
National Coral Reef Monitoring Program (NCRMP)

Reef Visual Census (RVC) Fish Survey Protocols U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands

2022

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

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Introduction

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

NCRMP surveying provides data from a broader geographic context that complements regional and local (site-specific) coral reef monitoring. NCRMP Fish surveys are conducted using the Reef Visual Census (RVC) stationary point count method (Brandt et al. 2009). Fish surveys are conducted at all NCRMP biological survey sites and may occur concurrently with Coral Demographic/Benthic Assessment surveys.

NCRMP Fish Survey Goals

The goal of the fish community surveys is to collect and report information on species composition, density, size, abundance, and derived metrics (*e.g.*, species richness, diversity) using the RVC method in a stratified random sampling design on hardbottom and coral reef habitats, less than 100ft, in U.S. coral reef jurisdictions.

General Task Description

The RVC method is modified from Bohnsack and Bannerot (1986), and occurs with the diver remaining at a fixed site. Fish are surveyed within an imaginary 15-m diameter cylinder centered on the diver and extending vertically from the substrate to the limits of vertical visibility, sometimes to the surface. Previously in Florida, two teams consisting of two divers per team sampled each site's primary sample unit concurrently. In 2020, the sample frame grid size was reduced from 100 x 100m to 50 x 50m, and sampling was subsequently altered to a single-stage design consisting of one team per primary sample unit. Each diver in the two-person team conducts a non-overlapping stationary point count fish survey. Data collected by each diver pair are considered non-independent and therefore averaged to capture variability at the site level.

Benthic Community Assessment and Coral Demographic surveys are not collected at all fish sites. However, sites that require both fish and benthic surveys, 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 2022a) and Coral Demographics Survey (CRCP 2022b) protocols detailed benthic methodologies.

NCRM Fish diver responsibilities include collecting:

- Fish Information
- Benthic Cover Information
- Stony Coral Tissue Loss Presence/Absence
- *Diadema antillarum* disease or mortality Presence/Absence
- Overall Topographic Information
- Site Photos

General Site Information

Navigate to the site

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

**** 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) ****

1. Each boat will have up to three (3) GPS units:
 - a. One (1) for navigation to sites, and
 - b. Each boat will have one (1) dive flag/float with a GPS unit attached. This setup is uniquely identified for each boat (i.e. each boat / diver team will use the same flag-float-GPS setup throughout a mission) and will be used by the diver teams to mark the site for surface support, mark a starting point for the dive teams, and verify site location with computer generated sites. Record each team's unique GPS # and dive flag numbers on the daily boat log (Figure 3; Appendix II).
 - c. If using a GPS unit other than handheld to navigate to the sites, a handheld GPS is used to collect topside waypoints (see step #3 listed below)
2. Dive teams enter the water at select GPS coordinates, descend to bottom, affix the surface float line to the bottom, set up 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.**
3. 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).

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

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

Establishing the cylinders – Evaluating the Site

Upon descent, the team assesses the suitability of the site by ascertaining: (1) presence/absence of hardbottom, (2) observed habitat type, and (3) visibility of the divers' survey cylinders (see definition in previous section titled "General Task Description).

1. Locate hardbottom – As the team descends and assesses the site, the fish team ascertains the presence of hardbottom.
 - a. Hardbottom presence/absence:
 - i. Present – If hardbottom is present, continue habitat type assessment
 - ii. Absent – If hardbottom is not **visible** at the site (no hardbottom at all, *i.e.*, continuous sand or seagrass combined with limited visibility)
 - Then the dive will be terminated and an alternate site selected
 - **Do not swim around searching for hardbottom – this is not reconnaissance.**
2. Observed habitat type – If the team(s) deploy over hardbottom they are to establish cylinders where deployed.
 - a. If necessary, during descent, divers will swim to appropriate 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. Cylinder set up – When a benthic team deploys with the RVC team, the team is to set up adjacent to the cylinders if possible, using the same 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).
4. Determine visibility – Under optimal visibility conditions, the maximum distance between dive buddies should be 15m (Appendix I). The surface float can be secured to the bottom and serve as a starting point to measure the radius of the sampling cylinder using the All Purpose Tool (APT; *i.e.*, 7.5m or 4.0m depending on visibility):
 - a. Determine visibility within the sampling cylinder.
 - 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, then the diver will set up in the middle of a 5m cylinder and slightly move from the middle to observe the area needed to fulfill the 7.5 m cylinder. The APT (Figure 1), or some other type of marker, can be used to mark the initial midpoint.

