

Standard Operating Procedure (SOP) #1

Before the Field Season

Version 3.01 (May 15, 2020)

Change History

New Version #	Revision Date	Author	Changes Made	Reasons for Change	Previous Version #
2.00	6/30/2007	Eric Brown	See Track Changes	Response to reviewer's	1.00
2.01	7/20/2007	Larry Basch	See Track Changes	Corrections, additions	2.00
3.00	8/22/2019	Kelly Kozar	Updates to SOP references. Added complete benthic taxon list for each park.	To reflect the new SOP numbers, and to have a complete list of species for each park.	2.01
3.01	5/15/2020	Sheila McKenna	Updates to camera equipment.	To ensure most updated information on camera setups by each park.	3.00

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, changes made, and reason for the change along with the new version number.

Purpose

Prior to the field season each year, usually beginning in early spring, observers are required to review the entire benthic protocol, including all SOPs listed in the protocol. This SOP outlines the annual steps to prepare for a field season ensuring the availability of proper equipment prior to the start of monitoring. More detailed descriptions of specific monitoring tasks are given in the SOPs for training observers (SOP #2), outlining safety procedures (SOP #3), using the GPS (SOP #4), preparing for a dive (SOP #6), establishing the sampling plots (SOP #7), and conducting the surveys (SOPs #8,9,10). In addition, this SOP provides procedures for the initial construction of the rugosity chain and coral settlement arrays (CSAs) that, once assembled, should provide years of service with minimal maintenance.

A master equipment list for the entire Benthic Marine Community Vital Sign Monitoring Protocol can be found in Appendix SOP 1.a of this SOP. The master equipment list should be updated simultaneously if any SOP associated with or containing gear lists is revised. A list of equipment required to complete the tasks specified in this SOP has been provided in Appendix SOP 1.b.

General Preparation and Review

Notebooks and Dive Logs

Notebooks and dive logs from previous surveys need to be reviewed to identify unique events that may be encountered in the current field season. A field notebook for the current survey year should be prepared with columns indicating sampling schedule, observer names, field hours, and unique occurrences. These fields may influence how the data are interpreted and reported. Survey reports are based on information recorded in field notebooks; therefore, it is imperative these are clearly organized for ease of field note entry. Field notebooks should be scanned at the end of each park's sampling event and uploaded to the PACN server (see SOP #12 Workspace Setup and Project Records Management and SOP #13 Datasheet Handling Procedures for more information).

Compile Species Lists

Lists of coral species and benthic cover types from previous surveys in a park or local area should be compiled from the existing database and reference manuals to identify benthic cover types which have a probability of being recorded. Prior knowledge of coral species and benthic cover types most likely to be encountered in a park will aid divers and image analysts. Copies of these combined lists should be updated and carried into the field as quick references in helping to identify corals and cover types. Appendix SOP 1.c lists common benthic cover types and coral species at each of the PACN parks.

Load Waypoints

Waypoints for each benthic transect must be loaded onto the Global Positioning System (GPS) unit prior to the start of the field season. Waypoints are the X and Y coordinates for each transect start point and are used to navigate to sampling locations. SOP #7 Selecting and Marking Subtidal Sampling Transect Locations contains instructions for generating transect locations in latitude and longitude for each of the PACN parks with their associated Universal Transverse Mercator (UTM) grid coordinates. SOP #4 Using Garmin® GPS Units contains instructions on loading transect locations into the GPS unit.

Prepare Compass Headings

A complimentary list of compass headings and depths should be compiled or updated in advance of the field season for each fixed transect within a park (see SOP #7 Selecting and Marking Subtidal Sampling Transect Locations). Paper copies of these compass headings and depths, in addition to the GIS/GPS version, should be carried into the field to ensure that each fixed transect is located at the same point and surveyed as in previous years.

Scheduling Field Work

Sampling Dates

Sampling dates should be scheduled and logistics organized well before the start of each field season. In the northern hemisphere, benthic surveys can be conducted after the first full week of May until the end of September to coincide with diminished wave activity. In the southern hemisphere, surveys can be scheduled after the first full week of November until the end of March. It is preferable to sample at approximately the same time each year (± 1 month) and as early in time as possible at a given park. Inclement weather, rough sea conditions, or personnel workloads may preclude the scheduling of sampling events to specific annual dates. Ideally, the

benthic monitoring needs to be scheduled at a time period that (± 1 month) coincides as close in time as possible with other marine protocols (e.g., marine fish) to examine any correlations with other data sets.

Crew

Monitoring efforts within each PACN park require a three to four person crew. Ideally, three people are needed to sample and one to serve as a boat operator/safety diver. Parks may possess site-specific safety requirements that must be followed. All personnel must read the Benthic Marine Community Monitoring Protocol and SOPs, including SOP #3 Safety Protocol, prior to entering the field.

Timing and Co-location

Three to four benthic transects should be scheduled for completion each field day (30 total transects annually). Thus, at least ten field days per park will be needed to complete the field portion of this protocol. To maximize efficiency, this protocol can be completed simultaneously with the PACN Marine Fish Monitoring Protocol. Once transects are set-up, if benthic monitoring is conducted on the same day as fish monitoring, the field work for the PACN Marine Fish Monitoring Protocol must be completed prior to conducting the field work for the Benthic Marine Community Monitoring Protocol at each monitoring location to prevent disturbance to, and bias in data on, fish. If co-location and co-visitation occurs, depending on the number of trained personnel available, fewer benthic transects can be done per day, and more days should be scheduled to complete co-located monitoring to ensure safety.

Organizing Supplies and Equipment

Review Equipment Lists

The marine ecologist at each park ensures that all equipment and supplies listed in the tables of Appendix SOP 1.a of this SOP have been compiled, organized, and made ready for the field season at least two months in advance. Advance preparation allows time to make needed repairs and order equipment.

Field Datasheets

Copies of the field datasheets (see specific SOPs for each anticipated task) must be made on waterproof paper with waterproof photocopies or printer ink (e.g., Xerox laser/copier; never-tear paper, not Rite-in-rain™).

Reference Manuals

Suggested reference manuals to facilitate identification of organisms encountered in benthic surveys for each park should be available to pertinent staff and the image analyst (Table SOP 1.1). Benthic assemblages vary by park so copies of appropriate reference materials must be available at the specific parks to which they apply and at the duty park or office of the image analysts.

Table SOP 1.1. Suggested reference materials by region and park.

Region and Park	Reference
American Samoa	
NPSA	Gosliner, T.M, D.W. Behrens, and G.C. Williams. 1996. Coral Reef animals of the Indo-Pacific. Sea Challengers, Monterey, California, USA.
	Littler, D.S., and M.M. Littler. 2003. South Pacific Reef Plants. Offshore Graphics, Inc., Washington, D.C., USA.
	Madrigal, L.G. 1999. Field Guide of Shallow Water Marine Invertebrates of American Samoa. American Samoa Government Department of Education, Division of Curriculum and Instruction. Pago Pago, American Samoa, USA.
	Payri, C, A. de R. N'Yeurt, and J. Orepuller 2000. Algues de Polyne'sia francaise Algae of French Polynesia. Au Vent des Isles, Editions Tahiti.
	Veron, J.E.N. 2000. Corals of the World. Australian Institute of Marine Science.
Guam/CNMI	
WAPA	Gosliner, T.M, D.W. Behrens, and G.C. Williams. 2004. Coral Reef Animals of the Indo-Pacific. Sea Challengers, Danville, California, USA.
	Littler, D.S., and M.M. Littler. 2003. South Pacific Reef Plants. Offshore Graphics, Inc., Washington, D.C., USA.
	Pauley, G. editor. 2004. Marine biodiversity of Guam and the Marianas. Micronesica 35-36:3-682.
	Payri, C, A. de R. N'Yeurt, and J. Orepuller 2000. Algues de Polyne'sia francaise Algae of French Polynesia. Au Vent des Isles, Editions Tahiti.
	Randall, R.H. 1977. Life on Guam: Coral Reef. Dept. of Education, Agana, Guam, USA.
	Veron, J.E.N. 2000. Corals of the World. Australian Institute of Marine Science, Townsville, Australia.
Hawaii Parks	
KALA & KAHO	Fenner, D. 2005. Corals of Hawaii: A Field Guide to the Hard, Black and Soft Corals of Hawaii and the Northwest Hawaiian Islands, Including Midway. Mutual Publishing, Honolulu, Hawaii, USA.
	Hoover, J. P. 1999. Hawaii's Sea Creatures, a Guide to Hawaii's Marine Invertebrates. Mutual Publishing.
	Huisman, J.M., I.A. Abbott, and C.M. Smith. 2007. Hawaiian Reef Plants. University of Hawai'i Sea Grant College Program, Honolulu, Hawai'i.
	Kay, E. A. 1979. Hawaiian Marine Shells Reef and Shore Fauna of Hawaii, Section 4: Mollusca. B.P. Bishop Museum, Special Publications 64(4):1-653.
	Littler, D.S., and M.M. Littler. 2003 South Pacific Reef Plants. Offshore Graphics, Inc., Washington, D.C., USA.
	Magruder, W.H., and J.W. Hunt. 1979. Seaweeds of Hawaii: A Photographic Identification Guide. Oriental Publishing, Honolulu, Hawaii, USA.
	Maragos, J. 1977 Section 1: Protozoa through Ctenophora. Pages 1-278 in D.M.Devaney and L.G. Eldredge, editors. Reef and shore fauna of Hawaii. Bishop Museum Press, Honolulu, Hawaii, USA.
	Veron, J.E.N. 2000. Corals of the World. Australian Institute of Marine Science, Townsville, Australia.

