

Standard Operating Procedure (SOP) #7

Selecting and Marking Subtidal Sampling Transect Locations

Version 3.01 (March 21, 2022)

Change History

New Version #	Revision Date	Author	Changes Made	Reasons for Change	Previous Version #
2.0	6/30/2007	Eric Brown	See Track Changes	Response to reviewer's comments	1.0
2.01	7/20/2007	Larry Basch	See Track Changes	Corrections, additions	2.0
3.0	7/14/2021	Mark Wasser	Moved fixed plot information to Appendix, updated temporary plot generation section.	No longer generating fixed plots. To update procedures and software, and for standardization across PACN protocols.	2.01
3.01	3/21/2022	Kim Weisenborn	Updated content to refer to new PACN I&M SharePoint. Updated figures and table references. Updated formatting in Appendix SOP 7.b.	PACN data is no longer stored on a networked server (I:\ drive) and is now stored on the PACN I&M SharePoint site.	3.0

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

This SOP describes how to select and mark subtidal transect locations. Benthic monitoring transect locations will have three separate components: 1) transects for obtaining percent cover, 2) coral settlement arrays and 3) individually tagged coral colonies along the transect.

A master equipment list for the entire Benthic Marine Community Monitoring Protocol can be found in Appendix SOP 1.a of SOP #1 Before the Field Season. The master equipment list should be updated simultaneously if this SOP is revised. A list of equipment required to complete the tasks specified in this SOP has been provided in [Appendix SOP 7.a](#) in this SOP.

Selecting Transect Locations

Note: This SOP has been updated to reflect that all fixed transect locations have been established, and only temporary transect locations need to be generated on an on-going basis. The legacy information documenting how fixed transects were generated and installed has been moved to [Appendix SOP 7.b](#), located at the end of this SOP.

If a new fixed plot needs to be added, please contact the PACN GIS Specialist (Mark Wasser, mark.wasser@nps.gov) and they can complete this procedure using an updated workflow with current software.

Locations for temporary transects will be randomly selected within ArcGIS® Desktop software (as of publication, the version in use is ArcGIS Pro® 2.7.3), and the criteria outlined below. Randomly selected alternative transect locations will also be generated in case the initial location is unsuitable with respect to benthic habitat type, area, or possesses conditions that make it unsafe to work. The following steps will be done prior to conducting any field work.

Generating Random Points for Temporary Transect Start Pins

Benthic Marine and Marine Fish Sites are co-located with Water Quality yearly sites. Refer to Water Quality SOP #5 Selecting Water Quality Sampling Stations¹, section Generating Random Point for Temporary Sampling Locations in Marine Areas for information on generating temporary sampling site selection.

Printing Field Maps & Coordinates

Print a double-sided document (8.5x11”) with a field map on one side and tables of coordinates for all sampling site locations on the other side. Laminate the document and provide to the dive crew for use. The following files are located in the [Water Quality Monitoring project workspace](#) in SharePoint:

Field Map locations:

[Water Quality Monitoring "Spatial info"](#) folder → Year folder → Park folder → “Map Products” folder (Figure SOP 7.1)

¹ <https://irma.nps.gov/DataStore/Reference/Profile/2265525> (accessed 21 March 2022).

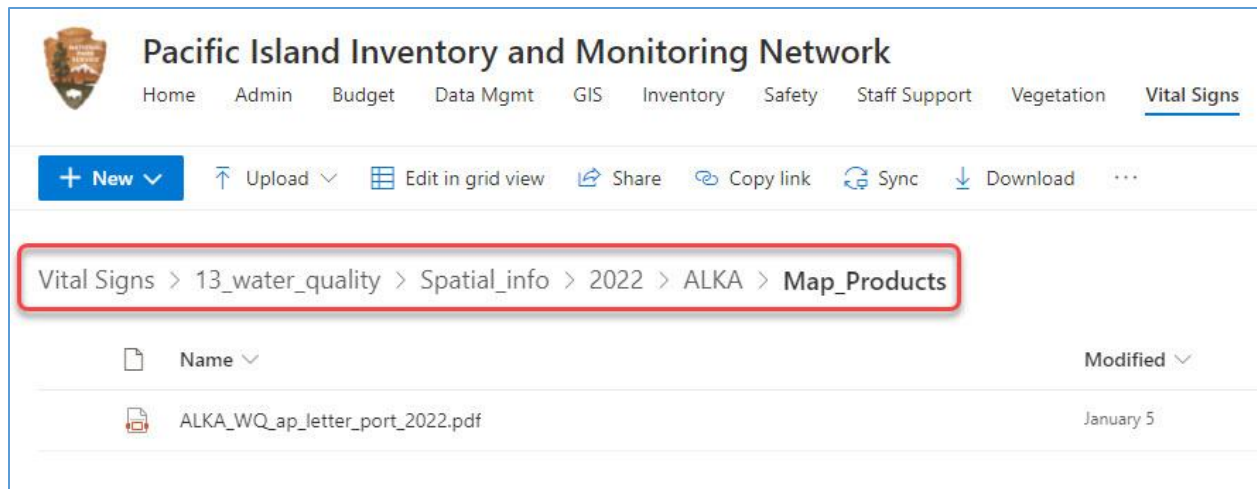


Figure SOP 7.1. Example of map products location for a particular year and park in SharePoint.

