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National Coral Reef Monitoring Program (NCRMP) Benthic Community Assessment Survey Field Protocols for U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands 2025

Coral Reef Conservation Program (CRCP), National Oceanic and Atmospheric Administration (NOAA)

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Introduction

The National Coral Reef Monitoring Program (NCRMP)'s biological sampling provides a biennial ecological characterization of general reef condition for reef fishes, corals, and benthic habitat (i.e., fish species composition, density, and size; coral species composition, density, size, condition; and benthic community cover) at a broad spatial scale (CRCP 2021). In the U.S. Atlantic, NCRMP biological sampling includes coral reef and hardbottom habitats in Florida, Flower Garden Banks, Puerto Rico, and the U.S. Virgin Islands (USVI). NCRMP surveys at stratified random sites where the sampling domain for each geographic region is partitioned by depth, reef complexity, sub-regional location (e.g., along-shelf position), and management zone.

NCRMP's benthic community data can inform new and ongoing reef management actions and strategies, document the occurrence of threatened and endangered species, evaluate the effect of environmental stressors (e.g., extreme weather events) on the reef benthic community, and provide a broader context to local monitoring efforts.

NCRMP Benthic Community Assessment Summary

An NCRMP Benthic survey includes one Benthic Community Assessment survey (CRCP 2025a) and one Coral Demographics survey (CRCP 2025b). Benthic surveys may occur at all or a subset of NCRMP Fish surveys (CRCP 2025c), and may be either conducted concurrently with NCRMP Fish surveys (Appendix I) or at separate field visits. This protocol provides an overview of the field methodology, including pre-dive, site orientation, and the coral demographics survey, as well as an overview of data accessibility and use.

NCRMP Benthic Community Assessment surveyors collect the following data:

1. Benthic cover (%) for ecologically important species or functional groups/types (e.g., macroalgae, turf algae, crustose coralline algae, scleractinian corals, sponges, sand/sediment, etc.).
2. Topographic complexity (substratum rugosity) within the survey area (15 x 2 m).
3. Abundance of commercially and ecologically important macroinvertebrates (i.e., Caribbean spiny lobster, Queen conch, long-spined sea urchins [*Diadema antillarum*]) within the survey area (15 x 2 m). Abundance of healthy, diseased, and dead *D. antillarum* within the survey area.
4. Presence or absence of ESA-listed Threatened and Endangered coral species within the survey area

(15 x 2 m) and at the site.

NCRMP Benthic Community Assessment Sequence of Events

NCRMP Benthic Community Assessment data collection occurs in four phases: (1) Pre-dive, (2) Site Information, (3) Benthic Community Assessment survey, and (4) Post-dive (Figure 1).

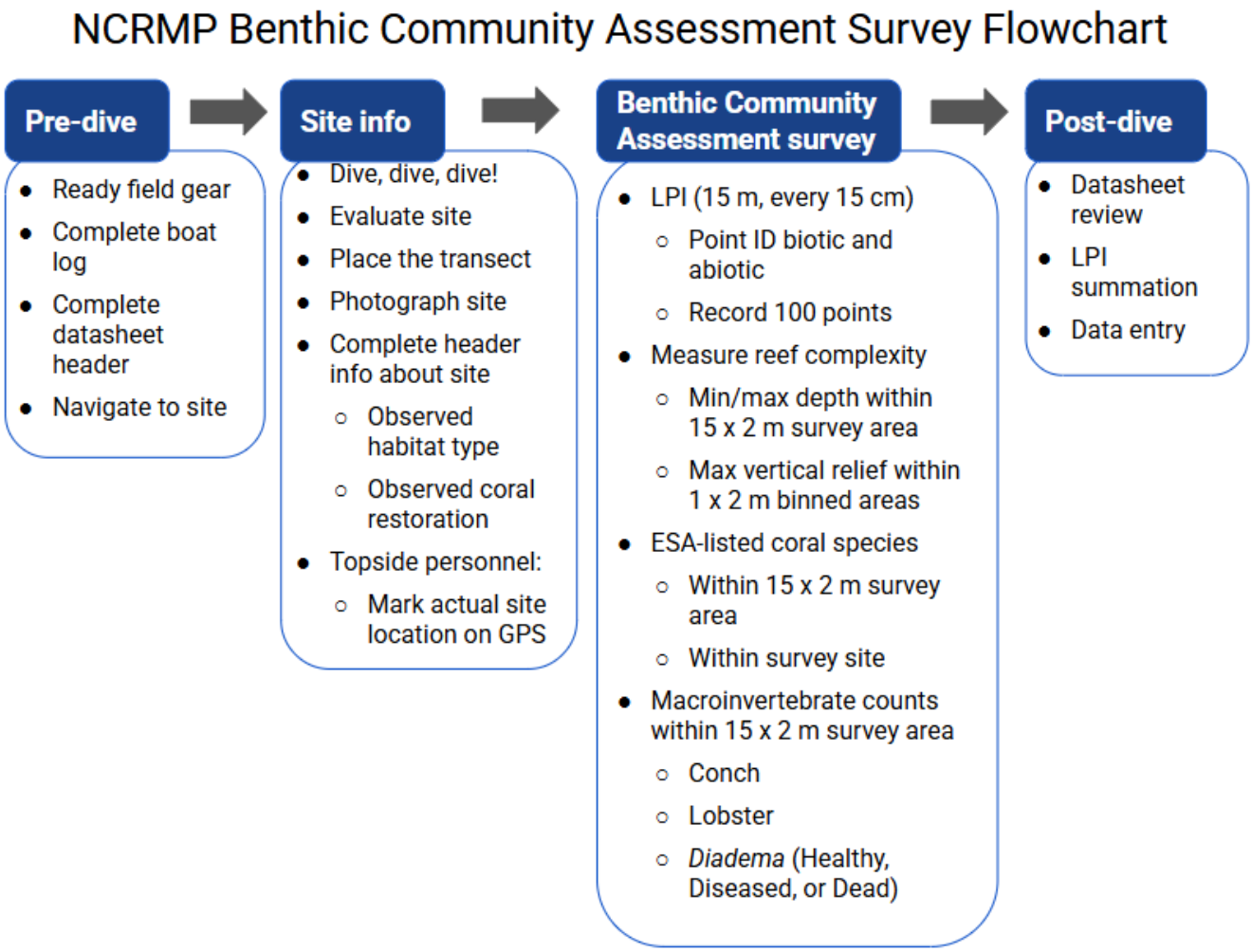


Figure 1. Benthic Community Assessment sequence of events.

Pre-dive

The pre-dive phase consists of organizing field equipment to take underwater and filling out station information on two datasheets prior to entering the water: the boat log and the Benthic Community Assessment datasheet (Figures 2 and 3).

Organize Field Equipment

The following field gear will be organized to take on the dive.

1. Benthic Community Assessment survey datasheet
2. Demographics datasheet

3. Benthic team transect tape (optional: weights for tape)
4. Clipboard, pencil, spare pencil
5. Small rigid measuring instrument, marked in cm (e.g., "Flexiruler") to assist Coral Demographics survey diver, and (optional) to aid in locating exact point under LPI transect tape
6. Measuring instrument marked in cm increments used for measuring coral colony dimensions and/or for measuring 1 m out from the transect tape (e.g., 0.5 or 1-m PVC, marked in units or with measuring tape securely attached, or APT), and for assisting in Coral Demographics data collection
7. Benthic team camera (with charged battery, and space on memory card) and housing
8. Dive flag with reel and GPS (only one is needed for a combined Benthic and Fish team)

Complete the Boat Log

Prior to the dive, key fields to record on the boat log for station information include the following (Figure 2; Appendix II):

1. Site – The 4-digit site number
2. Station – (1) All regions use a 1-stage sampling design
3. Team (Team member assignment) – Letter code identifying the type of survey data being collected by the diver within their dive team
    a. Fish (A/B) – A two-diver fish team consists of Diver A and Diver B.
    b. Benthic (J/X) – The diver collecting Benthic Community Assessment data is assigned the code 'J'; the diver collecting Coral Demographics data is assigned 'X'.

Date	DOD	Field ID	Station	Team	Diver	O2%	PSI IN	TIME IN
6/6/25	1	1026	1	A	Blondeau			
	1	1026	1	B	Grove			
	1	1026	1	J	Viehman			
	1	1026	1	X	Krampitz			
6/6/25	2	1200	1	A	Blondeau			
	2	1200	1	B	Grove			
	2	1200	1	J	Krampitz			
	2	1200	1	X	Viehman			

Figure 2. Example of boat log with station information filled out. DOD = Dive of the day. In this example, the first DOD consisted of four divers, one fish group and one benthic group. For the first DOD, the benthic divers are Viehman identified as team member J (Benthic Community Assessment diver), and Krampitz as team member X (Coral Demographics diver). For the second DOD, Krampitz is team member J, and Viehman is team member X as the divers rotated.

