Coral Reef Ecosystem Division – Standard Operating Procedures: Rapid Ecological Assessment (REA) Benthic Survey Data Collection

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Introduction:

The standard operating procedures outlined in this report apply to the Pacific RAMP surveys that CRED and its partners conduct in the coral reef ecosystems of ~ 50 primary islands, atolls, and shallow banks in the Hawaiian Archipelago (including Papahānaumokuākea Marine National Monument), the Mariana Archipelago (Guam and the Commonwealth of the Northern Mariana Islands, including the Marianas Trench Marine National Monument), American Samoa, and the Pacific Remote Islands Marine National Monument (Wake, Johnston, Palmyra, and Kingman Atolls and Howland, Baker, and Jarvis Islands). As part of CREDs ecosystem assessment and long term monitoring efforts, reef corals and benthic communities are surveyed at Rapid Ecological Assessment (REA) sites selected using a stratified random sampling design. The objectives and details of the methods employed are outlined here.

Objectives:

The objective of this document is to establish guidelines and procedures for implementation of survey design, training, sampling, and data entry for the monitoring of reef coral populations and communities as part of the Pacific Reef Assessment and Monitoring Program (Pacific RAMP) led by the Coral Reef Ecosystem Division (CRED) of the NOAA Pacific Islands Fisheries Science Center.

The two primary objectives of the monitoring effort are: 1) to determine status, trends, and variability of Scleractinian corals within each of five regions [Main Hawaii Islands (MHI), Northwest Hawaiian Islands (NWHI), American Samoa (SAMOA), Pacific Remote Island Areas (PRIA), Guam and the Commonwealth of the Northern Mariana Islands (MARIAN)] in the Pacific, islands within regions, and management zones using measures such as total and relative abundance (density), distribution, and size structure and 2) to determine status, trends, and variability in benthic reef coral communities within each of the five regions in the Pacific, islands within regions, and management zones, using measure such as relative abundance (percent cover), frequency of occurrence, coral community taxonomic composition and relative species richness.

Methodology: Summary

Sampling design

While there are several methods to select a sample from a population, a selection method can be devised that provides more accurate and precise survey estimates if information is known about a population. In situations where either there is very little information about the metrics to be collected or there is no spatial structure in the variance of these metrics, a simple random sampling design is appropriate. However, coral abundance metrics are typically heterogeneous and vary in space according to certain environmental covariates such as depth, vertical relief, and patchiness (Smith et al. 2011, Swanson 2011). Given the general knowledge of heterogeneous distributions of coral populations, benthic maps of environmental covariates can be used to effectively divide the sampled area into strata. Random samples can be allocated into these strata based on each stratum's proportional area and the variance structure of the population within the stratum. This type of stratified random sampling design is capable of more effectively and efficiently sampling a coral population than a simple random sampling design (Cochran 1977)

The stratification scheme employed for benthic REA surveys is specific to each of the five regions and based on the resolution of the benthic maps for each region. In general, the stratification incorporates geographic sub-regions of islands, cross-shelf (nearshore to offshore) components such as backreef, lagoon, and forereef, and depth (0-30m). Ultimately, reef habitat types that reflect a gradient of complexity and patchiness will be incorporated into the stratification scheme as the resolution of benthic maps improve for each region. The number of sites allocated to each stratum is determined by the proportion stratum area initially but in the future can be optimized for a suite of focal species using the variance structure of abundance for each. Sites within each stratum are located randomly.

The StRS design requires that surveys at each site are both efficient and high quality. Efficiency increases our ability to survey more sites which improves the power of both population and stratum-specific (spatial) estimates of abundance, density, size structure, partial mortality and prevalence of disease, bleaching etc. The quality of the data at each site translates to better estimates of abundance, size structure, and condition as well as interpretation of condition patterns such as partial mortality and disease and bleaching prevalence.

Benthic surveys

Surveys at each site are conducted within two, 18 meter belt transects and include the following suite of metrics:

(1) Adult coral colony (≥ 5 cm) size, condition and abundance
(2) Crustose coralline and Alcyonarian disease
(3) Alcyonarian presence
(4) Juvenile coral colony (< 5 cm) size and abundance
(5) Benthic cover

Adult coral colonies

Adult coral colonies (≥ 5 cm) are surveyed within four (1.0 x 2.5 m) segments on each transect ($10m^2$ per transect; $20m^2$ per site). Colonies are identified to lowest possible taxonomic level.

For the most part, corals in the Main and Northwest Hawaiian Islands regions (MHI, NWHI) are identified to species, and in the remaining three Pacific regions (MARIAN, PRIA, SAMOA), corals are identified to genus with the exception of a short list of species that are identifiable in situ. The empirical measurements, estimates, and evaluation of each colony include the following:

(1) Morphology is noted,
(2) Size is measured (maximum diameter to nearest cm),
(3) Partial mortality is estimated as percent of colony in terms of old dead and recent dead,
(4) Cause of recent mortality is identified if possible,
(5) Condition is assessed (including some disease and bleaching) along with the extent and level of severity.

Crustose coralline algae* (CCA) *and Alcyonarian disease

Within the same four segments per transect as the adult coral surveys, crustose coralline algae (CCA) diseases and Alcyonarian disease are surveyed. In each segment, each occurrence of a specific disease is identified and the lesion is measured (maximum diameter).