Coordinate Table locations:

Water Quality Monitoring "Spatial info" folder → Year folder → Park folder → "GIS_Data" folder → "Data" folder (Figure SOP 7.2)

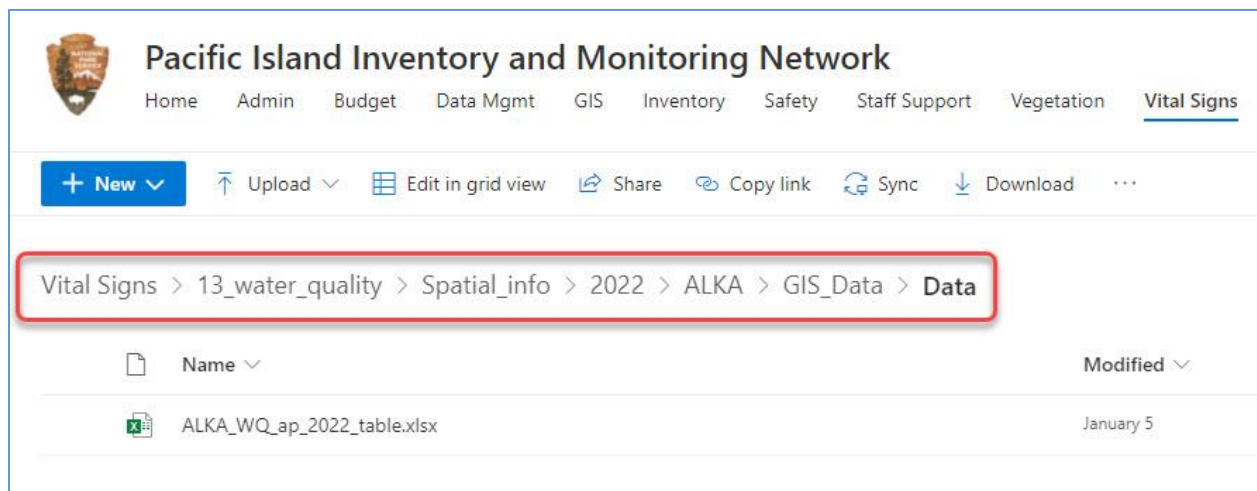


Figure SOP 7.2. Example of coordinate table location for a particular year and park in SharePoint.

Appendix SOP 7.a. Equipment necessary to install and re-install fixed transect locations

Table SOP 7.a.1. 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+)	More pins may be necessary if conditions warrant
Z-spar or Powerfast Epoxy (1 ea.)	Ensure that 1 gallon of both parts A&B (Z-Spar) or several tubes (Powerfast) are available
Mesh bag (1)	Ensure that this equipment is available
Tupperware containers for Z-spar (2)	One for each Z-spar compound part; Ensure that this equipment is available
2 or 5 lb. Sledgehammer (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, or maps of transect locations	See SOP #7 Selecting and Marking Subtidal Sampling Transect Locations
GPS (Global Positioning System) (1)	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 pencils (2)	Ensure that this equipment is available
U/W lights (2)	Ensure that this equipment is available
U/W light batteries (2 sets)	Ensure that this equipment is charged and 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 7.a.2. 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	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 CSA plate pairs per transect; See SOP #1 Before the Field Season for construction and labeling information
Cooler or tray 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
0.5 m long stainless steel threaded rods (3)	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 tag (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, 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 pencils (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
U/W light batteries (2 sets)	Ensure equipment has sufficient power charge
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 7.a.3. 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 (10)	Ensure that this equipment is available
Dymo embossed plastic labels (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
Dive weight	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
Surface float marker (2)	One for back-up; ensure that this equipment is available
U/W compass (1)	Ensure that this equipment is available
U/W slate with pencils (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 batteries (2 sets)	Ensure equipment has sufficient power charge
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

Appendix SOP 7.b. Procedures Followed for Fixed Plot Generation and Installation

***Note:** This SOP has been updated to reflect that all fixed transect locations have been established, and only temporary transect locations need to be generated on an on-going basis. Appendix SOP 7.b. documents the legacy information for how fixed transects were generated and installed.*

If a new fixed plot needs to be added, please contact the PACN GIS Specialist (Mark Wasser, mark_wasser@nps.gov) and they can complete this procedure using an updated workflow with current software.