Table SOP 1.1. Suggested reference materials by region and park (continued).

Region and Park	Reference
All Parks	
	Abbott, I.A. 1999. Marine Red Algae of the Hawaiian Islands. Bishop Museum Press, Honolulu, Hawaii, USA.
	Abbott, I.A., and J.M. Huisman. 2004. Marine Green and Brown Algae of the Hawaiian Islands. Bishop Museum Press, Honolulu, Hawaii, USA.
	Fabricius, K., and P. Alderslade. 2001. Soft corals and Sea Fans: A Comprehensive Guide to the Tropical Shallow Water Genera of the Central-West Pacific, the Indian Ocean and the Red Sea. Australian Institute of Marine Science, Townsville, Queensland, Australia.
	Payri, C, A. de R. N'Yeurt, and J. Orempuller 2000. Algues de Polynésie française Algae of French Polynesia. Au Vent des Isles, Editions Tahiti..
	Huisman, J.M., I.A. Abbott, and C.M. Smith. 2007. Hawaiian Reef Plants. University of Hawai'i Sea Grant College Program, Honolulu, Hawai'i.

Camera Gear

Camera gear will be overhauled and tested as appropriate. Camera functional tests and seal tests must be performed (see SOP #6 Pre-Dive Equipment Preparation), and replacement supplies ordered and tested. Each park will have its own camera setup. The Olympus® TG-5 Waterproof camera is being used at KAHO and WAPA. This camera uses an Olympus® LI-92B rechargeable battery and the Olympus® PT-059 waterproof tough underwater housing. For NPSA, the Canon® EOS D7 is used with the rechargeable Canon® 7.2V, 180 mAh Lion, (LPE6 model) battery and the Nauticam® NA7DMKII underwater housing. For KALA, the Canon® EOS M50 is used with a rechargeable 7.2V (Canon LP-EP12 model) battery and the Ikelite® 6973.15 underwater housing.

Boat, Motor and Trailer

Boat, trailer, and motor servicing should be independently verified for each park for field operation. Ensure that this required preparation has been done in accordance with the Department of Interior (DOI) Motorboat Operator Manual and park specific SOPs. Park-specific SOPs can be obtained from the Park Dive Officer or the certified motorboat operator at each park. SOP #23 After the Field Season also outlines the required post-field season maintenance for each.

Dive Gear

Prior to the start of the field season all dive gear should be checked, serviced, and tested as required by Reference Manual #4 – Safety and Operations Manual (RM-4)¹. Verify that required annual inspections and maintenance were completed for the gear in Table SOP 1.2.

Table SOP 1.2. Scuba gear requiring periodic inspection and maintenance.

Equipment	Certification or Required Service
Air cylinders	VIP certification (annually), check o-rings, hydrostatic testing for expired cylinders (once every 5 years)
Regulators	Annual Service
Buoyancy compensators	Annual Service

¹ https://www.nps.gov/policy/DOrders/RM-4_6-2014.pdf (accessed 15 May 2020)

Transect Lines

New transect lines should be purchased or old transect lines reconditioned for conducting the benthic cover survey as described in SOP #6 Pre-Dive Equipment Preparation and SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys.

Rugosity Equipment Preparation

This section details preparation of the rugosity chain used to conduct *in situ* rugosity measurements. It is important to standardize the link size across parks to insure comparability of the rugosity values. Once the initial chain has been assembled it should provide years of service with little maintenance. Use of the rugosity chain is described in detail in SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys.

Procedures:

Step 1: Use a 10 m light brass chain with 1.5 cm links (Figure SOP 1.1). Plastic chain links may be interspersed between the metal links to minimize impact on the substrate but this is only advised in low water motion environments.

Step 2: Label the chain at 1 m intervals using orange or yellow flagging tape. At 5 m it is useful to label the chain with two markers so that it is easier to count the 1 m segments.

The chain should be on a spool that is easy to deploy. Often hardware stores will have extra plastic reels that they use for rope or chain that one can acquire for free.

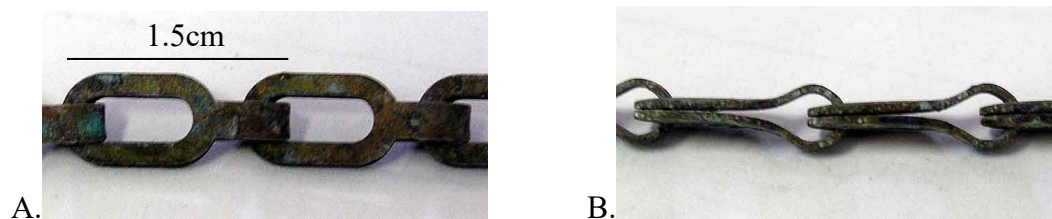


Figure SOP 1.1. Example of two links on a rugosity chain from a top (A) and side (B) view.

Coral Settlement Array (CSA) Construction and Preparation

This section details the materials and procedures to construct the Coral Settlement Arrays (CSAs). The finished product is a plate array (sampling unit) comprised of two terracotta tiles separated by a PVC spacer leaving a 1 cm gap between the tiles. The tile pair is installed on a CSA mounting pin (see SOP #7 Selecting and Marking Subtidal Sampling Transect Locations) such that the terracotta plate is approximately 15 cm off the substrate (Figure SOP 1.2). The underlying PVC plate provides the array with a uniform underlying “substratum” that might not be present if the natural benthos is used. Details of CSA installation and retrieval can be found in SOP #9 Conducting Coral Settlement Sampling.

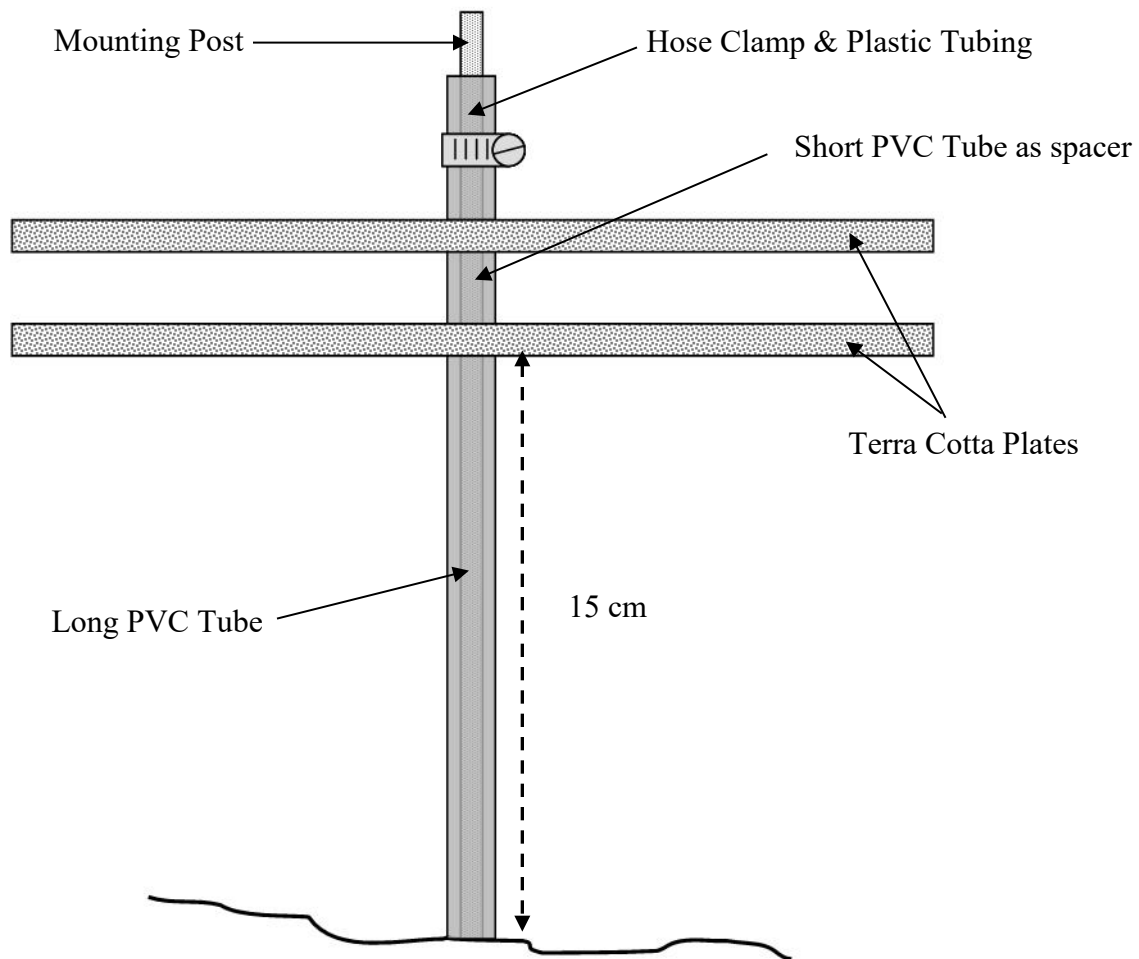


Figure SOP 1.2. Settlement tile array showing the plate pair attached to the 45 cm stainless threaded rod.