Anthozoan (other cnidarians) presence

In addition to the adult coral surveys, CCA diseases, and Alcyonarian disease, the presence of Anthozoans (other cnidarians including Alcyonarians, Zoantharians, and Ceriantipatharians) are also noted.

Juvenile coral colonies

Juvenile coral colonies (< 5 cm) are surveyed within three (1.0 x 1.0 m) segments on each transect ($3m^2$ per transect; $6m^2$ per site). Each juvenile colony is identified to lowest taxonomic level possible, morphology is noted, and size is measured using two measurements (maximum and perpendicular diameter). Similar to adult corals, juvenile corals in the Main and Northwest Hawaiian Islands regions (MHI, NWHI) are identified to species if possible, and in the remaining three Pacific regions (MARIAN, PRIA, SAMOA), juvenile corals are identified to genus with the exception of a short list of species that are identifiable in situ. However, in some cases, the juvenile corals are too small to identify to species no matter what region is being surveyed.

Benthic cover

Quadrats are photographed along two 18 meter transects which are used to estimate benthic cover. Photoquadrat images are collected at one meter intervals on each transects for a total of 15 quadrats per transect and 30 per site. These images are later analyzed by staff at CRED and partners at Scripps Institution of Oceanography, University of California San Diego, using the computer program Coral Point Count with Excel extensions (CPCe), to determine the benthic composition at higher taxonomic levels for each REA site (photographs from similar surveys at REA sites surveyed by the fish team will also be analyzed).

Methodology: Field implementation

Sampling design

For each survey cruise, a list of random sites and maps will be provided. The benthic team lead will provide a list of primary and alternate sites for each dive team along with maps to use as a reference daily.

Site location

Sample sites are located using a hand held GPS unit or the GPS aboard the boat. Upon arrival at the sample site, divers should attempt to determine (via a depth finder display or snorkeling) whether the stratum (benthic habitat) at the survey location is reef habitat. If the random site location is too deep for the stratum (habitat) type that is supposed to be surveyed, follow the contour of the reef towards a shallower location. The new site coordinates should be recorded while noting the original coordinates and the depth from the depth finder. If the benthic habitat is not reef habitat, the divers should swim in one direction for one minute (try to find consolidated hard bottom in depth range of target stratum). If no reef habitat is found, the divers should surface and move on to the next sampling location for the stratum indicated. A diver should NOT just swim toward a site that "looks" good (i.e. more coral)

Benthic surveys

At each site, the following tasks should be completed by each dive team:

1) Deployment of transects
2) Site characterization
3) Minimum and maximum depths for each transect (recorded in feet)
4) General site photographs
5) Signal boat for proper GPS coordinate location with PAM
6) Photoquadrats for benthic cover estimates
7) Ecological surveys: Adult corals, CCA and Alcyonarian disease, Alcyonarian presence, and Juvenile corals

The separation of tasks among the dive team may vary but all members should work cooperatively to survey each site as efficiently and safely as possible.

Deployment of transects

Two 18m transect lines should be deployed along either the structure of the reef or a depth contour (if steep incline) to the extent possible. The transect lines can be relatively parallel if a haphazard distance apart (at least 3 m separation). If the transects are deployed to follow a depth contour, the distance between them should be haphazard as well (not end-to-end). Each transect should be secured to bottom as tightly as possible.

Site characterization

One diver is assigned to record depth at both ends of each transect, take general site photos, note the general description of the site, and identify habitat type (which incorporates complexity and patchiness). The site characterization and habitat type should provide a description of the

general survey area (50 x 50 m grid cell). The categories for habitat type are modified from Kendall M.S. and M. Poti, (2011) and include the following eleven types:

1. Aggregate reef
2. Aggregate patch reef
3. Aggregate patch reefs
4. Pavement
5. Pavement with patch reefs,
6. Pavement with sand channels
7. Rock/boulder
8. Reef rubble
9. Spur and groove
10. Sand with scattered Coral/Rock
11. Wall

Because of the great variety of reef habitats comprising ecosystems around the many Pacific islands surveyed by CRED, a survey area may not fall neatly into one of these categories. The category with the definition that most closely fits the habitat should be selected. At the surface, the diver should discuss with their buddy and try to come to a consensus.

Aggregate Reef: Hard-bottom substrate with corals, also referred to as continuous or consolidated reef (Figure 1). This habitat type may have high relief but lacks the sand or pavement channels of Spur and Groove. Most reefs that do not obviously fall in other types are recorded as Aggregate reef.

Figure 1. Example of Aggregate reef. *NOAA photo*

Aggregate Patch Reef: May also be referred to as Individual Patch Reef. Coral formations that are isolated from other coral reef formations by sand or other habitats and that have no organized structural axis relative to the shore or shelf edge. They are characterized by an often circular or oblong shape with a vertical relief of one meter or more in relation to the surrounding seafloor

and are larger or equal to the general survey area (50x50m). This type is most commonly noted in lagoons (e.g., Rose Atoll) or backreefs (e.g., northern Pearl and Hermes Atoll and Midway Atoll). An aerial photo (Figure 2) shows a number of patch reefs in southern Kāne`ohe Bay, O`ahu, Hawai`i.