Generating Random Points for Fixed Transect Start Pins within ARCMAP®

1. Open ARCMAP® on your computer
2. Open park specific project file and associated layers which should include a map of the park, the park unit(s) boundaries, benthic habitats, and isobaths.
3. Criteria for generating points are as follows.
 - a. Within park boundaries plus adjacent coastal areas that may impact (or be impacted by) the park. Adjacent coastal areas extend to the edges of the watershed(s) in which the park lies.
 - b. Within 10 to 20 m depth contours
 - c. On hard substrate (basalt or limestone, or coral reef) that has been predetermined from the benthic habitat map.
4. Generate 30 points with X and Y coordinates that fall within depth contours and on hard substrate, using the following procedure.
 - a. Select the benthic contours shape file.
 - b. Create a polygon or raster file within the 10 m to 20 m depth contour. This can be done by right clicking on the contour shape file and selecting “Open Attribute Table”. Note this file must be the original point file (e.g., Lidar data file) and not a line file that has been interpolated from a point file.
 - c. Then select the “Options” button in the lower right hand corner of the window and choose “Select by Attributes” from the pull down menu. In the “Select by Attributes” dialog box enter in the query to select the appropriate depth contours (See example query phrase in Figure SOP 7.b.1).

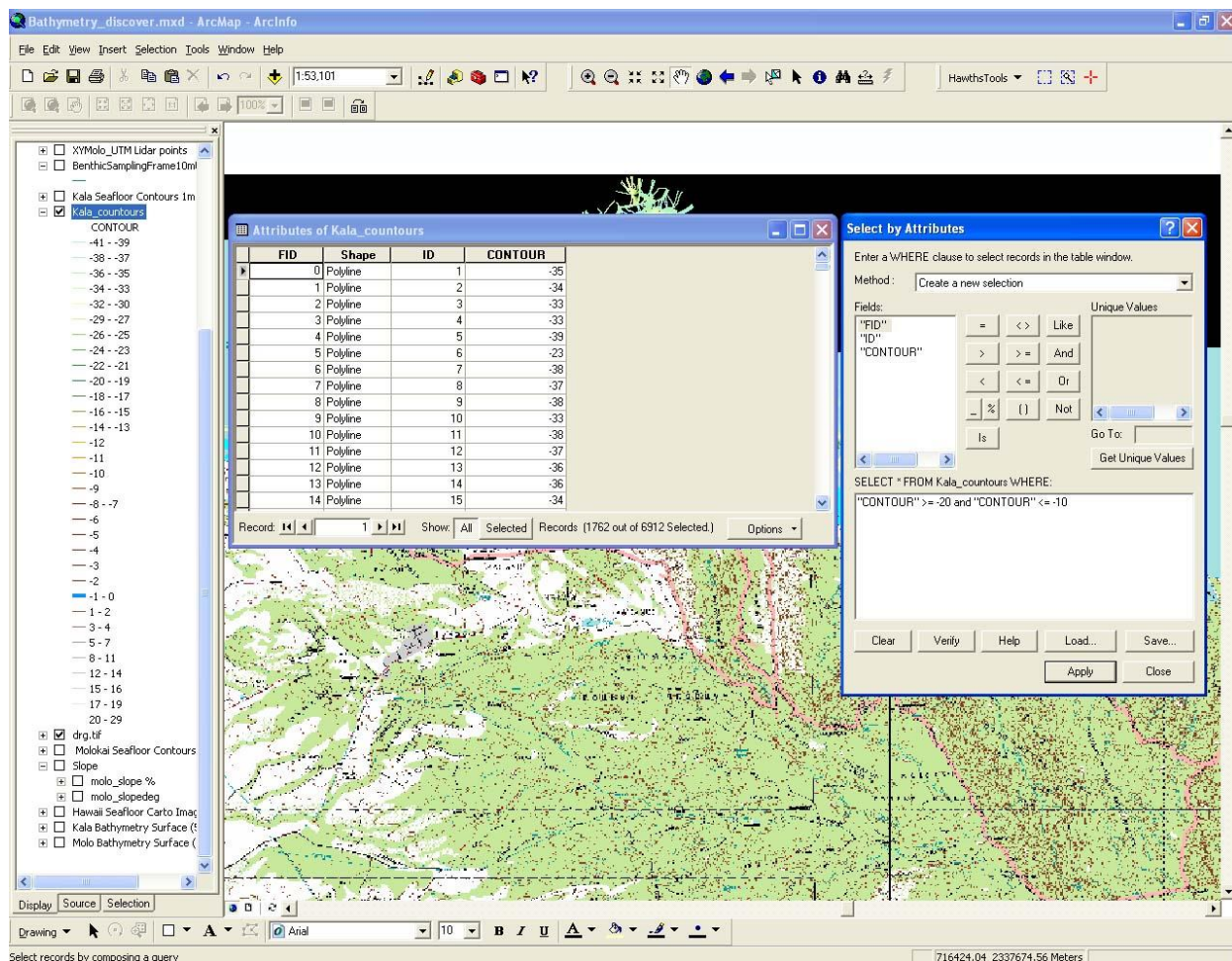


Figure SOP 7.b.1. Sample screen display for selecting depth contours within a shape file in ARCMAP® 9.0.

- d. Select this new layer and load the Hawth's tools from the View-Toolbar menu. Hawth's tools is a free extension that can be downloaded from <http://www.spatial ecology.com/htools/download.php> (accessed 5 July 2006; **Note:** this tool is no longer available at this website).
- e. Under the Hawth's Tools down arrow button, select the "Sampling Tools-Generate Random Points" option.
- f. Within the dialog box, select the polygon or raster file, check the "Prevent points from being located in the NODATA cells" box, enter 30 points within the "Generate this number of random points" box, and specify the output filename (Figure SOP 7.b.2). It should be noted that some parks (e.g., WAPA, KAHO) have sites with existing data sets and these sites will be included in the sampling frame to extend the historical perspective, assuming initial selection of these sites was random. The sites must meet the basic criteria (i.e., hard bottom, 10 to 20 m depth) to be incorporated into the sampling frame. Therefore, simply subtract the number of historical sites

from the total number of new points generated. For example, if three historical sites will be used in the sampling frame then simply generate 27 new points for consideration.

