Reef Visual Census (RVC) Fish Survey Protocol for the Atlantic Region: US Caribbean, Florida and the Gulf of Mexico: 2019

National Coral Reef Monitoring Program (NCRMP)
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Introduction

The National Coral Reef Monitoring Program (NCRMP) is a broad-spatial snapshot for reef condition (*i.e.*, fish species composition/density/size, benthic cover, and coral density/size/condition) to provide context for local-scale studies of tropical reef ecosystems. Data collection will occur at stratified random sites where the sampling domain for each region (*e.g.*, Puerto Rico, U.S. Virgin Islands (USVI), Flower Garden Banks (FGB) and Florida) 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.

NCRMP fish surveys conducted in the Pacific and Florida regions are conducted using the Reef Visual Census (RVC) point count method (Brandt et al., 2009) while the US Caribbean/Gulf of Mexico region (Puerto Rico, USVI, FGB) have traditionally used the belt transect method. To standardize fish data collection methods and for comparison purposes, all jurisdictions will be using the RVC method for conducting fish surveys beginning in 2016. The 2017 RVC protocols for USVI had 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. This protocol will describe fish surveys conducted in the U.S. reefs in the Caribbean, Gulf of Mexico, and Florida.

Goal of Fish Surveys

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 in the U.S. coral reef jurisdictions. While all jurisdictions will use the RVC method, slight adjustments must be made in order to account for regional implementation nuances. This protocol is intended for the Florida 2018 and USVI 2019 sampling season and may be refined in subsequent years.

General Task Description

The Reef fish Visual Census (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 the surface. In Florida, two individual teams, consisting of two divers per team, are each conducting a 7.5 m radius stationary point count fish survey. This is defined as a 2-stage survey design, where the 2nd stage is used to reduce variance. This differs in the U.S. Caribbean, where a 1-stage survey design is implemented by a team of two

divers. Data collected by each pair is averaged respectively to reduce variability at the site level.

Line Point-Intercept (LPI) 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 two diver 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 Assessment Protocols for the Atlantic Region: U.S. Caribbean, Florida and the Gulf of Mexico: 2019* and *Coral Demographics Survey Protocol for the Atlantic Region: U.S. Caribbean, Florida and Gulf of Mexico: 2019*

RVC Diver responsibilities include collecting:

- Fish information
- Benthic cover information
- Coral Disease information
- Overall topographic information
- Site photos

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 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 set up is unique for each boat and will be used by the diver teams to mark the site for surface support, to mark a starting point for the dive teams and to verify site location with computer generated sites. Record each team's unique GPS # and dive flag numbers on the daily boat log (Figure 1; 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 #3 below)
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.
    a. If 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).

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 decent, the team assesses the suitability of the site by ascertaining: (1) presence/absence of hardbottom, (2) observed habitat type, and (3) visibility of the cylinder.

1. 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 the site (no hardbottom at all, *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 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. When a benthic team deploys with the RVC team, benthics to set up adjacent to the cylinders if possible, using the same anchor point for the belt transect. Benthics can swim to nearby hardbottom if it is patchy where the RVC is established, if they remain in visual context with the RVC divers and the surface float (Appendix I).

4. Under optimal visibility conditions, the distance between dive buddies should be 15 m (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., 7.5 m or 4.0 m depending on visibility) as a:

a. Determine visibility of 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.