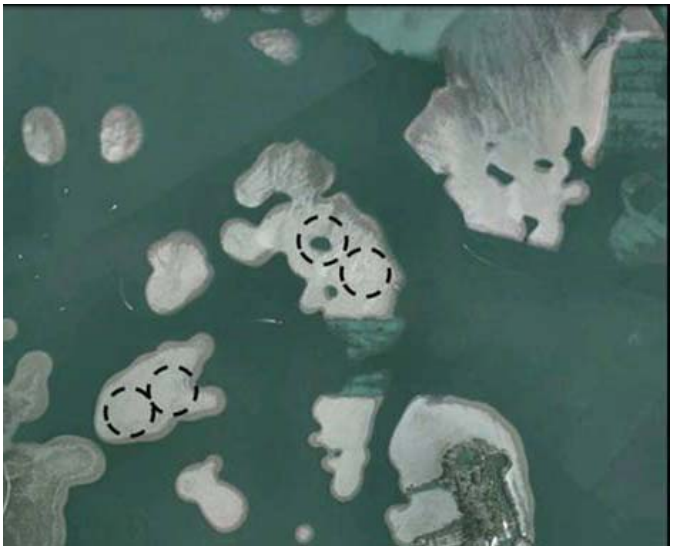


Figure 2.--Aerial view of patch reefs in southern Kāne`ohe Bay, O`ahu, Hawai`i.

Aggregate Patch Reefs: These features have the same defining characteristics of an Aggregate (Individual) Patch Reef, but are clusters of patch reefs that make up the survey area (Figure 3).

Figure 3. Example of Aggregate Patch Reefs habitat. *NOAA biogeo photo*

Pavement: Flat, low-relief, solid rock in broad areas often with partial coverage of sand, algae, hard coral, gorgonians, zooanthids, or other sessile invertebrates that are dense enough to begin to obscure the underlying surface (Figure 4).

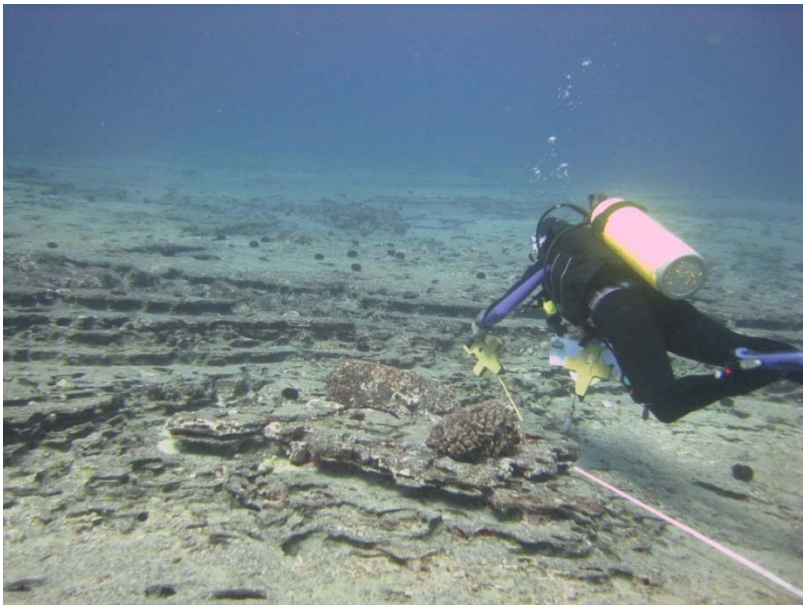


Figure 4. Example of pavement habitat. *Photo by D. White, Hawai`i Department of Land and Natural Resources*

Pavement with Patch Reefs: Areas of pavement with occasional patch reef formations that make up less than 10% of the general area (Figure 5).

Figure 5. Example of Pavement with Patch Reefs habitat. *NOAA biogeo photo.*

Pavement with Sand Channels: Habitats of pavement with alternating sand/surge channel formations that are perpendicular to the shore, bank, or shelf (Figure 6). The channels of this

feature have low vertical relief relative to spur and groove formations and are typically erosional in origin. This habitat type occurs in areas exposed to moderate wave surge such as the bank/shelf zone.

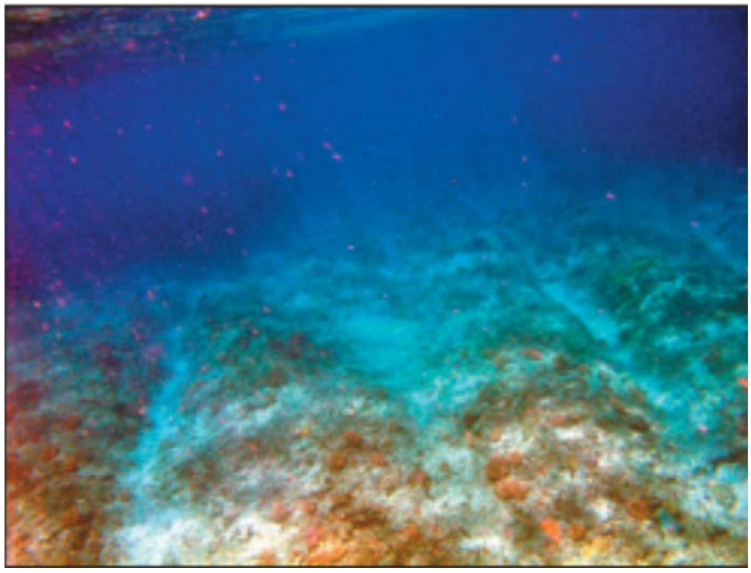


Figure 6. Example of Pavement with Sand Channels habitat. *NOAA biogeo photo*

Rock/Boulder: Large, irregularly shaped carbonate blocks or boulders or volcanic rock often extending offshore from the island bedrock or headlands. Can also occur as aggregations of loose rock fragments that have been detached and transported from their native beds. Individual boulders often range in diameter from .25 – 3 m, with very little benthic cover present (Figure 7).