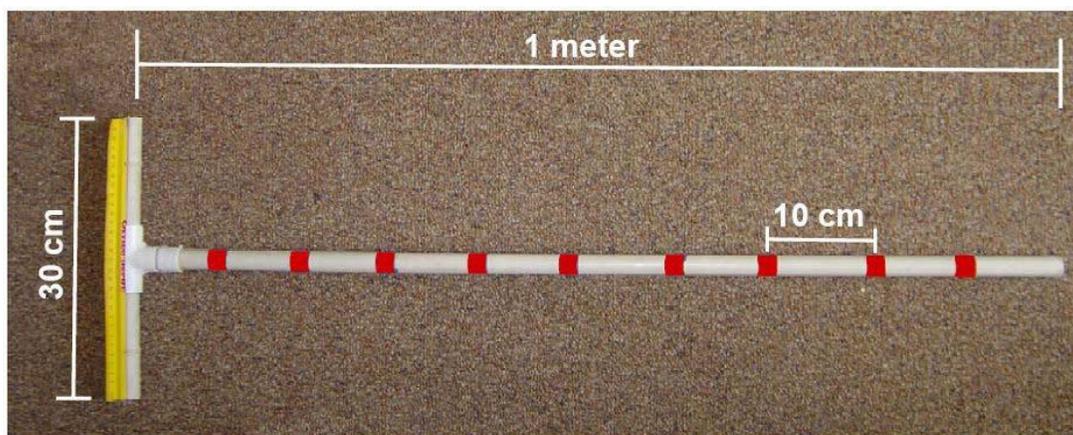


Figure 1. The All Purpose Tool (APT) used as a tool for measuring benthic relief, estimating fish lengths, and the dimensions of survey cylinder.

Additional APT uses:

- Visual aid to measure visibility and fish sizes
- Point of reference (e.g., edge of cylinder, fish measurement) during data collection
- Point of return for both divers following data collection

5. Termination of dive due to conditions: Certain environmental conditions are not safe for operations and surveys should be automatically terminated and alternates chosen when any of the following conditions are met.
 - a. Conditions are unsafe,
 - b. Visibility is less than 5m,
 - c. Bottom currents are strong enough that the divers cannot safely maintain a stationary position, or
 - d. Depth of the survey site is greater than 99ft.

Terminate a dive when any of the following conditions are met

- Conditions are unsafe,
- Visibility is low (<5m),
- Currents are strong, or
- Depth >99ft.

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

NCRMP Fish Survey Sequence of events

NCRMP Fish survey data collection occurs in three phases: (1) Pre-dive, (2) Fish counting/measuring, (3) Site/Benthic/Topographic Assessment (Figure 2).