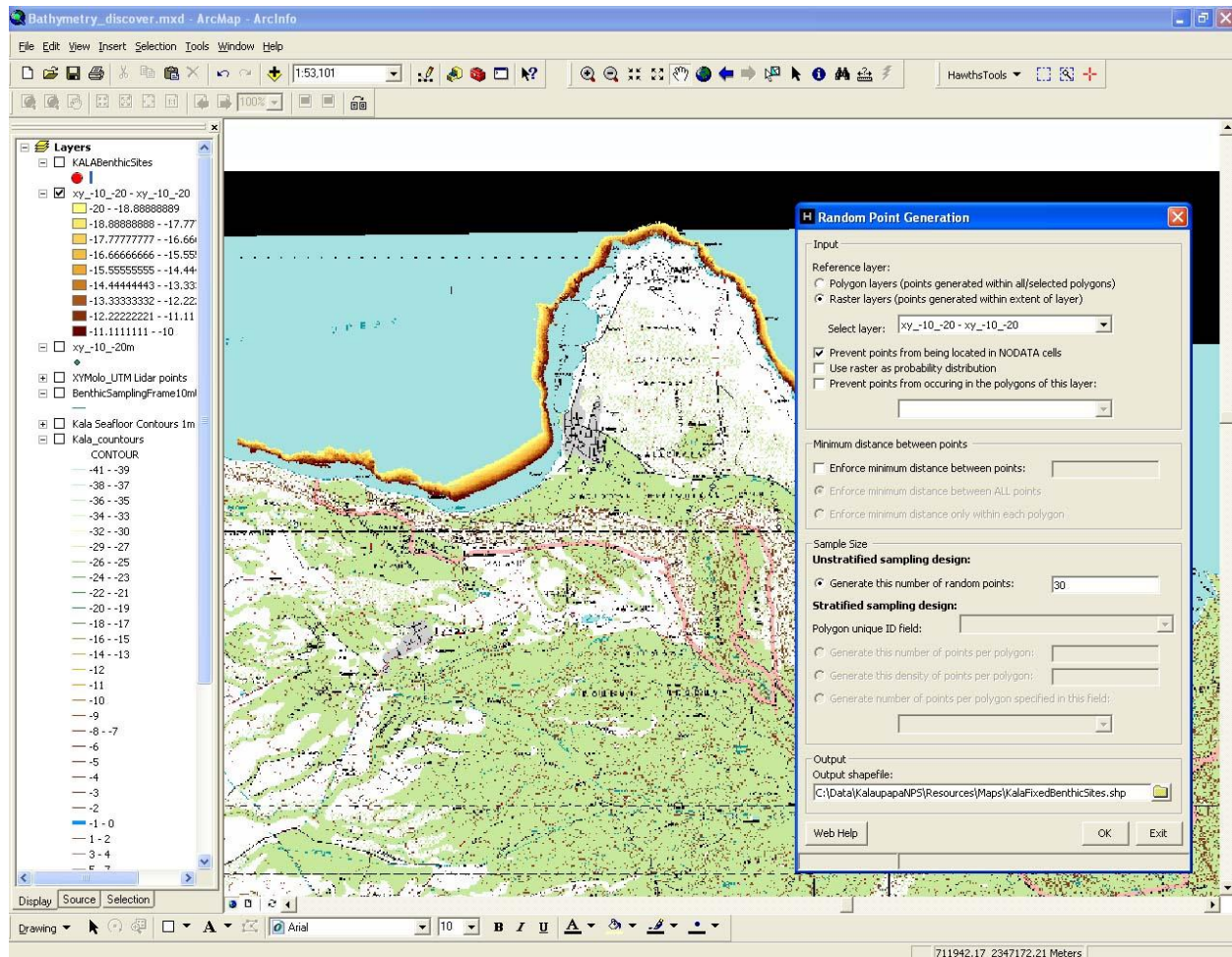


Figure SOP 7.b.2. Sample screen display for generating 30 random points within a shape file using the Hawth's Tools extension in ARCMAP® 9.0.

- g. Once the points have been displayed then use the Hawth's tools "Table Tools – Add XY to Table (points)" to create X and Y values for each of the random points within the newly created output shape file. Select the Point layer to identify the shape file and label the X and Y Fields within the Add new fields radio button.
5. Randomly select 15 of the 30 points that will be fixed and sampled annually beginning in year 1. The other 15 points will be used as alternative locations should any of the first 15 points be deemed unsuitable (e.g., sand instead of hard substrate) during the field installation. Random selection can be done using the Microsoft Excel® "RANDBETWEEN" function or simply picking points out of a hat. For example, in Excel assign the 30 points to 30 cells and label them sequentially from 1 to 30 in another column. Then in a third column highlight 30

cells and enter the formula =Randbetween(1,30). Select the point whose number is generated in the first 15 cells.

6. Establish a Microsoft Excel® file (e.g., KALA_transect metadata.xls) to record all XY coordinate pairs for transect start points that are used cumulatively over time, starting with year one. When new random points are generated, compare these against existing point coordinates to assure that no existing point coordinates are re-used, and add any new point coordinates to this list.

Establishing Fixed Study Sites

These procedures detail establishing a full benthic monitoring transect location with three separate monitoring components: 1) permanent steel pins to mark the start and end points of a transect location for obtaining percent cover, 2) installation of three Coral Settlement Arrays (CSA) per transect, and 3) ten individually tagged coral colonies per transect for growth rate monitoring. Note that implementing component # 3 is valuable, but optional depending upon time and park resources. Some parks may elect to implement component #3 after several years once experience has been obtained with the first two components. All three components listed above can be installed on a single 60 minute dive to establish one transect.

Before Entering the Field

1. Collect the equipment necessary to complete all tasks that will be conducted ([Appendix SOP 7.a](#)). Cut pins and other mounting rods to required lengths. As noted in SOP #1 Before the Field Season, transect pins should be approximately 0.40 meters long and CSA mounting rods should be at least 0.50 meters long.