Figure 7. Example of rock/boulder habitat. *NOAA photo*

Reef rubble: Unconsolidated small (< 10 cm) fragments of coral skeletons or reef rock often colonized with filamentous or other macroalgae (Figure 8). This habitat often occurs landward of well-developed reef formations in reef crest or backreef zones.

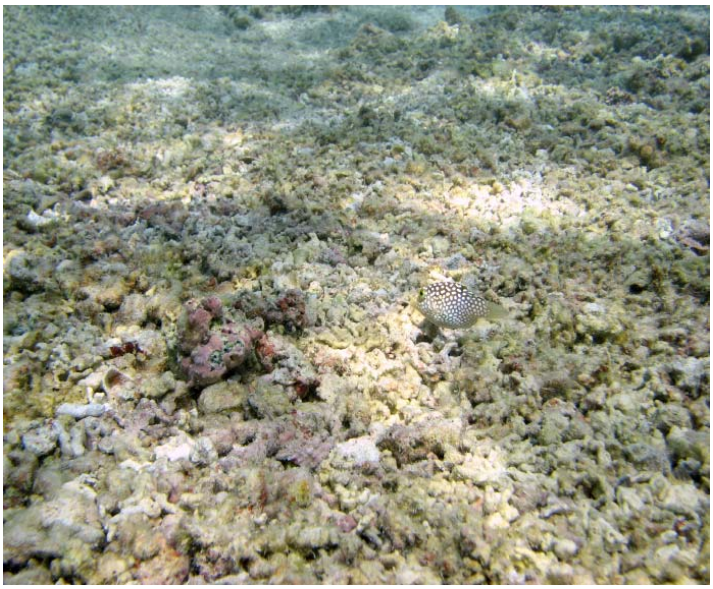


Figure 8. Example of rubble habitat. *NOAA photo*

Spur and groove: Habitat with alternating sand and coral formations that are oriented roughly perpendicular to the shore, bank, or shelf (Figure 9). The coral formations (spurs) of this habitat type typically have a high, vertical relief relative to pavement with sand channels and are separated from each other by 1–5 m of sand or hard-bottom (grooves) substrate, although the height and width of these elements may vary considerably.

Figure 9. Example of spur-and-groove habitat. *NOAA biogeo photo*

Sand with Scattered Coral and Rock: Primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that make up less than 10% of the general area (Figure 10). If the density of the small coral heads is greater than 10% of the general area the habitat is described as Aggregate Patch Reefs.

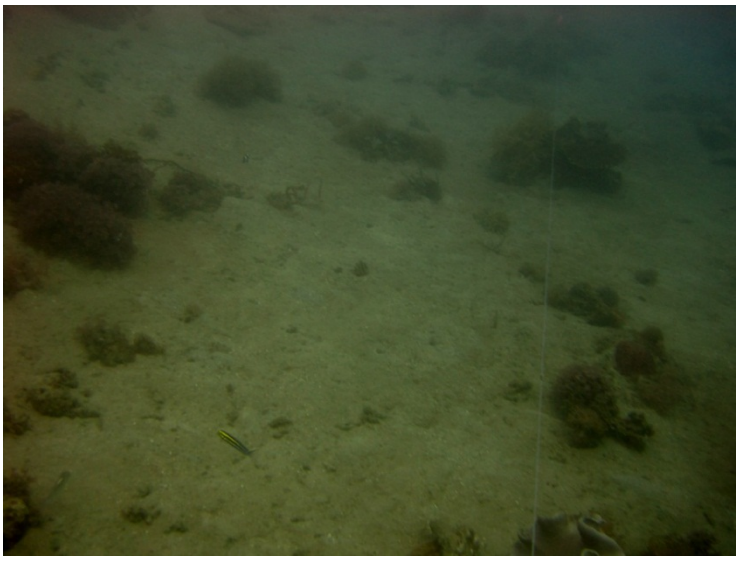


Figure 10. Example of Sand with Scattered Coral and Rock habitat. *NOAA photo*

An example field data sheet is included below with details to describe how the site specific information should be recorded.

