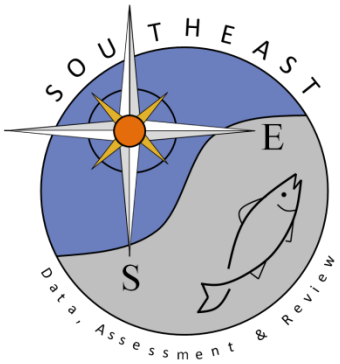
Line Point-Intercept (LPI) Survey Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary

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

SEDAR57-RD-01

May 2018



Line Point-Intercept (LPI) Survey Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary

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

Introduction

The National Coral Reef Monitoring Program (NCRMP) provides a biennial ecological characterization at a broad spatial scale of general reef condition for reef fishes, corals and benthic habitat (*i.e.*, fish species composition/density/size, benthic cover, and coral density/size/condition). Data collection occurs at stratified random sites where the sampling domain for each region (*e.g.*, Puerto Rico, U.S. Virgin Islands, Flower Garden Banks National Marine Sanctuary [FGBNMS]) is partitioned by habitat type and depth, sub-regional location (*e.g.*, along-shelf position) and management zone. NCRMP will provide broader geographic context to supplement local monitoring efforts and studies of tropical reef ecosystems.

Line point-intercept (LPI) sampling provides benthic cover estimates for ecologically important cover types/groups (*e.g.*, macroalgae, turf algae, crustose coralline algae, corals, sponges, sand/sediment, etc.). This method is complementary to the NCRMP coral demographics sampling method that collects detailed information on scleractinian corals, including density, size and condition (percent mortality and bleaching) measurements (Refer to *Coral Demographic Survey Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary*).

Goal of LPI Surveys

The goal of these surveys is to provide a quantification of percent cover of biotic and abiotic benthic components, using the LPI method in a stratified random sampling design in hardbottom and coral reef habitats in the U.S. Caribbean (U.S. Virgin Islands and Puerto Rico) and FGBNMS. Surveys are concurrent with and along the same transect as fish surveys (Appendix I; Refer to *Belt Transect Fish Survey Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary*).

General Task Description

There are two possible task allocation scenarios for LPI data collection:

1. <u>1 LPI diver:</u>
    - LPI diver collects LPI data and completes key species survey.
    - No demographic data are collected during this survey.

2. <u>1 LPI diver and 1 Coral Demographic diver:</u>
    - Upon completion of the LPI transect, the LPI diver coordinates with the Coral Demographic diver to assist with completing the demographic transect if bottom time and LPI diver benthic identification skills allow.

Line Point-Intercept (LPI) Transect Information

Establishing the transect
LPI surveys will be conducted at all fish survey sites (Appendix I).

1. The LPI diver (and Demographic diver, if present) will use the same transect as the fish diver (Appendix I).
    a. Benthic divers follow behind the Fish diver at a distance to avoid influencing swimming behavior of fishes (*i.e.*, the LPI diver starts when the Fish diver is near the 5m mark, or as visibility allows, then the Demographic diver starts).

    b. The Fish diver secures the start of transect tape and continues to keep the transect tape relatively taut throughout survey, using weights clipped to the transect tape.

    c. The Fish diver will avoid wrapping the tape around substrate or biotic object, as this will distort sampling distances and locations for the benthic diver.

    d. At Fish + LPI + Demographic sites, LPI diver may assist the Demographic diver to finish the coral demographic survey within depth/time limits of dive.
        i. If LPI diver assists Demographic diver in survey completion, LPI diver begins his/her demographic survey at the tenth meter of the survey and works until s/he finishes a complete meter and meets Demographic diver. LPI and Demographic divers will coordinate to avoid duplicating counts.

        ii. To ensure that all space is surveyed, there will be no surveys of partial meters.