Materials for Coral Settlement Array:

Equipment necessary to construct 45 CSAs (15 fixed sites x 3 CSAs each) can be found in Appendix SOP 1.b. It is important that the material used for plate construction remain as uniform as possible among all CSAs. It is recommended that a large supply of red-brick colored terra cotta tiles be purchased at once for several years use. If replacement plates are required at a later date, the same manufacturer, plate material and finish should be used to maintain some level of consistency of the tile materials.

Construction of One Plate Pair:

Step 1: Cut the stainless steel threaded rods in quarters (approximately 45 to 50 cm lengths) with at least one end cut at an angle. Use a miter saw with a diamond edged blade to cut the steel rod. A hand-held grinder outfitted with a cutting wheel can also be used.

Step 2: At this and other steps, it is important to minimize handling of tiles and exposure to metal, filings, oil (from fingers, etc.), or any other possible contaminants that will affect larval settlement to the tiles, as these can severely bias data. If necessary, cut the Sunshine Paver tiles in half to yield two plates with dimensions of 10 cm (4") X 10 cm (4") X 1.3cm (1/2"). Use a table saw with a rock cutting blade and water cooling system to cut the tiles.

Step 3: Drill a 1.25 cm (1/2") hole through the center point of both terracotta tiles. Use a standard drill press with a masonry bit. When drilling it is often good to pour water on the bit to keep it cool and prevent the tile from cracking. Tiles can even be placed in a clean water bath during the drilling operation to reduce cracking from heat expansion. Replace the drill bit after every 10 tiles, if necessary; a dull drill bit will cause the tiles to break during drilling.

Step 4: Construct a mock-up of the CSA using Figure SOP 1.2 as a guide. The 15 cm PVC pipe should slide over the stainless steel rod and be on the bottom sitting on the substrate. The lower terracotta tile should sit on top of this section of pipe. Then, place the 1 cm PVC pipe section above the lower tile and upper terracotta tile. Next, slide the 5 cm plastic tubing over the stainless steel rod to lock in the upper tile. Finally, affix the 2 cm hose clamp to the plastic tubing and tighten to secure the assembly to the rod. Alternatively, one can use a stainless steel threaded rod as the post with stainless steel nuts and washers to construct the CSA. The nuts and washers would be placed above and below the tiles to position them in the appropriate locations. The 1 cm PVC pipe should still be used as a spacer between tiles.

Step 5: Using an ultrafine point Sharpie marker, or an engraver, label each plate pair on an edge noting transect, tile number, date deployed, and with an arrow indicate which tile face is placed up. The following notation should be used (T5-23U-20060715↑) indicating transect 5, tile number 23 Upper, deployed on July 15th, 2006, and with the arrow showing which tile face is oriented up toward to the surface. If the deployment date is unknown, leave blank until the required information is available.

Step 6: Deconstruct the mock-up of the CSA and prepare the tiles as outlined below in Coral Settlement Tile Preparation.

Step 7: Repeat the preceding steps until all plate pairs have been constructed.

Coral Settlement Tile Preparation for re-use of the Tiles:

At least a month prior to the start of the field season, prepare the tiles for the current season by following these instructions. CSAs should provide many years of service with routine maintenance. Reusing the tiles each year also cuts down on the waste, reduces costs, shortens preparation time, and does not seem to adversely affect settlement rates (e.g., Friedlander and Brown 2006). To address possible biases in settlement, a paired experiment will be run during the first year at KALA and WAPA with both new and used plates. If differences are found in the settlement rate between tile treatments then the protocol will be altered accordingly.

Step 1: Once the coral settlement tiles have been examined microscopically, they should be soaked in vinegar two to three days to dissolve calcareous skeletons from the prior year. Previous

experience has shown that the vinegar solution does not change the tiles surfaces and therefore does not result in a sampling bias among years.

Step 2: Gently scrub tiles with a toothbrush.

Step 3: Soak tiles in tap water for another two to three days.

Step 4: Allow tiles to dry.

Step 5: Using an ultrafine point Sharpie marker, label each plate pair on an edge noting transect, tile number, date deployed, and with an arrow indicating which tile face is placed up. The following notation should be used (T5-23U-20060715↑) indicating transect 5, tile number 23 Upper, deployed on July 15th, 2006, and with the arrow showing which tile face is oriented up toward the surface. If the deployment date is unknown, leave blank until the information is available.

Step 6: Store tile pairs in a safe place until ready to re-deploy.

Literature Cited

Friedlander, A.M., and E.K. Brown. 2006. Hanalei Bay, Kaua`i marine benthic communities since 1992: Spatial and temporal trends in a dynamic Hawaiian coral reef ecosystem. Technical Report 003, HCSU [Hawaii Cooperative Studies Unit], Hawaii Cooperative Studies Unit, University of Hawai`i at Hilo, Hawaii, USA.

Appendix SOP 1.a. Equipment list for preparation of gear from the protocol.

Table SOP 1.3. Equipment list for preparing digital still camera for use in the Benthic Marine Communities Vital Sign Monitoring Protocol. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation.

Equipment (#/quantity)	Preparation & Maintenance
Digital still camera	See SOP #6 Pre-Dive Equipment Preparation
U/W housing	See SOP #6 Pre-Dive Equipment Preparation
Flat port	See SOP #6 Pre-Dive Equipment Preparation
NiMH – rechargeable AA camera batteries (4)	Label and charge
Compact flash cards size/capacity (2)	See SOP #6 Pre-Dive Equipment Preparation
Lens cleaner	Ensure that this equipment is available
Lens paper	Ensure that this equipment is available
Clean, lint free cloth (2)	Ensure that this equipment is available
O rings	See SOP #6 Pre-Dive Equipment Preparation
Silicone	Ensure that this equipment is available
Monopod or photoquadrat	See SOP #6 Pre-Dive Equipment Preparation
Red filter for camera lens	See SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys
Monopod with camera mount	Ensure that this equipment is available

Table SOP 1.4. Equipment list for installing permanent transect marking pins. This equipment list refers to SOP #7 Selecting and Marking Subtidal Sampling Transect Locations

Equipment (#/quantity)	Preparation and Maintenance
1 cm (3/8") X 40 cm (16") stainless steel threaded rod (2+)/transect	More, or longer pins may be necessary if conditions warrant
Z-spar or Powerfast Epoxy (1 ea.)	Ensure that 1 gallon of A&B (Z-Spar) or 1 tube (Powerfast) is available, in good condition
Mesh bag (1)	Ensure that this equipment is available
Tupperware containers for Z-spar (2)	One for each part of (A&B) of Z-spar compound; Ensure that this equipment is available
2 or 5 lb. Sledge hammer (2)	One for back up; Ensure this equipment is available
30 m transect line (2)	Labeled at 50 cm intervals; see SOP #1 Before the Field Season
Coordinates, depths, compass headings, and/or maps of transect locations	See SOP #7 Selecting and Marking Subtidal Sampling Transect Locations
GPS (1), with charged batteries	See SOP #4 Using Garmin® GPS Units
Transparent waterproof container for GPS (1)	Ensure that this equipment is available
U/W compass (1)	Ensure that this equipment is available
Surface float marker (2)	One for back-up; Ensure that this equipment is available
U/W slate with pencil (2)	Ensure that this equipment is available
U/W lights (2)	Ensure that this equipment is available
U/W light rechargeable batteries (2 sets)	Ensure that this equipment is available
Scuba gear	See SOP #6 Pre-Dive Equipment Preparation
Boat, motor, trailer, and associated gear	See SOP #6 Pre-Dive Equipment Preparation

Table SOP 1.5. Equipment list for conducting marine benthic cover surveys. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation and SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys.