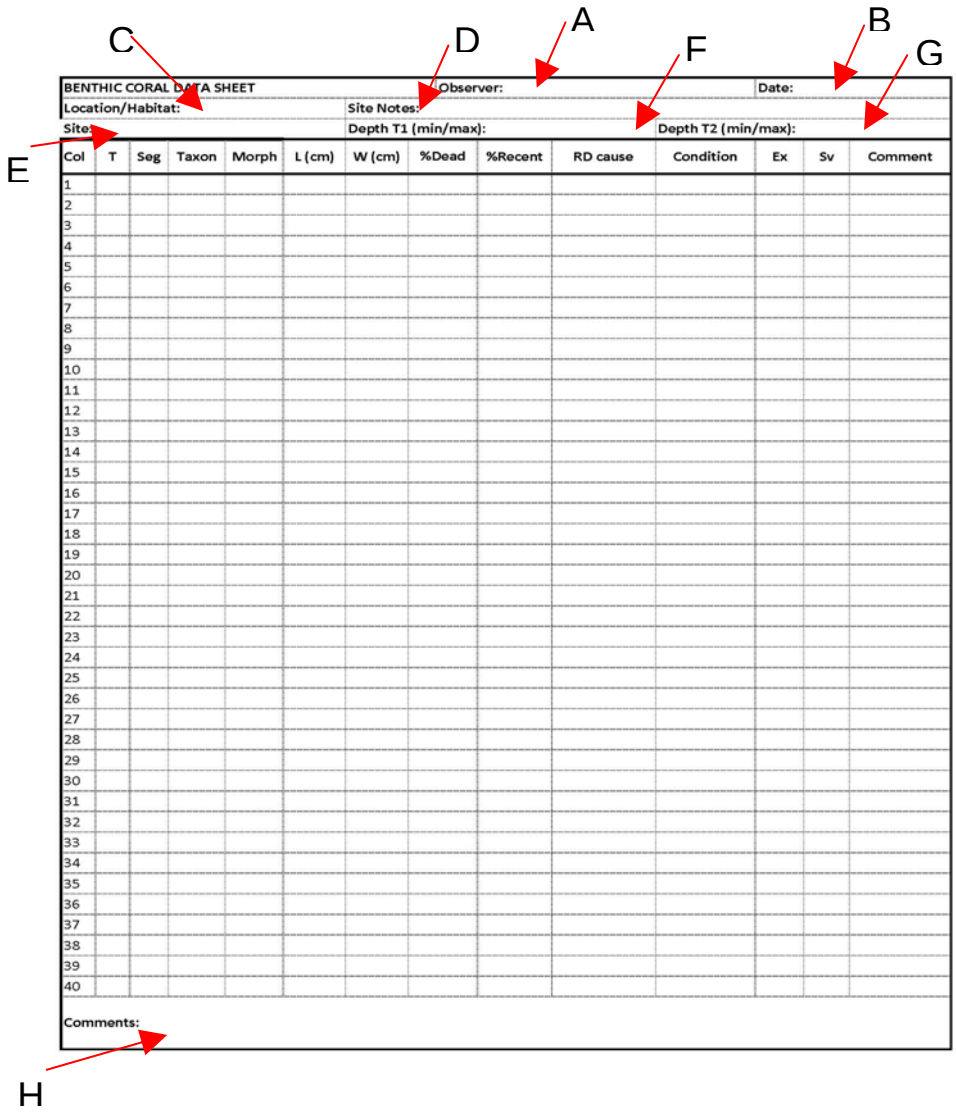


Figure 11. Benthic survey field data sheet.

A. Observer = name or initials
B. Date = date of survey
C. Location/habitat = Island / habitat type
D. Site notes = Quick notes of distinguishing features of the overall site (50x50cm), not just the segments surveyed, and general notes
E. Site = Either site number or even dive of the day (easy to back track to correct site id number)
F. Depth T1 = minimum and maximum depth of either end of transect 1 in feet

G. Depth T2 = minimum and maximum depth of either end of transect 2 in feet
H. Comments = Any additional comments or notes about the sites or surveys

Adult coral surveys

Surveys of adult coral colonies are conducted within four 1.0 x 2.5 meter segments along each transect (2 x 18 m transects) in the following manner and depicted in Figure 12:

0 - 2.5m (Segment 0)
5.0 - 7.5m (Segment 5)
10 - 12.5m (Segment 10)
15 - 17.5m (Segment 15)

The divers conducting the surveys should alternate segments to maintain a safe distance from their dive buddy (e.g., Diver 1 completes Segments 0 and 10 on transect #1 while Diver 2 completes Segments 5 and 15). Only adult coral colonies (≥ 5 cm) with the center of the colony found within the boundaries of the segment are included in the survey.

Figure 12. Example of survey segments on an 18m transect.

Figure 13. Diagram to show an example of the center rule used to survey coral colonies.

Adult coral surveys: What is an individual colony?
Due to partial mortality, identification of an individual colony can be difficult. Considerations used to determine an individual colony include:
1) Are there pieces of live tissue on a common skeletal structure?
2) Are the pieces of tissue similar in color and polyp form?
3) Are the pieces of live tissue more than 10 cm apart?

On some colonies, these live tissue pieces will be positive (YES) for the first two questions but may be more than 10 cm apart = **same colony**.
If the answer for 1 is NO and 2 is YES and its more than 10 cm away = **different colony**.
When answer to 1 is YES and 2 is NO then = **different colony** (even if less than 10 cm away).

Special note: If a colony is a fragment of a larger colony (fission) and less than 5 cm but cannot be defined as a juvenile, it must be included in the adult survey. These colonies are likely non-reproductive but have been shown to have similar growth rates as the intact adult tissue. By distinguishing juveniles from small colonies resulting from fission, estimates of juvenile abundance are improved.

Adult coral surveys: Morphology
Identification of morphology is essential to converting empirical length measurement from our field surveys to a surface area estimate for each colony. The morphology category is a simplified version of colony morphology and is identified within the following categories:

Encrusting (flat)	EF	Adheres to a flat surface
Encrusting (mounding)	EM	Adheres to a mounding surface (e.g. ledge)

Encrusting (columnar)	EC	Adheres to a relatively flat surface and has columns
Mounding/Massive	MD	Solid and similar in shape in all dimensions
Plating	PL	Forms simple plate
Foliose	FL	Plates that form whorls
Laminar	LM	Multiple plates
Branching	BR	Branches present
Knobby	KN	Stubby branches
Columnar	CO	Forms columns
Disc (free living)	FR	Not attached to any substrate (e.g. Fungia sp.)

