

# **Line Point-Intercept (LPI) Survey Protocol for the Atlantic, U.S. Caribbean and Gulf of Mexico: 2016**

National Coral Reef Monitoring Program (NCRMP)

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

## **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.*, Florida, 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 Atlantic, U.S. Caribbean and Gulf of Mexico: 2016*).

The 2016 LPI protocols have substantial differences than previous versions (years) as a result of NCRMP standardization throughout the project's regions (*e.g.* Florida and Pacific regions). Specific differences in methodologies between regions, where applicable, are noted within the protocols.

## **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 Florida, U.S. Caribbean (U.S. Virgin Islands and Puerto Rico) and FGBNMS. Surveys are concurrent with and along the same transect Coral Demographic surveys (Appendix I; Refer to *Coral Demographic Survey Protocol for the Atlantic, U.S. Caribbean and Gulf of Mexico: 2016*).

LPI and Coral Demographic surveys may be completed on the same dive as fish surveys (Appendix I, Figure A). If the surveys are implemented simultaneously then the benthic team should set up the transect on the appropriate habitat with the least amount of interference with the fish surveys. If the benthic survey is implemented without a fish team, then the transect can be established on the appropriate habitat.

## General Task Description

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

1. LPI data collection only:
  - LPI diver collects LPI data and completes key species and topographic surveys.
2. LPI data collection and Coral Demographic assistance:
  - Upon completion of the LPI data collection, the LPI diver coordinates with the Coral Demographic diver to assist with completing the demographic survey if bottom time and LPI diver benthic identification skills allow.

## General Site Information

### *Navigating to site*

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

1. Each boat will have up to three GPS units, if collecting fish and benthic data simultaneously, otherwise only 1 dive flag/float with GPS required for 1 team:
  - a. One for navigation to sites, and
  - b. One GPS unit attached to dive flag/float carried by each team deployed, uniquely identified for each team, benthic and/or fish.
    - i. Each dive team will have dive flag/float and GPS. Record each team's unique GPS # and dive flag numbers on the daily boat log (Figure 1; Appendix II).
2. Dive teams enter the water at selected GPS coordinates, descend to bottom, affix the surface float line to the bottom, set up survey areas and begin data collection.
3. As the dive team(s) deploy from the vessel, the boat captain will use the navigational GPS to take a waypoint of the surface float/flag(s) and record the coordinates on the boat log (Appendix II).

**\*\*Boat driver should take extreme care to avoid divers in the water.\*\***

### *Recording the station information*

Station information is to be recorded in two primary locations prior to entering the water: (1) *Boat/Dive log* and (2) *datasheet* (Figure 1 and Figure 3; Appendix II and III). The log and data sheet are to have the same information recorded on both.

Key fields to record for station information include:

1. *Site* – The 4-digit station number.

2. *Station* – The location of each “team” of replicate fish divers at the station. Always a “1” as replication is not conducted at each site.
3. *Team (Team member assignment)* – Letter code identifying the type of data is being collected by the diver within their dive group.
  - a. Fish (A/B) – A two-diver fish team consists of a Diver A and Diver B.
  - b. Benthic (J/X) – The diver collecting LPI data is assigned the code ‘J’; divers collecting Demographic data is assigned ‘X’.

\*\* Codes are assigned to diver positions within the team and type of data collected; therefore, diver team codes will change by station.

Example: Figure 1 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 Edwards and Viehman, identified by the J/X codes used. For the first dive, Edwards is identified as team member J (LPI diver) and Viehman is X (Demo diver). Notice for the second dive of the day, Viehman is assigned diver J for the benthic team.

Date	DOD	Site	Station	Team	Diver	O2%	PSI IN	TIME IN	Flag #
4/12/16	1	1200	1	A	Clark				1
	1	1200	1	B	Blondeau				1
	1	1200	1	J	Edwards				2
	1	1200	1	X	Viehman				2
4/12/16	2	1026	1	A	Nemeth				1
	2	1026	1	B	Clark				1
	2	1026	1	J	Viehman				2
	2	1026	1	X	Blondeau				2

**Figure 1.** Example of boat log with specific station information filled out. DOD = Dive of the day.

### *Evaluating the site*

1. As the team descends and assesses the site, the benthic team ascertains the presence of hardbottom and observed habitat type at the site.
  - a. Hardbottom presence/absence
    - i. Absent – If hardbottom is absent from the site (*i.e.*, continuous sand or seagrass combined with limited visibility),
      1. Then the dive will be terminated and an alternate selected,
      2. **Do not swim around looking for hardbottom.**
    - ii. Present – If hardbottom is present, continue habitat type assessment

