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# National Coral Reef Monitoring Program (NCRMP) Reef Visual Census (RVC) Fish Survey Protocols for the U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands 2024

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 community composition, and species-specific density (abundance) 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 conducts surveys at stratified-random sites where the sampling domain for each geographic region is partitioned by habitat attributes and depth, sub-regional location (*e.g.*, along-shelf position), and management zone.

NCRMP Fish surveys are conducted using the Reef Visual Census (RVC), stationary-point-count method (Brandt et al. 2009) that collects data on both ecologically and economically important reef fishes. Fish surveys are conducted at all NCRMP biological survey sites and may occur concurrently with Coral Demographic/Benthic Assessment surveys.

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

## NCRMP Fish Survey Summary

The RVC, stationary-point-count method is modified from Bohnsack and Bannerot (1986) and is conducted on shallow (<100ft), hardbottom coral reef habitats. Field surveys use a one-stage design to sample within a selected subset of 50 m x 50 m grid cells. A two-diver team surveys all fishes within adjacent 15-m diameter cylinders centered on each diver. Each imaginary cylinder vertically extends from the substrate to the sea surface. Within each cylinder, fishes are identified to the species level and counted, and fork length is estimated to the nearest centimeter. Data collected by the diver survey pair are not independent and are averaged at the site level.

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NCRMP Fish diver responsibilities include collecting:

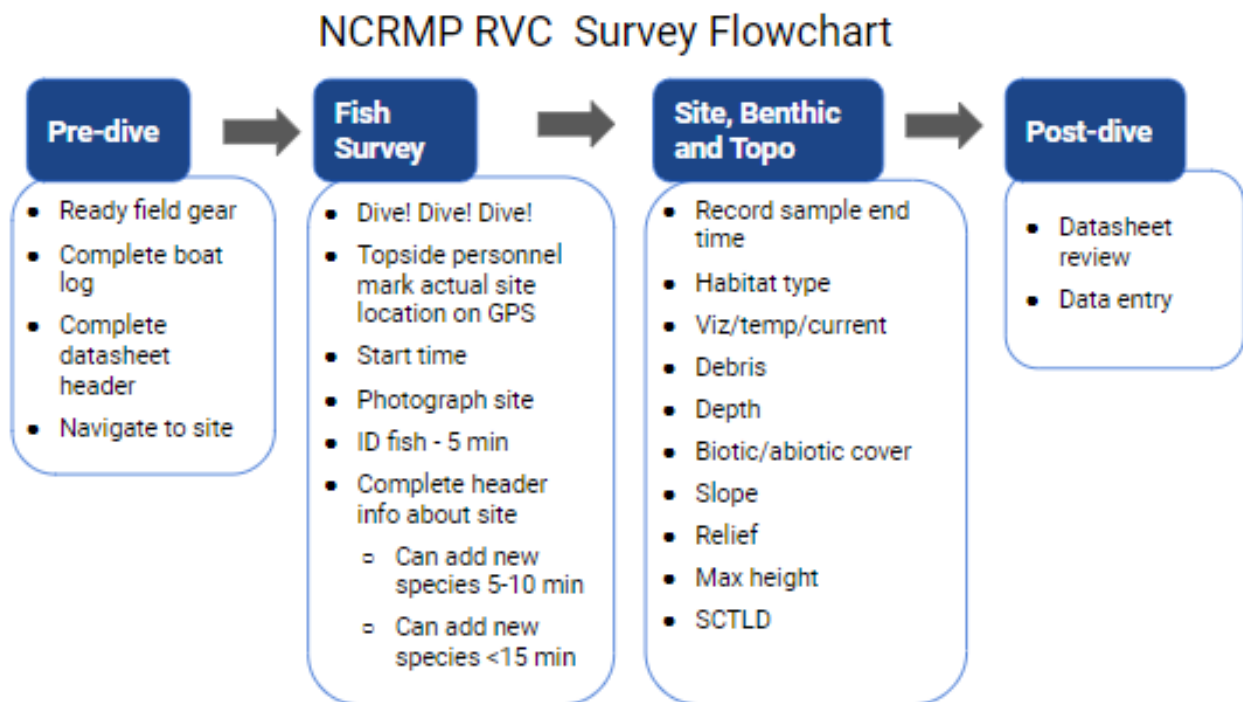
- Fish Information
- Benthic Cover Information
- Stony Coral Tissue Loss Presence/Absence
- Overall Topographic Information
- Site Photos

At some Fish survey sites, Benthic Community Assessment and Coral Demographic surveys are also collected. At these sites, a team of two benthic divers can be deployed simultaneously with the fish team (Appendix I; Figure A), and establish the benthic transect on the appropriate habitat with the least amount of interference with the fish surveys. Refer to Benthic Community Assessment (CRCP 2024a) and Coral Demographics Survey (CRCP 2024b) protocols for detailed benthic methodologies.

This protocol includes an overview of the field fish survey methodology, including pre-dive, site orientation, and the RVC survey, as well as an overview of data accessibility and use.

