

South Florida/Caribbean Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure CR09

Installing Monitoring Sites—Version 2.1

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Summary

This SOP describes the in-water selection criteria for the actual installation of the pins within four transect extensive sub-sites or twenty transect index sites. Four transect extensive sub-sites will have been selected and evaluated using the RHA method described in SOP CR08 *Conducting rapid habitat assessments—Version 2.1* (SFCN 2025a). If a 20-transect index site sampling design is used, the transects will have been randomly selected using SOP CR07 *Selecting and locating random sampling points using GPS—Version 2.1* (SFCN 2025b).

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
2002	Jeff Miller	Published Protocol: Miller, J. 2002. Using the AquaMap System at a Study Site. U.S. Geological Survey Technical Report.	Original published Aquamap protocol.	1.00
2008	Jeff Miller	Extensive 4 transect sub-site installation added	4 transect subsites added to overall monitoring protocol.	1.01
2009	Jeff Miller	Beginning and terminal pins added to transects on all index sites.	Installed in case Aquamap ceased working, site could continue to be monitored.	1.02
2010	Jeff Miller	Aquamap discontinued.	Manufacturer ceased producing Aquamap, device was failing, and SFCN discontinued use.	1.03
2015	Jeff Miller	SOP revised to meet I&M program, organization and format requirements.	To meet I & M program, organization and format requirements.	2.0
2020	Judd Patterson	SOP name changed from 9 to CR09.	Renamed according to regional guidance.	2.1

Four Transect Site Installation

Equipment needed

- Standard dive equipment
- GPS unit (boat mounted and/or handheld) with site coordinates loaded
- Weighted float line
- 18–24 inch (45.7–61 centimeter [cm]) Copper clad stakes (9 per site)
- Mallet/sledgehammer
- Transect tapes (preferably at least 4 of 25 meters [82 feet {ft}] each)
- Cable ties
- Slate and underwater paper for mapping

Procedures

1. On any given field day, sites should be chosen based on safe diving practices (deeper sites first, etc.) and proximity.
2. To approach the site, the boat should navigate to within 10 feet (3 m) of the coordinates of the site using the GPS and deploy a weighted float line. The location of the drop becomes the center position for the site. Because site installation is time consuming, it is recommended that the team anchors the boat; however, anchor in sand or the first dive team should set the anchor in sand to avoid negatively impacting the study site.
3. The transect design is four transects radiating from a center point along the four cardinal directions (Figure 1). Transects are 10 meters (32.8 ft) from the center pin and 10 meters (32.8 ft) in length.