- b. Observed habitat type – If the team(s) deploy over hardbottom they are to establish the transect where deployed.
  - i. If necessary, during descent, divers will swim to appropriate habitat
    1. If divers enter the water over sand, they will swim to nearby reef habitat for sampling.
    2. If divers enter the water over hardbottom different from that expected **and** observe expected habitat type nearby, they will swim to habitat for sampling.
  - ii. If divers enter the water over hardbottom different from that expected and **do not** observe expected habitat type nearby, they will establish the transect where deployed and indicate the habitat type on the datasheet and boat log.
2. **Terminating the dive** – surveys should be terminated and alternates chosen under the following conditions:
  - a. **Visibility is less than 2 m**, the dive should be terminated and an alternate selected.
  - b. **Bottom currents are strong enough that the divers cannot maintain a stationary position**, the dive should be terminated and an alternate selected.
  - c. **Depth of the selected site is greater than 99 ft**, the team should terminate the dive and choose an alternate.

Reasons to terminate a dive:

- Visibility (> 2m)
- Strong currents
- Depth (> 99ft)

## Line Point-Intercept (LPI) Transect Information

LPI surveys will be conducted at a subset of fish survey sites.

### *Establishing transect*

1. Fish team present
  - a. If hardbottom is present, benthic team will establish the transect as close to the fish team as possible without overlap or interference of the fish cylinder(s) (Appendix I: Figure A).
  - b. Benthic team will tie off surface float and transect tape. The LPI 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 (Figure 2).
  - c. The LPI diver will avoid wrapping the tape around substrate or biotic object, as this will distort sampling distances and locations for the benthic divers.
  - d. The end of the tape should be tied or clipped so that the transect tape is as tight as possible.

- e. If current is present at depth, transect tape may be aligned to face the current. If currents are too strong, survey should be terminated.
- f. If site is pavement or scattered coral in sand, soft weights may be used to weight the transect tape at the beginning and end to keep transect in place.



**Figure 2.** Example of weight attached to transect tape.

## 2. Fish team absent

- a. If hardbottom is present, benthic team will tie off surface float and transect tape. The LPI diver secures the start of transect tape and continues to keep the tape relatively taut throughout survey, using weights clipped to the tape (Figure 2).
  - b. The LPI diver will avoid wrapping the tape around substrate or biotic object, as this will distort sampling distances and locations for the benthic divers.
  - c. The end of the tape should be tied or clipped so that the transect tape is as tight as possible.
  - d. If current is present at depth, transect tape may be aligned to face the current. If currents are too strong, survey should be terminated.
  - e. If site is pavement or scattered coral in sand soft, weights may be used to weight the transect tape at the beginning and end to keep the transect in place.
3. Method type – Indicate whether the benthic survey was conducted with fish team present (combined) or absent (separate) in the **notes section of the datasheet** (Appendix III). Circle selection.

## *Data collection*

- 1. The LPI diver collects the following information (Appendix III):
  - a. *LPI data* – **100** points, at 15cm intervals, starting at the 15cm mark and ending at the 15 m mark along the transect tape.
    - i. 100 points (one point every 15cm) will be collected along the 15m section of the transect. No habitat will be skipped over (i.e., data are collected in non-hardbottom habitats, such as sand).