Example: Figure 2 provides an example of a boat log and the specific station information to record at

the dive site. The first dive of the day consisted of four divers, one fish group, and one benthic group. The benthic divers are Krampitz and Viehman, identified by the J/X codes used. For the first dive, Krampitz is identified as team member J (Benthic Assessment diver) and Viehman is X (Coral Demographics diver).

Datasheet Logistics and Station Information

The following information should be filled out legibly on the NCRMP Benthic Assessment datasheet (Figure 3; Appendix III).

1. Names of all divers
2. Field ID – The **Field ID** is a unique alpha-numeric number the diver is to record on the datasheet at each station.

   FIELD ID = (SITE#) + (STATION#) + (TEAM letter)
3. Date – **MM/DD/YYYY**
4. Sample time – Time of survey start
5. Mission data manager. The data manager will be assigned prior to the start of operations.
6. Number of survey meters completed. A fully completed survey has 15 m.

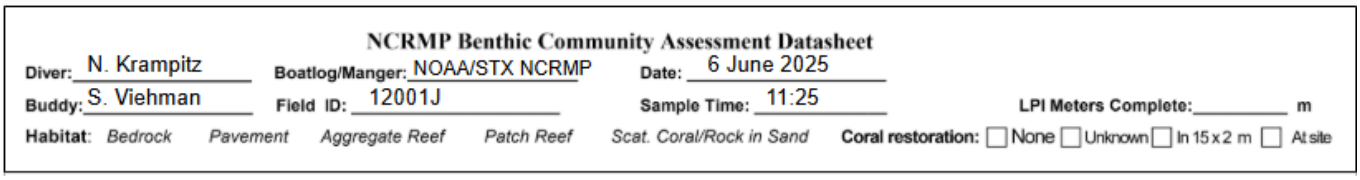

NCRMP Benthic Community Assessment Datasheet
Diver: N. Krampitz Boatlog/Manger: NOAA/STX NCRMP Date: 6 June 2025
Buddy: S. Viehman Field ID: 12001J Sample Time: 11:25 LPI Meters Complete: _____ m
Habitat: Bedrock Pavement Aggregate Reef Patch Reef Scat. Coral/Rock in Sand Coral restoration: ☐ None ☐ Unknown ☐ In 15 x 2 m ☐ At site

Figure 3. NCRMP Benthic Community Assessment Caribbean datasheet header with logistic and station information. In this example, Diver Edwards recorded the Field ID 12001J. According to the boat/dive log (Figure 2), Krampitz is diver J for site 1200 (in a 1-stage design).

Navigate to the Site

Once in the field, the vessel captain navigates to the pre-selected NCRMP site using a handheld GPS unit. On-site, divers are deployed and maintain visual contact with each other throughout the entire census.

1. Each vessel will have up to three **(3)** GPS units:
   a. One **(GPS 1)** for vessel navigation to sites, and
   b. Each boat will have one **(GPS 2)** dive flag/float with a GPS unit attached. 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 computer-generated sites. Record each team's unique GPS # and dive flag numbers on the daily boat log (Figure 2; Appendix II).
   c. If using a GPS unit other than a handheld to navigate to the sites, a handheld GPS **(GPS 3)** is used to collect topside waypoints (see #3 below).
2. If possible, before the divers deploy, the vessel captain and sampling team(s) should confirm the presence of hardbottom by evaluating the vessel's depth finder, boat's chart plotter, or from visual inspection over the side of the vessel (e.g., shallow habitats with high visibility). The vessel should not spend more than 5 minutes attempting to locate hardbottom habitat at each site. As the dive

team(s) deploy from the vessel, the boat captain will use the handheld GPS to mark a waypoint of the surface float/flag and record the coordinates on the boat log (Appendix II).

****Vessel operators will SAFELY mark waypoint AFTER divers have descended****

NCRMP Benthic Community Assessment Survey

Dive teams enter the water at the provided GPS coordinates, descend to the bottom, affix the surface float line to the bottom, set up survey areas, and begin data collection.

a. If the benthic team is diving with the fish team, **ALL dive teams enter the water as close to the same time as possible.**

**** Divers should always be aware of dive buddy and make frequent visual contact with dive buddy throughout entire dive (this includes during surveys as well) ****

Evaluating the Site

Upon descent, the team should first assess the site suitability by evaluating: (1) the presence of hardbottom, (2) the hardbottom habitat type, and (3) the dive conditions.

1. Hardbottom: As the team descends and assesses the site, the lead team ascertains the presence of hardbottom.
    a. Hardbottom presence/absence
        i. Present – If hardbottom is present, continue habitat type assessment.
        ii. Absent – If hardbottom is **not visible** at the site (no hardbottom at all, e.g., continuous sand or seagrass combined with limited visibility), the dive will be terminated and an alternate site selected.
        ****Do not swim around trying to locate hardbottom – it is not reconnaissance****
2. Hardbottom Habitat Type – If the team(s) deploy over hardbottom they are to establish the site where deployed.
    a. If necessary, during descent, divers will swim to hardbottom habitat within visual range:
        i. If divers enter the water over sand, they will swim to nearby reef habitat for sampling.
        ii. If divers enter the water over hardbottom different from that expected **and** observe expected habitat type within visible range from where deployed, they will swim to expected habitat for sampling.
    b. If divers enter the water over hardbottom different from that expected and **do not** observe expected habitat type nearby, they will establish the site where deployed and indicate the alternate habitat on the datasheet and boat log.
3. Dive Conditions – Divers should evaluate the dive conditions to ensure the safety of divers and to maintain high-quality benthic data collection. Certain environmental conditions are not safe for operations and surveys should be automatically terminated and alternate sites should be chosen.
    a. Assess the overall site conditions at the dive site. For example, if the dive site is unsafe due

to hazardous marine life, marine debris, vessel traffic, or for any other reason.

b. Determine if the water visibility is less than needed to safely complete a dive.

c. Evaluate the strength of the water currents at depth. Divers should be able to safely maintain a stationary position on the survey transect. The use of reef hooks is permitted if all the divers are appropriately trained and persistent currents are common in the region.

d. Determine the depth of the site. All NCRMP surveys should occur at <100ft (max 99ft).

Terminate a dive when any of the following conditions are met

STOP Unsafe dive conditions

STOP Strong currents

STOP Low visibility (<4m)

STOP Depth >99ft

****ALWAYS** indicate on the boat log why and when a dive was terminated **

Site Photographs

Although photos can be taken at any point during the dive, we recommend that the site photos are taken at the beginning of the dive so that they are not forgotten.

a. Station Documentation: <u>At least five</u> photographs are taken per site. The Coral Demographics diver coordinates with the Benthic Community Assessment diver on who will take the site photographs (and subsequently upload, organize, and re-name the images).

b. Take <u>one</u> photograph of the 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 should be clear and legible in the photograph.

c. Take <u>four</u> site photographs at the four cardinal compass headings (i.e. 0º: 0º, 90º, 180º, and 270º).

d. Additional photographs may be taken of anything unusual (e.g., rare fish, bleached or rare corals), for species identification purposes, and unique site features. If time permits, pictures of NCRMP sampling including that of other divers are welcome!

Establishing the Survey Transect

When a benthic team (Benthic Community Assessment and Coral Demographics divers) deploys with the Fish team (pair of RVC fish divers), they establish the survey adjacent to the cylinders if possible, using the same anchor point for the belt transect (Appendix I). We recommend laying the transect up-current if possible. Benthic teams may swim to nearby hardbottom if the habitat is patchy where the RVC cylinder is established.

*****Remember to always be in visual contact with your dive buddy*****

a. **Secure transect tape.** One of the Benthic divers secures the transect tape to the surface float line or reel or nearby.

b. **Lay out the transect.** The Benthic Community Assessment diver reels out the transect to a length greater than 15 m, secures the tape so that it is taut, and weights as needed (Figure 1).

If the site is pavement or scattered coral in sand, soft weights may be used to weigh down the transect tape at the beginning and end to keep the transect in place.

The diver will avoid wrapping the tape around substrate or biotic objects within the survey area, for this would distort sampling distances and locations for the benthic divers. Weights will not be placed on live coral.

c. The end of the tape should be tied or clipped so that the transect tape is as taut as possible.

If current is present at depth, transect tape may be aligned into the current. If currents are too strong, the survey should be terminated.

Benthic Community Assessment Survey

Once the transect has been established, the team begins to conduct the survey. The NCRMP Benthic Community Assessment survey is 15 m long. The line point intercept survey has 100 points along the 15 m survey. The survey area for select invertebrates, ESA-listed corals, and reef complexity is 15 x 2 m (Figure 4). At the end of the survey, fill out the completed meters on the datasheet (Figure 5).