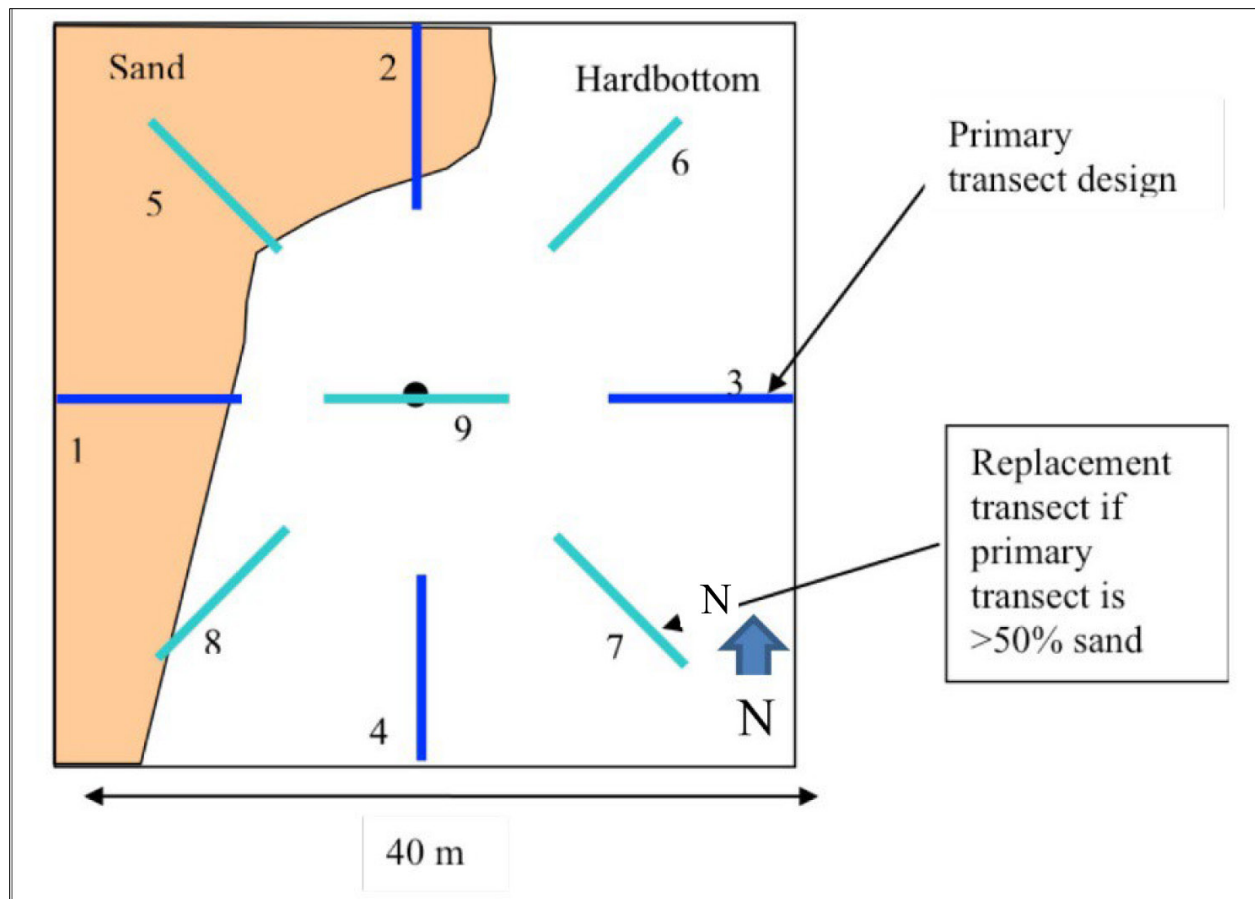


Figure 1. Decision tree on transect order of selection for four transect extensive sub-sites.

4. Divers descend the float line. If the site appears to have sufficient hardbottom to install four transects, the center pin is installed as close to the weight as possible. A mallet is used to pound the stake into the substrate, taking care to avoid live coral (and other live cover).
5. From the center pin, divers run four transects of greater than 20 meters (65.6 ft) in the cardinal directions. Each of the initial transects should be tied off to dead coral outcroppings or other non-living reef features.
6. The benthic composition between the 10 and 20 meter (32.8 and 65.6 ft) marks on the transect tape is evaluated to assure that greater than or equal to 5 meters (16.4 ft) is hardbottom. If a transect will encompass greater than 5 meters (16.4 ft) of sand, this transect is omitted and a replacement transect is evaluated for installation.
7. A replacement transect is selected in numerical order until the requisite four transects are found. As an example, in Figure 1, transects #1, #2 are greater than 50% sand and are excluded. Transect #5 is also excluded. The final design by visiting transects in order is transects #3, #4, #6 and #7.

8. Start and end pins are pounded in as close to the 10 and 20 meter (32.8 and 65.6 ft) marks as possible, taking care to avoid live coral or other live cover. The end pin must be at least 10 meters (32.8 ft) from the start pin.
9. After all pins are installed, transects are rerun from the start pins to the end pins of each transect. Cable ties are attached to the start pin with the number of cable ties reflecting the transect number, i.e. one cable tie for transect 1, two cable ties for transect 2, three cable ties for transect 3, four cable ties for transect 4.
10. A small subsurface float and line and a pair of temperature loggers (see Davis et al. 2025) are attached to the center pin.
11. Typically, the site is sampled upon installation (following SOPs CR01–CR06).
12. The site is mapped in detail, including depths, bearing and distance as precisely as possible to all pins (see example below). Other useful features for relocating pins (large/unusual coral colonies, sponges, sand channels, etc.) should be noted on the map (Figure 2).