## NCRMP Fish Survey Sequence of Events

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



**Figure 1.** NCRMP Fish reef visual census (RVC) sequence of events.

### Pre-dive

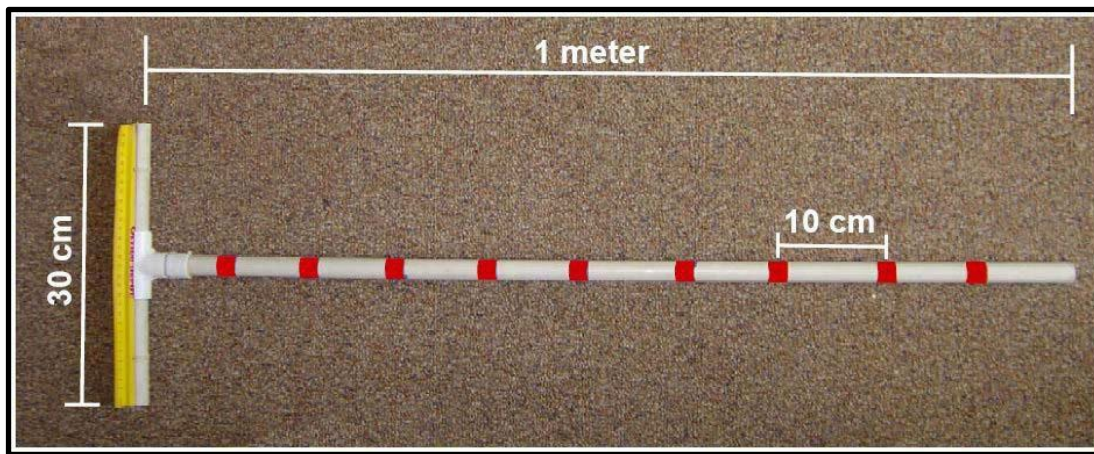
The pre-dive phase consists of organizing field equipment to take underwater and filling out station information on the boat log and the RVC datasheet prior to entering the water (Figures 3 and 4).

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## *Organize Field Equipment*

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

1. Fish survey datasheet
2. Clipboard
3. Pencil (& backup pencil)
4. All Purpose Tool (APT; Figure 2)
5. Team camera (with charged battery, and space on memory card) and housing.
6. Dive flag with GPS



**Figure 2.** The All Purpose Tool (APT) used for measuring water visibility, dimensions of the survey cylinder, fish lengths, and benthic relief.

## *Complete the Boat Log*

Prior to the dive, key fields to record on the boat log for station information include the following (Figure 3; 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. Use complete last name, not initials or abbreviations.
  - a. Fish (A/B) – A two-diver fish team consists of a Diver A and Diver B.
  - b. Benthic (J/X) – The diver collecting Benthic Community Assessment data is assigned the code ‘J’; the diver collecting Coral Demographics data is assigned ‘X’.

Date	DOD	Site	Station	Team	Diver	O <sup>2</sup> %	PSI IN
6/20/2024	1	1234	1	A	Cain		
	1	1234	1	B	Langwiser		
	1	1234	1	J	Edwards		
	1	1234	1	X	Viehman		
6/20/2024	2	1254	1	A	Blondeau		
	2	1254	1	B	Grove		
	2	1254	1	J	Cain		
	2	1254	1	X	Langwiser		

**Figure 3.** Example of boat log with specific station information filled out. DOD = Dive of the day.

Example: Figure 3 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 team and one benthic team. The fish divers are Cain and Langwiser, identified by the A/B codes. For the first dive, Cain is team member A and Langwiser is team member B. For the second dive of the day, Blondeau is team member A and Grove is team member B as the divers rotated.

### *Datasheet Logistics and Station Information*

Divers should pre-populate station information, same as recorded on the boat log, on their datasheet prior to entering the water (Figure 4; Appendix III). Fill in all categories legibly.

1. Last names of all divers. Use complete last name, not initials or abbreviations.
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)**

*Example* (Figure 4): Diver Cain recorded the **Field ID** 12341A. According to the boat/dive log (Figure 3), Cain is diver A for site 1234 (in a 1 stage design).
3. Date of survey.
4. **Dive Start Time** – The time divers leave the boat, while **Sample Start Time** marks the start of fish data collection and the 5-minute intervals.
5. Data manager. The data manager will be assigned prior to the start of operations.

Diver: <u>Cain</u>	Date: <u>6/20/2024</u>	Field ID: <u>12341A</u>	Data Manager: <u>Blondeau</u>
Buddy: <u>Langwiser</u>	Sample Start Time: _____	Habitat type:	
Dive Start Time: _____	Sample End Time: _____	Contiguous S&G	Rubble
Dive End Time: _____	Max Dive Depth: _____ ft	Contiguous Other	(Matrix)
<b>Substrate Slope</b>	Station Depth: _____ ft	Isolated	(Sand)
Max depth _____ ft	Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> LiveTrap <input type="checkbox"/> TrapDebris <input type="checkbox"/> Fishing <input type="checkbox"/> Other		
Min depth _____ ft	Coral restoration <input type="checkbox"/> None		
	Coral Disease with Tissue Loss: <input type="checkbox"/> None <input type="checkbox"/> Notsampled <input type="checkbox"/> Fast(>1 cm) <input type="checkbox"/> Slow(<1 cm)		
	<input type="checkbox"/> Site <input type="checkbox"/> Survey area <input type="checkbox"/> Unknown		

**Figure 4.** Example of pre-dive datasheet station entries prior to entering the water.

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## *Navigate to the Site*

Once in the field, the vessel captain navigates to the pre-selected NCRMP site using a handheld or vessel GPS unit.