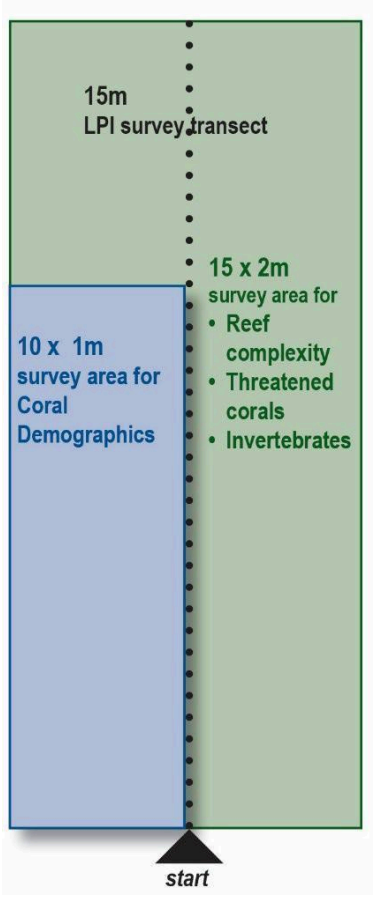


Figure 4. Diagram of NCRMP Coral Demographics survey area (blue), Benthic Community Assessment survey area for LPI transect (dotted line), and Benthic Community Assessment survey area for reef complexity, Threatened corals, and invertebrates (green).

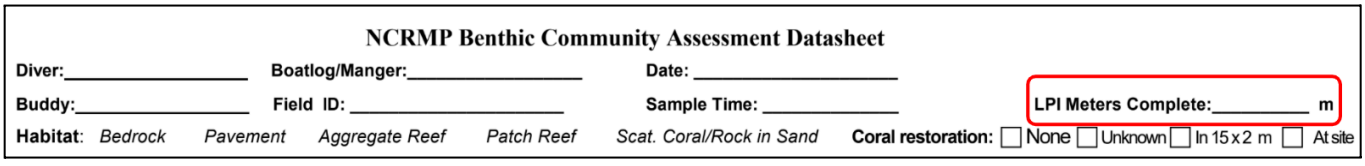


Figure 5. The NCRMP Benthic Assessment LPI survey length is 15 m. The surveyor completes the datasheet at the end of the dive with the meters completed. If the survey is complete, this should be 15 (m).

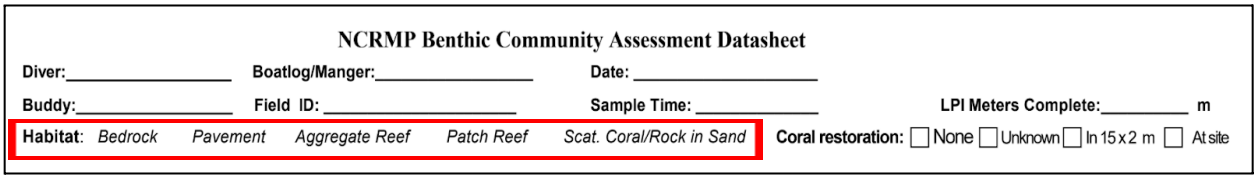
General Site Assessment

The Benthic Community Assessment diver collects the following header information at the site level. These may be scoped out during the dive and completed after the transect survey is finished.

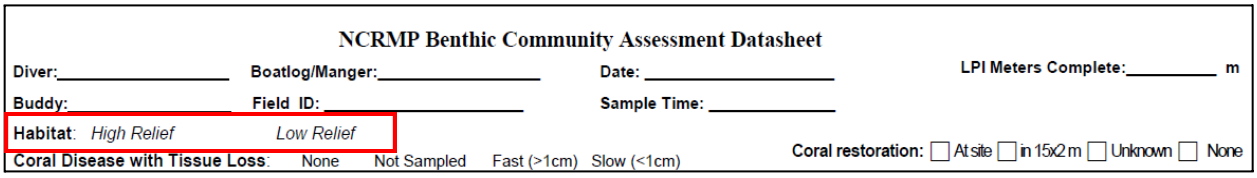
1. Observed habitat type – Post-survey, the diver enters the habitat type(s) observed during the dive. This may be different from the mapped habitat (Figures 6 a-c).
    a. Circle selection from the habitat categories (circle one on the Habitat datasheet).
    b. Immediately after the dive, the diver should discuss with their buddy and other team members and try to come to a consensus. If consensus is not achieved, divers should note that in the Field/Boat Log.

       NOTE: habitat types are different across regions (Appendix IV).

a.



b.



c.

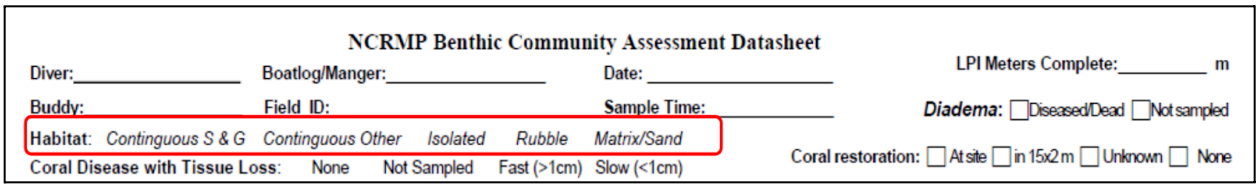


Figure 6. Hardbottom categories of observed habitat type and meters completed section on the Benthic Community Assessment datasheet for (a) Caribbean, (b) Flower Gardens Banks, and (c) Florida locations. *Note: Habitat categories differ by location.*

2. Restoration site - This identifies the presence of coral restoration (i.e., outplanting; Figure 8). Restoration outplanting may be indicated by epoxy or cement at the base of corals, coral tags, or potentially by species presence/abundance (e.g., Acroporids).
    - **At site**: restoration is present within the holistic NCRMP survey site. The survey site is defined as anywhere in the visible range of the dive site. This is not reconnaissance to seek out coral restoration, but to note presence of these corals observed outside the transect.
    - **In 15 x 2 m**: restoration is present within the BCA survey area.
    - **Unknown**: restoration is suspected within the site or BCA area, but there is uncertainty.
    - **None**: no evidence of restoration at either the site or within the BCA survey area.

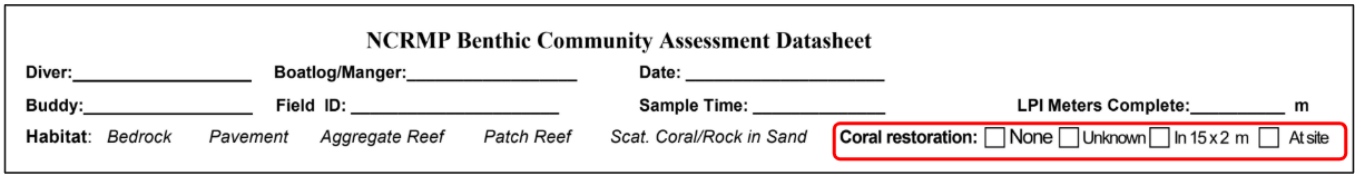

NCRMP Benthic Community Assessment Datasheet
Diver:_____ Boatlog/Manger:_____ Date: _____
Buddy:_____ Field ID: _____ Sample Time: _____ LPI Meters Complete:_____ m
Habitat: Bedrock Pavement Aggregate Reef Patch Reef Scat. Coral/Rock in Sand
Coral restoration: ☐ None ☐ Unknown ☐ In 15 x 2 m ☐ At site

Figure 8. Evidence of coral restoration. This can be at the site level and/or within the NCRMP Benthic Assessment 15 x 2 m survey area. It may also be marked as unknown or none within the header information on the NCRMP Benthic Community Assessment datasheet.

Benthic Community Assessment Survey Methodology

The Benthic Community Assessment methodology includes a line point intercept survey for cover (%), a belt transect for macroinvertebrate counts, topographic complexity, and ESA-listed coral species (Figures 1, 4).

1. **Line Point Intercept (LPI)**

   LPI data are collected on the following information:

   a. **Point identification – At 15 cm intervals along the transect tape, identify and categorize the substratum type according to available datasheet options (Appendix III). Identify the biotic organism (if any) for that abiotic substrate type (Hardbottom, Rubble, or Sand) at each 15 cm interval.**

   Identify points for evaluation objectively. Line a straight edge (e.g., pencil) with the transect point and vertically orientate it downward toward the substratum. Avoid bias, subjectivity, and "artificial selection" of favored substrates (e.g., corals).

   Record the first abiotic/biotic bottom type encountered in the point recording section of the datasheet (Figure 9).

   Canopy cover of hard organisms such as branching corals is a valid point (e.g., *Acropora* spp.).

   i. Point intercepts with the canopy cover of soft branching organisms, (e.g., calcareous algae, gorgonians, or sponges) and branching *Millepora* species **are not valid points**; however, point intercepts with the **holdfasts of such organisms are valid points and must be recorded**. In other words, canopy cover by "soft" branching organisms is only scored when the point intercepts a holdfast/attachment point.

   Example: A gorgonian encrusted with *Millepora* species

   1. **IF** the point intercepts the attachment point or holdfast of a gorgonian that is not encrusted by *Millepora*, the point is scored as *gorgonian*. **NOTE:** the vertical, flexible "fan" area of the sea fan is not a valid point, regardless of *Millepora* presence on the "fan".
   2. The point is scored as *Millepora* **ONLY IF** it intercepts the attachment point or holdfast of *Millepora* species or any other organism (such as a calcareous algae, gorgonian, or sponge) encrusted by *Millepora*.