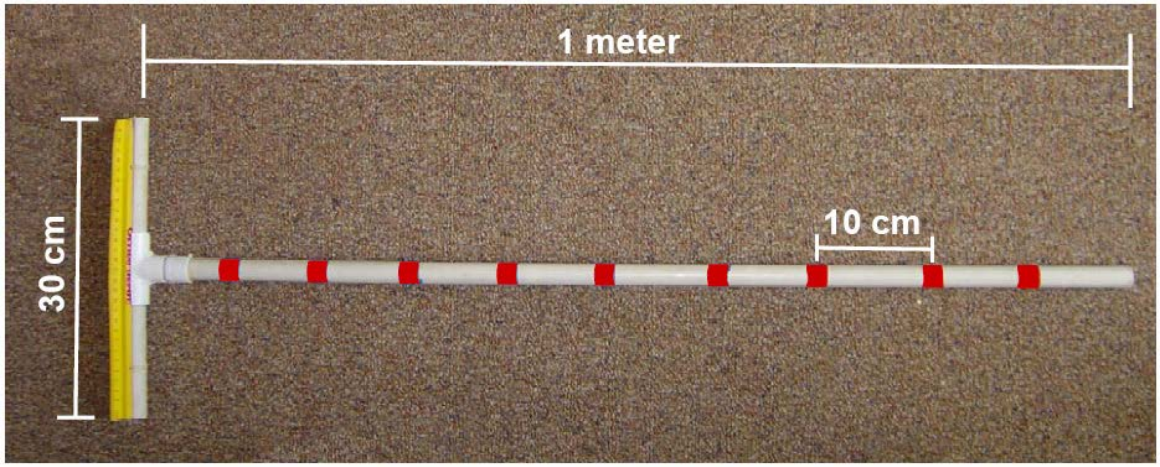


Figure 1. The All Purpose Tool (APT) used as a tool for measuring benthic relief, estimating fish lengths, and the dimensions of survey cylinder.

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. **Terminating the dive –** Certain environmental conditions are not safe for operations and surveys should be automatically terminated and alternates chosen when:

   a. **Visibility is less than 4 m**

   b. **Bottom currents are strong enough that the divers cannot maintain a stationary position**,

   c. **Depth of the selected site is greater than 99 ft**.

Reasons to terminate a dive:

- Visibility (< 4m)
- Strong currents
- Depth (> 99ft)

** **ALWAYS** Indicate reasons for terminating dives on boat logs**

RVC Sequence of events

RVC data collection occurs in three phases: (1) Predive, (2) fish counting/measuring, (3) and site/benthic/topographic assessment (Figure 2).