2. The LPI diver collects the following information (Appendix II):
    a. *LPI data* – **100** points, at 20cm intervals, starting at the 20cm mark and ending at the 20m mark along the transect tape.

    b. *Macroinvertebrate counts* – Spiny lobster (*Panulirus argus*), queen conch (*Lobatus gigas*) and long-spined sea urchin (*Diadema antillarum*) are enumerated in the 25m x 2m area of the belt transect AFTER completing the LPI survey, concurrently with the presence/absence component when the LPI diver is swimming from meter marker 25 (*i.e.*, the end of the transect tape) to meter marker 0 (*i.e.*, the beginning of the transect tape).

    c. *Presence/absence Endangered Species Act (ESA)-listed corals* – The presence/absence of seven (7) ESA-listed scleractinian coral species in the 25m x 2m belt transect area are recorded AFTER completing the LPI survey and concurrently with the macro-invertebrate (*i.e.*, lobster, conch, urchin) counts when the LPI diver is swimming from meter marker 25 (*i.e.*, the end of the transect tape) to meter marker 0 (*i.e.*, the beginning of the transect tape).

    d. Underwater photographs of the general survey area, including the transect seascape, heading(s) recorded on the data sheet, as well as interesting features and species identification questions.

3. LPI transects start at 20cm from the beginning of the transect tape (0m mark) and continue to the 20m mark.
    a. 100 points (one point every 20cm) will be collected along the 20m section of the transect. No habitat will be skipped over (*i.e.*, data are collected in non-hardbottom habitats, such as sand).
    b. Note that the 20m LPI transect survey length is less than the 25m fish belt transect length (Appendix I).
    c. One hundred (100) data points for benthic cover will be collected along the 20m transect length, with data collected at 20cm intervals. The estimated average time for completion is 15-20 min (5-7 points scored per minute).
        i. The LPI diver will frequently check the number of marks while collecting data; for example, at every meter marker, there should be multiples of five points accounted for on the datasheet.

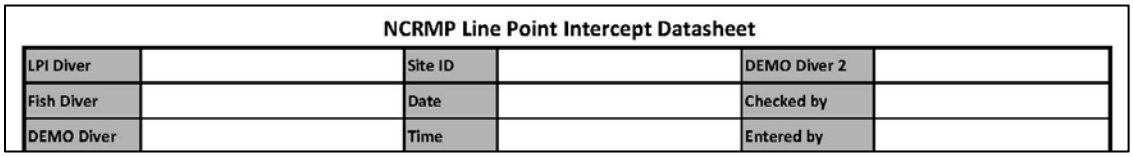
Field Equipment

- LPI and coral demographic datasheets, clipboard, pencil, spare pencil
- Instrument to aid in locating exact point under transect tape (*e.g.*, PVC stick, ruler)
- Slide marker to keep point location along transect (optional, *e.g.*, clothes pin)
- Camera (battery, housing)
- 50cm or 1m PVC stick or other rigid measuring device for key species surveys to accurately determine a 1m linear distance out from the transect tape AND demographic data collection (if assistance required).

Line Point-Intercept Survey Protocols

Data are collected on the following information:

1. *Logistic and station information* – Names of all divers, station, date, time of survey, diver checks and transect heading(s) (Figures 1 and 2, Appendix II). Fill in all categories legibly.
    a. The LPI diver must record the predetermined heading selected by the Fish diver prior to water entry. If an alternate heading is required, the LPI diver will note the new heading determined by the Fish diver and record the alternate heading on the LPI datasheet (Figure 2).



NCRMP Line Point Intercept Datasheet

LPI Diver		Site ID		DEMO Diver 2	
Fish Diver		Date		Checked by	
DEMO Diver		Time		Entered by	

Figure 1. NCRMP LPI datasheet header with logistic and station information.

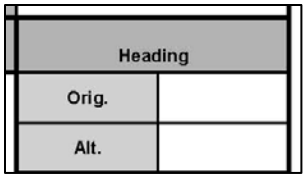


Figure 2. Chart to record Transect heading information obtained from the Fish diver's data sheet.

2. *Observed habitat type* – Identification of the habitat type observed at the diver scale (not mapped category, Figure 3). Circle selection.