1. Each boat will have up to three **(3)** GPS units:
  - a. One **(1)** for navigation to sites
  - b. Each dive team will have one **(1)** dive flag/float with a GPS unit attached to visually mark the site for surface support, provide a starting point for the surveys underwater, and to verify site location within the sample grid during the data QAQC process. Each unique GPS and dive flag number should be recorded on the daily boat log (Appendix II).
  - c. A handheld GPS **(1)** to collect topside waypoints on the boat log
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).

**\*\*Boat drivers will safely mark waypoint after divers have descended\*\***

## **Fish Survey**

Dive teams enter the water at the pre-selected GPS coordinates, descend to bottom, affix the dive reel that is attached to the surface dive flag to an appropriate attachment point on the bottom, evaluate the site, set up their survey areas, and begin data collection.

- a. If a benthic team is diving with the fish team, **ALL dive teams should 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 – The team assesses the site during descent or immediately after reaching the bottom.
  - a. Hardbottom presence/absence:
    - i. Present – If hardbottom is present, continue hardbottom habitat type assessment.
    - ii. Absent – If hardbottom is **not visible** at the site (no hardbottom at all, *i.e.*, continuous sand or seagrass) terminate the dive and select an alternate site.  
**\*\*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 cylinders where deployed.



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- 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 cylinders 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 RVC 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 4m. The divers should use an All Purpose Tool (APT) to quantitatively estimate visibility at the survey site (Figure 2).
  - c. Evaluate the strength of the water currents at depth. Divers should be able to safely maintain a stationary position within their dive cylinder. 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 RVC surveys should occur at <100ft (max 99ft).

**Terminate a dive when any of the following conditions are met**



Unsafe dive conditions



Strong currents



Low visibility (<4m)



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.

Photos should include RVC survey area for general site characterization. Additional photos may include divers conducting surveys, unique features, and species for identification purposes. One diver in each buddy team will take pictures.

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Station Documentation: At least five photographs per station.

- a. Take one 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 header information should be clear and legible in the photograph.
- b. Take four site photographs at four different directions to provide a 360° viewpoint of the site.
- c. Additional photographs may be taken during the survey of anything unusual (e.g., rare fish, bleached or rare corals), for species identification purposes, and of unique site features. If time permits, pictures of NCRMP sampling including that of other divers are welcome!

### *Establishing Survey Cylinders*

When there is good visibility and hardbottom habitat, fish divers should set up adjacent RVC cylinders that do not overlap. Divers should start from the affixed dive reel and use their APT (Figure 2) to measure out 7.5m, this will be the center of the survey cylinder. Divers should swim in opposite directions of each other to arrive at the center of their imaginary cylinder and then use the distance of the affixed reel as a reference for the edge of the cylinder to establish the extent of their cylinder (survey area) in all directions (Appendix I). If visibility is more limited, the following modifications should be made.

- i. If horizontal visibility is greater than or equal to 7.5m, then the radius of the cylinder will be 7.5m.
- ii. If the horizontal visibility is less than 7.5m but greater than 4 m, the diver will still conduct a survey in a 7.5m radius cylinder. The diver will swim out a measured distance from the dive reel, still keeping the dive buddy visible, to set up their cylinder. However, the diver will now need to slightly move from the middle (during survey) to observe the area needed to fulfill the 7.5 m cylinder. The APT, or some other type of marker, can be used to mark the initial midpoint and the dive reel and dive buddy are used as additional visual references

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

When a benthic team deploys with the RVC team, the team is to set up adjacent to the cylinders if possible, using the same affixed dive reel and float line as an anchor point for the belt transect. Benthic teams can swim to nearby hardbottom if it is patchy where the RVC cylinder is established. Benthic divers must remain in visual contact with the RVC divers and the surface float (Appendix I).

#### **Remember to use your APT to measure:**

- 1) Visibility
- 2) RVC cylinder size (radius)
- 3) Fish sizes (fork length)

Additional uses:

APTs can help to orient divers within their cylinder (center point), and/or point towards the dive reel to minimize disorientation during surveys

### *Fish Counting/Measuring*

Once the cylinders have been established the team begins to identify fish.