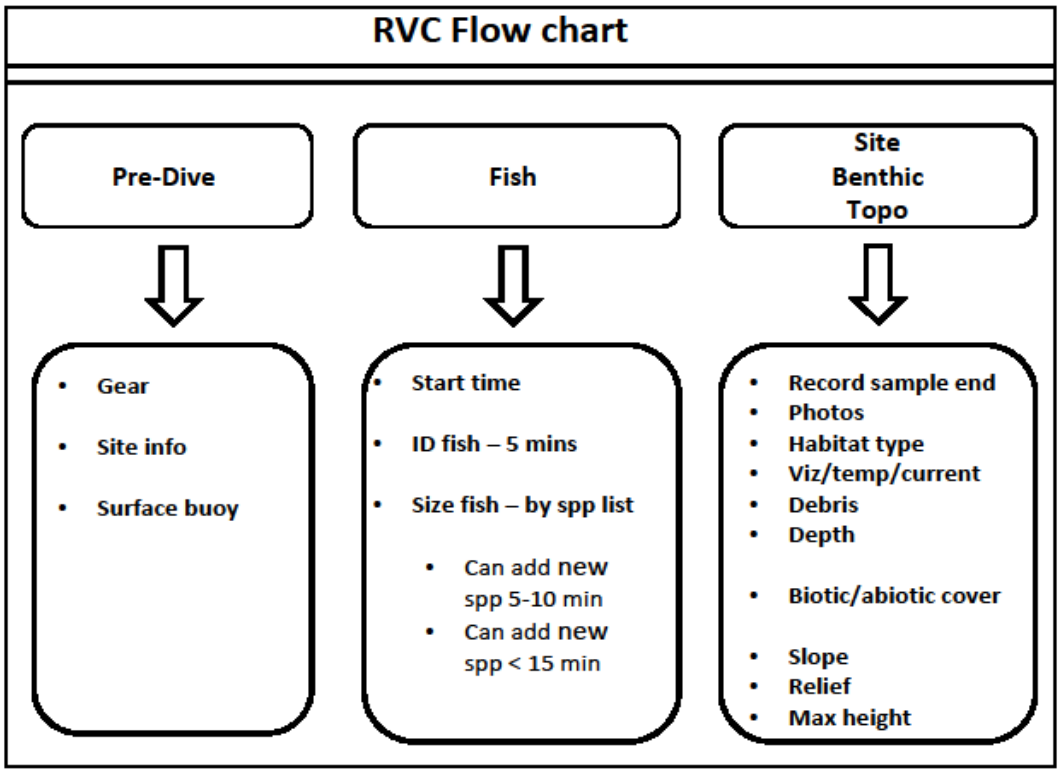


Figure 2. Reef visual census (RVC) sequence of events.

Predive

Station information is to be recorded in two primary locations prior to entering the water: *Boat/Dive log* (Figure 3) and *datasheet* (Figure 4).

Boat Log

Key fields to record for station information include (Figure 3):

1. *Site* – The 4-digit station number.
2. *Station* – The location of each "team" of replicate fish divers at the station.
    a. Caribbean and FGBNMS is 1-stage and always '1'
    b. Florida is 2-stage where '1' and '2' would be assigned
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 Assessment data is assigned the code 'J'; the diver collecting Demographic 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 potentially rotate**

4. *Comments* – After the survey is complete record coral disease with tissue loss at the site.

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

Divers should pre-populate station information, same as recorded on the boat log, on their datasheet prior to entering the water.

1. *Logistic and station information* – Names of all divers, Field ID, date, time of survey, mission data manager and meters completed (Figure 4; 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.

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 used for all Caribbean fish surveys).

- Dive start time is the time divers leave the boat.
- The diver can enter visibility as they will need to determine visibility as they establish the cylinder.

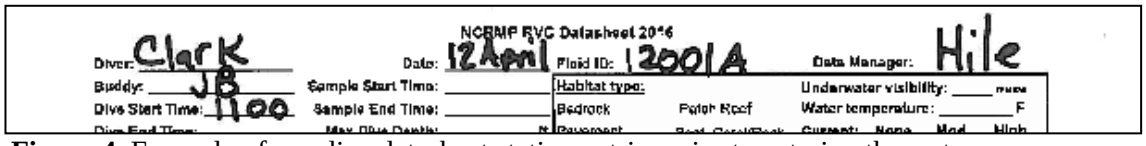


Figure 4. Example of pre-dive datasheet station entries prior to entering the water.

Fish counting/measuring

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

1. Each diver will identify to species 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 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 zoom 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 down the list of identified species on the datasheet and begins to estimate fork length size to the nearest 1 cm. For enumeration and size estimation for most species, one 360-degree rotation is typically made for each species (Figure 4).

   For example (Figure 5), fishes are measured by total number (N), average size (AVG), minimum size (Min) and maximum size (Max). 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.