   Example: algae (e.g., *Sargassum* spp., *Dictyota* spp.,).

   (1) A patch of *Dictyota* macroalgae growing on and covering crustose coralline algae (CCA) should be scored as *Dictyota* **ONLY IF** the point intersects with the *Dictyota* holdfast; otherwise, the point should be scored as CCA.

(2) A point is scored as *Sargassum* **ONLY IF** the point intersects with the holdfast or attachment point of the *Sargassum*. If the point intersects with the branching (non-holdfast) portion of the *Sargassum*, it should NOT be scored as *Sargassum*.

Record biotic and abiotic code every 15cm			Habitat code: H - Hardbottom S - Soft R - Rubble					
Meter	Cover	Hab	Meter	Cover	Hab	Meter	Cover	Hab
0.15			5.70			11.25		
0.30			5.85			11.40		
0.45			6m			11.55		
0.60			6.15			11.70		
0.75			6.30			11.85		
0.90			6.45			12m		
1.05m			6.60			12.15		
1.20			6.75			12.30		
1.35			6.90			12.45		
1.50			7.05			12.60		
1.65			7.20			12.75		
1.80			7.35			12.90		
1.95			7.50			13.05m		
2.1m			7.65			13.20		
2.25			7.80			13.35		
2.40			7.95			13.50		
2.55			8.1m			13.65		
2.70			8.25			13.80		
2.85			8.40			13.95		
3.0m			8.55			14.1m		

Figure 9. Point identification and point recording location on the datasheet.

b. **Abiotic substratum categories include hard (i.e., hardbottom or reef), soft (i.e., sand or mud), and rubble (Figure 9; Appendix V).**

c. **Biotic categories include coral to species, bare, algal turf, etc., as described in Appendix V. Appendix VI provides example photos of these categories.**

i. If a point falls on bare sand, the diver notes "Bare" in the cover column and "S" in the habitat column (Figure 9).

ii. If a point falls on turf algae growing on hardbottom with no sand trapped in the turf filaments, data is recorded as "H" in the habitat column next to the "TURF-no sediment" recorded in the cover column.

iii. Biotic category options (with the exception of coral species) are provided on the datasheet (Appendix III) to assist in point identification.

iv. **Meters completed** – Note the meter of completion of LPI survey on the datasheet determined by the data entered in the 15 cm-interval boxes (Figure 5).

2. Topographic Complexity Survey

a. **<u>Rugosity: Minimum/maximum depth.</u>**

This information provides the depth range of the sample unit, as well as the potential variability of the substratum in certain habitats such as spur and groove.

- Measurements are made within the entirety of the 15 x 2 m transect along **<u>BOTH</u>** transect sides (Figure 4), starting at meter 15, and 1 m out on each transect side.
- Using a digital depth gauge, record the maximum and minimum depth of the substratum encountered within the 15 x 2 m belt transect (recorded in feet) in the Rugosity section of the datasheet (Figure 9).

b. **<u>Relief - meters completed (m)</u>**

This is a whole integer indicating the total number of relief measurements completed by the diver and recorded in the Rugosity section of the datasheet (Figure 10). The target number is 15.

Rugosity 15x2m		
Min depth (ft)		
Max depth (ft)		
Meters complete relief:_____m		
Relief 15x2m (1x2 m cells)		
meter	meter	meter
0-1	5-6	10-11
1-2	6-7	11-12
2-3	7-8	12-13
3-4	8-9	13-14
4-5	9-10	14-15

Figure 10. Topographic complexity section on Benthic Community Assessment datasheet

c. **Reef complexity (Relief)**

Fifteen absolute measurements (whole cm) are collected to characterize the surface topography of the sample unit (i.e., 15 x 2 m transect).

- The entire transect is subdivided into 15, 1 x 2 m smaller subplots (n =15 per sample unit), with each subplot scored for the highest hard-bottom relief feature.
- Within each 1 x 2 m sub-plot the highest maximum hard relief feature (not including "soft complexity" features such as branching gorgonians, sponges, and fire corals) is measured and reported (cm) within the corresponding meter mark.
- If no search occurs, denote this with a large "X" through the entire relief column. If some portion of this survey does not occur, denote this with a large "X" through the portion that does not occur. Indicate the number of completed relief measurements (e.g., 0-15) using the above section. ***If this portion of the survey is not sampled, it is critical to indicate so on the datasheet. Not sampled is entirely different from a survey where relief was 0 cm in the 15 x 2 m survey area.***

3. Threatened/Endangered coral species

The presence or absence will be recorded for all seven (7) Atlantic/Caribbean coral species listed as Threatened or Endangered according to the U.S. Endangered Species Act both: 1) within the 15 x 2 m belt transect and 2) anywhere at the sample site (Figure 11).

Threatened coral species Presence(1) or Absence(0)		
	in 15 x 2m	*At site*
A. cervicornis		
A. palmata		
D. cylindrus		
O. annularis		
O. faveolata		
O. franksi		
M. ferox		

Figure 11. ESA coral section on Benthic Community Assessment datasheet. The presence or absence of ESA-listed coral species is noted if they are within the Benthic Community Assessment 15 x 2 m survey area or at the NCRMP site.

a. The transect area is the 15 x 2 m transect (Figure 4). This is also the same transect area that is surveyed for the macroinvertebrate counts.

b. The survey site is defined as anywhere in the visible range of the dive site. This is not reconnaissance to seek out ESA species, but to note presence of these corals observed outside the transect.

Presence or absence is recorded for each of these Atlantic/Caribbean ESA-listed or threatened scleractinian coral species: *Acropora palmata*, *A. cervicornis*, *Dendrogyra cylindrus*, *Orbicella annularis*, *O. faveolata*, *O. franksi*, and *Mycetophyllia ferox*.

a. **PRESENCE** of species – denoted by a "1" (one).

b. **ABSENCE** of species – denoted by a "0" (zero).

Photograph any colonies you are unable to identify to species and verify topside. If no search occurs, denote this with a large "X" through the entire ESA corals column. If some portion of this survey does not occur, denote this with a large "X" through the portion that does not occur. ***If this portion of the survey is not sampled, indicate so on the datasheet. Not sampled is different from a survey where species were absent (not encountered) within the 15 x 2 m survey area.***

4. Macroinvertebrate counts

All Caribbean spiny lobster (*Panulirus argus*), queen conch (*Lobatus gigas*), and long-spined sea urchins (*Diadema antillarum*) are counted within the 15 m x 2 m belt transect (Figure 4; Appendix I).

Macroinvertebates	Count (15 x 2 m)
P. argus	
L. gigas	
D. antillarum HEALTHY	
D. antillarum DISEASED	
D. antillarum DEAD	

Figure 12. Macroinvertebrate counts section on the NCRMP Benthic Community Assessment datasheet.

a. Healthy, diseased, and dead *Diadema* are counted specifically within the 15 x 2 m macroinvertebrate counts survey area (Figure 12).

If no search occurs, denote this with a large "X" through the entire Count column. ***If this portion of the survey is not sampled, it is critical to indicate so on the datasheet. Not sampled is different from a survey where species were absent (not encountered) within the 15 x 2 m survey area.***

5. Notes

Additional notes may be added to the bottom of the datasheet (Appendix III). Indicate any field observation that may be important, such as presence of an ecological mortality event (e.g., disease).

Assisting with the Coral Demographics Surveys

The Benthic Community Assessment diver will **always** bring a Coral Demographics datasheet, ruler,

and a PVC meter stick to facilitate assisting the Demographics diver in data collection.

1. When the Benthic Community Assessment diver assists the Coral Demographics diver in the Coral Demographics survey, the Benthic Community Assessment diver will confirm with the Coral Demographics diver that the demographic transect ends at 10 m, will start the Demographics survey at the tenth meter, and will work toward the Demographics diver.
2. The Benthic Community Assessment and Coral Demographics divers will coordinate to avoid duplicating counts and will meet at a full meter. The meter range surveyed by each diver will be written on each respective datasheet.
3. Benthic Community Assessment divers will have completed training on the Coral Demographics Survey protocols and will have scientific training in and current working knowledge of Caribbean scleractinian coral species identification.

Surveys typically last less than 30 minutes.

****Once all surveys are completed all divers should convene at the affixed float line and begin their ascent to the surface together ****

Post-dive: Data

Site Level Observations

After the survey is completed, if coral restoration (at site or survey area), invasive soft corals, or submerged debris were observed at the site then it should be indicated in the comments section of the boat log.

Datasheet Review

At the end of the survey, when divers are on the boat, the dive team exchanges datasheets for review by checking for completeness and legibility. **A diver cannot review his/her own datasheet**. This is a small but important step for finding and fixing errors that may have been written on the datasheet.