Figure 14 shows generalized examples of several morphological types. Colony morphology may not always fit neatly into one of these eleven categories, however, the one which best describes the general shape of the colony should be recorded.

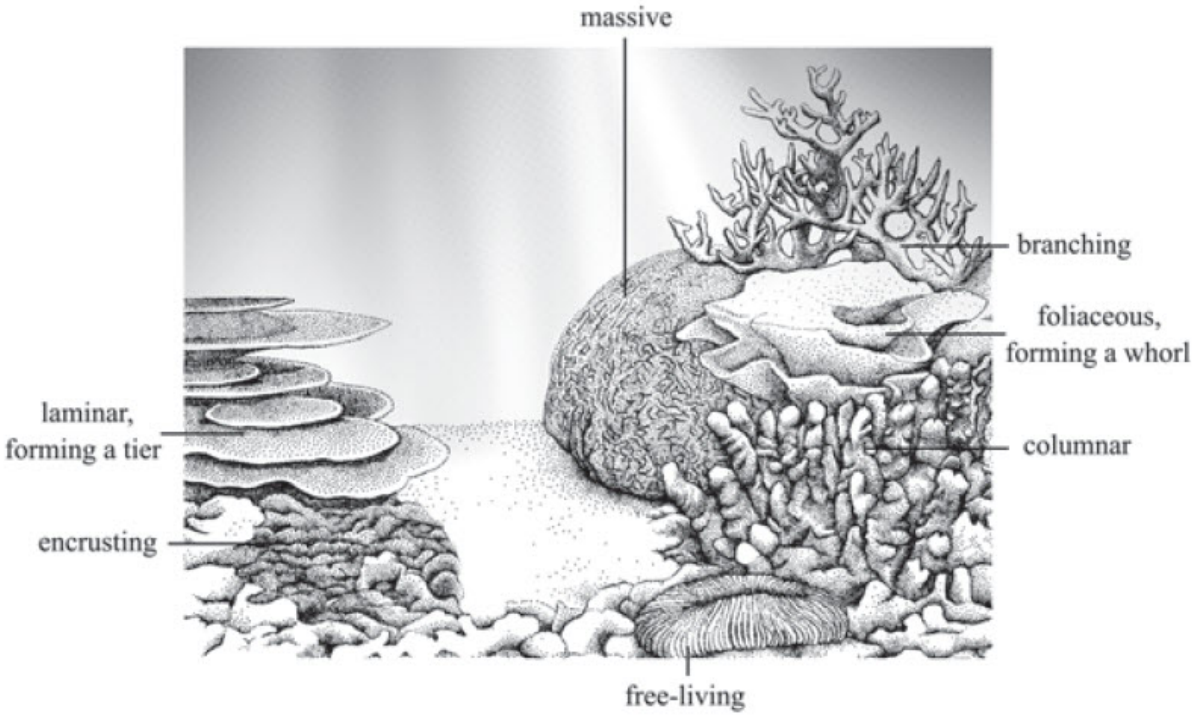


Figure 14. Examples of general coral colony morphology

Adult coral surveys: Measurement of colony size

The maximum diameter of an entire colony (including partial mortality) is measured to the nearest centimeter (cm). Maximum diameter must be measured with respect to colony orientation.

Adult coral surveys: Partial mortality

Partial mortality is estimated on each colony as a percent of colony surface area to 1 percent if possible. Old dead area is distinguished from recent dead area by the present of a stark white skeletal surface.

Old dead mortality is defined as the non-living portion of a colony where the corallite structures are either gone or covered over by organisms that are not easily removed. This portion of the colony is where the live tissue is presumed to have died within the last few months-years or longer.

Recent dead is defined as the non-living portion of a colony in which the corallite structures are still intact (unless freshly bitten by a fish or abraded) and the exposed skeleton is either stark white or has a thin layer of sediment, biofilm (i.e. bacteria), diatoms, microalgae, or tiny turf algae. The presumption of recent dead mortality is that this portion of the colony has died within the last day, days or months.

The cause of recent mortality (stark white skeleton) is recorded if possible. The cause is identified in a general category and a specific type when possible. (e.g. general = predation; specific = COTS predation). The general causes of recent mortality are the following: disease, predation, overgrowth, sediment, four types of damage – abrasion, broken, dislodged (loose) or toppled, other, and unknown. Within each of 10 general categories, there are several specific categories to define the cause of recent mortality where possible (Table 1). **Extent and severity are NOT recorded for recent dead causes.**

Table 1. General and specific causes of recent dead, partial mortality.