1. Each diver will identify to species level or lowest possible taxon and record on the datasheet, all fish that enter the cylinder for **5 minutes** (Figure 5). In this time period, the diver is essentially creating a species list and not numbering or sizing species (except for caveats, see subsection below) and focusing on capturing all the unique species in the cylinder. As a reminder, the cylinder extends from the seafloor to the surface (Appendix I, Figure B).
  - a. Not all species remain within the cylinder to be easily counted, therefore the diver should record numbers and sizes of fish species that are likely not going to be in the cylinder after the 5-minute identification phase. Highly mobile species such as jacks, sharks, or skittish species may travel in and out of the cylinder while a diver is in the identifying phase of the survey.
  - b. Divers are encouraged to use abbreviations for species to record data quickly. Either scientific code or common names are acceptable. Species code is defined as the first three of the genus and first four letters of the species name while common name abbreviations vary by diver. For example, to record yellowtail snapper, *Ocyurus chrysurus*, the species code would be 'ocy chry' while the common name abbreviation would be your version of shorthand (e.g., YTS, ytail, y snap, etc.). **Be consistent when recording species names.**
2. After the first 5 minutes, the diver should draw a line under the initial 5-minute species identification list marking the beginning of the new time period, 5 to 10 minutes. The diver then begins to work through the list of species observed on the datasheet. Each species is counted and fork length is estimated to the nearest 1 cm (Figure 5).

For example (Figure 5): Fishes are measured by total number (N), average size (AVG), minimum size (Min) and maximum size (Max). For the average size, what we are really after is the mode, or, what size are most of the fish for a given total number (n). For single fish, the number and size are listed. For two fish, the diver can list both sizes, either in the Min and Max columns, or if they are the same size, list the number twice.

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max
STEVARI	100	3	3	5					
SPHBARR	1	80							
SPAVIRI	4	20	18	27					
HAEFLAV	13	16	12	19					
SPA AURO	<sup>12</sup> 3	<sup>8</sup> 24	<sup>6</sup> 21	<sup>11</sup> 26					
CORGLAV	2		4	5					
OCYCHRY	5	17, 15	13	21, 14					
ACACOER	3	15	12	20					
CARLATU	2		38	40					
CANROST	1	4							

**Figure 5.** Example of fish observations during RVC survey.

3. Economically important species such as groupers and snappers should be individually sized up to a group total of 10 individuals (Table 1). If there are more than 10 in the group, the remainder should



be estimated with minimum, maximum, and average sizes individually. For example: Figure 5 lists OCY CHRY (*Ocyurus chrysurus*, yellowtail snapper) with 5 separate sizes.

**Table 1.** List of economically important species for individual sizing.

<i>Species Name</i>	<i>Common Name</i>	<i>Species Name</i>	<i>Common Name</i>
<i>Cephalopholis cruentata</i>	graysby	<i>Lutjanus jocu</i>	dog snapper
<i>Cephalopholis fulva</i>	coney	<i>Lutjanus mahogoni</i>	mahogany snapper
<i>Dermatolepis inermis</i>	marbled grouper	<i>Lutjanus synagris</i>	lane snapper
<i>Epinephelus adscensionis</i>	rock hind	<i>Mycteroperca bonaci</i>	black grouper
<i>Epinephelus guttatus</i>	red hind	<i>Mycteroperca interstitialis</i>	yellowmouth grouper
<i>Epinephelus morio</i>	red grouper	<i>Mycteroperca tigris</i>	tiger grouper
<i>Epinephelus striatus</i>	nassau grouper	<i>Mycteroperca venenosa</i>	yellowfin grouper
<i>Lutjanus analis</i>	mutton snapper	<i>Mycteroperca phenax</i>	scamp
<i>Lutjanus apodus</i>	schoolmaster	<i>Ocyurus chrysurus</i>	yellowtail snapper
<i>Lutjanus buccanella</i>	blackfin snapper	<i>Lachnolaimus maximus</i>	hogfish
<i>Lutjanus cyanopterus</i>	cubera snapper	<i>Pterois volitans</i>	red lionfish
<i>Lutjanus griseus</i>	gray snapper		

4. Some species, parrotfish in particular, often have bimodal size groups. If the diver is able to estimate both groups individually then it is recommended to record these data.
  - a. This provides a greater resolution of the community structure of these species.  
 For example, in Figure 5, the species code SPA AURO (*Sparisoma aurofrenatum*, redband parrotfish) commonly has groups of juveniles and adults intermixed.
  - b. If the diver is not comfortable with this technique then one range of sizes is sufficient.
5. The diver should add any new species observed during the 5 to 10 minute time period.
  - a. New species should be added, enumerated and sized concurrently as the diver is counting and measuring the species identified in the first 5 minutes.
6. After the 5 to 10 minute time period, the diver should draw another horizontal line on their datasheet (Figure 5).
  - a. If the fish survey continues after 10 minutes, new species can be added below the second line.

**\*\*The RVC survey is over when all fish have been identified, counted, and sized\*\***

**Surveys typically last from 15 to 20 minutes**

### Site/Benthic/Topographic Assessment

Following the fish survey, habitat information is collected and recorded on the data sheet (Appendix III). If new fish species are found during the habitat assessment portion; identify, enumerate and size the new species in the ‘after 10 minute’ time period. Often cryptic species (i.e., gobies, blennies, cardinalfish, etc.) are found while assessing the habitat.