Equipment (#/quantity)	Preparation & Maintenance
Digital still camera prepared and mounted into U/W housing and monopod	See SOP #6 Pre-Dive Equipment Preparation and SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys
Small wire brush to clean pins and coral colony labels	Ensure that this equipment is available
30 m transect line	Labeled at 50 cm intervals, see SOP #1 Before the Field Season
Coordinates, depths, compass headings, and/or maps of transect locations	Ensure that this equipment is available; See SOP #7 Selecting and Marking Subtidal Sampling Transect Locations
GPS (1)	Ensure in working order; See SOP #4 Using Garmin® GPS Units
Transparent waterproof container for GPS (1)	Ensure that this equipment is available
U/W compass (1)	Ensure that this equipment is available
Surface float marker (2)	One for back-up; Ensure that this equipment is available
U/W slate with pencil (2)	Ensure that this equipment is available
U/W field data forms	See SOP #8 Conducting Marine Benthic Cover and Rugosity Survey
U/W lights (2)	Ensure equipment is in working order
U/W light rechargeable batteries (2 sets)	Ensure equipment has sufficient power
Pelican case to store equipment (e.g., GPS) on boat.	Ensure that this equipment is available
Scuba gear	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season
Boat, motor, and trailer	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season

Table SOP 1.6. Equipment list for conducting benthic rugosity measurements. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation and SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys.

Equipment (#/quantity)	Preparation & Maintenance
Marked 10 m rugosity chain on spool	See SOP #1 Before the Field Season
30 m transect line	See SOP #1 Before the Field Season
Coordinates, depths, compass headings, maps of sampling locations	Ensure that this equipment is available; See SOP #7 Selecting and Marking Subtidal Sampling Transect Locations, SOP #6, Pre-Dive Equipment Preparation and check database and log book.
GPS (1), with charged batteries	Ensure in working order; See SOP #4 Using Garmin® GPS Units
Transparent waterproof container for GPS (1)	Ensure that this equipment is available
U/W compass (1)	Ensure that this equipment is available
U/W slate with pencil (2)	Ensure that this equipment is available
U/W field data forms	See SOP #8 Conducting Marine Benthic Cover and Rugosity Surveys
U/W lights (2)	Ensure equipment is in working order
U/W light rechargeable batteries (2 sets)	Ensure equipment has sufficient power
Scuba gear	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season
Boat, motor, and trailer	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season

Table SOP 1.7. Equipment list for installation and retrieval of the coral settlement arrays. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation, SOP #7 Selecting and Marking Subtidal Sampling Transect Location, and SOP #9 Conducting Coral Settlement Sampling.

Equipment (#/quantity)	Preparation & Maintenance
Digital still camera prepared and mounted into U/W housing and monopod	See SOP #6 Pre-Dive Equipment Preparation
White slate to set white balance on camera	Ensure that this equipment is available
Coral settlement arrays	3 plate pairs per transect; See SOP #1 Before the Field Season for construction and labeling information
Cooler to hold CSAs (2-3)	Ensure that this equipment is available
Ice	Ensure that this equipment is available
Foam pad (1 per cooler)	Ensure that this equipment is available
Pliers and flat head screwdriver (2)	2 of each; Ensure that this equipment is available
5 pound sledge hammer (2)	Ensure that this equipment is available
1 cm (3/8") x 50 cm (20") stainless steel threaded rods (3)	Ensure that this equipment is available
Plastic 90 degree angle protractor	Ensure that this equipment is available
Z-spar or Powerfast Epoxy (1 ea.)	Ensure that 1 gallon of A&B (Z-Spar) or 1 tube (Powerfast) available
Underwater drill	Ensure equipment is in working order
Re-usable tags (at least 45 – 1/CSA))	See SOP #9 Conducting Coral Settlement Sampling
Engraver, dremel drill, or similar tool	See SOP #9 Conducting Coral Settlement Sampling
30 m transect line (2)	Labeled at 50 cm intervals; see SOP #1 Before the Field Season
Heavy duty, pre-labeled re-sealable plastic bags	See SOP #9 Conducting Coral Settlement Sampling
Mesh gear bags (1)	Ensure that this equipment is available
Repair supplies (new threaded rods, epoxy, spare hardware)	See SOP #9 Conducting Coral Settlement Sampling
Coordinates, depths, compass headings, maps of CSA locations	Ensure that this equipment is available; See SOP #7 Selecting and Marking Subtidal Sampling Transect Locations and SOP #9 Conducting Coral Settlement Sampling
GPS (1)	Ensure in working order; See SOP #4 Using Garmin® GPS Units
Transparent waterproof container for GPS (1)	Ensure that this equipment is available
U/W compass (1)	Ensure that this equipment is available
U/W slate with pencil (2)	Ensure that this equipment is available
U/W field data forms	Ensure sufficient number of copies available
U/W lights (2)	Ensure equipment is in working order

Table SOP 1.7. Equipment list for installation and retrieval of the coral settlement arrays. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation, SOP #7 Selecting and Marking Subtidal Sampling Transect Location, and SOP #9 Conducting Coral Settlement Sampling. (continued)

Equipment (#/quantity)	Preparation & Maintenance
U/W light rechargeable batteries (2 sets)	Ensure equipment has sufficient power
Pelican case (1)	Ensure equipment is available
Surface float marker (2)	one for back-up; Ensure equipment is available
Scuba gear	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season
Boat, motor, and trailer	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season

Table SOP 1.8. Equipment list for processing coral settlement arrays (CSAs). For more information, see SOP #17 Settlement Analysis.

Equipment (#/quantity)	Preparation & Maintenance
10% bleach solution (3-4 gal/tray)	Solution can be re-used
Tray for bleach solution	Tray (s) can be any size as long as tiles are immersed in solution
Bubble wrap (1 sheet per plate)	Used for dry plate transport, storage

Table SOP 1.9. Equipment list for microscopic analysis of coral settlement arrays (CSAs). For more information, see SOP #17 Settlement Analysis.

Equipment (#/quantity)	Preparation & Maintenance
Dissecting microscope (6-50x)	Ensure has swing arm stand, ocular micrometer, and phototube
Light source (1) and spare bulbs (2)	Ensure equipment is ready and available
Foam pad/bubble wrap (2-3)	Used for resting tile on
Blue or black fine tip permanent marker (2)	Ensure equipment is ready and available
Probe for cleaning debris on tile (2)	Ensure equipment is ready and available
Bench counter	Ensure equipment is ready and available
Digital camera with	Ensure equipment is ready and available

Table SOP 1.10. Equipment list for cleaning coral settlement plates. For more information, see SOP #17 Settlement Analysis.

Equipment (#/quantity)	Preparation & Maintenance
Household vinegar (3-4 gal/tray)	Ensure equipment is ready and available
Tray for vinegar	Tray (s) can be any size as long as tiles are immersed in solution. Ensure equipment is ready and available
Bubble wrap (1 sheet per plate)	Used for plate storage; ensure equipment is ready and available
Toothbrush (1)	Ensure equipment is ready and available
Microscope or hand lens (1)	Ensure equipment is ready and available

Table SOP 1.11. Equipment list for tagging and conducting the coral growth measurements. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation and SOP #7 Selecting and Marking Subtidal Sampling Transect Locations.

Equipment (#/quantity)	Preparation & Maintenance
1 m flexible fiberglass measuring tape with centimeter markings	Ensure that this equipment is available
Calipers	Ensure that this equipment is available
Stainless steel wire or cable ties (12 with 2 of these extra)/transect	Ensure that this equipment is available
Dymo labels made of plastic (10)	See SOP #1 Before the Field Season
Metal or plastic tags (10)	See SOP #10 Measuring Coral Growth
Small hole punch (2)	Ensure that this equipment is available
Small wire brush (2)	Ensure that this equipment is available
Flagging tape (2 rolls)	Ensure that this equipment is available
Mesh gear bags (2)	Ensure that this equipment is available
Weighted object for marking sites (e.g., Pelican float)	Ensure that this equipment is available
30 m transect line	Labeled at 50 cm intervals; see SOP #1 Before the Field Season
Coordinates, depths, compass headings, maps of sampling locations	Ensure that this equipment is available; See SOP #7 Selecting and Marking Subtidal Sampling Transect Locations
GPS (1)	Ensure in working order; See SOP #4 Using Garmin® GPS Units
Transparent waterproof container for GPS (1)	Ensure that this equipment is available
U/W compass (1)	Ensure that this equipment is available
U/W slate with pencil (2)	Ensure that this equipment is available
U/W field data forms	See SOP #10 Measuring Coral Growth
U/W lights (2)	Ensure equipment is in working order
U/W light rechargeable batteries (2 sets)	Ensure equipment has sufficient power
Scuba gear	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season
Boat, motor, and trailer	See SOP #6 Pre-Dive Equipment Preparation and SOP #23 After the Field Season

Table SOP 1.12. Equipment list for conducting diving activities. This equipment list refers to SOP #6 Pre-Dive Equipment Preparation section on Dive Equipment Preparation.