2. Ensure all random points have been generated, printed, and downloaded into the GPS.
3. Print relevant forms on plastic coated paper for in-water use. Forms for CSA installation and tagging corals are needed in-water.

Navigating to Selected Sites

1. Using a Global Positioning System (GPS) unit in which the random transect location points are already stored, navigate by boat, or surface swim, to the location using the GPS's navigation feature. If surface swimming, put the GPS in a transparent waterproof container attached to a surface float such as an inner tube with dive flag and a line with a bottom weight to be set at the transect start point (see SOP #4 Using Garmin® GPS Units for information on using GPS).
2. When approaching the random point, assess the area for safety. If the point is not a location that is safe to dive or anchor the boat, discard the point and adopt one of the next closest alternative points. Move on to the next location. Repeat steps 1 and 2 until a random point is found that is determined to be safe for field work.

3. When within approximately 3 meters of the site, carefully but quickly lower a surface float marker or Pelican® surface float with a bottom weight (~1 kg) so that it comes to rest as close as possible to transect start/terminus pin location.
4. Allow the boat to drift a short distance off the site before lowering and setting the anchor or tying boat's bow line to a mooring buoy (if available near the site).
5. Always attempt to lower the anchor into a nearby sand or non-colonized rock or boulder patch. If no sand or rock patch is available, attempt to lower anchor so that it does not impact live coral or other live benthic organisms. If a permanent mooring buoy-line is available nearby, use it to securely tie off boat's bow line. Then, locate the deployed surface float by taking a compass bearing to it.
6. Using mask, fins, and snorkel, determine the bottom substrate composition from the surface float along the predetermined compass bearing for a minimum of 25 to 30 m. If the underlying bottom includes unconsolidated material (e.g., sand) or too small of an area of contiguous hard bottom, discard the location and adopt an alternative random point to replace it. Collect the float and move to the next point. Repeat until a site with appropriate safety and bottom characteristics is located.