Diver: _____	Date: _____	Field ID: _____	Data Manager: _____
Buddy: _____	Sample Start Time: _____	Habitat type: _____	Underwater visibility: _____ M
Dive Start Time: _____	Sample End Time: _____	Contiguous S&G Rubble	Water temperature: _____ F
Dive End Time: _____	Max Dive Depth: _____ ft	Contiguous Other (Matrix)	Current: None Mod. High
Substrate Slope	Station Depth: _____ ft	Isolated (Sand)	
Max depth _____ ft	Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> LiveTrap <input type="checkbox"/> TrapDebris <input type="checkbox"/> Fishing <input type="checkbox"/> Other		Coral restoration <input type="checkbox"/> None
Min depth _____ ft	Coral Disease with Tissue Loss: <input type="checkbox"/> None <input type="checkbox"/> Not sampled <input type="checkbox"/> Fast (>1 cm) <input type="checkbox"/> Slow (<1 cm)		<input type="checkbox"/> Site <input type="checkbox"/> Survey area <input type="checkbox"/> Unknown
Max vertical Relief	Biotic Cover - Dominant Biological Cover %		
Hard Relief _____ m	SAND HARDBOTTOM		
Soft Relief _____ m	Abiotic Footprint	"Bare"	Algae (<1cm)
Surface Relief Coverage %	SAND %	Macro Algae	Algae (>1cm)
Hard Soft	HARD-B %	Sea grass	Live Stony Coral
< 0.2 m % %	RUBBLE %	Sponge	Octocoral
0.2-0.5 m % %	Total 100%	Other 1 _____	Sponge
0.5-1.0 m % %		Other 1 _____	Other 1 _____
1.0-1.5 m % %			Other 1 _____
> 1.5 m % %			
TOTAL 100% 100%		TOTAL 100%	100%

Figure 6. Site, benthic, and topographic assessment components on the RVC datasheet.

The following variables are measured and recorded:

1. Observed Habitat Type: The diver enters the habitat type observed (Figure 7).

Circle one selection of the habitat categories on the datasheet.

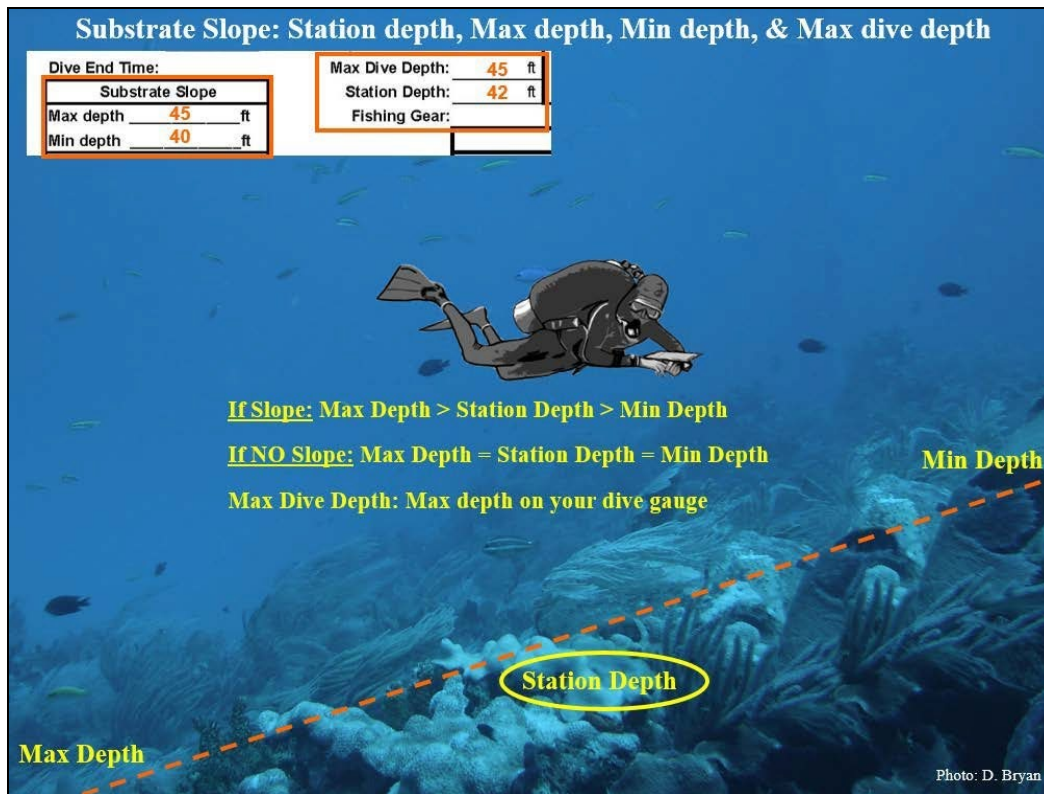
Immediately after the dive, the diver should discuss with their buddy and other team members to try to come to a consensus. If a consensus is not achieved, divers should note it on the boat log.