1. *Benthic Assessment datasheet* – Review includes, at a minimum, verifying the following:
    a. Completeness and legibility of site information prior to dive.
    b. Completeness and legibility of all data fields.
    c. Completeness and legibility of total meters completed.
    d. Completeness and legibility of percent hardbottom of survey component.
    e. Discuss among team members and concur on habitat type.
    f. Note the presence of multiple datasheets per site if applicable. Circle “combined” on the datasheet if assisted by another diver(s).
    g. Annotation in the “Notes” section as applicable.

Data Entry and Information Storage

1. A link to the data entry website will be provided at the start of each mission and/or season.

2. The Benthic Community Assessment diver is responsible for all of this survey data entry for the site, even if other diver(s) contribute to collection of BCA survey info.
3. In preparation for entry into the NCRMP data portal, the Benthic Community Assessment diver tallies the LPI section of Benthic Community Assessment datasheet by biotic categories by abiotic substrate. Tally totals are to equal the number of rows of recorded data (Figure 13).

   TIP: Excel sheets with macros are available upon request to support this tally. Save one tab per site to assist with data proofing later.

   TIP: This section is a useful reference when recording the points for the biotic categories.

Corals (sp)	H	S	R		H	S	R
				Bare			
				Turf no sediment			
				Turf w/ sediment			
				Dictyota			
				Halimeda			
				Lobophora			
				Macro - calc			
				Macro - fleshy			
				CCA			
				Peyssonnelia			
				Ramicrusta			
				Gorg - encrust			
				Gorg - upright			
				Sponge - other			
				Sponge - Cliona			
				Cyano/Diatom			
				Millepora			
				Palythoa			
				Seagrass			
				Other			

Figure 13. Binned LPI section of Benthic Community Assessment datasheet to tally biotic categories by abiotic substrate for entry into database. Tally totals are to equal the number of rows of recorded data. *This section is also to be used to assist in identifying biotic categories for point recording.*

4. All data should initially be entered into the data entry site in a timely fashion. For 'blitz' style small boat (e.g., USVI) and liveaboard missions (e.g., Flower Garden Banks, Dry Tortugas, and Florida Keys cruises) all data should be entered in by the end of the sampling trip and data sheets will be collected by pre-identified NOAA NCRMP personnel before departure.
5. The Benthic diver pair will coordinate on who leads photo uploading, organizing, labeling, and sharing (i.e., in a folder on an identified cruise laptop or to NOAA's google drive).

Data Proofing

After data entry has been completed, individual divers will be responsible for proofing their data. This is the first part of a much larger data QAQC process and a diver's attention to detail and timely turnaround time immensely help the NCRMP team to produce an analysis-ready dataset.

Specific instructions will be provided following the mission and/or sampling season by email. The general steps to be followed by each diver are provided below.

1. Download their proofing report(s) from the data entry website.
2. Locate and/or download/view scanned copies of their underwater datasheets.
3. Check the data for errors. Make sure the data entry system exactly matches the data you wrote down underwater. Document any errors.

4. Make corrections to the entered data as needed.

NCRMP Benthic Community Assessment Data Accessibility and Use

NCRMP data is publicly accessible in multiple locations, including the NCRMP Data Visualization Tool https://ncrmp.coralreef.noaa.gov/ and the Coral Reef Conservation Program website https://www.coris.noaa.gov/monitoring/biological.html.

NCRMP data and analysis scripts are open source and available on GitHub. The Benthics R package is available at https://github.com/MSE-NCCOS-NOAA/NCRMP_benthics (Groves, Mateski, Krampitz, Sturm, and Viehman 2025).

For all publications that use or reference NCRMP data, NCRMP should be acknowledged appropriately. In addition, the following acknowledgement should be included: "NOAA's National Coral Reef Monitoring Program (NCRMP) data was funded by NOAA's Coral Reef Conservation Program, project 743." Please share publications with the NCRMP team for awareness.

References

NOAA Coral Reef Conservation Program (CRCP). 2021. National Coral Reef Monitoring Plan. NOAA Coral Reef Conservation Program. Silver Spring, MD. 39 pp. doi: 10.25923/fqkq-w497

NOAA Coral Reef Conservation Program (CRCP). 2025a. National Coral Reef Monitoring Program (NCRMP) Coral Demographics Survey Field Protocols for U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands 2025. NOAA Coral Reef Conservation Program. 28 pp. doi: 10.25923/bbw7-ry84

NOAA Coral Reef Conservation Program (CRCP). 2025b. 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 2025. NOAA Coral Reef Conservation Program. 23 pp. doi: 10.25923/0yr2-5g02

Acknowledgements

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For more information, contact:
Benthic Team, Coral Demographics and Benthic Community Assessment surveys:
Dr. Shay Viehman, shay.viehman@noaa.gov; NCCOS, Benthic Team Lead
Dr. Alexis Sturm, lexie.sturm@noaa.gov, NCCOS, Benthic Data Analyst
Nicole Krampitz[2]; nicole.krampitz@noaa.gov; NCCOS, Benthic Data Analyst
Dr. Chris Jeffrey[2], chris.jeffrey@noaa.gov; NCCOS, CSS Lead

NCRMP Coordination:
Dr. Alexis Sturm, lexie.sturm@noaa.gov, NCCOS, US Caribbean/Flower Gardens Operations Lead
Dr. Jay Grove, jay.grove@noaa.gov; SEFSC, Florida Operations Lead
Dr. Erica Towle, erica.towle@noaa.gov; CRCP, National NCRMP Coordinator

Fish Team, RVC surveys:
Dr. Jay Grove, jay.grove@noaa.gov; SEFSC, Fish Team Lead
Jeremiah Blondeau, jeremiah.blondeau@noaa.gov; SEFSC, Fish Data Manager
Caitlin Langwiser, caitlin.langwiser@noaa.gov; SEFSC, Fish Team and Unit Diver Supervisor
Erin Cain[1], erin.cain@noaa.gov; SEFSC, Fish Team and Field Trainer
Dr. Dione Swanson[1], dione.swanson@noaa.gov; SEFSC, Fish Data Analyst

NOAA Affiliates
[1] *University of Miami*
[2] *CSS, Inc.*

Appendices

Appendix I. Illustrations of survey placement and survey areas

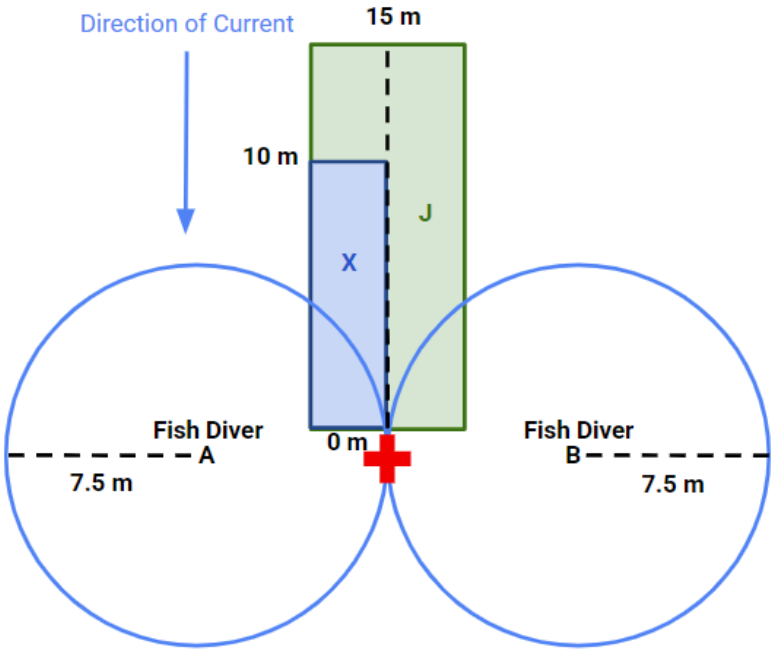


Figure A. Placement of co-sampled fish and benthic survey areas on continuous hardbottom. RVC Fish divers (A, B) within a 15-m diameter cylinder (7.5 m radius cylinder), Coral Demographics diver (X) in a 10 x 1 m area (blue), and Benthic Community Assessment diver (J) in a 15 x 2 m area (green). The red "✚" represents the benthic affixed dive reel attached to the surface flag and GPS unit.

Appendix II. Example boat/dive log.