Installing Permanent Transect Marking Pins

The following protocol steps assume that divers have successfully navigated to and selected the fixed transect site and that it meets all suitability criteria for transect placement. Care must be taken when initially installing transect locating pins. One permanent transect will be installed at each monitoring transect location. Stainless steel threaded rod stock (All Thread) will be used as transect marking pins in non-living hard substrate. Other areas have developed methods to install transects without the use of permanent pins (e.g., large cable ties, marker floats). These methods are not feasible for the PACN parks because of environmental conditions and the necessity that transects be easily revisited and highly reproducible. In particular, large wave disturbances such as typhoons, and typical winter storm swells require that markers have a low cross-sectional area to reduce drag, do not physically degrade (e.g., cable ties), and are anchored deep enough in the substrate to survive substantial habitat disturbance. Refer to the equipment list needed to install permanent transect marking pins in [Appendix SOP 7.a](#).

1. Upon descent, examine both possible transect directions along the isobath to ensure that at least one section contains a minimum 25 m length of contiguous habitat. If neither direction meets this criterion, then resurface and select one of the alternative points.
2. When a point is determined to be suitable, starting in appropriate substrate as close as possible to the weight on the bottom of the float marker, install a stainless steel threaded pin into solid substrate by hammering the pin into a crack or crevice with a 2 or 5 pound sledgehammer. Alternatively, an appropriate diameter hole is drilled into solid hard bottom (basalt, limestone or dead coral) using a rock or masonry drill bit in an underwater drill. Permanently epoxy the pin into a vertical position using a suitable fast-setting two-part

marine epoxy, such as Powerfast or Z-Spar. Powerfast is packaged in dual “caulking” or syringe-like tubes, to mix epoxy parts and minimize epoxy handling. Z-Spar comes in separate metal containers; each part needs to be transferred to separate plastic containers for underwater use. Latex gloves should always be worn when handling epoxy, including underwater. Place an appropriate amount of epoxy in hole, then press rod into hole, tapping it gently with a hammer to set pin. If needed, apply epoxy around the base of the installed pin. The start and end pins of the transect should extend at least ten cm above the bottom.

3. Install one cable tie around the rod to denote the start pin. Leave the trailing end of the cable tie intact to facilitate relocation.
4. Randomly select a possible transect direction along the isobath unless only one direction contains contiguous habitat. One can use a preselected list of random numbers for compass bearings or spin a knife handle to determine direction. Take a compass bearing at the depth of the pin along the isobath (using a wrist or diving console mounted underwater compass with side sighting capability) and record the bearing on an underwater slate. If the bottom is of uniform depth, the compass bearing should be run parallel to shore to ensure measurement of similar habitat. Care must be taken to keep the compass away from stainless steel pins or any other ferrous metals, including any dive gear and tools.
5. Use a fiberglass transect tape marked in meters to measure the initial transect length. The transect tape should have a loop and small brass clip at the 0 m end and a loop and small brass clip on the handle. Loop and secure the 0 m end of the tape to the start pin. Two divers then swim the compass bearing along the isobath slightly above the bottom, one maintaining the bearing and the second holding the tape allowing it to feed out freely. The latter diver should look back at the tape often to ensure that it remains straight and taut. The divers should swim along the depth contour following the selected, or predetermined, random compass heading.
6. Once the appropriate 25 m distance has been swum, the diver handling the tape should stop and slightly stretch the tape again so that it is tight along the bottom.
7. Temporarily secure it on the bottom (e.g., to a temporary stake, rock or dead coral head).
8. The diver that swam the compass bearing should turn 180 degrees and swim back along the transect to check transect orientation, placement along the isobath, and tautness. If necessary, orientation or placement should be corrected to match the compass heading and isobath.
9. The two divers should then install the end pin at the 25 m mark, as was done at the start (0 m) pin.
10. Install two cable ties around the rod to denote the end pin. Leave the trailing end of the cable ties intact to facilitate relocation.