- ii. The estimated average time for completion is 15-20 min (5-7 points scored per minute).
  - b. *Topographic complexity data* – The LPI diver will also collect topographic relief information (Appendix III; Refer to *Topographic Complexity Survey Protocol for the Atlantic, U.S. Caribbean and Gulf of Mexico: 2016*).
    - i. Timing for topography measurements is generally 1-2 minutes.
  - c. *Macroinvertebrate counts* – Spiny lobster (*Panulirus argus*), queen conch (*Lobatus gigas*) and long-spined sea urchin (*Diadema antillarum*) are enumerated in the 15m x 2m area of the belt transect AFTER completing the LPI survey.
    - i. This survey area lies within the 15m x 2m transect area and is defined as the full length of the transect (*i.e.*, 15m length) with a width of one meter on each side of the transect tape (Appendix I: Figure B). This is also the same transect area that is surveyed for the ESA-listed coral species presence-absence.
  - d. *Presence/absence Endangered Species Act (ESA)-listed corals* – The presence/absence of seven (7) ESA-listed scleractinian coral species in the 15m x 2m transect area are recorded AFTER completing the LPI survey.
    - i. Macroinvertebrate count and ESA coral surveys can be conducted in the same transect pass. Timing is generally 3-4 minutes.
  - e. *Site Photographs (when fish diver(s) absent)* – Underwater photographs of the survey datasheet, general survey area, including the transect seascape, as well as interesting features and species identification questions are taken.
2. The LPI diver may assist the Demographic diver to finish the coral demographic survey within depth/time limits of dive.
- i. LPI diver should bring a Demographic data sheet
  - ii. If LPI diver assists Demographic diver, LPI diver begins his/her demographic survey at the tenth meter of the survey and works until s/he meets Demographic diver. LPI and Demographic divers will coordinate to avoid duplicating counts upon convergence.

## 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)
- Camera (battery, housing)
- 50cm or 1m PVC stick or other rigid measuring device for rugosity, topography/relief and 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, Field ID, date, time of survey, mission data manager and meters completed (Figure 3; Appendix III). Fill in all categories legibly.
  - a. **Field ID** – The **Field ID** is a unique alpha-numeric number the diver is to record on the datasheet at each station.

$$\text{FIELD ID} = (\text{SITE \#}) + (\text{STATION \#}) + (\text{TEAM letter})$$

Example for Caribbean (Figure 3): Diver Edwards recorded the **Field ID** 12001J. According to the boat/dive log (Figure 1): Edwards is diver J for site 1200, Station numbers will be 1 for all LPI surveys in the Caribbean, Florida and Gulf of Mexico.

Diver: <u>Edwards</u>	Boatlog/Manger: <u>Hile</u>		
Buddy: <u>Viehman</u>	Field ID: <u>12001J</u>	Date: <u>1/12/2016</u>	Sample Time: <u>1100</u>
Habitat: <u>Bedrock</u> <u>Pavement</u> <u>Agg. Reef</u> <u>Patch Reef</u> <u>Scat. Coral/Rock in Sand</u>			Meters Complete: _____ m

**Figure 3.** NCRMP LPI datasheet header with logistic and station information.

2. *Observed habitat type* – Identification of the habitat type observed at the diver scale (not mapped category, Figure 5). Circle selection. NOTE: Habitat types across jurisdictions are different (Table 1).

**Table 1.** Habiata type differences across jurisdictions.

Florida	Caribbean	GOM/FGBNMS
Contiguous spur and groove	Bedrock	High relief coral reef
Contiguous other	Pavement	Low relief
Isolated	Patchreef	
Rubble	Aggregate reef	
Matrix	Scattered coral and rock in sand	
Sand		





3. *Topographic complexity* – Measurements of slope, vertical relief and surface area topography are collected on the way back to transect tape beginning (Refer to *Topographic Complexity Survey Protocol for the Atlantic, U.S. Caribbean and Gulf of Mexico: 2016*).
- a. Data are recorded in the “Rugosity” and “Relief” section of the datasheet (Figure 4; Appendix III)

Rugosity	
15x2m	
Min depth (ft)	
Max depth (ft)	
Max vert ht (cm)	
Relief	
15x2m (bin by 1x2 m; 15 total ticks)	
0 - 19 cm	
20 - 49 cm	
50 - 99 cm	
100 - 149 cm	
150 - 199 cm	
≥ 200 cm	

**Figure 4.** Location of topographic complexity section on LPI datasheet.

4. *Point identification* – At 15cm intervals along the transect tape, identify and categorize the substratum type according to protocol/available datasheet options (Figure 5, Appendix III). Identify the biotic organism (if any) each point for the substrate type (if any) and record on appropriate 15cm interval.

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

**Figure 5.** Point identification and point recording location on LPI datasheet.

- a. Abiotic/substratum categories include hard (*i.e.*, hardbottom or reef), soft (*i.e.*, sand or mud), and rubble (Figure 7; Appendix IV).