**NOTE: Habitat types are different across regions (Figure 7; Appendix IV).**

(a) Diver: _____	Date: _____	Field ID: _____	Data Manager: _____
Buddy: _____	Sample Start Time: _____	Habitat type: _____	Underwater visibility: _____ M
Dive Start Time: _____	Sample End Time: _____	Bedrock Aggregate Reef	Water temperature: _____ F
Dive End Time: _____	Max Dive Depth: _____ ft	Pavement Patch Reef	Current: None Mod. High
Substrate Slope	Station Depth: _____ ft	Scat. Coral/Rock in Sand	
Max depth _____ ft	Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> LiveTrap <input type="checkbox"/> TrapDebris <input type="checkbox"/> Fishing <input type="checkbox"/> Other		Coral restoration <input type="checkbox"/> None
(b) Diver: _____	Date: _____	Field ID: _____	Data Manager: _____
Buddy: _____	Sample Start Time: _____	Habitat type: _____	Underwater visibility: _____ M
Dive Start Time: _____	Sample End Time: _____	High Relief	Water temperature: _____ F
Dive End Time: _____	Max Dive Depth: _____ ft	Low Relief	Current: None Mod. High
Substrate Slope	Station Depth: _____ ft		
Max depth _____ ft	Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> LiveTrap <input type="checkbox"/> TrapDebris <input type="checkbox"/> Fishing <input type="checkbox"/> Other		Coral restoration <input type="checkbox"/> None
(c) Diver: _____	Date: _____	Field ID: _____	Data Manager: _____
Buddy: _____	Sample Start Time: _____	Habitat type: _____	Underwater visibility: _____ M
Dive Start Time: _____	Sample End Time: _____	Contiguous S&G Rubble	Water temperature: _____ F
Dive End Time: _____	Max Dive Depth: _____ ft	Contiguous Other (Matrix)	Current: None Mod. High
Substrate Slope	Station Depth: _____ ft	Isolated (Sand)	
Max depth _____ ft	Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> LiveTrap <input type="checkbox"/> TrapDebris <input type="checkbox"/> Fishing <input type="checkbox"/> Other		Coral restoration <input type="checkbox"/> None

Figure 7. Hardbottom categories of observed habitat type and meters completed section on the RVC datasheet for (a) Caribbean, (b) Gulf of Mexico, and (c) Florida locations.

2. Water Visibility, Temperature, and Current: Temperature (°F) and visibility (m) should be recorded at depth. A water current category should be circled: "None" (none), "Mod." (Moderate; diver can stay in the same position with a gentle kick), "High" (diver struggles to stay in position; Figure 6).
3. Substrate Slope: The maximum and minimum depths within the sample cylinder. These values refer to the maximum and minimum depths on the imaginary plane underlying the sample cylinder. If there is a slope these depths will be different (Figure 8), if there is no slope (i.e., only structure such as a pinnacle) the numbers should be the same.



**Figure 8.** Illustration of substrate slope and depth measurements.

4. **Max Vertical Relief:** The maximum vertical relief within the sample cylinder of both hard (e.g., coral structure, coralline spur, rocky outcrop, barrel sponge) and soft (e.g., octocorals, sponges and macroalgae) substrate (Figure 6). Divers should use their APT to collect these measurements. These values should not be zero.
5. **Surface Relief Coverage:** Estimate the percent of hard (e.g., coral structure, coralline spur, rocky outcrop, barrel sponge) and soft (e.g., algae, octocorals, soft sponges, sand) vertical relief in the following categories: <0.2m, 0.2–0.5m, 0.5–1.0m, 1.0–1.5m, and >1.5 m (Figure 6). These values should sum to 100%.
6. **Abiotic Footprint:** The percentage of the cylinder consisting of sand, hardbottom, and rubble (Figure 6). These percentages should sum to 100%.
  - a. Sand is coarse biogenic or oolitic (0.5–2mm grain sizes) and finer silt (<0.2mm) particles.
    - i. Sand is considered the substratum when sediment depth is >2–3 cm. A surface “dusting” of sediment particles overlying a consolidated substratum is considered hardbottom not sand.
    - ii. Seagrass should be coded as sand since the biotic “grass” is growing in the abiotic sand substrate.
  - b. Rubble ranges from coarse gravel (>5 mm) to unconsolidated and moveable rocks (e.g. dislodged and moveable coral fragments); this category has a loose and moveable nature.
  - c. Consolidated hardbottom includes solid, consolidated lithogenic or biogenic substratum, including living and dead coral, and non-coral hardbottom.