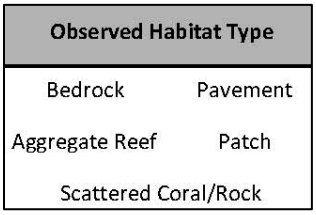


Figure 3. Hardbottom categories of observed habitat type on the LPI datasheet.

3. *Photographs* – The LPI diver photographs the general survey area while waiting for the fish surveyor to proceed down the transect (providing at least a 5m head-start). Photos will include the specific transect survey area for general site characterization. Additional photos may include divers conducting surveys, unique features, and for species identification purposes.

    a. Station Documentation: 6-7 photographs per station

        i. Take <u>one</u> 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 should be clear and legible in the photograph (Figures 1 and 2, Appendix II). **NOTE:** LPI diver is to wait until transect heading is established by the Fish diver before photo of datasheet is taken.

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

        iii. Take <u>one</u> photograph in the direction of the **ORIGINAL** transect heading.

        iv. In the event an alternate heading is used, take <u>one</u> photograph in the direction of the **ALTERNATE** transect heading, immediately after taking the photo of **ORIGINAL** transect heading. SEVEN photos will be taken for the stations that use an alternate heading.

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

    c. For the process for downloading and storing site photographs, refer to *Photo Documentation Manual*.

4. *Point identification* – At 20cm intervals along the transect tape, identify and categorize the substratum type according to protocol/available datasheet options (Figure 4, Appendix III). Identify each point for the substrate type and the biotic organism (if any).

    a. Abiotic/substratum categories include hard (*i.e.*, hardbottom or reef), soft (*i.e.*, sand or mud), and rubble (Figure 4, Appendix III).

    b. Biotic categories include coral to species, bare, algal turf, etc., as shown in Figure 3 and described in Appendix III. Appendix IV provides example photos of these categories.

        i. If a point falls on bare sand, one mark is recorded in the "Soft" column along the "Bare" row.

        ii. If a point falls on turf algae growing on hardbottom with no sand trapped in the turf filaments, one mark is recorded in the "Hardbottom" column along the "TURF-no sediment" row.

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

Categories: one tick every 20cm	Hardbottom	Soft	Rubble
Coral (to Species)			
Bare			
TURF-no sediment			
TURF w/sediment			
MACRO-*Dictyota*			
MACRO-*Halimeda*			
MACRO-*Lobophora*			
MACRO-other fleshy			
MACRO-other calcareous			
CCA			
Peyssonnelia			
GORG upright			
GORG encrusting			
SPONGE other			
SPONGE *Cliona* spp			
CYANOBACT/DIATOM			
Millepora			
PALYTHOA			
SEAGRASS			
Other			

Figure 4. Abiotic and biotic section of LPI datasheet.

5. *Recording the Point* – Record the first abiotic/biotic bottom type encountered.

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

    b. Point intercepts with the canopy cover of soft branching organisms, (*e.g*., a 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 not scored unless the point intercepts a holdfast/attachment point.

        i. Example: *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*.

        ii. 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*.

6. *Macroinvertebrate count*s – All Caribbean spiny lobster (*P. argus*), queen conch (*L. gigas*), and long-spined sea urchins (*D. antillarum*) are counted within the 25m x 2m belt transect (Figure 5).

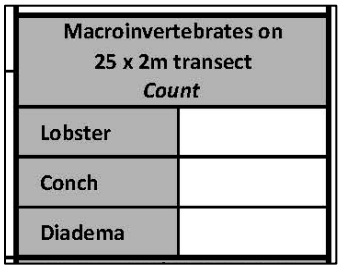


Figure 5. Macroinvertebrate section on LPI datasheet.

a. This survey area lies within the 25m x 4m fish belt transect area and is defined as the full length of the transect (*i.e.*, 25m length) with a width of one meter on each side of the transect tape (Appendix I). This is also the same transect area that is surveyed for the ESA-listed coral species presence-absence.

b. A 25m x 2m belt transect area provides density estimates of numbers of organisms of each species per $50m^2$, while ensuring that all area is thoroughly surveyed.

c. If no search occurs, denote this with a large "X" through the entire Count column. If some portion of this survey does not occur, denote this with a large "X" through the portion that does not occur. ***This is critical to record at those sites where, due to logistics, the macro-invertebrate counts could not be completed, which is entirely different from a survey where no organisms were encountered within the 25m x 2m survey area.***

7. *ESA-listed coral species presence-absence* – Presence-absence within the 25m x 2m belt transect of all seven (7) Atlantic/Caribbean coral species listed on the ESA will be recorded at each site (Figure 6).