11. If relocating the end pin will be difficult (e.g., site typically has poor visibility) then divers can also install shorter threaded rods every 5 meters between end pins, ensuring the tape remains taut as they work. The pins should be installed as above, except that no more than ten cm of the threaded rods should extend above the substrate. Install the additional pins between the end pins only if necessary, because this procedure may detract from the underwater natural setting of each park.
12. The transect tape is reeled up after all pins are installed. Once epoxy is set and monitoring commences, the 0 m tape end is looped or clipped to the start pin, the tape looped once around either the intermediate pins or natural anchor points, and then looped or clipped to the end pin. By clipping or looping the meter tape, this will ensure that it is pulled taut and does not move around a lot in surge. The tape cannot move much, or future measurements along the transects will have poor precision and reproducibility.
13. If surge is a problem, then an alternative approach is to use a 35 to 40 m ¼" diameter leaded line that is deployed as above between the end pins. This line is marked at every meter and laid along the bottom during photo quadrat sampling.
14. Note: the random transects will not have permanent pins to mark the start and end points. Follow and repeat Step 1 for each transect. Instead of attaching transect tape to pins, temporarily attach tape ends to non-living natural anchors or temporary pins on the bottom. Continue with Steps 4 to 8.

Installing Coral Settlement Arrays (CSA)

The following protocol steps assume that divers have successfully navigated to and selected the fixed transect site and installed the permanent transect marking pins. To complete installation, three CSAs need to have been constructed, labeled, and conditioned as described in SOP #1 Before the field season. Refer to the equipment list needed to install CSAs in [Appendix SOP 7.a](#).

1. Selection of points for placement of the CSAs is done at pre-determined points along the benthic percent cover transect line. Three pins are installed 2.5 meters off the transect on the shoreward side at the following locations:
 - a. The start pin
 - b. The end pin
 - c. At the mid-point of the transect (12.5 m mark)
2. The stainless threaded rod of the CSA should be set approximately 0.25 m into solid substrate (whenever possible, and no less than 0.1 to 0.15 m). Use protractor to drill holes and set rods vertically in substrate. The rod should be installed into a hole of approximate diameter, e.g., ½ inch and tapped with a hammer to set, and then affixed in place with a marine epoxy; excess epoxy can be molded around the rod on the surrounding substrate by hand, with latex gloves, which should always be worn when handling epoxy. Preferably, an underwater drill is

used to make holes, the hole is partly backfilled with epoxy and the rod inserted. Care must be taken to ensure that all CSA rods are installed straight – vertical to the bottom. Excess epoxy can be molded around the rod by hand as described above.

3. The epoxy must be cured for at least 24 hours before settlement tiles are mounted on rods, so that chemicals catalyzed when the two epoxy parts are mixed do not contaminate the settlement tiles. Coral and other larvae are extremely sensitive to chemical and other signals, including oils from fingers, which strongly bias any initial settlement micro-site preference and longer-term recruitment patterns.
4. The settlement tile pairs are fastened to the threaded rods using the appropriate hardware and tools; (e.g., flat head screwdriver, pliers, as appropriate). Tool(s) should be tied to a short piece of thin, strong (parachute type) cord, which is attached to a gear bag or diver's BC with a small brass clip or carabiner.
5. Place the long PVC tube (15 cm long) over the mounting rod (Figure SOP 7.b.3).