Recent dead cause			
General category	RDGEN	Specific category	RDSPE
Disease	**DZGN**	Disease - general	DZGN
		Cyanophyte infection	CYA
		Banded Fungal Infection	BFI
		Black band disease	BBD
		Brown band disease	BRD
		Porites ulcerative white spot	PUS
		Sub-acute tissue loss	TLS
		Acute tissue loss - White syndrome	WSY
		Other	OTH
Predation	**PRED**	Predation - general	PRED
		Crown of thorns	COTS
		Fish predation	FISH
		Gastropod predation	GAST
Overgrowth	**OVRG**	Overgrowth - general	OVRG
		Algae general	ALGA
		Macroalgae	MACA
		Encrusting algae	ENCA
		Turf algae	TRFA
		Crustose coralline algae	CRCA
		Sponge	SPON
		Octocoral	OCTO
		Zoanthid	ZOAN
		Tunicate	TUNI
		Stony coral - Scleractinia and Milleporina sp.	CORA
Sediment	**SEDI**	Sediment necrosis	SEDI
Damage - Abrasion	**DAMA**	Anchor	ANCH
		Rope	ROPE
		Chain	CHAN
		Line	LINE
		Net	FNET
		Other	OTHR
		Unknown	UNKN
Damage - Broken	**DAMB**	Anchor	ANCH
		Rope	ROPE
		Chain	CHAN
		Line	LINE
		Net	FNET
		Other	OTHR
		Unknown	UNKN
Damage - Dislodged (loose)	**DAMD**	Anchor	ANCH
		Rope	ROPE
		Chain	CHAN
		Line	LINE
		Net	FNET
		Other	OTHR
		Unknown	UNKN
Damage - Toppled	**DAMT**	Anchor	ANCH
		Rope	ROPE
		Chain	CHAN
		Line	LINE
		Net	FNET
		Other	OTHR
		Unknown	UNKN
Other	**OTHR**	Other	OTHR
Unknown	**UNKN**	Unknown	UNKN

Adult coral surveys: Coral colony condition

The condition of a colony should be noted (things that don't necessarily cause stark white recent mortality but can affect the colony). All condition codes require an assessment of extent = % of colony affected. Three condition codes [BLE, SGA, PTR] require assessment of extent (% of colony affected) and severity (range of values from 0 to 5 which reflect normal to severe e.g. bleaching severity values range from 0 = no bleaching to 5 = stark white)

Table 2. List of conditions that may be found on coral colonies.

	CONDITION	
Code	**Disease description**	**Affected**
NDZ	No Disease	Coral + Octocorals
ALG	Algal infection	Coral
CYA	Cyanophyte infection	Coral
BFI	Banded Fungal Infection	Coral
FUG	Endolithic Fungal Infection	Coral
BBD	Black band disease	Coral
BRD	Brown band disease	Coral
PDS	Porites Discolored Swelling	Porites
SGA	Skeletal growth anomalies	Coral
PTR	Porites trematodiasis	Porites
PRS	Hyperpigmented response	Coral
PRS	Pigmentation Response	Coral
PRS	Pink line/spot syndrome	Coral
PUS	Porites ulcerative white spot	Porites
BIN	Barnacle infestation	Coral
TIN	Tube worm infestation	Coral
OTH	Other	Coral
AND	Alcyonarian necrotizing disease	Octocorals
BLE	Bleaching	Coral + Octocorals
BLP	Patchy bleaching	Coral + Octocorals
DIS	Discolorations other than bleaching	Coral
CCD	Coralline cyanobacterial disease	CCA
CFD	Coralline fungal disease	CCA
CLD	Coralline lethal disease (aka Coralline White Band Syndrome)	CCA
CLOD	Coralline lethal orange disease	CCA
CRS	Coralline ring syndrome	CCA
DAMA	physical damage - abrasion	Coral
DAMB	physical damage - broken	Coral
DAMD	physical damage - dislodged (loose)	Coral
DAMT	damage - toppled	Coral

CCA and Alcyonarian disease surveys

Within the same four segments per transect as the adult coral surveys, crustose coralline algae (CCA) diseases and Alcyonarian disease are surveyed. Table 3 lists these disease and the codes for each. In each segment, an occurrence of a specific disease is identified and the lesion is measured (maximum diameter). For example, if four separate lesions of coralline cyanobacterial disease are found within a segment, the code CCD is listed on four separate lines along with the measurement of each lesion.

Table 3. List of Alcyonarian disease and crustose coralline algae diseases.

	CONDITION	
Code	**Disease description**	**Affected**
AND	Alcyonarian necrotizing disease	Alcyonarians
CCD	Coralline cyanobacterial disease	CCA
CFD	Coralline fungal disease	CCA
CLD	Coralline lethal disease (aka Coralline White Band Syndrome)	CCA
CLOD	Coralline lethal orange disease	CCA
CRS	Coralline ring syndrome	CCA

Presence of Anthozoans

Presence of all colonies within the class Anthozoan should be noted within each segment. For example, if **one or more colonies** of the following genus/species are found within a segment, record the species/genus code on the data sheet. No other information is recorded.

For the MARIAN region:

Alcyonarians

Heliopora coerulea	(HCOE)
Cladiella sp.	(CLSP)
Dendronephthya sp.	(DESP)
Lobophytum sp.	(LOBP)
Sarcophyton sp.	(SARS)
Sinularia sp.	(SISP)
Stereonephthya sp.	(STES)

Zoantharians

Protopalythoa sp.	(PRSP)
Zoanthus sp.	(ZOSP)
Palythoa sp.	(PASP)

Ceriantipatharians

Wire corals	(WIRE)

Juvenile coral surveys
Surveys of juvenile coral colonies (< 5 cm) are conducted within three 1.0 x 1.0 meter segments along each transect in the following manner (Figure 15):

0 – 1.0m	(Segment 0)
5.0 – 6.0m	(Segment 5)
10.0 – 11.0m	(Segment 10)