Presence(1)/Absence(0) on 25 x 2m transect	
A. palmata	
A. cervicornis	
D. cylindrus	
M. ferox	
O. annularis	
O. faveolata	
O. franksi	

Figure 6. LPI datasheet section with ESA-listed coral species.

a. This transect lies within the 25m x 4m fish belt transect and is defined as the full length of the transect (*i.e.*, 25m length) with a width of one meter on each side of the transect tape (Appendix I).

   i. This is the same belt transect area that is surveyed for the macroinvertebrate counts as described above.

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

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

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

c. Photograph any colonies that are of uncertain identity and verify.

d. 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. ***This is critical to record at those sites where, due to logistics, the ESA- listed coral presence-absence surveys could not be completed, which is entirely different from a survey where species were absent (not encountered) within the 25m x 2m survey area.***

Assisting with the Demographics Surveys

If both LPI and Demographic surveys are conducted concurrently at a site, LPI diver will bring a Demographic datasheet to facilitate assisting Demographic diver in data collection.

1. When the LPI diver assists the Demographic diver in the demographic survey, LPI diver starts her/his demographic survey at the tenth meter and works toward the Demographic diver.

2. LPI and Demographic divers will coordinate to avoid duplicating counts, and will meet at a full meter.

3. To ensure that all space is surveyed, there will be no surveys of partial meters.

4. LPI divers will be familiar with Coral Demographics Survey Protocol (Refer to *Coral Demographic Survey Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary*).

Data sheet review

At end of survey, when divers are on boat, the dive team exchanges datasheets for review by checking for completeness and legibility. A diver cannot review his/her own datasheet. After the datasheet has been reviewed, the reviewer initials the "checked by diver" box (Figure 1).

1. *Fish datasheet* – Review includes, at a minimum, verifying the following:
    a. Completeness and legibility of all logistics information; including random heading(s) and the reason for a change in random heading, if applicable.

    b. Completeness and legibility of all species codes, bin size class marks and size numbers (for select species and individuals >35cm)

    c. Completeness and legibility of all Topographic Complexity records.
        i. Stratum slope – Minimum and maximum depth (recorded in ft).

        ii. Maximum vertical relief (recorded in cm)

        iii. Surface area topography – 24 total tick marks.

2. *LPI datasheet* – Review includes, at a minimum, verifying the following:

    a. Completeness and legibility of all logistics information.

    b. Confirmation of correct observed habitat type with dive team and is circled.

    c. Completeness and legibility of macroinvertebrate records. NOTE: All boxes are to be filled out. If this component was not conducted, "X" through section is required.

    d. Completeness and legibility of ESA-listed coral records. NOTE: All boxes are to be filled out. If this component was not conducted, "X" through section is required.

2. *Coral Demographic datasheet* – Review includes, at a minimum, verifying the following:

    a. Completeness and legibility of all logistics information; including identification of second Demographic surveyor (if applicable).

    b. Completeness and legibility of transect start and end locations (integer)

