

## **OFFSHORE ISLETS SURVEY PROTOCOL**

A modification of the Hawai'i Rapid Ecological Assessment (REA) protocols developed by the Hawai'i Division of Aquatic Resources (after Maragos & Gulko, 2002), used by the NOAA Coral Reef Ecosystem Division for coral reef monitoring, and later modified by DAR, USFWS & NOAA's Pacific Island Regional Office for use in active marine investigations:

### Team Composition:

- Fish/Invertebrate Team – 2 divers
- Invertebrate/Algae Team – 2 divers
- Surface Support Team (1 vessel operator)

### Recommended REA Equipment:

- 2 30m transect lines marked to cm on both sides
- 1 Reef SCUBA Accessories Inc. Cave Reel with 25+ m of yellow line marked off every 1 m and every 1/2 m differently.
- 1 1-m archeological meter scale marked every 10 cm in black and white bars (available from Forestry Suppliers; [www.forestry-suppliers.com](http://www.forestry-suppliers.com)); used by the benthic team.
- 1 Cave Reel (Reef SCUBA Accessories Inc.) with 10 m of #3 stainless or brass chain for measuring rugosity used by the benthic team.
- Specific data sheets for each specialty that includes dive number and GPS info
- 2 PAM floats with dive flags and 200 m Manta reels
- GPS in waterproof housing
- 4 – 6 Numbered Pelican Floats for establishing impact perimeter and for identifying key points for GPS.
- Handheld waterproof sonar to measure depth from surface.
- Handheld waterproof laser rangefinder (monocular or similar device) to measure surface distances.
- 0.25 m quadrat for measuring community assemblage and conducting algal assessment.
- 2 underwater digital cameras (minimum 4 mpeg) with close-up and macro features. Used by benthic team (it's advisable to also have a camera with the fish team)
- Sealable Sample Buckets with lids labeled: Algal; Coral; Invert.
- 0.66 and 0.165 collapsable camera stands for epibenthic photography

### Survey Protocol:

#### **General Reconnaissance**

- On arrival at a site, the two diver teams conduct an exploratory dive to delineate the area of focus for the quantitative surveys. The area evaluated can be based upon existing knowledge from previous investigations, public reports, or other available information, but will be sufficiently broad in scope to define the general characteristics of the location in terms of its physical structure, environmental conditions and special sub-habitats such as caves and ledges, or areas of massive or high coverage coral.
- Each diver team carries a surface safety float so that their locations can be monitored by the boat operator, and numbered pelican floats that can be surface-deployed at points of specific interest or the furthest extent of the reconnaissance. If a benthic diver spots a unique sub-habitat the diver releases the pelican float and records characteristics of the sub-habitat along with the number of the diver's Pelican float, the GPS location of which is recorded by surface support personnel. Photo-documentation of the sub-habitat should be done with the digital photographs.
- Comprehensive notes are taken on algae, invertebrates and fish that can be identified on site, and samples will be taken of algae and invertebrates that cannot be identified on site for preservation and laboratory identification, along with records of the specific habitat type from which the organisms were collected. The conditions of abnormal corals and

other benthos in the area is assessed and photographed, including the extent of bleaching, apparent diseases, *Acanthaster* predation, alien species competition, entanglement in fishing gear, evident ship grounding, anchor damage, or destructive fishing.

- All members of the benthic team record presence and relative amounts of known alien and invasive benthic species (algal and invertebrate) and fish occurring within the survey area.

## **Quantitative measurements of benthic coverage and fish assemblages**

### **Fish/Invertebrate Team General Protocol**

- Each dive team consists of two divers swimming 25 m belt transects towing a PAM float that serves as surface marker throughout the dive and can provide a safety stop line during strong current conditions while still allowing the surface boat operator to follow the divers as the current moves them away during their safety stops. Use of PAM floats and marking of the transects is done as follows:
- The fish team enters the water with a PAM float and begins the first transect, marking the spot with a pelican buoy. The fish team also records a compass bearing for each transect to assist with later mapping efforts.
- The movement of the float away from the pelican buoy on the second pass by the fish observer provides a signal for the benthic team to enter the water and descend to the start of the first transect line, such that the benthic team does not interfere with the data collection of the fish team by causing additional disturbance to fish populations during the counts. At the end of the third transect the fish team deploys a second pelican float to mark the end of the three transects and rolls up the third transect line.
- After the fish team has completed the first transect, the benthic team enters the water, and swims to the pelican buoy, towing the second PAM float throughout their dive to mark their continuing position. They then proceed to survey and photograph along the first two transect lines and roll up these lines when they are finished.
- Surface GPS waypoints are taken for the two pelican floats when they are retrieved, which mark the end points of the three transect series