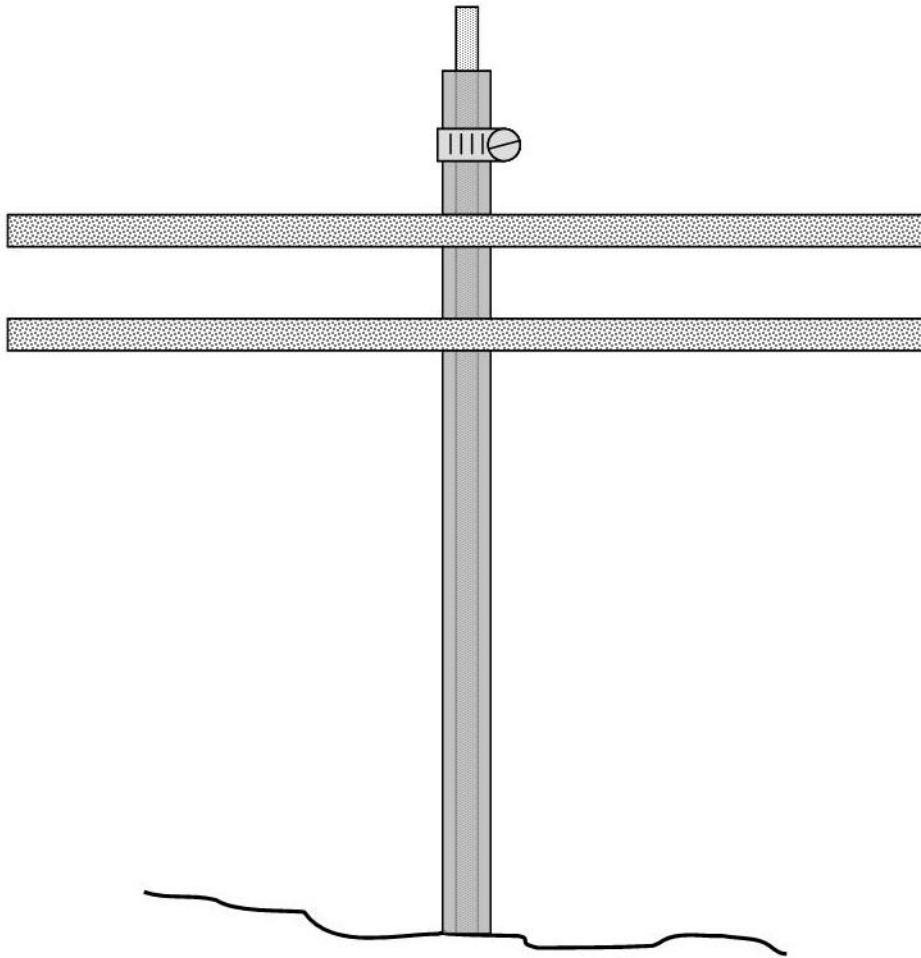


Figure SOP 7.b.3. Settlement tile array showing the plate pair attached to the 45 cm stainless steel threaded rod.

6. Place the lower terra cotta plate onto the rod with the edge arrow pointing upward. It should rest on the top of the PVC tube such that it is 15 cm off the bottom and parallel to the substratum. Double check to ensure the plate was installed with the edge arrow pointing up.
7. Place a short PVC tube (1 cm long) on the mounting pin.
8. Place the upper tile onto the pin with the edge arrow pointing upward so it rests on the top of the short PVC tube. A gap of 1 cm should be present between the tiles. Ensure the two tiles are parallel to each other. Double check to ensure the upper plate was installed with the edge arrow pointing up.
9. Place a 5 cm section of 1 cm outer diameter clear plastic tubing over the top of the CSA pin and push until snug against the upper tile plate. Place a 2 cm diameter hose clamp over the plastic tubing and tighten it with a flat head screwdriver or pliers.

10. Record the plate # information on the settlement datasheet in [Appendix SOP 7.c](#).

(Optional) Tagging Individual Corals for Repeated Growth Rate Measurements

The following protocol steps assume that divers have successfully navigated to and selected the fixed transect site and installed the permanent transect marking pins. Growth rate measurement is an important, but optional procedure and will take two divers with one dive per transect. The first ten *Pocillipora eydouxi* colonies encountered within 1 m to each side of the permanent transect line will be identified and monitored for growth (See Veron 2000 for photograph and defining morphological traits of *P. eydouxi*). A total of 150 coral colonies (on 15 permanent transects) will be tracked for growth monitoring. Working in close proximity to coral colonies should be done with care to ensure that the colonies are not damaged, although minor damage will heal. Refer to the equipment list needed to tag individual corals in [Appendix SOP 7.a](#).

1. Swim slowly along the transect and search for colonies of *Pocillipora eydouxi* within 1 m to either side of the line.
2. Selection of colonies should begin when the first coral colony is encountered from the start of the transect and proceed in sequence toward the end of the transect.
3. All colony size classes encountered with a basal diameter greater than two centimeters should be considered. Basal diameter of colonies smaller than two centimeters are too small to accurately track over time.
4. The first ten colonies should be selected on each transect.
5. Once a colony is located, attach a plexiglass or plastic tag, pre-labeled using an engraver (e.g., Dremel tool) or Dymo tape (embossed) labeler, to the substrate in close proximity to the colony using stainless steel wire, plastic cable ties, or nails. The tag setup must be at a sufficient distance to avoid contact with the colony and allow for future growth. The tag should be marked with an individual identification number using the following format: four letter park identifier - three digit number starting at 001 – two digit year (example: WAPA-001 - 05). See SOP #1 Before the Field Season for details on making coral colony tags.
6. Sketch a map, on an underwater slate, the relative position of colonies, with their identification numbers, distance along, and to the transect line. After the dive transcribe this information into a log book for future reference when relocating the colonies. This information will also be documented in the benthic database.
7. Periodically use gloved fingers to gently rub the tags to remove fouling organisms and maintain tag readability. Tags can be cleaned whenever performing other tasks along the transect line.

Appendix SOP 7.c. CSA datasheet (with optional photo log)

Datasheet used to record information on deployment and retrieval of coral settlement arrays (CSAs). Codes for the plate surfaces are as follows: UT=Upper Top; UB=Upper Bottom; LT=Lower Top; LB=Lower bottom. A copy of this datasheet can be found in Appendix SOP 9.b. of SOP #9 Conducting Coral Settlement Sampling. If any changes are made to this datasheet, update copy in SOP #9.

Settlement Log

Observers:

Year:

[illegible]