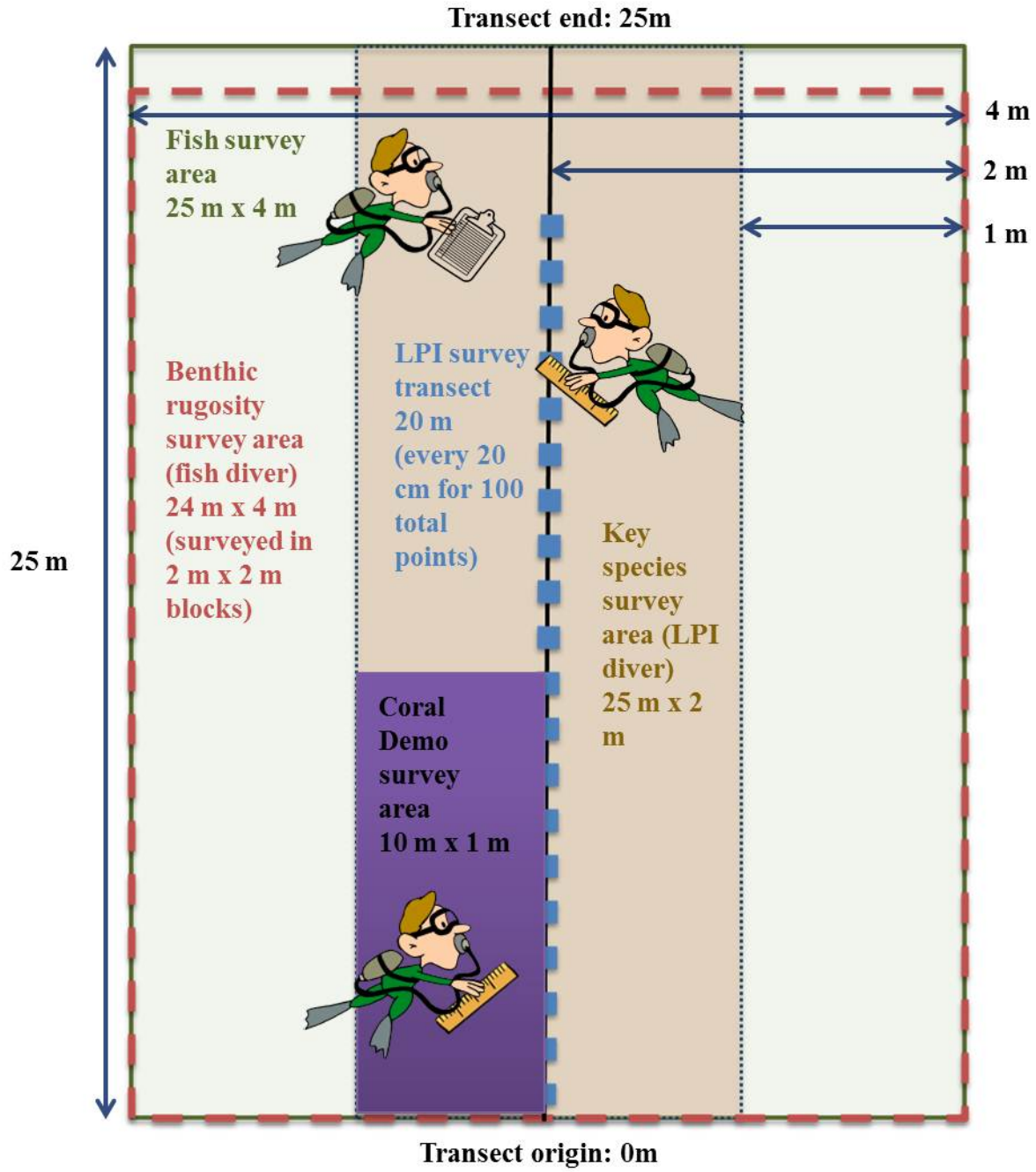
    c. Completeness and legibility of percent hardbottom of survey component.

    d. Annotation in "Notes" section reporting the presence of multiple datasheets utilized for data collection (if applicable).

Appendix I.

Diagram of all surveys

Diagram of all surveys indicating size of each respective survey area. Fish, LPI, and Coral Demographics will be surveyed as the divers move out away from the transect origin. Other invertebrates (*e.g.*, spiny lobster, queen conch, long-spined sea urchins) and topographic complexity will be surveyed as the divers return to the transect origin.



Appendix II.

Template of datasheet used for Line Point-Intercept Protocol.