- b. Biotic categories include coral to species, bare, algal turf, etc., as described in Appendix IV. Appendix V provides example photos of these categories.
      - i. If a point falls on bare sand, the diver notes “Bare” in cover column and “S” in the habitat column (Figure 5).
      - 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” record in the cover column.
    - c. **Meters completed** – Note the meter of completion on the datasheet determined by the data entered in the 15cm-interval boxes (Figure 3).
  - 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).
  - Biotic category options (with the exception of corals) are provided on the datasheet (Appendix III) to assist in point identification.
3. *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*.
4. *Macroinvertebrate counts* – All Caribbean spiny lobster (*P. argus*), queen conch (*L. gigas*), and long-spined sea urchins (*D. antillarum*) are counted within the 15m x 2m belt transect (Figure 6; Appendix I: Figure B).
  - a. Survey area lies within the 15m x 2m transect (Appendix I: Figure B). This is also the same transect area surveyed for ESA-listed coral species presence-absence.
  - b. A 15 m x 2 m transect area provides density estimates of numbers of organisms of each species per 30 m<sup>2</sup>, 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 macroinvertebrate counts could not be completed, which is entirely different from a survey where no organisms were encountered within the 15m x 2m survey area.***

Macroinverts count	
15x2m	
<i>P. argus</i>	
<i>S. gigas</i>	
<i>D. antillarum</i>	

**Figure 6.** Macroinvertebrate section on LPI datasheet.

5. *ESA-listed coral species presence-absence* – Presence-absence within the 15m x 2m belt transect of all seven (7) Atlantic/Caribbean coral species listed on the ESA will be recorded at each site (Figure 7).
  - a. This survey area lies within the 15m x 2m transect (Appendix I: Figure B). This is also the same transect area that is surveyed for the macroinvertebrate counts.
  - 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 15m x 2m survey area.*

Precense(1)/Absence(0)	
15x2m	
<i>A. palmata</i>	
<i>A. cervicornis</i>	
<i>D. cylindrus</i>	
<i>M. ferox</i>	
<i>O. annularis</i>	
<i>O. franksi</i>	
<i>O. faveolata</i>	

**Figure 7.** ESA coral section on LPI datasheet.

## Assisting with the Demographics Surveys

The LPI diver will **always** 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. LPI divers will be familiar with Coral Demographics Survey Protocol (Refer to *Coral Demographic Survey Protocol for the Atlantic, U.S. Caribbean and Gulf of Mexico: 2016*).

## 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.

1. *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 it 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.

Categories Data Entry Counts							
Corals (sp)	H	S	R		H	S	R
				Bare			
				Turf w sed			
				Turf no sed			
				Dict			
				Hali			
				Lobophora			
				Macro - fleshy			
				Macro - calc			
				CCA			
				Peysonnellia			
				Gorg - upright			
				Gorg - encrust			
				Sponge - other			
				Sponge - Clionna			
				Cyano/Diatom			
				Millepora			
				Palythoa			
				Seagrass			
				Other			

- e. 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 – 15 total tick marks.
  
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 total meters completed.
  - 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).

**Figure 8.** Binned section of LPI 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.*

### **Datasheet preparation for data entry**

Prior to data entry, recorded points on the datasheet **MUST** be tallied and binned by biota and substrate type as indicated on the LPI datasheet and noted in the designated area on the LPI datasheet (Figure 8).

1. Tallied values are required for data entry into online database.
2. Divers are to **verify total number of points** in “binned” section of datasheet so that the **total equals** the number of points recorded on the datasheets.

## Appendix I. Illustrations of survey placement and survey areas

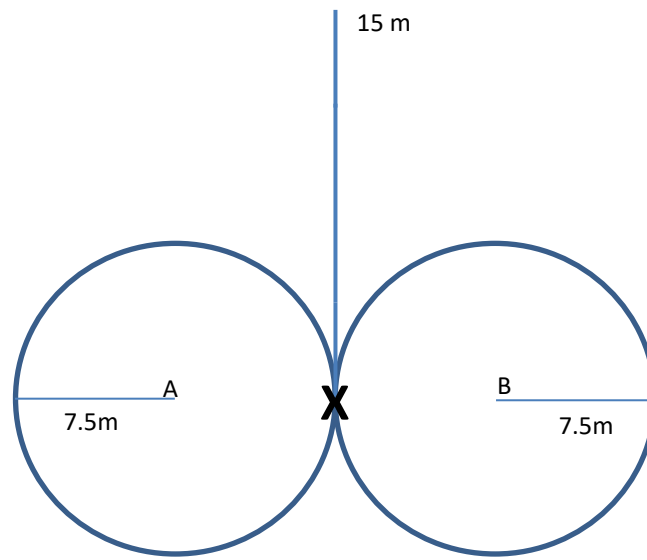


Figure A. Suggested placement of survey areas if continuous hardbottom. A and B represent two fish divers.