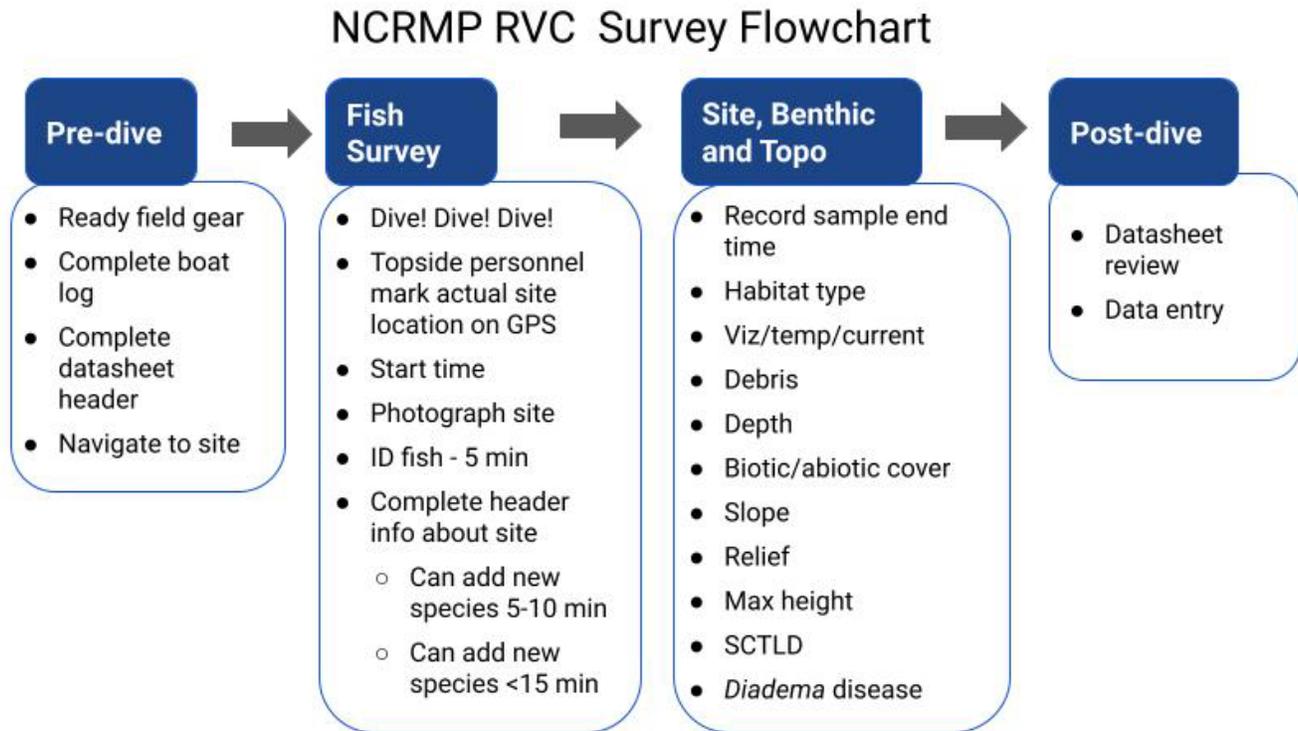


Figure 2. NCRMP Fish reef visual census (RVC) sequence of events.

Pre-dive

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

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 1)
5. Benthic team camera (with charged battery, and space on memory card) and housing.
6. Dive flag with GPS

Complete 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 are now 1-stage
3. Team (Team member assignment) – Letter code identifying the type of survey data being collected by the diver within their dive team.
 - a. Fish (A/B) – A two-diver fish team consists of 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’.

**** Codes are assigned to diver positions within the team and type of data collected; therefore, diver team codes could change by station as divers rotate ****

4. *Comments* – After the survey is complete, record any coral disease with tissue loss at the site, specifically, for cases of Stony Coral Tissue Loss Disease and any observed diseased/dead *Diadema*.

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

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 Clark and Blondeau, identified by the A/B codes. For the first dive, Clark is team member A and Blondeau is team member B. For the second dive of the day, Nemeth is team member A and Clark 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. Names of all divers
2. **Field ID** – The **Field ID** is a unique alpha-numeric number the diver is to record on the datasheet at each station.
 - **FIELD ID = (SITE #) + (STATION #) + (TEAM letter)**