NCRMP Line Point Intercept Datasheet

LPI Diver		Site ID		DEMO Diver 2	
Fish Diver		Date		Checked by	
DEMO Diver		Time		Entered by	

Categories: one tick every 20cm	Hardbottom	Soft	Rubble	Heading	
Coral (to Species)				Orig.	
				Alt.	
				Observed Habitat Type	
				Bedrock Pavement	
Bare				Aggregate Reef Patch	
				Scattered Coral/Rock	
				Macroinvertebrates on 25 x 2m transect *Count*	
TURF-no sediment				Lobster	
TURF w/sediment				Conch	
MACRO-*Dictyota*				Diadema	
MACRO-*Halimeda*				Presence(1)/Absence(0) on 25 x 2m transect	
MACRO-*Lobophora*				A. palmata	
MACRO-other fleshy				A. cervicornis	
MACRO-other calcareous				D. cylindrus	
CCA				M. ferox	
Peyssonnelia				O. annularis	
GORG upright				O. faveolata	
GORG encrusting				O. franksi	
SPONGE other					
SPONGE *Cliona* spp					
CYANOBACT/DIATOM					
Millepora					
PALYTHOA					
SEAGRASS					
Other					

NOTES

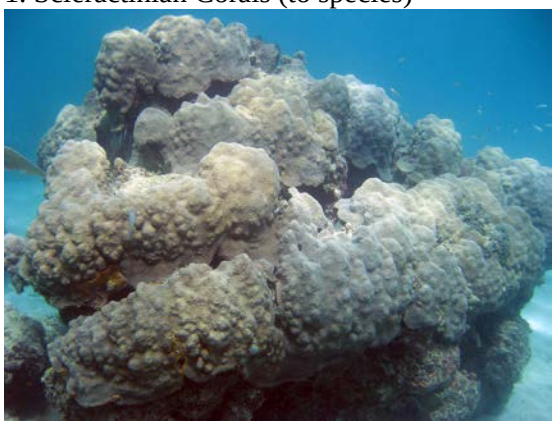
Appendix III.

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 <2.5cm (1 inch) deep
    b. Soft = bare sand, depth of ≥2.5cm (1 inch)
    c. Rubble = uncolonized; >2.5cm 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*
    b. *Halimeda*
    c. *Lobophora*
    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* species
6. *Peyssonnellia*
7. Gorgonians
    a. Upright - basal attachment only. Do not record branch canopy cover.
    b. Encrusting – includes *Briareum asbestinum* and *Erythropodium caribaeorum*
8. Sponges
    a. *Cliona* spp. - In the Atlantic, 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.
9. Cyanobacteria/Diatoms
10. *Millepora* – milleporid hydrocorals
11. Palythoa – colonial zoanthids, including both *P. caribeorum* and *P. mammilosa*
12. Seagrasses – all species combined
13. Other – include hydroids, anemones, corallimorpharians, zoanthids other than *Palythoa*, bryozoans, and tunicates

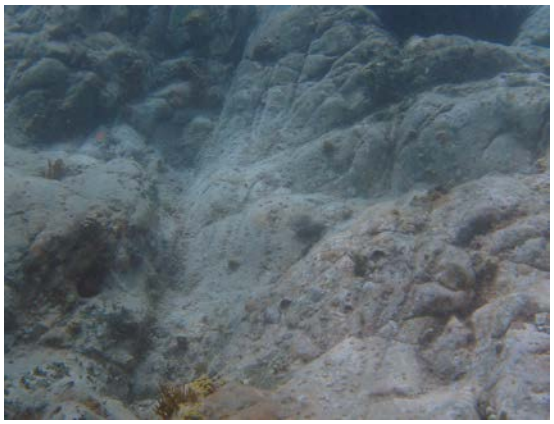
Appendix IV. Examples of benthic categories for LPI surveys.