Date: **NCRMP**

Divemaster: **Supervisor's Dive Log** **Page _____ of _____**

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

DOD= # dive of day

Appendix III. Benthic Community Assessment Datasheets

Example 1: Puerto Rico and U.S. Virgin Islands datasheet

NCRMP Benthic Community Assessment Datasheet

Diver:_____ **Boatlog/Manger:**_____ **Date:** _____

Buddy:_____ **Field ID:** _____ **Sample Time:** _____ **LPI Meters Complete:**_____ **m**

Habitat: *Bedrock* *Pavement* *Aggregate Reef* *Patch Reef* *Scat. Coral/Rock in Sand* **Coral restoration:** ☐ None ☐ Unknown ☐ In 15x2 m ☐ At site

Line Point Intercept: Record biotic and abiotic code every 15 cm Habitat code: H - Hardbottom S - Soft R - Rubble

Meter	Cover	Hab	Meter	Cover	Hab	Meter	Cover	Hab
0.15			5.70			11.25		
0.30			5.85			11.40		
0.45			6 m			11.55		
0.60			6.15			11.70		
0.75			6.30			11.85		
0.90			6.45			12 m		
1.05 m			6.60			12.15		
1.20			6.75			12.30		
1.35			6.90			12.45		
1.50			7.05			12.60		
1.65			7.20			12.75		
1.80			7.35			12.90		
1.95			7.50			13.05 m		
2.1 m			7.65			13.20		
2.25			7.80			13.35		
2.40			7.95			13.50		
2.55			8.1 m			13.65		
2.70			8.25			13.80		
2.85			8.40			13.95		
3.0 m			8.55			14.1 m		
3.15			8.70			14.25		
3.30			8.85			14.40		
3.45			9 m			14.55		
3.60			9.15			14.70		
3.75			9.30			14.85		
3.90			9.45			15 m		
4.05 m			9.60					
4.20			9.75					
4.35			9.90					
4.50			10.05 m					
4.65			10.20					
4.80			10.35					
4.95			10.50					
5.1 m			10.65					
5.25			10.80					
5.40			10.95					
5.55			11.1 m					

Notes

Circle survey grouping
Combined Separate

Rugosity (15 x 2 m)

Min depth (ft)	
Max depth (ft)	

Meters complete relief:_____m

Relief
(15x2 m, 1x2 m cells)

meter	meter	meter
0-1	5-6	10-11
1-2	6-7	11-12
2-3	7-8	12-13
3-4	8-9	13-14
4-5	9-10	14-15

Macroinvertebates	Count (15 x 2 m)
P. argus	
L. gigas	
D. antillarum HEALTHY	
D. antillarum DISEASED	
D. antillarum DEAD	

Threatened coral species
Presence (1) or Absence (0)

	in 15x2 m	*At site*
A. cervicornis		
A. palmata		
D. cylindrus		
O. annularis		
O. faveolata		
O. franksi		
M. ferox		

Categories Data Entry Counts

Corals (sp)	H	S	R

	H	S	R
Bare			
Turf no sediment			
Turf w/ sediment			
Dictyota			
Halimeda			
Lobophora			
Macro - calc			
Macro - fleshy			
CCA			
Peyssonnelia			
Ramicrusta			
Gorg - encrust			
Gorg - upright			
Sponge - other			
Sponge - Cliona			
Cyano/Diatom			
Millepora			
Palythoa			
Seagrass			
Other			

Example 2: Flower Garden Banks datasheet

NCRMP Benthic Community Assessment Datasheet

Diver:_____ Boatlog/Manger:_____ Date: _____

Buddy:_____ Field ID: _____ Sample Time:_____ LPI Meters Complete:_____ m

Habitat: *High Relief* *Low Relief*

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

Coral restoration: ☐ At site ☐ In 15x2m ☐ Unknown ☐ None

Line Point Intercept: Record biotic and abiotic code every 15cm Habitat code: H - Hardbottom S - Soft R - Rubble

Meter	Cover	Hab	Meter	Cover	Hab	Meter	Cover	Hab
0.15			5.70			11.25		
0.30			5.85			11.40		
0.45			6m			11.55		
0.60			6.15			11.70		
0.75			6.30			11.85		
0.90			6.45			12m		
1.05m			6.60			12.15		
1.20			6.75			12.30		
1.35			6.90			12.45		
1.50			7.05			12.60		
1.65			7.20			12.75		
1.80			7.35			12.90		
1.95			7.50			13.05m		
2.1m			7.65			13.20		
2.25			7.80			13.35		
2.40			7.95			13.50		
2.55			8.1m			13.65		
2.70			8.25			13.80		
2.85			8.40			13.95		
3.0m			8.55			14.1m		
3.15			8.70			14.25		
3.30			8.85			14.40		
3.45			9m			14.55		
3.60			9.15			14.70		
3.75			9.30			14.85		
3.90			9.45			15m		
4.05m			9.60					
4.20			9.75					
4.35			9.90					
4.50			10.05m					
4.65			10.20					
4.80			10.35					
4.95			10.50					
5.1m			10.65					
5.25			10.80					
5.40			10.95					
5.55			11.1m					

Notes

Circle survey grouping
Combined Separate

Rugosity (15x2m)		
Min depth (ft)		
Max depth (ft)		
Meters complete relief:_m		
Relief (15x2m, 1x2 m cells)		
meter	meter	meter
0-1	5-6	10-11
1-2	6-7	11-12
2-3	7-8	12-13
3-4	8-9	13-14
4-5	9-10	14-15

Macroinvertebrate counts (15x2m)	
P. argus	
L. gigas	
D. antillarum	

Threatened coral species Presence(1) or Absence(0)		
	in 15 x 2m	*At site*
A. cervicornis		
A. palmata		
D. cylindrus		
O. annularis		
O. faveolata		
O. franksi		
M. ferox		

Categories Data Entry Counts

Corals (sp)	H	S	R		H	S	R
				Bare			
				Turf no sediment			
				Turf w/ sediment			
				Dictyota			
				Halimeda			
				Lobophora			
				Macro - calc			
				Macro - fleshy			
				CCA			
				Peyssonnelia			
				Ramicrusta			
				Gorg - encrust			
				Gorg - upright			
				Sponge - other			
				Sponge - Clionna			
				Cyano/Diatom			
				Millepora			
				Palythoa			
				Seagrass			
				Other			

Example 3: Florida datasheet

NCRMP Benthic Community Assessment Datasheet

Diver:_________________ Boatlog/Manger:_________________ Date:_________________

Buddy:_________________ Field ID:_________________ Sample Time:_____________ LPI Meters Complete:__________ m

Habitat: *Continguous S & G* *Continguous Other* *Isolated* *Rubble* *Matrix/Sand*

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

Coral restoration: ☐ At site ☐ in 15x2m ☐ Unknown ☐ None

Line Point Intercept: Record biotic and abiotic code every 15cm Habitat code: H - Hardbottom S - Soft R - Rubble

Meter	Cover	Hab	Meter	Cover	Hab	Meter	Cover	Hab
0.15			5.70			11.25		
0.30			5.85			11.40		
0.45			6m			11.55		
0.60			6.15			11.70		
0.75			6.30			11.85		
0.90			6.45			12m		
1.05m			6.60			12.15		
1.20			6.75			12.30		
1.35			6.90			12.45		
1.50			7.05			12.60		
1.65			7.20			12.75		
1.80			7.35			12.90		
1.95			7.50			13.05m		
2.1m			7.65			13.20		
2.25			7.80			13.35		
2.40			7.95			13.50		
2.55			8.1m			13.65		
2.70			8.25			13.80		
2.85			8.40			13.95		
3.0m			8.55			14.1m		
3.15			8.70			14.25		
3.30			8.85			14.40		
3.45			9m			14.55		
3.60			9.15			14.70		
3.75			9.30			14.85		
3.90			9.45			15m		
4.05m			9.60					
4.20			9.75					
4.35			9.90					
4.50			10.05m					
4.65			10.20					
4.80			10.35					
4.95			10.50					
5.1m			10.65					
5.25			10.80					
5.40			10.95					
5.55			11.1m					

Rugosity (15x2m)

Min depth (ft)	
Max depth (ft)	
Meters complete relief: m	

Relief (15x2m, 1x2 m cells)

meter	meter	meter
0-1	5-6	10-11
1-2	6-7	11-12
2-3	7-8	12-13
3-4	8-9	13-14
4-5	9-10	14-15

Macroinvertebrate counts (15x2m)

P. argus	
L. gigas	
D. antillarum	

Threatened coral species Presence(1) or Absence(0)

	in 15 x 2m	*At site*
A. cervicornis		
A. palmata		
D. cylindrus		
O. annularis		
O. faveolata		
O. franksi		
M. ferox		

Categories Data Entry Counts

Corals (sp)	H	S	R

	H	S	R
Bare			
Turf no sediment			
Turf w/ sediment			
Dictyota			
Halimeda			
Lobophora			
Macro - calc			
Macro - fleshy			
CCA			
Peyssonnelia			
Ramicrusta			
Gorg - encrust			
Gorg - upright			
Sponge - other			
Sponge - Clionna			
Cyano/Diatom			
Millepora			
Palythoa			
Seagrass			
Other			

Notes

Circle survey grouping
Combined Separate

Appendix IV. NCRMP habitat type classifications

Puerto Rico and U.S. Virgin Islands[1]