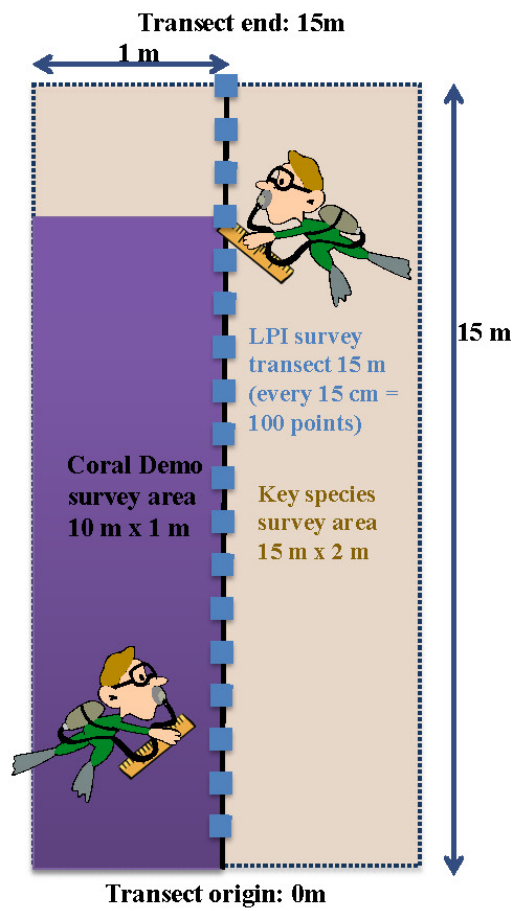


Figure B. Diagram of benthic surveys indicating size of each respective survey area.





# Appendix III. Line Point-Intercept Datasheet

## 1. Example of Florida datasheet

NCRMP Line Point Intercept Datasheet									
Diver: _____		Boatlog/Manger: _____							
Buddy: _____		Field ID: _____		Date: _____		Sample Time: _____			
Habitat: _____		Contiguous S&G		Contiguous Other		Isolated		Rubble (Matrix) (Sand)	
Meters Complete: _____ m									
Record biotic and abiotic code every 15cm						Habitat code: H - Hardbottom S - Soft R - Rubble		Rugosity	
Meter	Cover	Hab	Meter	Cover	Hab	Meter	Cover	Hab	15x2m
0.15			5.70			11.25			Min depth (ft)
0.30			5.85			11.40			Max depth (ft)
0.45			6m			11.55			Max vert ht (cm)
0.60			6.15			11.70			Relief
0.75			6.30			11.85			15x2m (bin by 1x2 m; 15 total ticks)
0.90			6.45			12m			0 - 19 cm
1.05m			6.60			12.15			20 - 49 cm
1.20			6.75			12.30			50 - 99 cm
1.35			6.90			12.45			100 - 149 cm
1.50			7.05			12.60			150 - 199 cm
1.65			7.20			12.75			≥ 200 cm
1.80			7.35			12.90			Macroinverts count
1.95			7.50			13.05m			15x2m
2.1m			7.65			13.20			<i>P. argus</i>
2.25			7.80			13.35			<i>S. gigas</i>
2.40			7.95			13.50			<i>D. antillarum</i>
2.55			8.1m			13.65			Presence(1)/Absence(0)
2.70			8.25			13.80			15x2m
2.85			8.40			13.95			<i>A. cervicornis</i>
3.0m			8.55			14.1m			<i>A. palmata</i>
3.15			8.70			14.25			<i>D. cylindrus</i>
3.30			8.85			14.40			<i>O. annularis</i>
3.45			9m			14.55			<i>O. faveolata</i>
3.60			9.15			14.70			<i>O. franksi</i>
3.75			9.30			14.85			<i>M. ferox</i>
3.90			9.45			15m			
4.05m			9.60			Categories Data Entry Counts			
4.20			9.75			Corals (sp)	H	S	R
4.35			9.90						Bare
4.50			10.05m						Turf w sed
4.65			10.20						Turf no sed
4.80			10.35						Dict
4.95			10.50						Hall
5.1m			10.65						Lobophora
5.25			10.80						Macro - fleshy
5.40			10.95						Macro - calc
5.55			11.1m						CCA
Notes									Peysonnellia
									Gorg - upright
									Gorg - encrust
									Sponge - other
									Sponge - Clionna
									Cyano/Diatom
									Millipora
									Palythoa
									Seagrass
									Other
Circle method type						Combined Separate			