Equipment (#/quantity)	Preparation & Maintenance
Air cylinders	Verify hydro and VIP, fill with compressed air or NITROX. See SOP #23 After the Field Season
Fins	Ensure that this equipment is available
Booties	Ensure that this equipment is available
Wetsuit	Ensure that this equipment is available
Hooded vest (optional)	Ensure that this equipment is available
Weights	Ensure that this equipment is available
Belt/integrated weight container	Ensure that this equipment is available
BC	Verify annual service. See SOP #23 After the Field Season
Regulator	Verify annual service. See SOP #23 After the Field Season
Mask & Snorkel	Ensure that this equipment is available
Dive computer	Ensure that this equipment is available
Thermometer	Ensure that this equipment is available
Compass	Ensure that this equipment is available
Knife, dive tool, or shears	Ensure that this equipment is available
Rescue "sausage" (international orange)	Ensure that this equipment is available
Whistle or surface noise maker	Ensure that this equipment is available
Underwater noise maker (e.g., subduck, knife)	Ensure that this equipment is available
Save a dive kit	Ensure that this equipment is available
Dive tables as backup	Ensure that this equipment is available
Spare gear (mask, fin, snorkel, straps, cable ties, O-rings, other as needed)	Ensure that this equipment is available
Brass clips – attached to BC, gear bags, or equipment (e.g., camera housing, hammers)	Ensure that this equipment is available
Dive bag for boat work	Ensure that this equipment is available
Bucket for shore work	Ensure that this equipment is available

Table SOP 1.13. Equipment list for operating motor boats. This equipment list refers to SOP #23 After the Field Season.

Equipment (#/quantity)	Preparation & Maintenance
DAN O2 kit	Ensure that this equipment is available
Dive flag	Ensure that this equipment is available
Flares	Ensure that this equipment is available
Survival kit (with signal mirror)	Ensure that this equipment is available
Extra water	Ensure that this equipment is available
PFDs for each person	Ensure that this equipment is available
Spare tool and parts kit (See equipment list below.)	Ensure that this equipment is available
EPIRB	Ensure that this equipment is available
First aid kit	Ensure that this equipment is available
VHF and park radio or cell phone	Ensure that this equipment is available
Water intake “rabbit ears”	Ensure that this equipment is available
Water hose	Ensure that this equipment is available
Battery	Ensure that this equipment is available
Battery charger	Ensure that this equipment is available
Fuel tanks (ncluding one extra, full)	Ensure that this equipment is available
Fuel filter	Ensure that this equipment is available
Outboard motor leg oil	Ensure that this equipment is available
Impeller	Ensure that this equipment is available
Propeller	Ensure that this equipment is available
Mooring lines	Ensure that this equipment is available
Anchor, chain, and line	Ensure that this equipment is available
Bilge pump	Ensure that this equipment is available
Fire extinguisher	Ensure that this equipment is available, in operating condition
Compass	Ensure that this equipment is available
GPS/plotter	Ensure that this equipment is available
Depth finder	Ensure that this equipment is available

Table SOP 1.14. Equipment list for collecting information on environmental variables. This equipment list refers to conducting any of the surveys associated with this protocol.

Equipment (#/quantity)	Preparation & Maintenance
Hobo temperature pro data loggers	Ensure that this equipment is available
Cable ties	Ensure that this equipment is available
Wire cutters	Ensure that this equipment is available

Table SOP 1.15. Equipment list for permanent transect pin maintenance, as needed.

Equipment (#/quantity)	Preparation & Maintenance
Pins (threaded stainless steel rod)	Ensure that this equipment is available
Z-spar (or other 2-part marine epoxy)	Ensure that this equipment is available
Cable ties	Ensure that this equipment is available
Mesh bag	Ensure that this equipment is available
Tupperware containers	Ensure that this equipment is available
Sledge hammer	Ensure that this equipment is available
Slate and pencils	Ensure that this equipment is available

Table SOP 1.16. Equipment list for tools and repairs, as needed.

Equipment (#/quantity)	Preparation & Maintenance
Fin and mask straps	Ensure that this equipment is available
O rings	Ensure that this equipment is available
Electrical tape	Ensure that this equipment is available
Duct tape	Ensure that this equipment is available
Pliers	Ensure that this equipment is available
Wire cutters	Ensure that this equipment is available
Cable ties	Ensure that this equipment is available
Snorkel keepers	Ensure that this equipment is available
Multimeter	Ensure that this equipment is available
Multi purpose tool (e.g., Leatherman)	Ensure that this equipment is available
Boat equipment (e.g. spark plugs, fuel line, priming bulb, shackles, bailing wire, pliers, wrench, tape)	Ensure that this equipment is available

Table SOP 1.17. Equipment list for other equipment needed to complete any of the surveys in this protocol.

Equipment (#/quantity)	Preparation & Maintenance
Secchi disk	Ensure that this equipment is available
Dive float lines (10m and 15m)	Ensure that this equipment is available
Rubbermaid container with lid	Container can be any size to help stow equipment and/or tiles on the boat. Ensure that this equipment is available
GPS with waterproof cover	Ensure that this equipment is available
U/W paper	Ensure that this equipment is available
Dry bag for boat work	Ensure that this equipment is available
Pelican float for marking waypoints	Ensure that this equipment is available

Table SOP 1.18. Equipment list for paperwork needed to complete any of the surveys in this protocol.

Equipment (#/quantity)	Preparation & Maintenance
Permits	Ensure that this equipment is available
Log book for documenting dives and accomplishments.	Ensure that this equipment is available
Charts and grid layouts	Ensure that this equipment is available
Call local marine enforcement agency as appropriate (e.g., DOCARE 808 984-8110)	Ensure that this equipment is available
Pencils	Ensure that this equipment is available
Pens	Ensure that this equipment is available
Eraser	Ensure that this equipment is available
Permanent marker	Ensure that this equipment is available

Don't forget lunch and liquids (to keep hydrated)!

Appendix SOP 1.b. Equipment list for preparation of gear from this SOP

Table SOP 1.19. Equipment list for preparation of gear from this SOP.

Equipment	Quantity	Notes
1 cm (3/8") X 183 cm (6') stainless steel threaded rod	12	Can be purchased from Fastening Specialty in Honolulu, Hawaii (808-486-3440) (Item # TR386SS-CNM). Each threaded rod will yield enough mounting brackets for 4 CSAs.
Sunshine Pavers 20cm (8") X 10cm (4") X 1.3cm (1/2") unglazed terracotta tiles that have a wire cut texture	60	Can be purchased from: Florida Brick and Clay Company, 1708 Turkey Creek Road, Plant City, Florida 33567. Purchasing a least 60 tiles will leave 30 tiles as spares in case some get broken in transport, construction or use.
15cm (5.5") X 2.5cm (1") diameter PVC pipe	45	PVC piping can be purchased from any local hardware store or plumbing supplier (rinse PVC to remove plastic dust and filings after cutting before assembling CSAs). Keep PVC and other parts clean to prevent contamination
1cm(1/2") X 2.5cm (1") diameter PVC pipe	45	PVC piping can be purchased from any local hardware or plumbing supplier (rinse PVC to remove plastic dust and filings after cutting before assembling CSAs).
5cm (2") by 2.5cm (3/8") length of clear food grade, plastic tubing	45	Plastic tubing can be purchased from any local hardware or plumbing supplier.
2cm (3/4") stainless steel hose clamp	45	Hose clamps can be purchased from any local hardware or plumbing supplier.
1.3cm (1/2") diameter masonry drill bit	12	Bit should be changed after every ~10 tiles, as necessary
Miter saw with diamond edged blade	1	Hacksaw also will work
Table saw with rock cutting blade	1	Bench model is ok.
Drill press	1	Bench model is ok.
Ultrafine point sharpie	1	

Appendix SOP 1.c. List of benthic cover types or substrates by park

Table SOP 1.20. List of benthic cover types or substrates detected at Kalaupapa National Historical Park (KALA).

Substrate Type	Taxon
Algae	<i>Acanthophora pacifica</i>
Algae	<i>Acanthophora spicifera</i>
Algae	<i>Actinotrichia</i> sp
Algae	<i>Amansia</i> sp
Algae	<i>Amphiroa</i> sp
Algae	<i>Apoglossum</i> sp
Algae	<i>Asparagopsis</i> sp
Algae	<i>Boodlea</i> sp
Algae	<i>Botryocladia</i> sp
Algae	<i>Chlorophyta</i>
Algae	<i>Chrysocystis</i> sp
Algae	Cyanobacteria
Algae	<i>Dasya</i> sp
Algae	<i>Derbesia</i> sp
Algae	<i>Dichotomaria</i> sp
Algae	<i>Dictyopteris</i> sp
Algae	<i>Dictyosphaeria</i> sp
Algae	<i>Dictyota</i> sp
Algae	<i>Distromium</i> sp
Algae	<i>Dotyella hawaiiensis</i>
Algae	<i>Galaxaura</i> sp
Algae	<i>Ganonema</i> sp
Algae	<i>Gelidium</i> sp
Algae	<i>Halimeda</i> sp
Algae	<i>Haloplegma duperreyi</i>
Algae	<i>Helminthocladia simplex</i>
Algae	<i>Hydroclathrus</i> sp
Algae	<i>Hypnea</i> sp
Algae	<i>Hypoglossum</i> sp
Algae	<i>Jania</i> sp
Algae	<i>Laurencia</i> sp
Algae	<i>Liagora</i> sp
Algae	<i>Lobophora</i> sp
Algae	<i>Lyngbya</i> sp
Algae	<i>Martensia</i> sp

Table SOP 1.20. List of benthic cover types or substrates detected at Kalaupapa National Historical Park (KALA) (continued).