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

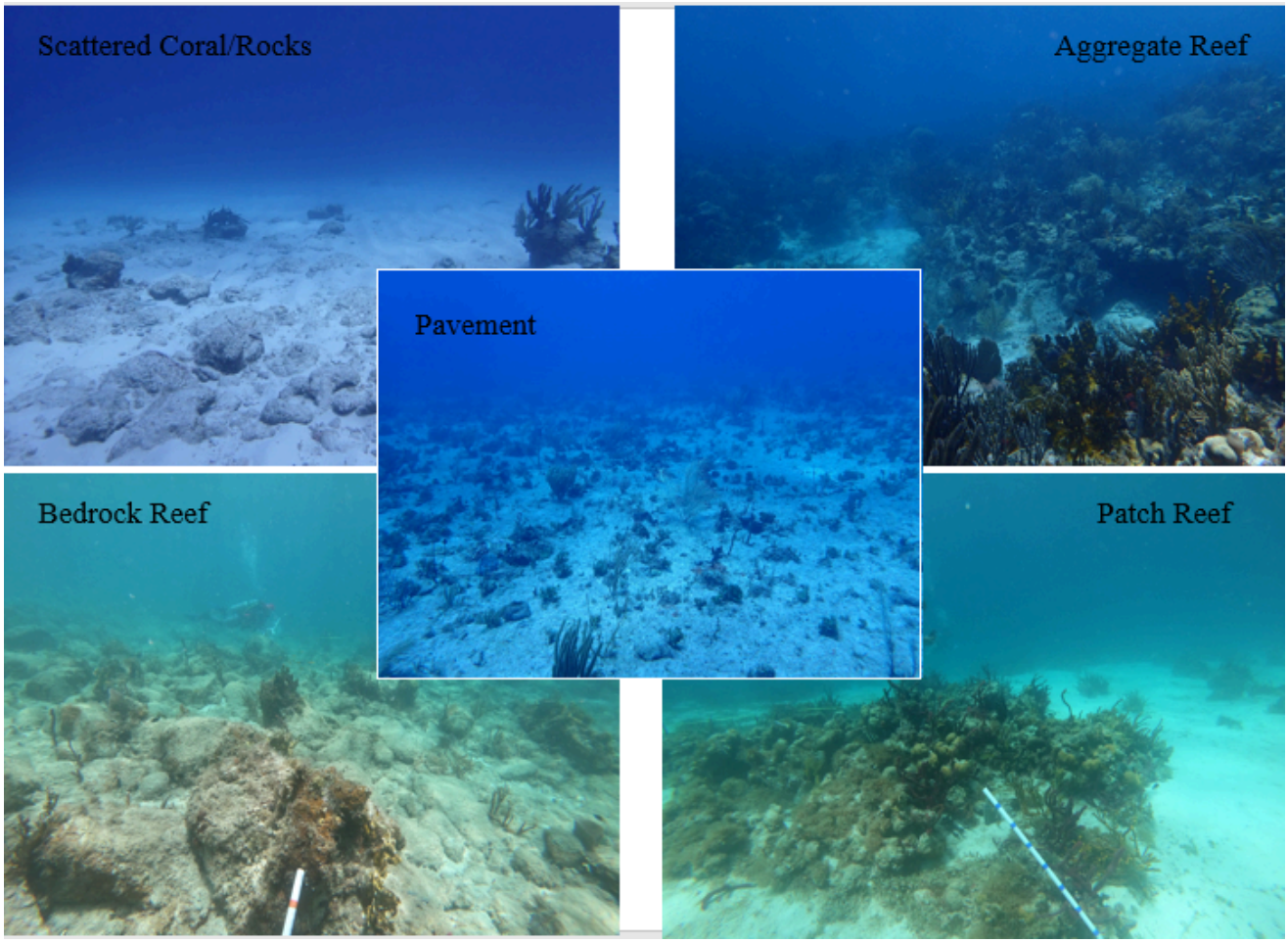


Figure A. NCRMP US Caribbean habitat type classifications

[1]Adapted from:
Kendall, M.S., C.R. Kruer, K.R. Buja, J.D. Christensen, M. Finkbeiner, R.A. Warner, and M.E. Monaco. 2001. Methods Used to Map the Benthic Habitats of Puerto Rico and the U.S. Virgin Islands. NOAA Technical Memorandum NOS NCCOS CCMA 152. Silver Spring, MD. 46 pp.

Flower Garden Banks

High relief: The coral reef zone that typically consists of rugose boulder or reef-building coral species.

Low relief: The coral reef zone that refers to the deeper (generally between 30-52 m), less rugose, and non-reef building species.

Florida Reef Tract[2]

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; e.g., patch reefs, rocky outcrops, pinnacles.

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

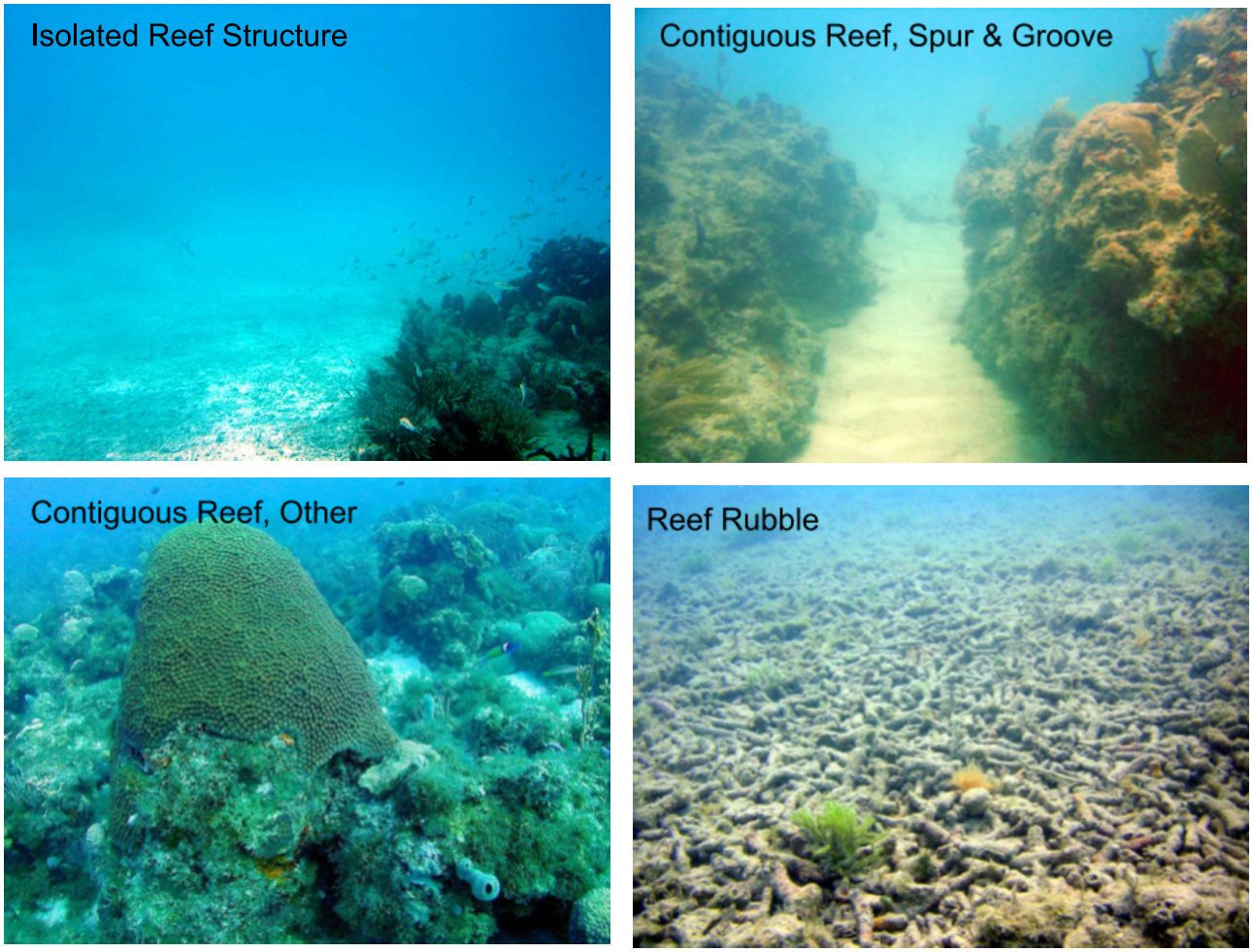


Figure B. NCRMP Florida habitat type classifications

**Matrix and Sand are considered legacy categories and will no longer be used.*

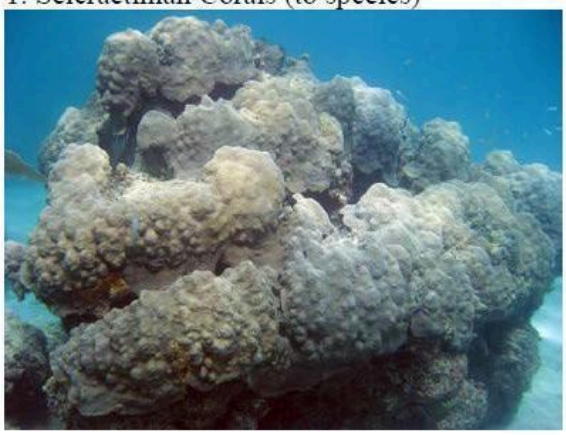
[2]Adapted from:
Brandt, M. E., N. Zurcher, A. Acosta, J. S. Ault, J. A. Bohnsack, M. W. Feeley, D. E. Harper, J. H. Hunt, T. Kellison, D. B. McClellan, M. E. Patterson, and S. G. Smith. 2009. A cooperative multi-agency reef fish monitoring protocol for the Florida Keys coral reef ecosystem. Natural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

