

American Samoa Coral Bleaching Response Protocol – Feb 2017 (revised Jan 2018)

This protocol is intended to be used by observers with various backgrounds/training without introducing a substantial observer bias. The protocol is described in 5 steps and survey methods are organized in a tiered layout, starting with a basic large-scale survey and developing progressively into more intensive small-scale surveys.

Step 1: Monitoring ocean conditions

Prior to the initiation of the bleaching season the following tools can be used to monitor ocean conditions and forecast a potential coral bleaching event:

- **NOAA Coral Reef Watch** - Sign up for email alerts and check the website for Hotspots and Degree Heating Weeks maps (<http://coralreefwatch.noaa.gov/satellite/index.html>)
- **Sea surface temperatures** - Sea surface temperatures recorded by PACIOOS temperature buoy can be accessed by signing up for daily email alerts (<http://www.pacioos.hawaii.edu/regions/amsamoa/>)
- **Weather forecasts** - Track weather patterns and record any long periods of high temperatures and calm seas as potential bleaching events.
- **Community outreach** - Educational materials should be prepared and provided to fishermen, local communities and schools to request for reporting of any bleaching observations. Information about coral reefs and bleaching are presented in Appendix 3.
- **Long-term monitoring sites** – all territorial coral reef monitoring programs should record initial observations of coral bleaching and report to the relevant group to initiate further monitoring
- **Temperature loggers** - The CRAG Territorial Monitoring program initiated logger deployment in November 2015 at 30ft depth on the reef slope and 3ft depth on the reef flat at 8 sites (Leone, Amanave, Fagamalo, Fagasa, Amalau, Aoa, Alofau, Nu'uuli), in addition to 3 lagoon pool sites (Alofau, Airport, Faga'alu) around Tutuila. NPS initiated logger deployment in 2015 at 3 sites in Tutuila (Vatia, Tafeu, Muliulu-Fagasa) every 5m from 5-25m depth and at 3 pools in Ofu (Pools 300, 400, 500). Standard procedures include installing 2 loggers at each location to provide a backup in case of loss. Loggers can be wrapped in black electric tape to reduce fouling. Loggers should be replaced with new batteries prior to the bleaching season. At selected sites loggers can be retrieved during the bleaching season to monitor actual water temperatures and correlate with coral bleaching predictions and weather patterns. Temperature logger data can be analyzed to understand island-wide and site-specific summer temperature averages and bleaching threshold levels.

Step 2: Classify the bleaching event

If there is not enough information to classify the event at this point (a few subjective reports of bleaching) move to Step 3. If there are multiple reliable reports on the bleaching event use the guidelines in Table 1 to classify the event.

It is important to consider what stage the bleaching event is at (beginning, middle, end) when choosing an appropriate response/survey method. In addition, the habitat has to be considered – manta tows are only recommended for slope sites. Additionally, resources (boat time, observer qualifications/training, etc.) have to be considered when making a decision on what survey methods to use. Table 1 provides a summary of how to classify a bleaching event.

Table 1: Classification of bleaching event, adapted from Marshall & Shuttenberg (2006):

***only use Tier 1 for slope sites. For pools and reef flat start with Tier 2.**

Event Classification	Description	Suggested survey method*
Minor Bleaching Event	<p>Low coral bleaching (1-10% colonies are white) at multiple sites from multiple locations.</p> <p>OR reports of moderate bleaching from a few sites only.</p>	<p>Spot-tows to determine if the event is progressing into a moderate/major event. Tier 2 surveys at priority locations.</p>
Moderate Bleaching Event	<p>10-50% colonies are white at multiple sites.</p> <p>OR severe bleaching (>50%) from a few sites only.</p>	<p>Tier 1, then if resources allow Tier 2, and then Tier 3</p>
Major Bleaching Event	<p>Severe to extreme bleaching (>50% colonies completely white) from multiple sites</p>	<p>Tier 1, then if resources allow Tier 2, and then Tier 3</p>