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7. Biotic Cover: The percentage of the abiotic cover category that supports biotic cover (Figure 6).
- SAND: The percentage of the sand substrate that corresponds to the following categories: bare, under/supporting growth of macroalgae, under/supporting growth of seagrass, under/supporting growth of sponges, and other. These values should sum to 100%.
  - HARDBOTTOM: Imagine an aerial, canopy view of the cylinder to determine the percentage of the hardbottom substrate covered with algae <1 cm height (e.g., turf algae, *Lobophora*), macroalgae >1 cm height (e.g., *Halimeda*, *Dictyota*), live coral, octocoral, sponge, and other abundant benthic taxonomic groups. These values should sum to 100%.
8. Submerged Debris: Indicate if active fishing traps, trap debris, fishing gear (e.g., line, nets) or other man-made debris (e.g., anchors, rope, tires) are present.
9. Coral Restoration: This notes the presence of coral restoration (i.e., outplanting) evident at the survey site or within the RVC survey cylinder. Restoration or outplanting may be indicated by epoxy or cement at the base of corals along with tagged corals and by the species (e.g., Acroporids).
- If the diver suspects restoration but is unsure, then 'Unknown' should be checked and if there is no evidence 'None' should be checked.
  - The survey site is defined as anywhere in the visible range of the dive site; this is not reconnaissance to seek out coral restoration.
10. Coral Disease with Tissue Loss – Stony Coral Tissue Loss Disease (SCTLD) is prevalent in Florida and the U.S. Caribbean. This header field provides site-level observations on the presence of recent mortality and associated coral tissue loss related to disease, an indicator for SCTLD (Figure 9).
- Each diver is to note 1 of the 4 options with an 'X' in the appropriate box:
- **None** – no disease with tissue loss is observed at the site.
  - **Not Sampled** – diver did not include this measurement in their survey.
  - **Fast (>1cm)** – fast (acute) tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of recent mortality (uncolonized dead skeleton) is >1 cm in width/diameter. This fast (>1cm) rate of disease spread can be indicative of SCTLD.
  - **Slow (<1cm)** – slow (sub-acute) tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of recent mortality is <1 cm in width/diameter.

Diver: J. Blondeau	Date: 6/1/2022	Field ID:	Data Manager: Blondeau
Buddy: C. Langwiser	Sample Start Time:	Habitat type:	Underwater visibility: _____ M
Dive Start Time:	Sample End Time:	Contiguous S&G	Water temperature: _____ F
Dive End Time:	Max Dive Depth: _____ ft	Contiguous Other (Matrix)	Current: None Mod. High
Substrate Slope	Station Depth: _____ ft	Isolated (Sand)	
Max depth _____ ft	Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> Live Trap <input type="checkbox"/> Trap Debris <input type="checkbox"/> Fishing <input type="checkbox"/> Other		Coral restoration <input type="checkbox"/> None
Min depth _____ ft	Coral Disease with Tissue Loss: <input type="checkbox"/> None <input type="checkbox"/> Not sampled <input type="checkbox"/> Fast (>1 cm) <input type="checkbox"/> Slow (<1 cm)		<input type="checkbox"/> Site <input type="checkbox"/> Survey area <input type="checkbox"/> Unknown
Max vertical Relief	Biotic Cover - Dominant Biological Cover %		
Hard Relief _____ m	<input type="checkbox"/> Diadema <input type="checkbox"/> Diseased/Dead <input type="checkbox"/> Not sampled		
	SAND		HARDBOTTOM

Figure 9. Site level coral disease with Tissue Loss is in the header information on the datasheet.

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

## Post-Dive Actions

### *Site Level Observations*

After the survey is completed, if coral disease with tissue loss (i.e., slow or fast) 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. *RVC fish datasheet* – Review includes, at a minimum, verifying the following:
  - a. Completeness and legibility of all site information prior to dive.
  - b. Completeness and legibility of all species, counts, and sizes.
  - c. Completeness and legibility of topographic complexity records.
  - d. Completeness of submerged debris and coral disease with tissue loss (datasheet & boat log).
  - e. Discuss among team members and concur on habitat type.
  - f. Discuss any new, unique, rare, or strange observations (e.g., behaviors, schools/shoals, colorations, sizes, new species, etc.). This can help with species identification errors.

### *Data Entry and Information Storage*

Each diver is responsible for entering the RVC survey data from each site surveyed. A link to the data entry website will be provided at the start of each mission and/or season.

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.

The RVC diver pair will coordinate on who leads photo uploading, organizing, labeling, and sharing



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(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.

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Brandt, M.E., Zurcher, N., Acosta, A., Ault, J.S., Bohnsack, J.A., Feeley, M.W., Harper, D.E., Hunt, J.H., Kellison, G.T., McClellan, D.B., Patterson, M.E., Smith, S.G., 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.

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CRCP. 2024b. 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– 2024. NOAA Coral Reef Conservation Program. 27 pp. doi: [10.25923/hgpr-jm80](https://doi.org/10.25923/hgpr-jm80)

## Acknowledgements

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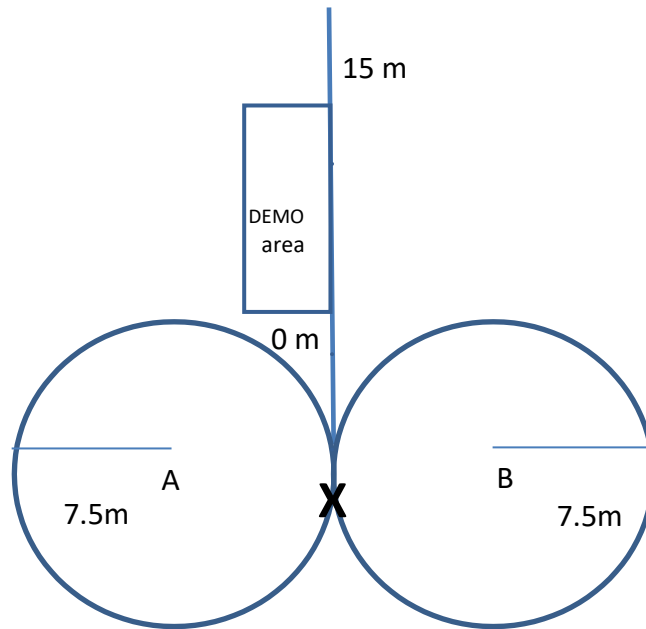
<sup>2</sup> CSS, Inc.