### **Fish Transect Protocol** ( Modified after DAR WHAP & NOWRAMP 2000 protocols)

- The fish specialist sets three 25 m transect lines (two of which are also used by the benthic REA team). The fish observer is accompanied by the invertebrate specialist, who follows closely behind the fish specialist through all three legs of each transect and records all macroinvertebrates occurring within 0.5 m of either side of the transect line.
- During the deployment leg of the transect, the diver records size-class-specific (Total Length, TL) counts of all fishes greater than 20 cm within visually estimated but defined belt widths 2 m on each side of the line), while small and cryptic fish (i.e. less than 20 cm) are counted on a belt width 1 m on each side of the line during the “swim-back” leg.
- Each fish is identified to species. The result is a density estimate of all fishes > 20 cm Total Length (TL) within a 25-m long x 4-m wide (100-m<sup>2</sup>) area on an initial (“swim-out”) leg, followed by a density estimate of fishes ≤ 20 cm TL within a 25-m long x 2-m wide (50-m<sup>2</sup>) area) on the subsequent (“swim back”) leg, on each of 3 transects, at each dive-station, conditions permitting. Three transects worth of data provided totals of 600 m<sup>2</sup> searched for large, relatively vagile fish and 300 m<sup>2</sup> for small, site-attached reef fishes, respectively.
- For cave and vertical wall habitats, the “swim-back” leg is combined with the out-going leg, with the divers proceeding at half the normal speed; this is necessary because, due to specific habitat constraints associated with vertical walls and caves, the fish move away from the divers such that they would not be counted on the return leg.
- All fish transects record rare species and unusual fish habitats during the dive. Upon completion of transects, the fish/invertebrate transect divers retrieve the third transect line and ascend the safety float.

- The data are used both to estimate numerical (and biomass) densities and to describe relative abundance (post-classified sensu DACOR: [Dominant, Abundant, Common, Occasional, Rare] used to qualitatively describe relative abundance.) of the fish assemblage.
- Additional recording of species presence off transects during the reconnaissance dive are used to generate a parent species list for biodiversity and rare species.

#### **Invertebrate Transect Protocol**

- Following closely behind the fish transect specialist, the invertebrate specialist makes site-specific identifications of both epibenthic and cryptic macro-invertebrates along a 0.5 m band on either side of both benthic transect lines and takes samples of specimens to be preserved and identified later. The first time that a diver encounters an unknown invertebrate on the transect line the specimen is collected and placed in a bag with as much collection information as possible. For all subsequent encounters the diver notes on his/her data sheet that the invert was seen again. Unknown species are photographed and/or collected for later identification and analysis, and specimens eventually deposited as vouchers in the Bishop Museum's invertebrate collection. Target species include: cnidarians (zoanthids, anemones, and hydrocorals), echinoderms (sea urchins, sea cucumbers, and sea stars), mollusks (bivalves, nudibranchs, gastropods and cephalopods), and crustacea (hermit crabs, lobsters, large crabs and shrimp)
- At the end of the transects the invertebrate specialist collects a dead coral head ca. 10 cm in diameter or a similar quantity of loose coral rubble into a sturdy plastic bag for preservation and later identification of invertebrates. Cryptic species are assessed and identified through post-dive examination and sorting from the dead coral or rubble.

#### **Invertebrate (Coral)/Algae Team General Protocol**

- Two 25 m transects are conducted per dive. After a wait of 10 to 15 minutes (using the position of the two surface floats as a guide to when the fish team is beginning the second transect), the benthic team enters the water and begins taking data on the first 25 m transect line previously laid and left behind by the fish team. The delay by the benthic team is required in order to minimize disturbance of fish populations being censused by the fish team.
- At the beginning of each transect one of the divers lays a 10 m rugosity and records the length of the chain as it lies on the transect. All members of the benthic team record presence and relative amounts of known alien and invasive benthic species (algal and invertebrate) as they occurred on the transect lines and elsewhere in the survey area

#### **Coral Transect Protocol**

- The coral specialist photographs bottom coverage along the entire length of the line at 1.2 m above the center of the line. Photographs are taken using a camera platform which gives a consistent image size throughout the transects of ca. 0.67 m<sup>2</sup> at the cameras maximum wide angle setting.
- Photographs are taken along the transect line at 1.0 m intervals with the transect line centered in each photograph using line marks as locators.
- Transect photographs are later analyzed using Coral Point Point with Excel (CPCe) software. Each coral colony is coded by its quadrat location and number, outlined using CPCe and its area calculated. This data is used to calculate total areas and size class distribution by species, as well as percent coverage, on the transects. The digital photos also provide a permanent record for future reference. Corals showing signs of disease, predation, abnormal growth, bleaching or direct human impact can be noted.

#### **Algal Transect Protocol:**

- The algal specialist uses a camera platform to photograph quadrats with an 0.165 m<sup>2</sup> image size along the two 25 m transects and collects samples of macroalgal species as

- possible from a 0.5 m band on either side of the transect line. Photographs are taken every two meters along each transect for a total of 25 images per site.
- The first time that a diver encounters a rare or unidentifiable alga on a transect line it is collected and placed in a bag along with as much collection information as possible. Turf algae are collected by chiseling small randomly selected pieces of dead coral/limestone substrate from the bottom that appear to support dense filamentous algae. Crustose coralline algae are collected by chiseling or breaking off pieces of the benthos where this algae occurs.
  - Collected macro-algae or turf algae specimens are either frozen or preserved in 4% formalin in seawater until they can be sorted and identified using a microscope. Specimens are either dried or stored in 4% Formalin. All samples collected in these surveys will be deposited as voucher specimens at the Bishop Museum's phycological collection.
  - Images from the transects are analyzed using CPCe point intercept with 55 random points per image and percent frequency by species and of various algal functional forms and dominant or keystone algae categories are determined from the total 2750 points analyzed per site. The algal specialist will also differentiate community cover (algal/coral/rock/sand/etc.) within the transects..

Upon completion of the coral/algal transect measurements one of the divers retrieves the two transect lines and both divers returns with these and the quadrat frames to the boat.