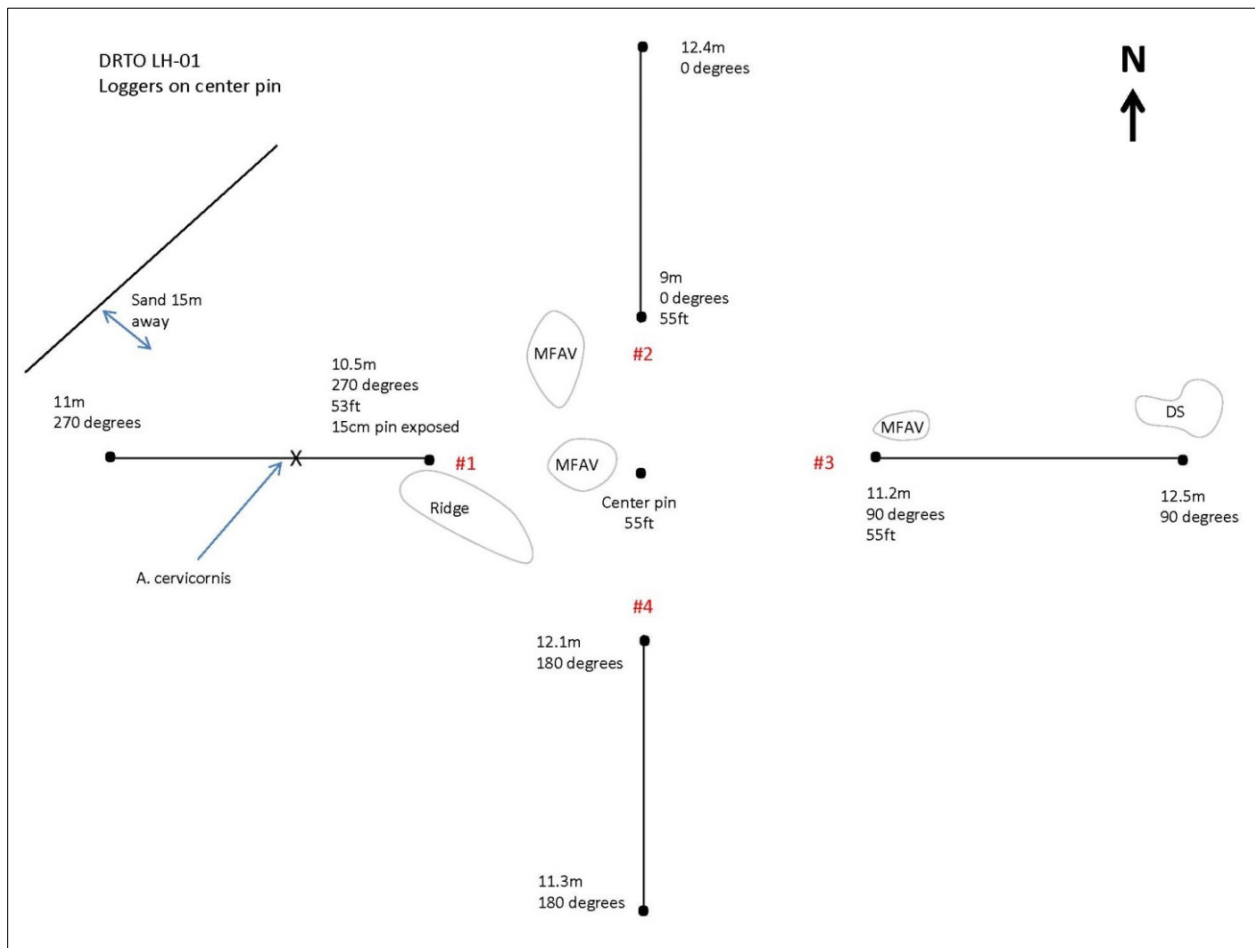


Figure 2. Example of a site map created to guide finding transect pin locations.

20 Transect Index Site Installation

Equipment needed

- Standard dive equipment
- GPS unit (boat mounted and/or handheld) with site coordinates loaded
- Weighted float line
- Copper clad stakes with stamped ID numbers
- Mallet/sledgehammer
- Transect tapes (25 meters [82 ft] and up to 100 meters [328 ft])
- Slate and underwater paper for recording depth and time of pin installation.
- Cable ties

Procedures

1. The boat should navigate to within 10 feet (3 m) of the coordinates of a transect using the GPS and deploy a weighted float line. The handheld GPS (in a waterproof housing) is fastened atop the surface float. This line and drop becomes the location of the start of the transect. The first dive team should set the anchor in sand to avoid negatively impacting the study site.
2. Divers descend the float line. At the point where the weight drops, a transect tape is attached to a nonliving part of the bottom and a 10 meter (32.8 ft) transect is run on a predetermined compass bearing (a bearing that positions the transect along the reef features and that maintains a similar depth contour). The transect tape is run out beyond the 10 meter (32.8 ft) point.
3. The benthic composition under the transect from 0–10 meters (0–32.8 ft) is evaluated to assure that greater than or equal to 5 meters (16.4 ft) is hardbottom. If the transect will contain greater than 5 meters (16.4 ft) sand, the installation of the transect is aborted and the team moves on (following ranges and bearings) to the next possible transect point.
4. If the transect is greater than or equal to 5 meters (16.4 ft) hardbottom, the transect is installed. An origin pin is installed into the substrate as close to the weighted drop point as possible taking care to avoid live coral or other live cover. The end pin must be installed at least 10 meters (32.8 ft) from the start pin (do not adjust the transect bearing). A cable tie is placed on the terminal pin to identify it.
5. Typically, upon installation, the site is sampled (following SOPs CR01–CR06).

6. After installation and sampling, two divers surface to the float/GPS. Coordinates are saved as a “marked waypoint” as directly as possible overtop the origin pin.
7. The weighted line is reeled up and the divers navigate to the next sample point using the surface handheld GPS. Upon arriving at that location, the weighted line is deployed. The divers descend and begin the transect installation process (number 2–4 above).
8. Following installation of the next transect, a dive team uses transect tapes (likely the 100 meter [32.8 ft] tape) to map the straight line distance and bearing between the start pins of the two transects. This may take several swims between the points to assure a straight line and accurate compass bearing sighting. These ranges and bearings are used for future sampling events.
9. This cycle continues until all transects are installed, the number of pins carried has been exhausted, or safe dive limits have been approached.

Literature Cited

- Davis, A. D., A. J. Atkinson, M. W. Feeley, J. Miller, J. M. Patterson, L. Richter, C. S. Rogers, R. J. Waara, K. R. T. Whelan, and B. Witcher. 2025. Coral reef ecosystem water temperature monitoring protocol: Protocol narrative—version 1.2. Science Report—2025/265. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2308365> (last accessed April 2025).
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