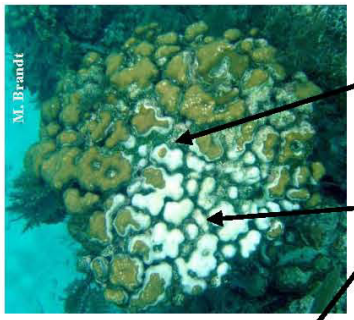
***Palythoa*: pale in color. When polyps are open, the mouths are hollow and deep. When touched, the colony feels soft and rubbery.**

Bottom of the data sheet



Living vs. bleached vs. recently dead stony coral:

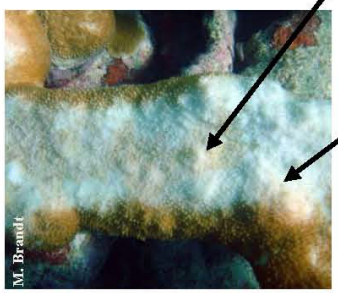
Living tissue: Corallites (polyp structure) are well defined, tentacles can sometimes be observed, no sediment on tissue.
Bleached coral: Tissue still present, algal symbionts absent or degraded giving colony a pale or whitish appearance.
Recently dead coral: Tissue absent. Sediment can settle and some algal colonization may have begun <1 day after death.
Old dead coral: Tissue absent, skeleton degraded, heavy sediment and algal colonization. Dead coral can appear alive if corallite structure is not degraded (e.g., brain corals and *Montastraea cavernosa* often retain their corallite structure long after death).

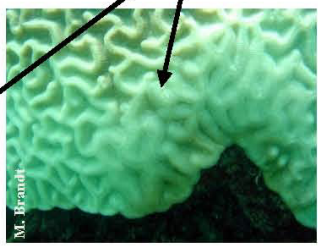


Normal living tissue

Recently dead

Bleached tissue





For questions or comments about these cards, please contact Marilyn Brandt at mbrandt@rsmas.miami.edu or 305-421-4736.

Appendix C. Printable Data Sheets

The following pages are data sheets formatted so that they can be printed directly onto sheets of underwater paper for use in the field. For this reason, no page numbers or headings are included.

- 1st page: Virgin Islands Fish/Habitat Data Sheet
- 2nd page: Florida Fish/Habitat Data Sheet: US
- 3rd page: Field/Boat Log form

Diver: _____ Date: _____ Field ID: Data Manager:

Buddy: _____ Sample Start Time: _____ Habitat type: Underwater visibility: _____M

Dive Start Time:_____ Sample End Time: _____ Bedrock Aggregate Reef Water temperature: _____ F

Dive End Time: Max Dive Depth: _____ ft Pavement Patch Reef Current: None Mod. High

Station Depth: _____ ft Scat. Coral/Rock in Sand

Submerged Debris: ☐None ☐LiveTrap ☐TrapDebris ☐Fishing ☐Other

Coral restoration ☐ None ☐Site ☐Survey area ☐Unknown

Coral Disease with Tissue Loss: ☐None ☐Not sampled ☐Fast (>1 cm) ☐Slow (<1 cm)

Substrate Slope
Max depth _____ft
Min depth _____ft

Max vertical Relief
Hard Relief _____m
Soft Relief _____m

Surface Relief Coverage %	Hard	Soft
< 0.2 m	%	%
0.2-0.5 m	%	%
0.5-1.0 m	%	%
1.0-1.5 m	%	%
> 1.5 m	%	%
TOTAL	100%	100%

Abiotic Footprint	
SAND	%
HARD-B	%
RUBBLE	%
Total	100%

Biotic Cover - Dominant Biological Cover %			
SAND		HARDBOTTOM	
"Bare"		Algae (<1 cm)	
Macro Algae		Algae (>1 cm)	
Sea grass		Live Stony Coral	
Sponge		Octocoral	
Other 1 _____		Sponge	
Other 1 _____		Other 1 _____	
		Other 1 _____	
TOTAL	100%		100%

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max

NOTES

Diver: _____ Date: _____ Field ID: Data Manager:

Buddy: _____ Sample Start Time: _____

Dive Start Time: _____ Sample End Time: _____

Dive End Time: Max Dive Depth: _____ ft

Station Depth: _____ ft

Habitat type:	
Contiguous S&G	Rubble
Contiguous Other	(Matrix)
Isolated	(Sand)

Underwater visibility: _____ M

Water temperature: _____ F

Current: None Mod. High

Substrate Slope
Max depth _____ ft
Min depth _____ ft

Max vertical Relief
Hard Relief _____ m
Soft Relief _____ m

Submerged Debris: ☐None ☐LiveTrap ☐TrapDebris ☐Fishing ☐Other

Coral Disease with Tissue Loss: ☐None ☐Not sampled ☐Fast (>1 cm) ☐Slow (<1 cm)

Coral restoration ☐ None ☐Site ☐ Survey area ☐ Unknown

Surface Relief Coverage %	Hard	Soft
< 0.2 m	%	%
0.2-0.5 m	%	%
0.5-1.0 m	%	%
1.0-1.5 m	%	%
> 1.5 m	%	%
TOTAL	100%	100%

Abiotic Footprint	
SAND	%
HARD-B	%
RUBBLE	%
Total	100%

Biotic Cover - Dominant Biological Cover %			
SAND		HARDBOTTOM	
"Bare"		Algae (<1cm)	
Macro Algae		Algae (>1cm)	
Sea grass		Live Stony Coral	
Sponge		Octocoral	
Other 1 _____		Sponge	
Other 1 _____		Other 1 _____	
		Other 1 _____	
TOTAL	100%		100%

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max

NOTES

NCRMP BOAT LOG and Supervisor Dive Log

Date: **Boat Log Manager:**

Divemaster: **Page _____ of _____**

Date	DOD	Field ID	Station	Team	Diver	O2%	PSI IN	TIME IN	Flag #	Actual Dive		TIME OUT	PSI OUT	Comments
										Depth	BT			

For each site, note the presence of any the following corals at the site by listing that species in a comment line of that site's dive details:
M. meandrites, P. strigosa, D. labyrinthiformis, C. natans, D. stokesii and E. fastigiata

DOD= # dive of day