Example (Figure 4): Diver Clark recorded the **Field ID** 12001A. According to the boat/dive log (Figure 3), Clark is diver A for site 1200 (and 1 stage is used for all fish surveys).
3. Date of survey
4. **Dive Start Time** – the time divers leave the boat while Time of Survey marks the start of fish data collection and the 5-minute intervals.
5. Mission data manager

| | | | |
|---------------------|---|---|--------------------------------|
| 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 | Rubble |
| Dive End Time: | Max Dive Depth: _____ ft | Contiguous Other | (Matrix) |
| 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"/> 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 | |
| Max vertical Relief | Diadema <input type="checkbox"/> Diseased/Dead | Biotic Cover - Dominant Biological Cover % | |
| Hard Relief _____ m | <input type="checkbox"/> Not sampled | SAND | HARDBOTTOM |

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

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). This includes the space above the cylinder (Appendix I, Figure B).
2. Not all species loiter around the cylinder and let themselves be counted, therefore the diver may record numbers and sizes of those fish that are most likely not going to be in the cylinder both during and after the 5-minute identification phase to assure they are recorded. 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.
3. After 5 minutes, the diver begins to work through the list of identified species on the datasheet and begins to estimate fork length size to the nearest 1cm (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.

| TOTAL | | | | | TOTAL | | | | |
|---------|--------------------|-----|-----|-----|---------|---|-----|-----|-----|
| Species | N | Avg | Min | Max | Species | N | Avg | Min | Max |
| STVA | 100 | 3 | 3 | 5 | | | | | |
| SPBA | 1 | 80 | | | | | | | |
| SPVI | 4 | 20 | 18 | 27 | | | | | |
| HAFL | 13 | 16 | 12 | 19 | | | | | |
| SPAU | 12 | 8 | 6 | 11 | | | | | |
| | 3 | 24 | 21 | 26 | | | | | |
| COGL | 2 | | 4 | 5 | | | | | |
| OCCN | 17, 15, 13, 21, 14 | | | | | | | | |
| MAPL | 1 | 19 | | | | | | | |

Figure 5. Example of fish observations during RVC survey.

4. After the 5-minute identification phase, new species may be added as the diver is counting and measuring the species identified in the first 5 minutes.
 - a. The diver should draw a line under the initial 5-minute list and add the new species below the line marking the 10-minute interval. New species may be added during the next 5-minute time period.
 - b. If the fish survey is continuing into 15 minutes, new species can be added in a third grouping by drawing a third line delineating the 15-minute interval (Figure 6).

| Species | N | Avg | Min | Max | Species | N | Avg | Min | Max |
|---------|------------|-----|-----|-----|---------|---|-----|-----|-----|
| HAFL | 21 | 17 | 11 | 20 | | | | | |
| LATR | 1 | 29 | | | | | | | |
| STLE | 3 | 5 | 4 | 7 | | | | | |
| EPGU | 21, 24, 19 | | | | | | | | |
| CARU | 1 | 27 | | | | | | | |
| LUJO | 1 | 22 | | | | | | | |
| CALA | 1 | 31 | | | | | | | |

Figure 6. Example of adding new fish species after the 5-, 10- and 15-minute intervals.

5. Some species, parrotfish in particular, have individuals that have bimodal size groups. If the diver is comfortable with estimating both groups individually then it is recommended that they do so.
 - a. This provides a greater resolution of the community structure of these species.
For example, in Figure 5, the species code SPAU (*Sparisoma aurofrenatum*, redband parrotfish) commonly has groups of juveniles and adults intermixed.
 - b. If the diver is not experienced or comfortable with this technique then one range of sizes is sufficient.

6. Important commercial and/or recreational 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.

Table 1. List of commercial and/or recreational 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 | | |

****The point count is over when all fish have been identified, counted and sized****

Site/Benthic/Topographic assessment

Following the fish survey, habitat information is collected and recorded on the data sheet (Appendix III).