Substrate Type	Taxon
Algae	<i>Microdictyon</i> sp
Algae	<i>Neomeris</i> sp
Algae	<i>Padina melemele</i>
Algae	<i>Padina</i> sp
Algae	<i>Peyssonnelia</i> sp
Algae	<i>Phaeophyceae</i>
Algae	<i>Plocamium</i> sp
Algae	<i>Portieria hornemannii</i>
Algae	<i>Portieria</i> sp
Algae	<i>Rhodophyta</i>
Algae	<i>Sargassum</i> sp
Algae	<i>Schizothrix</i> sp
Algae	<i>Schizymenia</i> sp
Algae	<i>Stypopodium</i> sp
Algae	<i>Symploca</i> sp
Algae	<i>Tolypocladia</i> sp
Algae	<i>Trichosolen</i> sp
Algae	<i>Tricleocarpa</i> sp
Algae	<i>Valonia</i> sp
Algae	Macroalgae
Algae	Coralline algae
Algae	Turf algae
Coral	<i>Cyphastrea ocellina</i>
Coral	<i>Leptastrea bewickensis</i>
Coral	<i>Leptastrea pruinosa</i>
Coral	<i>Leptastrea purpurea</i>
Coral	<i>Leptoseris incrustans</i>
Coral	<i>Lobactis scutaria</i>
Coral	<i>Montipora capitata</i>
Coral	<i>Montipora flabellata</i>
Coral	<i>Montipora incrassata</i>
Coral	<i>Montipora patula</i>
Coral	<i>Montipora studeri</i>
Coral	<i>Pavona duerdeni</i>
Coral	<i>Pavona varians</i>
Coral	<i>Pocillopora damicornis</i>
Coral	<i>Pocillopora grandis</i>

Table SOP 1.20. List of benthic cover types or substrates detected at Kalaupapa National Historical Park (KALA) (continued).

Substrate Type	Taxon
Coral	<i>Pocillopora ligulata</i>
Coral	<i>Pocillopora meandrina</i>
Coral	<i>Pocillopora molokensis</i>
Coral	<i>Pocillopora verrucosa</i>
Coral	<i>Porites bernardi</i>
Coral	<i>Porites brighami</i>
Coral	<i>Porites compressa</i>
Coral	<i>Porites lobata</i>
Coral	<i>Porites lutea</i>
Coral	<i>Porites solida</i>
Coral	<i>Psammocora nierstraszi</i>
Coral	<i>Turbinaria</i> sp
Invert	<i>Acanthaster planci</i>
Invert	Bivalvia
Invert	Bryozoa
Invert	<i>Callyspongia</i> sp
Invert	<i>Conus</i> sp
Invert	<i>Culcita novaeguineae</i>
Invert	<i>Cypraea</i> sp
Invert	<i>Diadema paucispinum</i>
Invert	<i>Didemnum</i> sp
Invert	<i>Diogenidae</i>
Invert	<i>Echinometra mathaei</i>
Invert	<i>Echinometra oblonga</i>
Invert	<i>Echinostrephus aciculatus</i>
Invert	<i>Echinothrix calamaris</i>
Invert	<i>Echinothrix diadema</i>
Invert	<i>Glossodoris rufomarginata</i>
Invert	<i>Gymnangium hians</i>
Invert	<i>Halgerda terramtuentis</i>
Invert	<i>Heterocentrotus mamillatus</i>
Invert	<i>Hexabranhus sanguineus</i>
Invert	<i>Hipponix imbricatus</i>
Invert	<i>Holothuria</i> sp
Invert	Hydroidolina
Invert	<i>Linckia multifora</i>

Table SOP 1.20. List of benthic cover types or substrates detected at Kalaupapa National Historical Park (KALA) (continued).

Substrate Type	Taxon
Invert	<i>Mesonea radians</i>
Invert	<i>Palythoa caesia</i>
Invert	<i>Pennaria disticha</i>
Invert	<i>Percnon planissimum</i>
Invert	Porifera
Invert	<i>Protopalythoa</i> sp
Invert	<i>Reteporellina denticulata</i>
Invert	<i>Sarcothelia edmondsoni</i>
Invert	<i>Sinularia densa</i>
Invert	<i>Spirobranchus giganteus</i>
Invert	<i>Trapezia intermedia</i>
Invert	<i>Triphyllozoon</i> sp
Invert	Tunicate
Invert	<i>Zoanthus</i> sp
Substrate	Non-Coral
Substrate	Other
Substrate	Bare Rock
Substrate	Sand
Substrate	Substrate

Table SOP 1.21. List of benthic cover types or substrates detected at War in the Pacific National Historical Park (WAPA).

Substrate Type	Taxon
Algae	<i>Amphiroa</i> sp
Algae	<i>Asparagopsis</i> sp
Algae	<i>Callophycus</i> sp
Algae	<i>Caulerpa</i> sp
Algae	<i>Ceratodictyon</i> sp
Algae	Chlorophyta
Algae	<i>Chrysocystis</i> sp
Algae	<i>Cladophora</i> sp
Algae	<i>Crouania</i> sp
Algae	Cyanobacteria
Algae	<i>Derbesia</i> sp
Algae	<i>Dichotomaria</i> sp
Algae	<i>Dictyosphaeria</i> sp
Algae	<i>Dictyota</i> sp
Algae	<i>Galaxaura</i> sp
Algae	<i>Halimeda</i> sp
Algae	<i>Halymenia</i> sp
Algae	<i>Hypnea</i> sp
Algae	<i>Jania</i> sp
Algae	<i>Liagora</i> sp
Algae	<i>Mesophyllum</i> sp
Algae	<i>Neogoniolithon</i> sp
Algae	<i>Neomeris</i> sp
Algae	<i>Padina</i> sp
Algae	<i>Peyssonnelia</i> sp
Algae	<i>Phaeophyceae</i>
Algae	<i>Rhodophyta</i>
Algae	<i>Sargassum</i> sp
Algae	<i>Symploca</i> sp
Algae	<i>Tolypocladia</i> sp
Algae	<i>Turbinaria</i> sp
Algae	<i>Tydemania</i> sp
Algae	<i>Udotea</i> sp
Algae	<i>Valonia</i> sp
Algae	<i>Wrangelia</i> sp
Algae	Macroalgae
Algae	Coralline algae

Table SOP 1.21. List of benthic cover types or substrates detected at War in the Pacific National Historical Park (WAPA) (continued).

Substrate Type	Taxon
Algae	Turf algae
Coral	<i>Acanthastrea echinata</i>
Coral	<i>Acanthastrea regularis</i>
Coral	<i>Acropora humilis</i>
Coral	<i>Alveopora</i> sp
Coral	<i>Astrea curta</i>
Coral	<i>Astreopora myriophthalma</i>
Coral	<i>Astreopora randalli</i>
Coral	<i>Cycloseris</i> sp
Coral	<i>Cyphastrea microphthalma</i>
Coral	<i>Cyphastrea serailia</i>
Coral	<i>Diploastrea heliopora</i>
Coral	<i>Dipsastraea favus</i>
Coral	<i>Dipsastraea matthaii</i>
Coral	<i>Dipsastraea pallida</i>
Coral	<i>Echinopora lamellosa</i>
Coral	Faviids
Coral	<i>Favites</i> sp
Coral	<i>Fungia</i> sp
Coral	<i>Galaxea fascicularis</i>
Coral	<i>Goniastrea edwardsi</i>
Coral	<i>Goniastrea pectinata</i>
Coral	<i>Goniastrea retiformis</i>
Coral	<i>Goniopora lobata</i>
Coral	<i>Herpolitha limax</i>
Coral	<i>Hydnophora microconos</i>
Coral	<i>Leptastrea purpurea</i>
Coral	<i>Leptoria phrygia</i>
Coral	<i>Lobactis scutaria</i>
Coral	<i>Lobophyllia hemprichii</i>
Coral	<i>Montipora floweri</i>
Coral	<i>Montipora foveolata</i>
Coral	<i>Montipora informis</i>
Coral	<i>Montipora venosa</i>
Coral	<i>Montipora verrucosa</i>
Coral	<i>Oulophyllia crispa</i>
Coral	<i>Paragoniastrea australensis</i>

Table SOP 1.21. List of benthic cover types or substrates detected at War in the Pacific National Historical Park (WAPA) (continued).