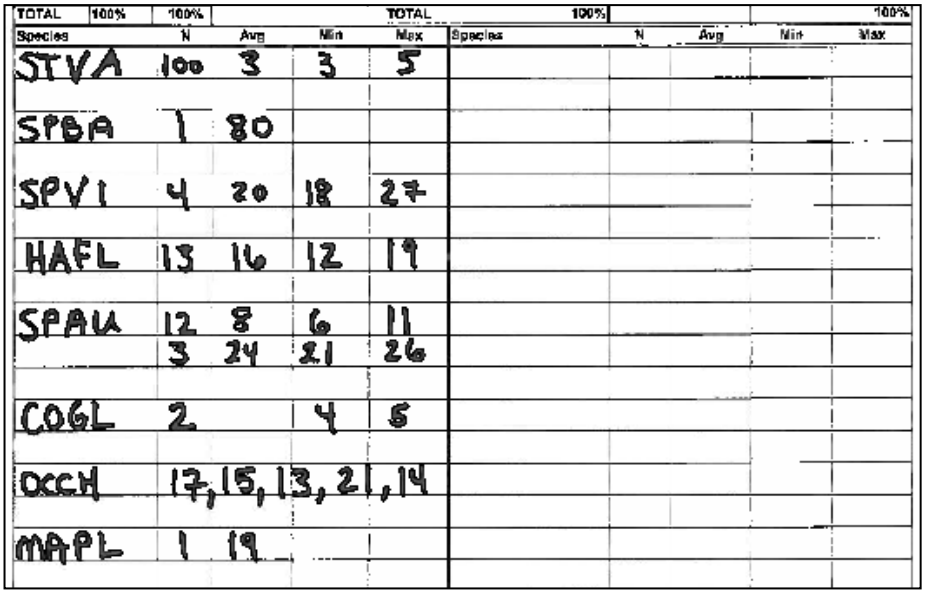


Figure 5. Example of fish observations during RVC survey.

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 fish below that line.

   b. The diver can add new species for 5 more minutes and draw another line under the second grouping of species.

c. If the fish survey is continuing into 15 minutes, new species can be added in a third grouping (Figure 6).

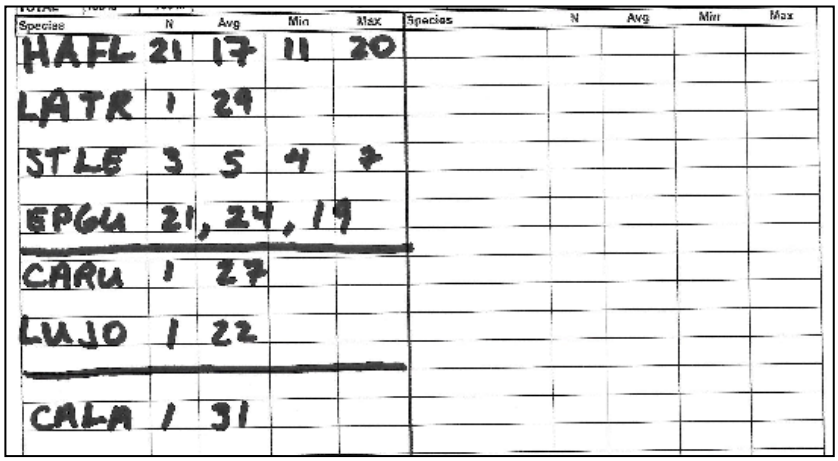


Figure 6. Example of adding new fish species after the 5 and 10 minute segments.

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. These species are:

Table 1. List of commercial and/or recreational species for individual sizing.

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

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

Site/Benthic/Topographic assessment

Following the fish survey, site information is collected and recorded on the Fish/Habitat data sheet (Figure 7). The following variables are measured and recorded:

1. Habitat type: chosen from the following categories (circle **one** on the Fish/Habitat datasheet). At the surface, the diver should discuss with their buddy and other team members and try to come to a consensus. If a consensus is not achieved divers should note that in the Field/Boat Log. **NOTE: habitat types are different in the U.S. Caribbean, Flower Garden Banks, and Florida (Appendix IV).**

2. 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. (diver is able to stay in same position with a gentle kick), High (diver struggles to stay in same position).

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 (Appendix V).

4. Max Vertical Relief: the maximum vertical relief within the sample cylinder of both hard (e.g., coral structure, coralline spur, rocky outcrop) and soft (e.g., octocorals, sponges and macroalgae) substrate. These values should not be zero.

5. Surface Relief Coverage: for hard vertical relief (e.g., coral structure, coralline spur, rocky outcrop): 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. 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.

7. Abiotic Footprint: the percentage of the cylinder comprised of sand, hardbottom and rubble. 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 (< 0.2 mm).

        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 hard-bottom. 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 taxanomic 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.