| | | | |
|--|---|---------------------------|--------------------------------|
| Diver: _____ | Date: _____ | Field ID: _____ | Data Manager: _____ |
| Buddy: _____ | 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 |
| | Station Depth: _____ ft | Isolated (Sand) | |
| Submerged Debris: <input type="checkbox"/> None <input type="checkbox"/> LiveTrap <input type="checkbox"/> Trap/Debris <input type="checkbox"/> Fishing <input type="checkbox"/> Other | Coral restoration <input type="checkbox"/> None | | |
| 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 | | |
| Diadema <input type="checkbox"/> Diseased/Dead <input type="checkbox"/> Not sampled | Biotic Cover - Dominant Biological Cover % | | |
| Substrate Slope | SAND | "Bare" | Algae (<1cm) |
| Max depth _____ ft | Hard Relief _____ m | Macro Algae | Algae (>1cm) |
| Min depth _____ ft | Soft Relief _____ m | Sea grass | Live Stony Coral |
| Max vertical Relief _____ m | Abiotic Footprint | Sponge | Octocoral |
| Hard Relief _____ m | SAND | Other 1 _____ | Sponge |
| Soft Relief _____ m | HARD-B | Other 1 _____ | Other 1 _____ |
| Surface Relief Coverage % | RUBBLE | Other 1 _____ | Other 1 _____ |
| Hard | Total 100% | TOTAL | 100% |
| < 0.2 m | | | |
| 0.2-0.5 m | | | |
| 0.5-1.0 m | | | |
| 1.0-1.5 m | | | |
| > 1.5 m | | | |
| TOTAL 100% | | | |

Figure 7. Site, benthic, and topographic assessment components on the RCV datasheet.

The following variables are measured and recorded:

1. Observed habitat type – Post-dive, the diver enters the habitat type(s) observed during the dive. This may be different from the mapped habitat (Figures 8a-c).
 - a. Circle selection from the habitat categories (circle one on the Fish datasheet).
 - b. Immediately after the dive, the diver should discuss with their buddy and other team members and try to come to a consensus. If consensus is not achieved, divers should note that in the Field/Boat Log.
 - c. **NOTE: Habitat types are different across regions (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 |
| | Station Depth: _____ ft | Scat. Coral/Rock in Sand | | |
| | Substrate Slope | | | |
| | 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 |
| | Station Depth: _____ ft | | | |
| | Substrate Slope | | | |
| | 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 |
| | Station Depth: _____ ft | Isolated (Sand) | | |
| | Substrate Slope | | | |
| | 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 8. 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. *Note: Habitat categories differ by location.*

- Water temperature and currents: temperature and visibility at the bottom; water current estimated by divers for each paired survey; categories as follows: “None” (none), “Mod.” (Moderate; diver can stay in the same position with a gentle kick), “High” (diver struggles to stay in position; Figure 7).
- 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 9).



Figure 9. Illustration of substrate slope and depth measurements.

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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 7). These values should not be zero.
 5. Surface Relief Coverage: for hard vertical relief (e.g., coral structure, coralline spur, rocky outcrop, barrel sponge): the estimated percentages of hard/soft relief that fall into the following categories (all values in meters): <0.2, 0.2–0.5, .05–1.0, 1.0–1.5, and >1.5 (Figure 7). These values should sum to 100%.
 6. Surface Relief Coverage for soft vertical relief (e.g., octocorals, sponges and algae): the category (<0.2, 0.2–0.5, .05–1.0, 1.0–1.5, and >1.5m) representing the average vertical relief of all soft relief should be indicated by writing “100%” by that category (Figure 7).
 7. Abiotic Footprint: the percentage of the cylinder comprised of sand, hardbottom and rubble (Figure 7). These percentages should sum to 100%.
 - a. Sand is defined as coarse biogenic or oolitic sand (grain sizes typically between 0.5–2 mm) and finer silt sized particles (<0.2mm).
 - i. Sand is considered the substratum when sediment depth is usually 2–3 cm in depth or greater.
 - ii. It excludes a surface “dusting” of sediment particles overlying a consolidated substratum.
 - b. Rubble ranges from coarse gravel (>5 mm) to unconsolidated and moveable rocks (e.g. dislodged and moveable coral fragments). This category differs from consolidated hardbottom because of its loose and moveable nature.
 - c. Consolidated hardbottom includes solid, consolidated lithogenic or biogenic substratum, including living and dead coral, and non-coral hardbottom. Areas covered by seagrass should be coded as sand, since the biotic “grass” is growing in the abiotic sand substrate.
 8. Biotic Cover
 - a. 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%. See preceding section for sand definition.
 - b. HARDBOTTOM: While looking at an aerial, canopy view of the cylinder, 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%.
 9. Submerged Debris: indicate if live fishing traps, trap debris, fishing gear (line, etc.) or other man-made debris are present.
 10. Coral Disease with Tissue Loss – Stony Coral Tissue Loss Disease is prevalent in many locations in Florida and the Caribbean. This header field provides a high-level observation of the site-level presence of recent mortality and associated coral tissue loss related to disease at the site level and is 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.