<sup>3</sup> Lynker, Inc

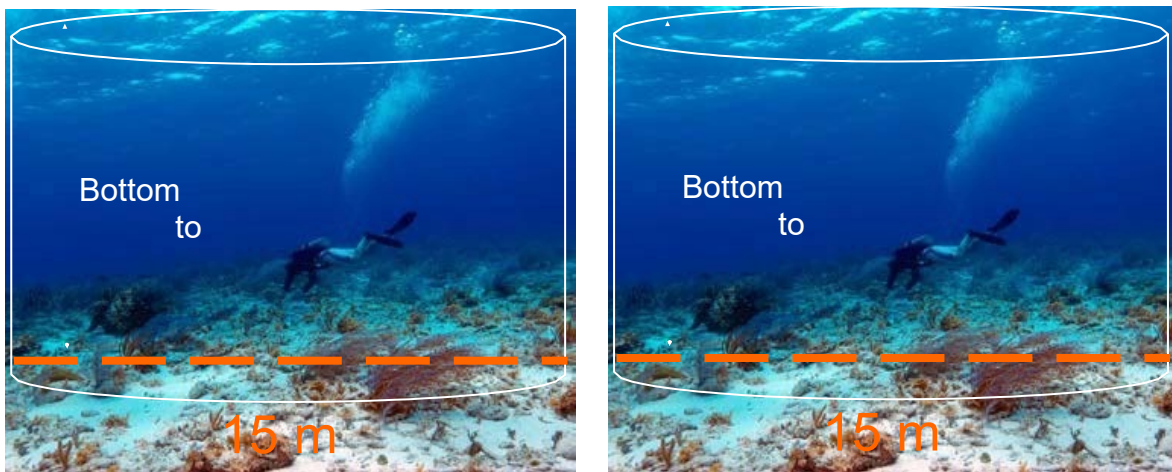
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## Appendices

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



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



**Figure B.** Photos indicating optimal cylinder placement. The dive team's surface buoy will be tied to the bottom in between both cylinders. The benthic team may start the transect in the vicinity of the fish team's surface buoy.











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## *Appendix IV. NCRMP habitat type classifications*

### **Puerto Rico and U.S. Virgin Islands<sup>1</sup>**

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).

### **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<sup>2</sup>**

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.

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<sup>1</sup>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.

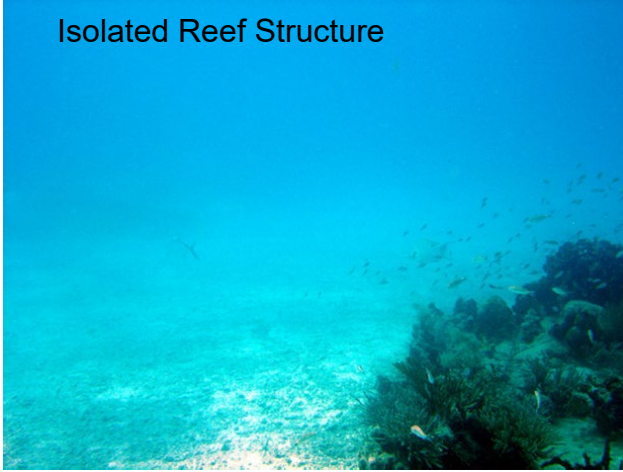
<sup>2</sup>Adapted from:

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

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**Appendix IV. NCRMP Florida habitat type classifications**

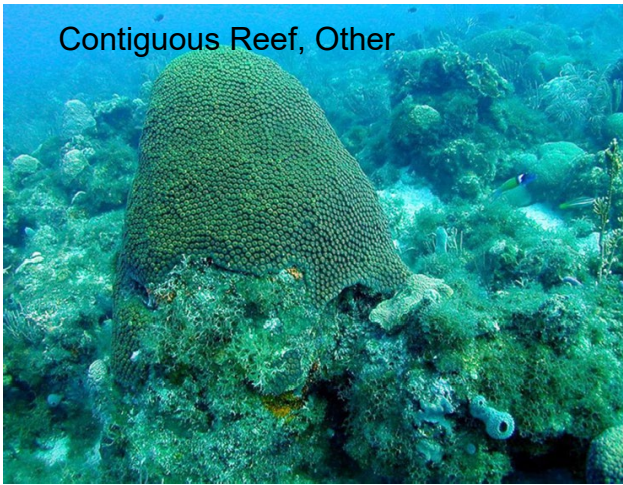
Isolated Reef Structure



Contiguous Reef, Spur & Groove



Contiguous Reef, Other



Reef Rubble