## 2. Example of Caribbean datasheet

NCRMP Line Point Intercept Datasheet												
Diver: _____		Boatlog/Manger: _____										
Buddy: _____		Field ID: _____		Date: _____		Sample Time: _____						
Habitat: <i>Bedrock</i> <i>Pavement</i> <i>Agg. Reef</i> <i>Patch Reef</i> <i>Scat. Coral/Rock in Sand</i>						Meters Complete: _____m						
Record biotic and abiotic code every 15cm						Habitat code: H - Hardbottom S - Soft R - Rubble		Rugosity				
Meter	Cover	Hab	Meter	Cover	Hab	Meter	Cover	Hab	15x2m			
0.15			5.70			11.25			Min depth (ft)			
0.30			5.85			11.40			Max depth (ft)			
0.45			6m			11.55			Max vert ht (cm)			
0.60			6.15			11.70			Relief 15x2m (bin by 1x2 m; 15 total ticks)			
0.75			6.30			11.85						
0.90			6.45			12m			0 - 19 cm			
1.05m			6.60			12.15			20 - 49 cm			
1.20			6.75			12.30			50 - 99 cm			
1.35			6.90			12.45			100 - 149 cm			
1.50			7.05			12.60			150 - 199 cm			
1.65			7.20			12.75			≥ 200 cm			
1.80			7.35			12.90			Macroinverts count 15x2m			
1.95			7.50			13.05m						
2.1m			7.65			13.20			<i>P. argus</i>			
2.25			7.80			13.35			<i>S. gigas</i>			
2.40			7.95			13.50			<i>D. antillarum</i>			
2.55			8.1m			13.65			Presence(1)/Absence(0) 15x2m			
2.70			8.25			13.80						
2.85			8.40			13.95			<i>A. cervicornis</i>			
3.0m			8.55			14.1m			<i>A. palmata</i>			
3.15			8.70			14.25			<i>D. cylindrus</i>			
3.30			8.85			14.40			<i>O. annularis</i>			
3.45			9m			14.55			<i>O. faveolata</i>			
3.60			9.15			14.70			<i>O. franksi</i>			
3.75			9.30			14.85			<i>M. ferox</i>			
3.90			9.45			15m						
4.05m			9.60			Categories Data Entry Counts						
4.20			9.75			Corals (sp)	H	S	R	H	S	R
4.35			9.90							Bare		
4.50			10.05m							Turf w sed		
4.65			10.20							Turf no sed		
4.80			10.35							Dict		
4.95			10.50							Hall		
5.1m			10.65							Lobophora		
5.25			10.80							Macro - fleshy		
5.40			10.95							Macro - calc		
5.55			11.1m							CCA		
Notes										Peysonnellia		
										Gorg - upright		
										Gorg - encrust		
										Sponge - other		
										Sponge - Clionna		
										Cyano/Diatom		
										Millepora		
										Palythoa		
										Seagrass		
										Other		
Circle method type						Combined		Separate				

## Appendix IV. 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  $\geq 2.5$ cm (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 *Peyssonellia* species
6. *Peyssonellia*
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. caribaeorum* and *P. mammosa*
12. Seagrasses – all species combined
13. Other – include hydroids, anemones, corallimorpharians, zoanthids other than *Palythoa*, bryozoans, and tunicates

## Appendix V. Examples of benthic categories for LPI surveys.

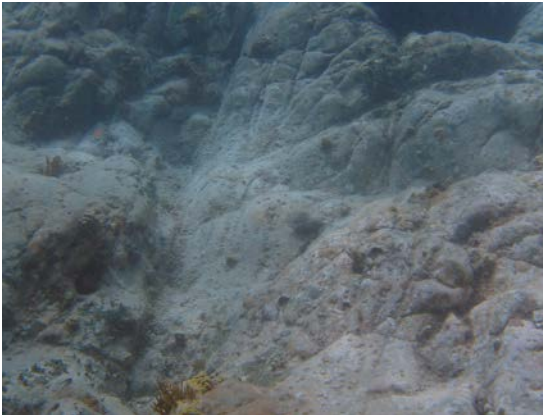
1. Scleractinian Corals (to species)