- **Fast (>1cm)** - 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 >1cm in width/diameter, therefore rate of disease spread is considered fast (acute). This rate can be indicative of Stony Coral Tissue Loss Disease.
- **Slow (<1cm)** - tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of recent mortality is <1cm in width/diameter, therefore rate of disease spread is considered slow (sub-acute).

| | | | |
|---------------------|---|---|------------------------|
| Diver: J. Blondeau | Date: 6/1/2022 | Field ID: | Data Manager: Blondeau |
| Buddy: C. Langwiser | 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) |
| 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 | Diadema <input type="checkbox"/> Diseased/Dead | Biotic Cover - Dominant Biological Cover % | |
| Hard Relief m | <input type="checkbox"/> Not sampled | SAND | HARDBOTTOM |

Figure 9. Coral disease with Tissue Loss at the site level within the header information on the NCRMP Fish datasheet.

11. *Diadema antillarum* – Presence noted of any Diseased/Dead Diadema observed at the site level (Figure 10). If divers do not look for Diseased/Dead Diadema. If no box is checked, then no diseased or dead Diadema were observed.

| | | | |
|---------------------|---|---|------------------------|
| Diver: J. Blondeau | Date: 6/1/2022 | Field ID: | Data Manager: Blondeau |
| Buddy: C. Langwiser | 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) |
| 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 | Diadema <input type="checkbox"/> Diseased/Dead | Biotic Cover - Dominant Biological Cover % | |
| Hard Relief m | <input type="checkbox"/> Not sampled | SAND | HARDBOTTOM |

Figure 10. Diadema at the site level within the header information on the NCRMP Fish datasheet.

Site Photographs

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

1. 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 heading information should be clear and legible in the photograph.
 - b. Take four site photographs at the four cardinal compass headings (i.e. 0°, 90°, 180° and 270°).
 - c. 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.

Data sheet review

At the end of the 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.** 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 size numbers.
 - c. Completeness and legibility of topographic complexity records.
 - d. Completeness of submerged debris and coral disease with tissue loss. Record coral disease with tissue loss in the boat log.
 - e. Discuss among team members and concur on habitat type.
 - f. Discuss any strange, unique, weird (first time you have ever seen it) type of species as this can help with species ID errors.