Step 3: Determine survey schedules

Depending on the event classification, the habitat types and available resources, different survey schedules are recommended as follows:

- Limited information or minor event:** If there is only very limited information on the bleaching event or if the event was classified as ‘minor’, conduct frequent spot-tows (a spot-check manta tow at a few key locations) to get a general idea of the bleaching situation to determine if the event is progressing into a moderate/major event. Resources have to be considered in determining how often a manta tow can be carried out and how much reef can be covered. It is recommended that spot-tows are carried out 1 day every month and that all 4 quadrants (NE, NW, SE, and SW) of the island and/or specific priority areas are covered. If resources allow, conduct Tier 2 surveys at priority sites.
- Moderate or major event:** If the event is classified as ‘moderate’ or ‘major’, conduct Tier 1 surveys (manta tows) to document the bleaching event on a large-scale and enable the organization to collect data on the extent and severity of bleaching on the deeper reef slopes. It will also aid in identifying areas of higher resilience to bleaching as these areas are most valuable for management purposes. If possible, manta tow surveys should be carried out monthly to document bleaching progression through time. If resources are limited (e.g. limited access to boats) then the Tier 1 manta tow survey should be carried out towards the peak of the bleaching event (when bleaching is at its worst) to be able to draw conclusions on overall severity as well as areas of higher resilience (i.e. areas that show reduced bleaching severity).

Table 2: Suggested survey methods, considering event classification, habitat and available resources.

Event Classification	RESOURCES					
	Low <i>No dedicated funds Limited trained staff</i>		Medium <i>Some dedicated funding Trained staff or ability to train Available boats</i>		High <i>Substantial dedicated funds Bleaching program exists Qualified scientific staff</i>	
	<i>Slopes</i>	<i>Reef flats/Pools</i>	<i>Slopes</i>	<i>Reef flats/Pools</i>	<i>Slopes</i>	<i>Reef flats/Pools</i>
Limited information OR Minor event	Spot tows	Tier 2 (timed-swims)	Spot-tows Tier 2 (timed-swims)	Tier 2 (timed-swims)	Tier 1 (manta tows) Tier 2 (timed-swims) Tier 3 (transects)	Tier 2 (timed-swims) Tier 3 (transects)
Moderate event OR Major event	Tier 1 (manta tows)	Tier 2 (timed-swims)	Tier 1 (manta tows) Tier 2 (timed-swims)	Tier 2 (timed-swims) Tier 3 (transects)	Tier 1 (manta tows) Tier 2 (timed-swims) Tier 3 (transects)	Tier 2 (timed-swims) Tier 3 (transects)

When to conduct surveys

Once the Tier 1 survey is completed and resources allow, progress to Tier 2 surveys at priority sites and/or random sites within all 4 quadrants (NE, NW, SE, and SW) of the island. If resources allow, it is advantageous to carry out a survey during the start, middle, and towards the end of the bleaching event to collect information on bleaching progression through time. If resources are limited, it is recommended to carry out Tier 2 surveys towards the peak of the bleaching event to collect the most meaningful information (i.e. functional groups affected, severity, and mortality). Once Tier 2 surveys are completed and resources allow, progress to Tier 3 surveys at priority sites.

Reef Flat and Pool Habitats

For all event classifications for **reef flats and pools**, move straight to Tier 2 surveys in priority areas. Then, if resources (time, observers) allow, carry out Tier 3 surveys at priority sites.

Step 4: Select survey method

Tier 1: Large-scale (Manta) tow survey

[Minimum resources: 2 observers | GPS | Boat]

Aim: Classify bleaching and map estimated coral cover and bleaching on a large scale.

GPS setup: Set GPS on ‘Tracking’ mode and keep in the boat, synchronize the GPS time to the observers watch, record coordinates (track) throughout the entire tow (every 10 sec). Record the start and end time of the tow.