Appendix V. NCRMP Benthic Community Assessment LPI survey: categories and definitions

1. Corals – scleractinian corals to species
2. Bare Substratum (hardbottom, rubble, or sand)
    a. Hardbottom = uncolonized, with or without dusting/ veneer of sand <2.5 cm (1 inch) deep
    b. Soft = bare sand, depth of ≥2.5 cm (1 inch)
    c. Rubble = uncolonized; >2.5 cm grain size (see Wentworth Scale), larger than sand, moveable, up to cobbles and boulders (25+ cm) that are moveable.
3. Turf Algae – visible algal tufts or filaments on the substratum
    a. No sediment – only algal filaments with no trapped sediment
    b. With sediment – algal filaments with trapped sediment that has a cushiony texture
4. Macroalgae
    a. *Dictyota* spp.
    b. *Halimeda* spp.
    c. *Lobophora* spp.
    d. Other fleshy, non-calcareous forms such as *Laurencia*, *Padina*, and *Sargassum*
    e. Other calcareous forms – e.g., *Penicillus* and *Udotea*, branching red algae such as *Galaxaura*, *Amphiroa*, and *Jania*
5. CCA – crustose coralline algae, exclusive of *Peyssonnellia* and *Ramicrusta* species
6. *Peyssonnelia* spp. – red alga
7. *Ramicrusta* spp. – encrusting red algae
8. Gorgonians
    a. Upright - basal attachment only. Do not record branch canopy cover.
    b. Encrusting – includes *Briareum asbestinum* and *Erythropodium caribaeorum*
9. Sponges
    a. *Cliona* spp. – In these geographic regions, the following species could be encountered: *aprica*, *caribbea*, *delitrix*, and *langae*
    b. Other – including and combining upright and encrusting morphotypes. Similar to branching gorgonians, branch sponge canopy cover is not recorded.
10. Cyanobacteria/Diatoms
11. *Millepora* spp. – milleporid hydrocorals
12. *Palythoa* spp. – colonial zoanthids, including both *P. caribeorum* and *P. mammilosa*
13. Seagrasses – all species combined
14. Other – include hydroids, anemones, corallimorpharians, zoanthids other than *Palythoa*, bryozoans, and tunicates

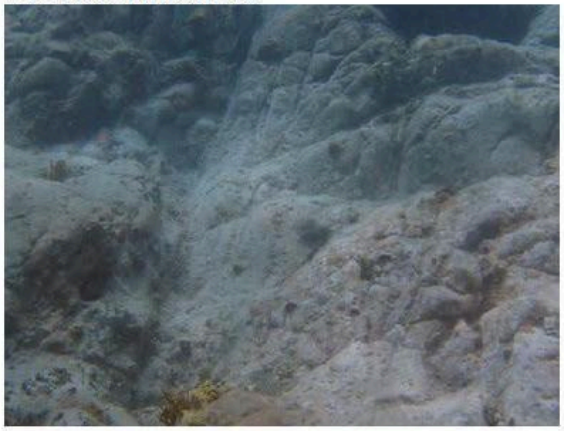
Appendix VI. Field Identification Definitions and Examples

1. Scleractinian Corals (to species)



2c. Bare Rubble

2a. Bare Hardbottom



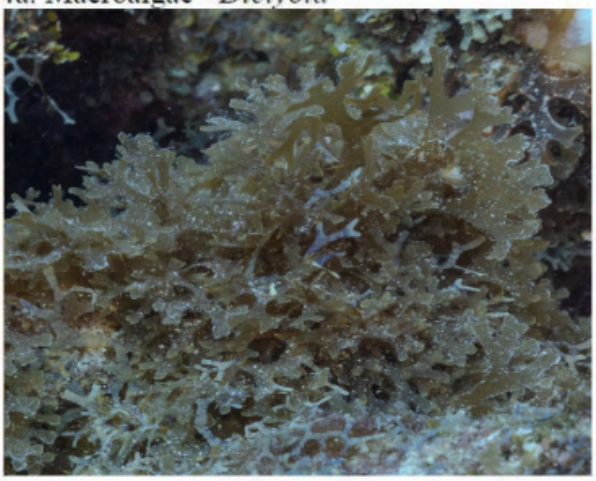
3a. Turf Algae (no sediment)

2b. Bare Soft (Uncolonized sand)

3b. Turf Algae with Sediment

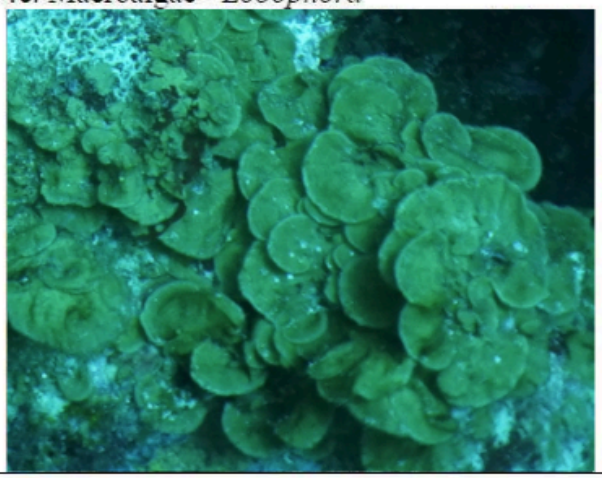
Appendix VI.
Continued

4a. Macroalgae - *Dictyota*



4b. Macroalgae - *Halimeda*

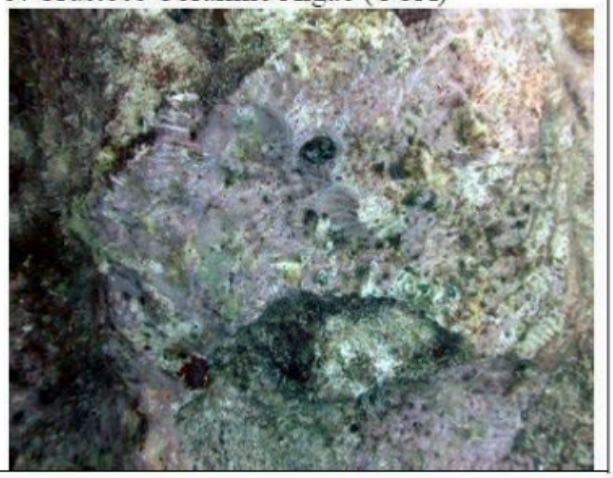
4c. Macroalgae - *Lobophora*



4d. Macroalgae – Other Non-calcareous

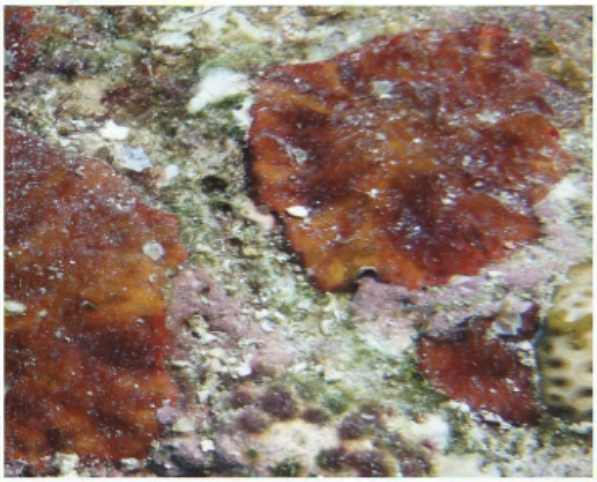
4e. Macroalgae – Other Calcareous

5. Crustose Coralline Algae (CCA)



Appendix VI.
Continued

6. *Peyssonnelia*



7. *Ramicrusta*

8a. Gorgonian - Upright

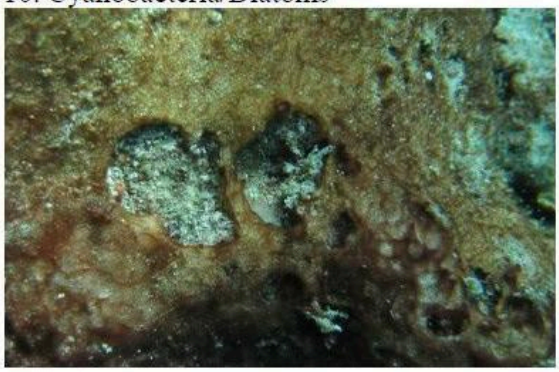
8b. Gorgonian - Encrusting

9a. Sponges – *Cliona* spp.

9b. Sponges - Other

Appendix VI.
Continued

10. Cyanobacteria/Diatoms



14. Other (anemones)

11. Milleporid Hydrocorals (*Millepora*)

14. Other (corallimorpharians)

12. Palythoa (colonial zoanthid)

14. Other (zoanthids)

13. Seagrass