Substrate Type	Taxon
Coral	<i>Pavona chiriquiensis</i>
Coral	<i>Pavona frondifera</i>
Coral	<i>Pavona varians</i>
Coral	<i>Pavona venosa</i>
Coral	<i>Platygyra daedalea</i>
Coral	<i>Platygyra pini</i>
Coral	<i>Plesiastrea versipora</i>
Coral	<i>Pocillopora damicornis</i>
Coral	<i>Pocillopora grandis</i>
Coral	<i>Pocillopora meandrina</i>
Coral	<i>Pocillopora verrucosa</i>
Coral	<i>Porites annae</i>
Coral	<i>Porites cylindrica</i>
Coral	<i>Porites deformis</i>
Coral	<i>Porites lichen</i>
Coral	<i>Porites lobata</i>
Coral	<i>Porites lutea</i>
Coral	<i>Porites massive sp</i>
Coral	<i>Porites rus</i>
Coral	<i>Psammocora contigua</i>
Coral	<i>Psammocora haimiana</i>
Coral	<i>Psammocora profundacella</i>
Coral	<i>Psammocora stellata</i>
Coral	<i>Stylocoeniella armata</i>
Coral	<i>Stylocoeniella guentheri</i>
Coral	<i>Turbinaria stellulata</i>
Invert	<i>Acanthaster planci</i>
Invert	<i>Actiniaria</i>
Invert	<i>Asteroidea</i>
Invert	<i>Culcita novaeguineae</i>
Invert	<i>Dysidea sp</i>
Invert	<i>Echinoidea</i>
Invert	<i>Echinostrephus aciculatus</i>
Invert	<i>Gastropoda</i>
Invert	<i>Halgerda guahan</i>
Invert	<i>Heliopora coerulea</i>
Invert	<i>Heteractis sp</i>

Table SOP 1.21. List of benthic cover types or substrates detected at War in the Pacific National Historical Park (WAPA) (continued).

Substrate Type	Taxon
Invert	<i>Holothuria (Halodeima) edulis</i>
Invert	<i>Holothuria (Mertensiothuria) leucospilota</i>
Invert	<i>Holothuria</i> sp
Invert	<i>Linckia laevigata</i>
Invert	<i>Linckia multifora</i>
Invert	<i>Lobophytum</i> sp
Invert	<i>Miamira sinuata</i>
Invert	Nudibranch
Invert	Porifera
Invert	<i>Sarcophyton</i> sp
Invert	<i>Sinularia</i> sp
Invert	<i>Spheciospongia vagabunda</i>
Invert	<i>Spirobranchus</i> sp
Invert	<i>Stichopus chloronotus</i>
Invert	<i>Terpios</i> sp
Invert	<i>Tridacna maxima</i>
Invert	<i>Tridacna</i> sp
Invert	<i>Tubipora</i> sp
Invert	Tunicate
Invert	Zoanthidae
Substrate	Non-Coral
Substrate	Bare Rock
Substrate	Rubb
Substrate	Sand
Substrate	Unknown

Table SOP 1.22. List of benthic cover types or substrates detected at Kaloko-Honokōhau National Historical Park (KAHO).

Substrate Type	Taxon
Algae	<i>Asparagopsis</i> sp
Algae	<i>Caulerpa</i> sp
Algae	<i>Chlorodesmis</i> sp
Algae	<i>Chlorophyta</i>
Algae	<i>Chrysocystis</i> sp
Algae	Cyanobacteria
Algae	<i>Dictyosphaeria</i> sp
Algae	<i>Dictyota</i> sp
Algae	<i>Galaxaura</i> sp
Algae	<i>Gibbsmithia</i> sp
Algae	<i>Halimeda</i> sp
Algae	<i>Hypnea</i> sp
Algae	<i>Jania</i> sp
Algae	<i>Laurencia</i> sp
Algae	<i>Lobophora</i> sp
Algae	<i>Neomeris</i> sp
Algae	<i>Padina</i> sp
Algae	<i>Peyssonnelia</i> sp
Algae	<i>Phaeophyceae</i>
Algae	<i>Portieria</i> sp
Algae	<i>Ralfsia</i> sp
Algae	<i>Rhodophyta</i>
Algae	<i>Sargassum</i> sp
Algae	<i>Symploca</i> sp
Algae	<i>Tolypocladia</i> sp
Algae	Macroalgae
Algae	Coralline algae
Algae	Turf algae
Coral	<i>Leptastrea bewickensis</i>
Coral	<i>Leptastrea purpurea</i>
Coral	<i>Leptoseris incrustans</i>
Coral	<i>Leptoseris mycetoseroides</i>
Coral	<i>Lobactis scutaria</i>
Coral	<i>Montipora capitata</i>
Coral	<i>Montipora patula</i>
Coral	<i>Montipora tuberculosa</i>
Coral	<i>Pavona varians</i>

Table SOP 1.22. List of benthic cover types or substrates detected at Kaloko-Honokōhau National Historical Park (KAHO) (continued).

Substrate Type	Taxon
Coral	<i>Pleuractis granulosa</i>
Coral	<i>Pocillopora damicornis</i>
Coral	<i>Pocillopora grandis</i>
Coral	<i>Pocillopora meandrina</i>
Coral	<i>Porites brighami</i>
Coral	<i>Porites compressa</i>
Coral	<i>Porites evermanni</i>
Coral	<i>Porites lobata</i>
Coral	<i>Porites lutea</i>
Coral	<i>Porites rus</i>
Coral	<i>Porites solida</i>
Coral	<i>Psammocora haimiana</i>
Coral	<i>Psammocora nierstraszi</i>
Coral	<i>Psammocora stellata</i>
Invert	<i>Acanthaster planci</i>
Invert	<i>Actinopyga obesa</i>
Invert	<i>Culcita novaeguineae</i>
Invert	<i>Diadema paucispinum</i>
Invert	Echinoidea
Invert	<i>Echinometra mathaei</i>
Invert	<i>Echinometra oblonga</i>
Invert	<i>Echinostrephus aciculatus</i>
Invert	<i>Echinothrix calamaris</i>
Invert	<i>Echinothrix diadema</i>
Invert	Gastropoda
Invert	<i>Gymnangium hians</i>
Invert	<i>Heterocentrotus mamillatus</i>
Invert	<i>Hipponix imbricatus</i>
Invert	<i>Holothuria atra</i>
Invert	Holothuriidae
Invert	Hydroidolina
Invert	<i>Ophiocoma erinaceus</i>
Invert	<i>Palythoa caesia</i>
Invert	Porifera
Invert	<i>Sarcothelia edmondsoni</i>
Invert	<i>Sinularia densa</i>
Invert	<i>Spheciospongia vagabunda</i>

Table SOP 1.22. List of benthic cover types or substrates detected at Kaloko-Honokōhau National Historical Park (KAHO) (continued).

Substrate Type	Taxon
Invert	<i>Spirobranchus giganteus</i>
Invert	<i>Tripneustes gratilla</i>
Invert	Zoanthidae
Substrate	Non-Coral
Substrate	Bare Rock
Substrate	Sand
Substrate	Substrate

Table SOP 1.23. List of benthic cover types or substrates detected at National Park of American Samoa (NPSA).

Substrate Type	Taxon
Algae	<i>Amphiroa</i> sp
Algae	<i>Asparagopsis</i> sp
Algae	<i>Caulerpa</i> sp
Algae	<i>Chlorodesmis fastigiata</i>
Algae	<i>Chlorodesmis</i> sp
Algae	<i>Chlorophyta</i>
Algae	Cyanobacteria
Algae	<i>Dichotomaria marginata</i>
Algae	<i>Dictyosphaeria</i> sp
Algae	<i>Dictyota</i> sp
Algae	<i>Halimeda</i> sp
Algae	<i>Jania</i> sp
Algae	<i>Lobophora</i> sp
Algae	<i>Lyngbya</i> sp
Algae	<i>Neogoniolithon</i> sp
Algae	<i>Neomeris</i> sp
Algae	<i>Neoralsia expansa</i>
Algae	<i>Peyssonnelia</i> sp
Algae	<i>Phaeophyceae</i>
Algae	<i>Rhodophyta</i>
Algae	<i>Schizymenia</i> sp
Algae	<i>Turbinaria</i> sp (algae)
Algae	<i>Valonia</i> sp
Algae	Macroalgae
Algae	Coralline algae
Algae	Turf algae
Coral	<i>Acanthastrea brevis</i>
Coral	<i>Acanthastrea echinata</i>
Coral	<i>Acropora abrotanoides</i>
Coral	<i>Acropora austera</i>
Coral	<i>Acropora clathrata</i>
Coral	<i>Acropora cophodactyla</i>
Coral	<i>Acropora cuneata</i>
Coral	<i>Acropora cytherea</i>
Coral	<i>Acropora digitifera</i>
Coral	<i>Acropora gemmifera</i>
Coral	<i>Acropora globiceps</i>

Table SOP 1.23. List of benthic cover types or substrates detected National Park of American Samoa (NPSA) (continued).