10. Coral disease with Tissue Loss: in light of increasing concern for coral disease in Florida and the Caribbean, a field was added to all dive sheets to track evidence of recent mortality and associated coral tissue loss related to disease at the site level using the following selections in your header information.

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

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 was not able to observe
Fast (>1cm) - tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of tissue loss is >1cm in width/diameter, therefore rate of disease spread is fast (acute).
Slow (<1cm) - tissue loss due to disease is observed on at least 1 coral colony at the site and the maximum width of tissue loss is <1cm in width/diameter, therefore rate of disease spread is slow (sub-acute).

NCRMP RVC Datasheet 2018

Diver: RC
Buddy: JB
Dive Start Time: 1000
Dive End Time: 1030
Date: 4/Apr/1
Sample Start Time: 1005
Sample End Time: 1020
Max Dive Depth: 49 ft
Station Depth: 48 ft
Field ID: 10001A
Data Manager: Hile
Habitat type: Bedrock, Pavement, Aggregate Reef, Patch Reef, Scat. Coral/Rock in Sand
Underwater visibility: 8 m
Water temperature: 90 F
Current: None, Mod., High
Submerged Debris: X None ☐ LiveTrap ☐ TrapDebris ☐ Fishing ☐ Other

Substrate Slope
Max depth 47 ft
Min depth 49 ft

Max vertical Relief
Hard Relief 0.5 m
Soft Relief 0.4 m

Surface Relief Coverage %

	Hard	Soft
< 0.2 m	90 %	90 %
0.2-0.5 m	10 %	10 %
0.5-1.0 m	%	%
1.0-1.5 m	%	%
> 1.5 m	%	%
TOTAL	100%	100%

Abiotic Footprint

SAND	5	%
HARD-B	90	%
RUBBLE	5	%
Total	100%	

Biotic Cover - Dominant Biological Cover %

SAND		HARDBOTTOM	
"Bare"	97	Algae (<1cm)	63
Macro Algae	1	Algae (>1cm)	15
Sea grass		Live Stony Coral	5
Sponge	2	Octocoral	4
Other 1		Sponge	9
Other 1		Other 1 SCA	10
		Other 1	
TOTAL	100%		100%

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max

Figure 7. Example of site information, benthic cover and topographic information gathered during an RVC survey in the U.S. Caribbean (note the habitat types).

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. In Florida, one diver in each two diver buddy team will take pictures. In the U.S. Caribbean, benthic and fish teams often dive together and the benthic assessment diver will take pictures.

1. Station Documentation: at least five photographs per station
    a. Take one photograph of station and logistic information at the top of the datasheet prior to taking any photographs of the site. The station name, date, time and heading information should be clear and legible in the photograph.
    b. Take four site photographs at the four cardinal compass headings (i.e. 0^o, 90^o, 180^o and 270^o).
    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.

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

Field Equipment

- SCUBA gear
- Fish survey datasheet, clipboard, pencil (& backup pencil)
- All Purpose Tool (APT; Figure 1)
- Camera/housing

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. *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 (Florida). Record coral disease with tissue loss in the boat log.
    e. 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.