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Appendices

Appendix I. Illustrations of NCRMP survey placement and survey areas

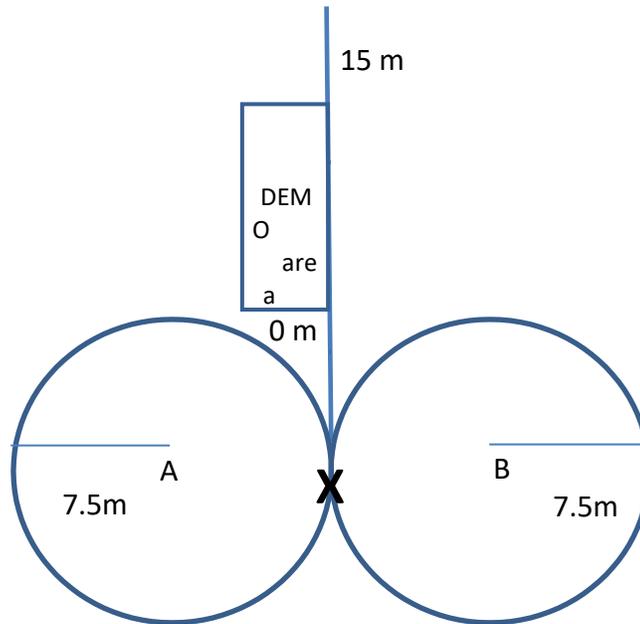


Figure A. Suggested placement of fish and benthic survey areas combined if continuous hardbottom. A and B represent two fish divers.

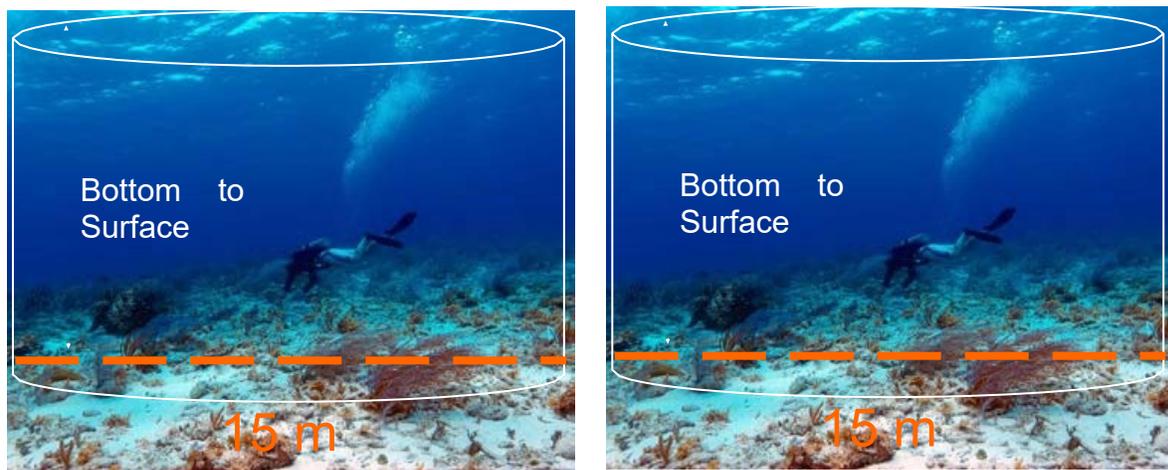


Figure B. Photos indicating optimal cylinder placement. The dive team's surface buoy will be tied to the bottom in between both cylinders. The benthic team may start the transect in the vicinity of the fish team's surface buoy.

Appendix IV. NCRMP habitat type classifications

Puerto Rico and U.S. Virgin Islands¹

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 Tract²

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.

¹Adapted from:

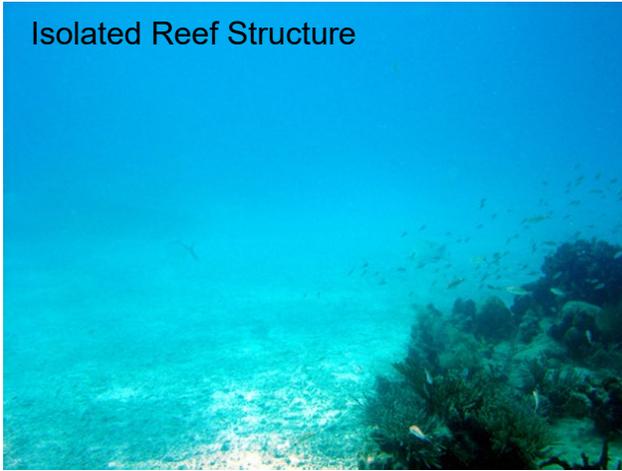
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²Adapted from:

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

Appendix IV. NCRMP habitat type classifications

Isolated Reef Structure



Contiguous Reef, Spur & Groove



Contiguous Reef, Other



Reef Rubble