Substrate Type	Taxon
Coral	<i>Acropora granulosa</i>
Coral	<i>Acropora humilis</i>
Coral	<i>Acropora hyacinthus</i>
Coral	<i>Acropora insignis</i>
Coral	<i>Acropora intermedia</i>
Coral	<i>Acropora kimbeensis</i>
Coral	<i>Acropora latistella</i>
Coral	<i>Acropora monticulosa</i>
Coral	<i>Acropora nana</i>
Coral	<i>Acropora nasuta</i>
Coral	<i>Acropora pagoensis</i>
Coral	<i>Acropora palifera</i>
Coral	<i>Acropora paniculata</i>
Coral	<i>Acropora polystoma</i>
Coral	<i>Acropora retusa</i>
Coral	<i>Acropora samoensis</i>
Coral	<i>Acropora seriata</i>
Coral	<i>Acropora tenuis</i>
Coral	<i>Acropora valida</i>
Coral	<i>Acropora verweyi</i>
Coral	<i>Alveopora spongiosa</i>
Coral	<i>Astrea annuligera</i>
Coral	<i>Astrea curta</i>
Coral	<i>Astreopora cucullata</i>
Coral	<i>Astreopora gracilis</i>
Coral	<i>Astreopora myriophthalma</i>
Coral	<i>Astreopora randalli</i>
Coral	<i>Clavularia</i> sp
Coral	<i>Coscinaraea columna</i>
Coral	<i>Coscinaraea exesa</i>
Coral	<i>Coscinaraea</i> sp
Coral	<i>Ctenactis</i> sp
Coral	<i>Cyphastrea microphthalma</i>
Coral	<i>Cyphastrea serailia</i>
Coral	<i>Diploastrea heliopora</i>
Coral	<i>Dipsastraea favus</i>
Coral	<i>Dipsastraea helianthoides</i>

Table SOP 1.23. List of benthic cover types or substrates detected National Park of American Samoa (NPSA) (continued).

Substrate Type	Taxon
Coral	<i>Dipsastraea matthaii</i>
Coral	<i>Dipsastraea pallida</i>
Coral	<i>Dipsastraea speciosa</i>
Coral	<i>Dipsastraea truncata</i>
Coral	<i>Echinophyllia aspera</i>
Coral	<i>Echinopora lamellosa</i>
Coral	<i>Euphyllia glabrescens</i>
Coral	Faviids
Coral	<i>Favites abdita</i>
Coral	<i>Favites complanata</i>
Coral	<i>Favites flexuosa</i>
Coral	<i>Favites pentagona</i>
Coral	<i>Favites russelli</i>
Coral	<i>Fungia concinna</i>
Coral	<i>Fungia fungites</i>
Coral	<i>Galaxea astreata</i>
Coral	<i>Galaxea fascicularis</i>
Coral	<i>Gardineroseris planulata</i>
Coral	<i>Goniastrea edwardsi</i>
Coral	<i>Goniastrea minuta</i>
Coral	<i>Goniastrea pectinata</i>
Coral	<i>Goniastrea retiformis</i>
Coral	<i>Goniastrea stelligera</i>
Coral	<i>Goniopora</i> sp
Coral	<i>Halomitra pileus</i>
Coral	<i>Herpolitha limax</i>
Coral	<i>Hydnophora exesa</i>
Coral	<i>Hydnophora microconos</i>
Coral	<i>Isopora crateriformis</i>
Coral	<i>Leptastrea bewickensis</i>
Coral	<i>Leptastrea pruinosa</i>
Coral	<i>Leptastrea purpurea</i>
Coral	<i>Leptastrea transversa</i>
Coral	<i>Leptoria irregularis</i>
Coral	<i>Leptoria phrygia</i>
Coral	<i>Leptoseris foliosa</i>
Coral	<i>Leptoseris mycetoseroides</i>

Table SOP 1.23. List of benthic cover types or substrates detected National Park of American Samoa (NPSA) (continued).

Substrate Type	Taxon
Coral	<i>Leptoseris scabra</i>
Coral	<i>Leptoseris yabei</i>
Coral	<i>Lithophyllon scabra</i>
Coral	<i>Lobactis scutaria</i>
Coral	<i>Lobophyllia hemprichii</i>
Coral	<i>Merulina ampliata</i>
Coral	<i>Merulina scabricula</i>
Coral	<i>Montastraea</i> sp
Coral	<i>Montipora aequituberculata</i>
Coral	<i>Montipora calcarea</i>
Coral	<i>Montipora caliculata</i>
Coral	<i>Montipora cocosensis</i>
Coral	<i>Montipora corbettensis</i>
Coral	<i>Montipora crassituberculata</i>
Coral	<i>Montipora danae</i>
Coral	<i>Montipora efflorescens</i>
Coral	<i>Montipora effusa</i>
Coral	<i>Montipora floweri</i>
Coral	<i>Montipora foveolata</i>
Coral	<i>Montipora grisea</i>
Coral	<i>Montipora informis</i>
Coral	<i>Montipora millepora</i>
Coral	<i>Montipora mollis</i>
Coral	<i>Montipora nodosa</i>
Coral	<i>Montipora orientalis</i>
Coral	<i>Montipora peltiformis</i>
Coral	<i>Montipora spumosa</i>
Coral	<i>Montipora stilosa</i>
Coral	<i>Montipora tuberculosa</i>
Coral	<i>Montipora turgescens</i>
Coral	<i>Montipora venosa</i>
Coral	<i>Montipora verrucosa</i>
Coral	<i>Mycedium elephantotus</i>
Coral	<i>Oulophyllia crispa</i>
Coral	<i>Oxypora lacera</i>
Coral	<i>Pachyseris rugosa</i>
Coral	<i>Pachyseris speciosa</i>

Table SOP 1.23. List of benthic cover types or substrates detected National Park of American Samoa (NPSA) (continued).

Substrate Type	Taxon
Coral	<i>Pavona chiriquiensis</i>
Coral	<i>Pavona clavus</i>
Coral	<i>Pavona decussata</i>
Coral	<i>Pavona duerdeni</i>
Coral	<i>Pavona explanulata</i>
Coral	<i>Pavona maldivensis</i>
Coral	<i>Pavona varians</i>
Coral	<i>Pavona venosa</i>
Coral	<i>Platygyra daedalea</i>
Coral	<i>Platygyra pini</i>
Coral	<i>Platygyra sinensis</i>
Coral	<i>Plesiastrea versipora</i>
Coral	<i>Pocillopora damicornis</i>
Coral	<i>Pocillopora grandis</i>
Coral	<i>Pocillopora meandrina</i>
Coral	<i>Pocillopora</i> sp
Coral	<i>Pocillopora verrucosa</i>
Coral	<i>Porites arnaudi</i>
Coral	<i>Porites australiensis</i>
Coral	<i>Porites cylindrica</i>
Coral	<i>Porites lichen</i>
Coral	<i>Porites lobata</i>
Coral	<i>Porites lutea</i>
Coral	<i>Porites randalli</i>
Coral	<i>Porites rus</i>
Coral	<i>Porites solida</i>
Coral	<i>Porites vauhani</i>
Coral	<i>Psammocora digitata</i>
Coral	<i>Psammocora haimiana</i>
Coral	<i>Psammocora nierstraszi</i>
Coral	<i>Psammocora profundacella</i>
Coral	<i>Sandalolitha dentata</i>
Coral	<i>Stylocoeniella armata</i>
Coral	<i>Turbinaria frondens</i>
Coral	<i>Turbinaria reniformis</i>
Coral	<i>Turbinaria stellulata</i>
Invert	<i>Acanthaster planci</i>

Table SOP 1.23. List of benthic cover types or substrates detected National Park of American Samoa (NPSA) (continued).

Substrate Type	Taxon
Invert	<i>Acanthaster</i> sp
Invert	Actiniaria
Invert	Ascidian
Invert	Asteroidea
Invert	<i>Cladiella</i> sp
Invert	<i>Conus</i> sp
Invert	Corallimorphidae
Invert	<i>Culcita novaeguineae</i>
Invert	<i>Diadema</i> sp
Invert	<i>Dysidea</i> sp
Invert	Echinoidea
Invert	<i>Echinostrephus aciculatus</i>
Invert	<i>Heteractis aurora</i>
Invert	<i>Lambis scorpius</i>
Invert	<i>Lambis</i> sp
Invert	<i>Linckia</i> sp
Invert	<i>Lobophytum</i> sp
Invert	<i>Millepora exaesa</i>
Invert	<i>Palythoa</i> sp
Invert	Porifera
Invert	<i>Sarcophyton</i> sp
Invert	<i>Sinularia</i> sp
Invert	<i>Spirobranchus giganteus</i>
Invert	<i>Stichodactyla</i> sp
Invert	<i>Tridacna</i> sp
Invert	Tunicate
Substrate	Non-Coral
Substrate	Other
Substrate	Bare Rock
Substrate	Sand
Substrate	Silt
Substrate	Substrate