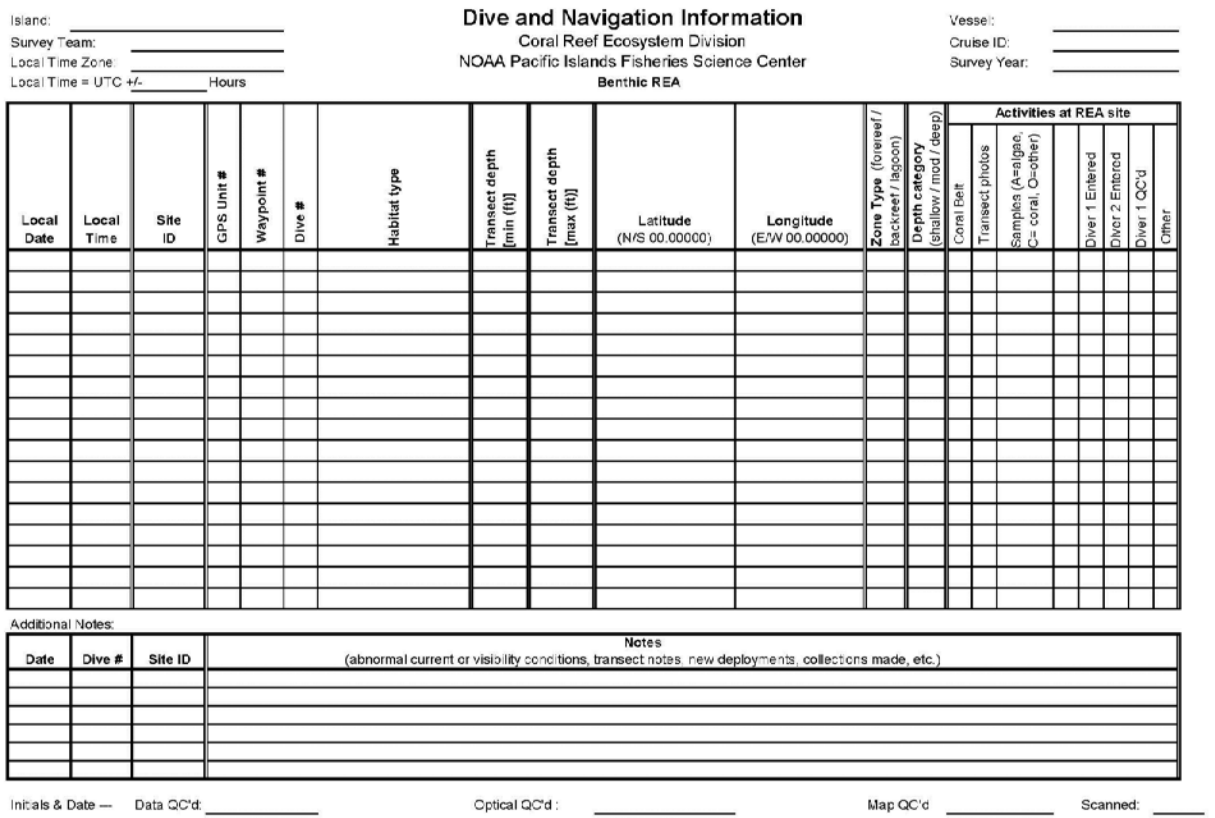
Similar to adult colonies, the center of the juvenile colony must be within the boundaries of the segment to be included in the survey. Juvenile colonies should be distinguished in the field by a distinct tissue and skeletal boundary (not a fragment of larger colony). Each colony is measured for size by recording both the maximum and perpendicular diameter to the nearest 2 mm (used to determine surface area).

Figure 15. Diagram of juvenile coral survey segments in relation to those surveyed for adult corals.

Photoquadrats
Quadrats are photographed along two 18 meter transects which are used to estimate benthic cover. Photoquadrat images are collected at one meter intervals, starting at 1 m to the 15 meter mark, on each transect for a total of 15 quadrats per transect and 30 per site. Photoquadrat consists of a high-resolution digital camera mounted on a photoquadrat pole. The diver should take proper care to photograph the image perpendicular to the reef and NOT AT AN ANGLE. Also, the diver should clearly show the beginning of transect 1 and 2 by photographing one finger or two fingers.

After the dive is complete:

Fill out the "Dive Navigation" data sheet with the appropriate information completely (Figure 16). This sheet is turned in to the data management person at the end of each dive day.



Island: _____
Survey Team: _____
Local Time Zone: _____
Local Time = UTC +/- _____ Hours

Dive and Navigation Information
Coral Reef Ecosystem Division
NOAA Pacific Islands Fisheries Science Center
Benthic REA

Vessel: _____
Cruise ID: _____
Survey Year: _____

Local Date	Local Time	Site ID	GPS Unit #	Waypoint #	Dive #	Habitat type	Transect depth [min (ft)]	Transect depth [max (ft)]	Latitude (N/S 00.00000)	Longitude (E/W 00.00000)	Zone Type (forereef / backreef / lagoon)	Depth category (shallow / mod / deep)	Activities at REA site: Coral Belt	Transect photos	Samples (A=algae, C= coral, O=other)		Diver 1 Entered	Diver 2 Entered	Diver 1 QC'd	Other

Additional Notes:

Date	Dive #	Site ID	Notes (abnormal current or visibility conditions, transect notes, new deployments, collections made, etc.)

Initials & Date — Data QC'd: _____ Optical QC'd: _____ Map QC'd _____ Scanned: _____

Figure 16. Example of the "Dive Navigation" data sheet.