1. Scleractinian Corals (to species)

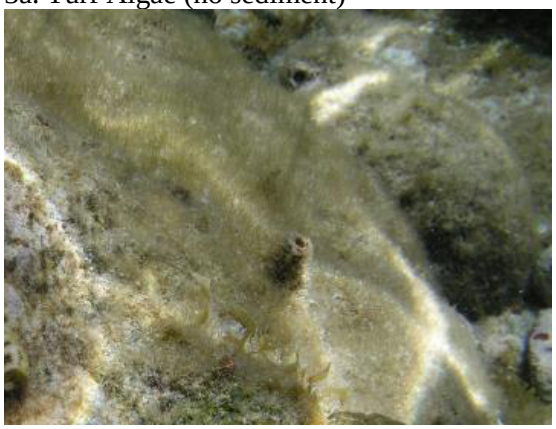


2c. Bare Rubble

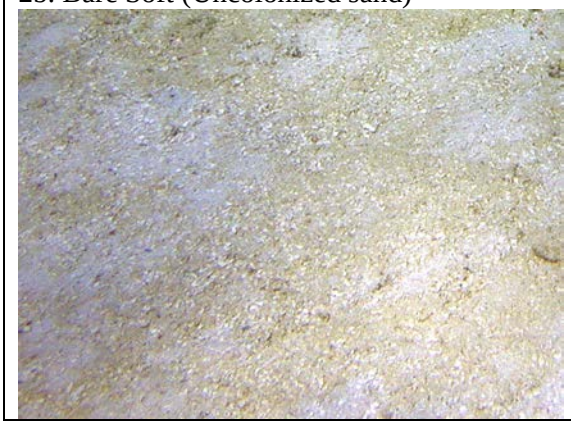
2a. Bare Hardbottom



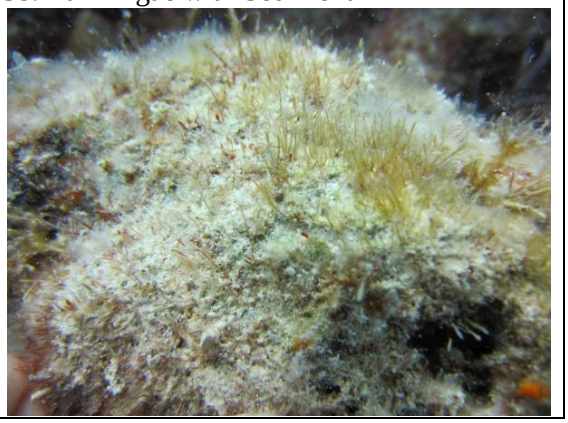
3a. Turf Algae (no sediment)



2b. Bare Soft (Uncolonized sand)