2c. Bare Rubble



2a. Bare Hardbottom



3a. Turf Algae (no sediment)



2b. Bare Soft (Uncolonized sand)



3b. Turf Algae with Sediment



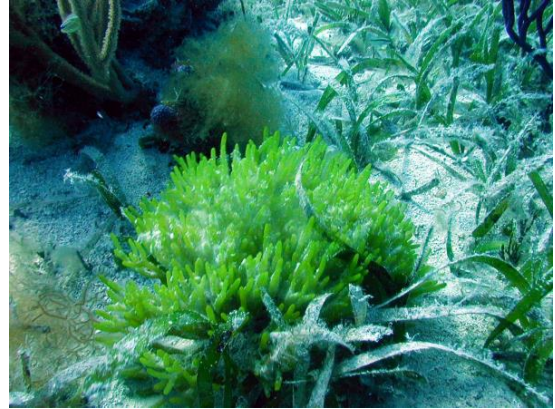


## Appendix V. continued

4a. Macroalgae - *Dictyota*



4d. Macroalgae – Other Non-calcareous



4b. Macroalgae - *Halimeda*



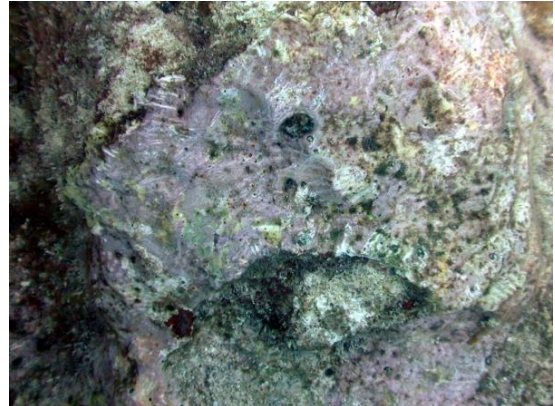
4e. Macroalgae – Other Calcareous



4c. Macroalgae - *Lobophora*



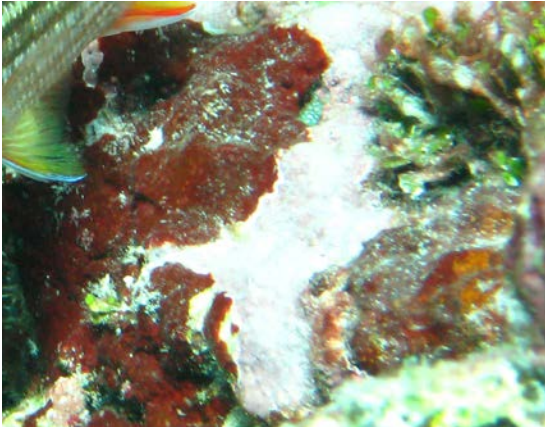
5. Crustose Coralline Algae (CCA)





## Appendix V. continued

6. *Peyssonnelia*



8a. Sponges – *Cliona* spp.



7a. Gorgonian - Upright



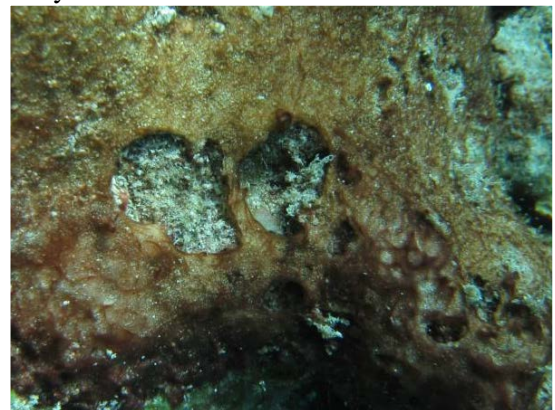
8b. Sponges - Other



7b. Gorgonian - Encrusting



9. Cyanobacteria/Diatoms





## Appendix V. continued

10. Milleporid Hydrocorals (*Millepora*)



13. Other (anemones)



11. Palythoa (colonial zoanthid)



13. Other (corallimorpharians)



12. Seagrass



13. Other (zoanthids)