Appendix I. Illustrations of survey placement and cylinders

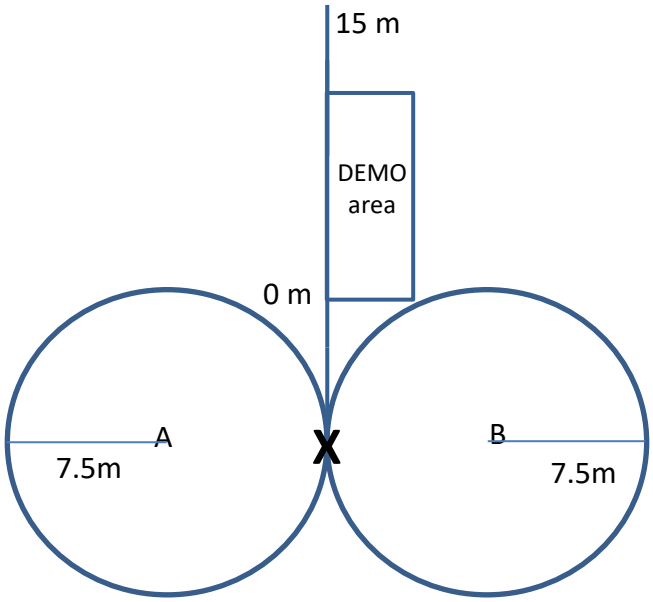


Figure A. Suggested placement of fish and benthic survey areas combined if continuous hardbottom. A and B represent two fish divers.

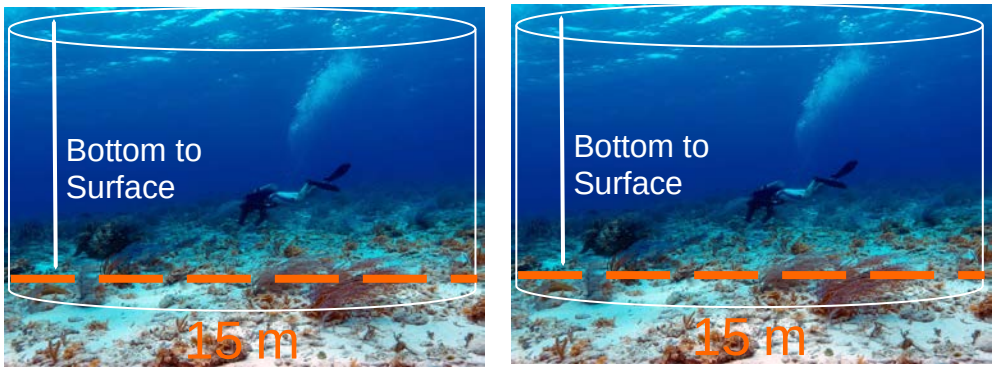


Figure B. Photos indicating optimal cylinder placement. The dive teams surface buoy will be tied to the bottom in between both cylinders. Benthic team may start transect in the vicinity of the fish teams surface buoy.