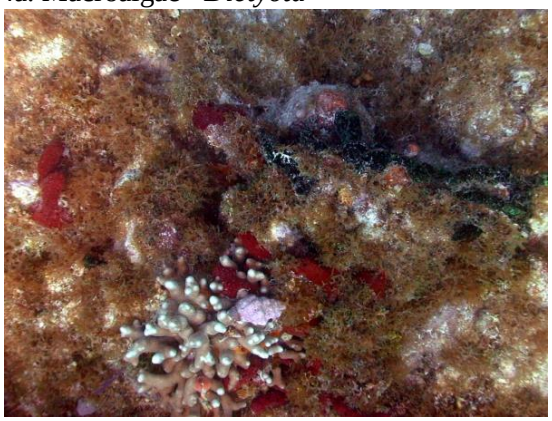


3b. Turf Algae with Sediment



Appendix IV. continued

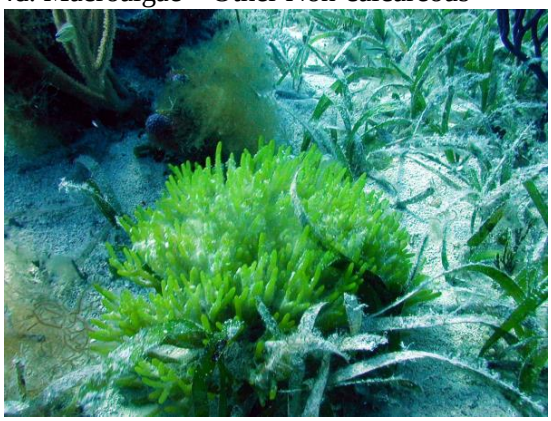
4a. Macroalgae - *Dictyota*



4b. Macroalgae - *Halimeda*

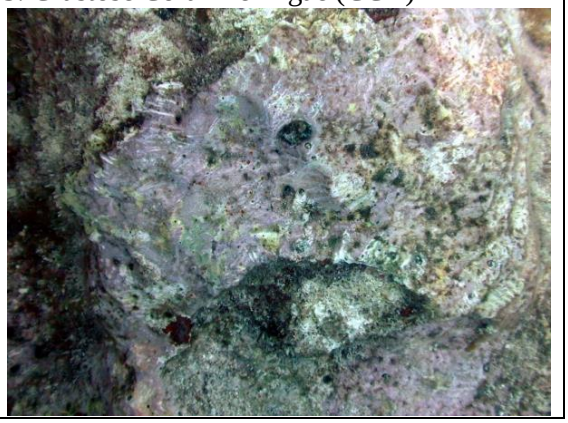
4c. Macroalgae - *Lobophora*

4d. Macroalgae – Other Non-calcareous



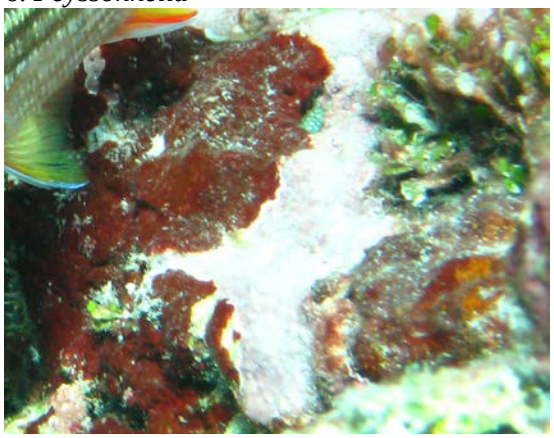
4e. Macroalgae – Other Calcareous

5. Crustose Coralline Algae (CCA)



Appendix IV. continued

6. *Peyssonnelia*



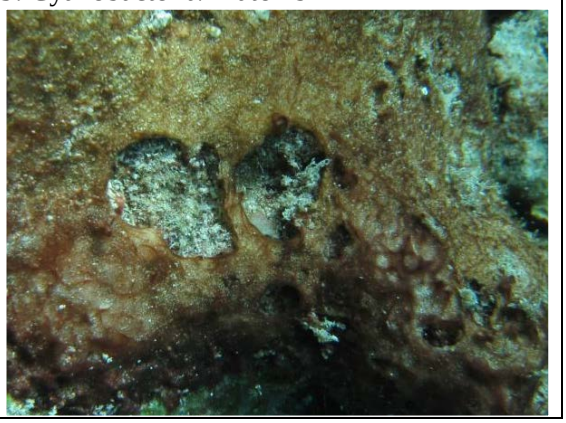
8a. Sponges – *Cliona* spp.

7a. Gorgonian - Upright

8b. Sponges - Other

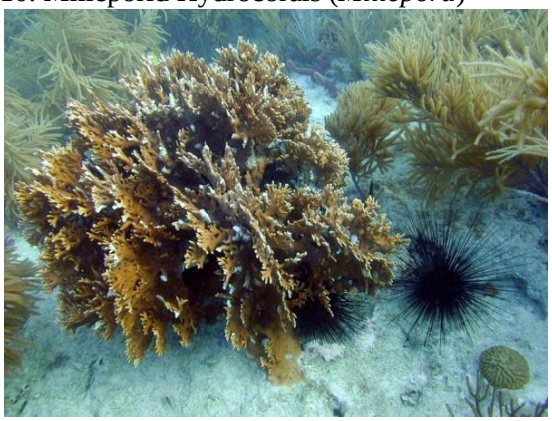
7b. Gorgonian - Encrusting

9. Cyanobacteria/Diatoms



Appendix IV. continued

10. Milleporid Hydrocorals (*Millepora*)



11. Palythoa (colonial zoanthid)

12. Seagrass

13. Other (anemones)

13. Other (corallimorpharians)

13. Other (zoanthids)