APPENDIX II. Example of Boat Log

Date: NCRMP

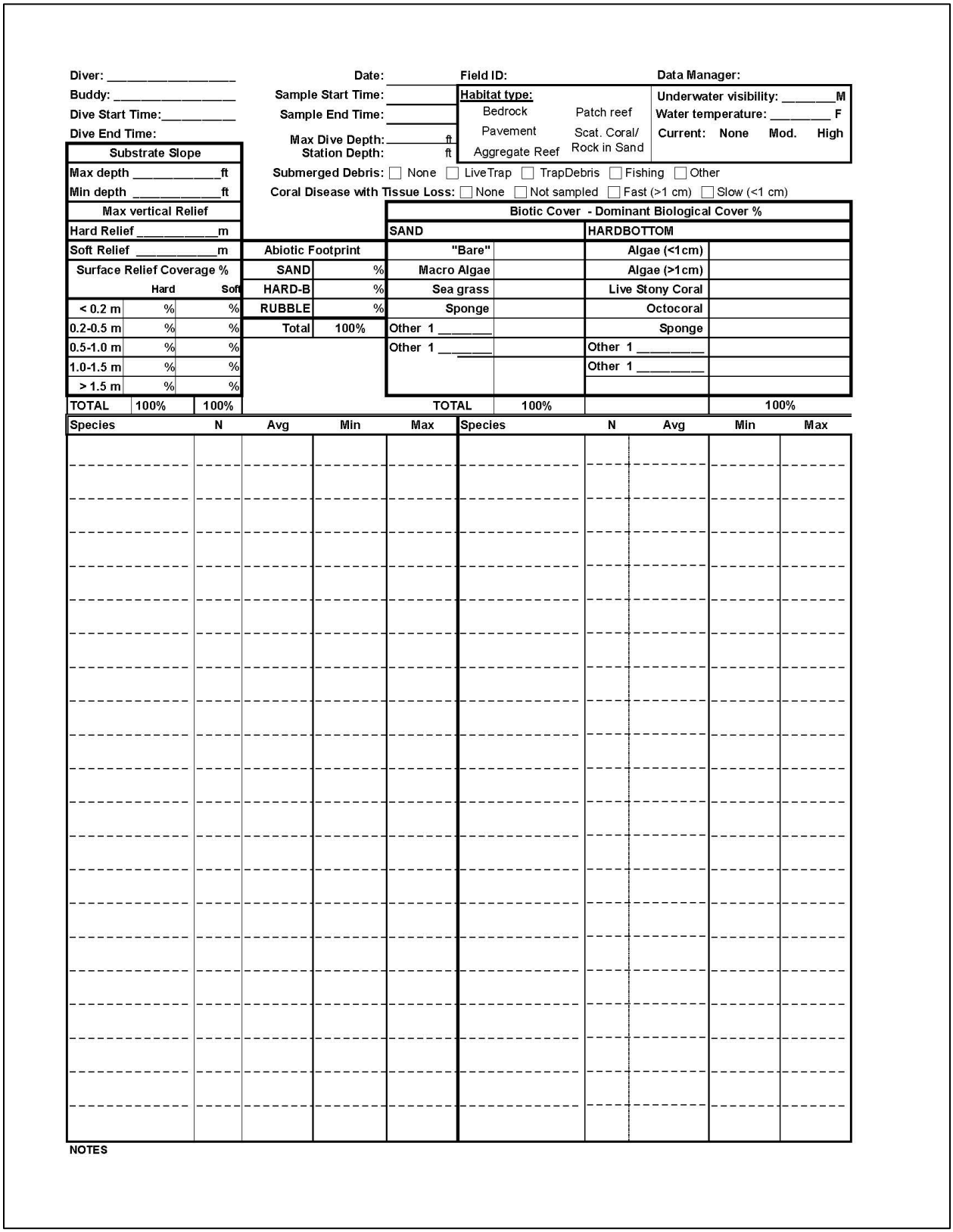
Divemaster: **Supervisor's Dive Log** **Page _____ of _____**

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

DOD= # dive of day

Appendix III. RVC Datasheets

Example 1: 2019 RVC Datasheet for U.S. Caribbean



Diver: _____ Date: _____ Field ID: Data Manager:

Buddy: _____ Sample Start Time: _____ Habitat type: Underwater visibility: _____M

Dive Start Time:_____ Sample End Time: _____ Bedrock Patch reef Water temperature: _____ F

Dive End Time: Pavement Scat. Coral/ Rock in Sand Current: None Mod. High

Max Dive Depth: _____ft Aggregate Reef

Station Depth: ft

Submerged Debris: ☐ None ☐ LiveTrap ☐ TrapDebris ☐ Fishing ☐ Other

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

Substrate Slope
Max depth _____ft
Min depth _____ft

Max vertical Relief
Hard Relief _____m
Soft Relief _____m

Surface Relief Coverage %		
	Hard	Soft
< 0.2 m	%	%
0.2-0.5 m	%	%
0.5-1.0 m	%	%
1.0-1.5 m	%	%
> 1.5 m	%	%
TOTAL	100%	100%

Abiotic Footprint	
SAND	%
HARD-B	%
RUBBLE	%
Total	100%

Biotic Cover - Dominant Biological Cover %			
SAND		HARDBOTTOM	
"Bare"		Algae (<1cm)	
Macro Algae		Algae (>1cm)	
Sea grass		Live Stony Coral	
Sponge		Octocoral	
Other 1 _____		Sponge	
Other 1 _____		Other 1 _____	
		Other 1 _____	
TOTAL	100%		100%

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max

NOTES

Appendix III.

Example 2: 2018 RVC Datasheet for the FGBNMS

Diver: _____ Date: _____ Field ID: _____ Data Manager: _____

Buddy: _____ Sample Start Time: _____ Habitat type: Underwater visibility: _____M

Dive Start Time: _____ Sample End Time: _____ High Relief / Low Relief Water temperature: _____ F

Dive End Time: _____ Max Dive Depth: _____ ft Current: None Mod. High

Station Depth: _____ ft

Submerged Debris: ☐ None ☐ LiveTrap ☐ TrapDebris ☐ Fishing ☐ Other

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

Substrate Slope
Max depth _____ft
Min depth _____ft

Max vertical Relief
Hard Relief _____m
Soft Relief _____m

Surface Relief Coverage %	Hard	Soft
< 0.2 m	%	%
0.2-0.5 m	%	%
0.5-1.0 m	%	%
1.0-1.5 m	%	%
> 1.5 m	%	%
TOTAL	100%	100%

Abiotic Footprint	
SAND	%
HARD-B	%
RUBBLE	%
Total	100%

Biotic Cover - Dominant Biological Cover %			
SAND		HARDBOTTOM	
"Bare"		Algae (<1cm)	
Macro Algae		Algae (>1cm)	
Sea grass		Live Stony Coral	
Sponge		Octocoral	
Other 1 _____		Sponge	
Other 1 _____		Other 1 _____	
		Other 1 _____	
TOTAL	100%		100%

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max

NOTES

Appendix III.

Example 3: 2018 RVC Datasheet for Florida and the Dry Tortugas

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)

Submerged Debris: ☐ None ☐ LiveTrap ☐ TrapDebris ☐ Fishing ☐ Other

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

Substrate Slope
Max depth _____ft
Min depth _____ft

Max vertical Relief
Hard Relief _____m
Soft Relief _____m

Surface Relief Coverage %	Hard	Soft
< 0.2 m	%	%
0.2-0.5 m	%	%
0.5-1.0 m	%	%
1.0-1.5 m	%	%
> 1.5 m	%	%
TOTAL	100%	100%

Abiotic Footprint	
SAND	%
HARD-B	%
RUBBLE	%
Total	100%

Biotic Cover - Dominant Biological Cover %			
SAND		HARDBOTTOM	
"Bare"		Algae (<1cm)	
Macro Algae		Algae (>1cm)	
Sea grass		Live Stony Coral	
Sponge		Octocoral	
Other 1 _____		Sponge	
Other 1 _____		Other 1 _____	
		Other 1 _____	
TOTAL	100%		100%

Species	N	Avg	Min	Max	Species	N	Avg	Min	Max

NOTES

Appendix IV. Habitat Types

U.S. Caribbean habitat types[1]

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

Bedrock: Exposed bedrock contiguous with the shoreline. May be colonized or uncolonized (often covered by a thin sand veneer with sparse coverage of biota).

Patch reef: Coral formations that are isolated from other coral reef formations by sand, seagrass or other habitats. Can be an individual patch reef or aggregate patch reefs.

Pavement: Flat, low-relief, solid carbonate rock. May be colonized or uncolonized (often covered by a thin sand veneer with sparse coverage of biota).

Scattered coral/rock in sand: Primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually (i.e., smaller than individual patch reef).

Gulf of Mexico (Flower Garden Banks National Marine Sanctuary) habitat types

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 and the Dry Tortugas: four main habitat types[2]

Contiguous Spur & Groove: A continuing reef structure with well-defined spur (hardbottom) and groove (sand channel) formations. Can be low or high relief spur and groove.

Contiguous Other: Contiguous low relief hardbottom.

Isolated: Larger reef formations that are isolated by sand, seagrass or other habitats; e.g., patch reefs, rocky outcrops, pinnacles.

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

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

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

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

Appendix IV. Slope and depth illustrations

Illustration of substrate slope and depth measurements.