1. Two observers are slowly towed over a depth of approximately 30 feet (if conditions allow). Stop the boat every 5 minutes. Observers have to consider the area of reef that they saw over the past 5 minutes, use the assessment scales (Appendix 1) and datasheet examples (Appendix 2) to record:
 - o Time and estimated Depth
 - o Coral Cover - % of live hard coral present
 - o Bleaching Extent - whether the coral is live / bleached / recently dead
 - o Bleaching Severity – if coral is partially or completely bleached

Example observation: “The area covered in 5 minutes had an estimated coral cover of #2 (10-40%), bleaching extent is estimated to affect #3 (50-90%) of these corals with a bleaching severity of #2 (completely bleached)”.

2. *(In addition to #1)* If the observers are familiar with different coral growth forms, they should take a closer look around at the stopping point and record the same information as above but this time based on functional groups (i.e. cover, bleaching and severity is estimated for each functional group – see a list of functional groups at the end of this document). Only consider the current location/stopping point for the estimations.

Note: If bleaching is very patchy (not continuous), instead of stopping every 5 minutes, the observers can signal when they see bleaching and only then the boat is stopped and the data recorded. In the case of a moderate and/or severe event make a special note of areas that show no or very light bleaching.

Tier 2: Site-specific survey

[Min. resources: 2 - 4 observers | GPS with float | Camera]

Aim: Record site-specific information on which corals (species, genus, functional groups) are bleached to understand if bleaching severity is different between the coral groups.

GPS setup: Attach a waterproof GPS to a float and reel. Set GPS on ‘Tracking’ mode and synchronize the GPS time to the observers watch, record coordinates (track) throughout the entire tow (every 5 sec). Attach the reel and float to an observer and tow above. Record the start and end time of the tow.

1. **Slopes:** Conduct dives at 2 different depths: 40ft and 15ft. Observers 1 and 2 swim along the 40ft depth contour for 25 minutes, aiming to cover 300-400m. At the end of the swim, ascend to 15ft and swim back along the depth contour and back to the start of the dive.
2. **Reef flats and pools:** Observers 1 and 2 swim around the chosen area for 30 minutes.
3. Record all species / genus / functional group (*choose appropriate level of ID depending on the abilities of the observer. Note: if identifying to species or genus also record growth form*), estimate:
 - o Time and estimated Depth
 - o Coral Cover - % of live hard coral present in the survey area
 - o Bleaching Extent - % of hard coral affected by bleaching
 - o Bleaching Severity – if colony is partially or completely bleached

NOTE 1: If only 2 observers are available, Observer 1 should estimate and Observer 2 should take photos.

Example observation: “It was estimated that the absolute cover of Acropora tables observed in the survey area was #1 (1-10%), and of all the Acropora tables observed about half were bleached, therefore a Bleaching Extent category #3 (10-50%), and bleaching severity of #1 (partially bleached <50% of colony affected)”

4. Observer 3 takes opportunistic photos, including:
 - o General wide scale habitat scenery
 - o Individual corals (from the top and the side if possible) of different bleached and unbleached species / genera / functional groups
5. Observer 4 takes a video camera (e.g GoPro or underwater camera) recording:

- o General wide scale habitat along transect, ensuring steady and slow movement to ensure high quality video. Observer should aim to record 3 to 5 meters of habitat within the frame.

Data Quality Checking:

- o Observers 1 and 2 should compare notes as soon as possible following the dive to agree upon a single estimate for the different observations, which should be recorded on the datasheets.
- o Photos and video footage taken by observers 3 and 4 should be downloaded and reviewed as soon as possible by at least two of the most experienced people to record observations as detailed as possible on estimated coral cover, bleaching extent and bleaching severity of different coral growth forms and if possible coral genera.

Tier 3: Transect-specific survey

[Min: 2 observers | GPS with float | 100m Transect | Camera]

Aim: to calculate quantitative bleaching prevalence values for a site and provide information to assist with understanding the ecological impacts on the reef ecosystem.

1. Attach a waterproof GPS to a float and reel and set on ‘Tracking’ mode (record every 1 minute)
2. Attach the float to the reef (rock or dead coral) at the beginning of the transect
3. Lay out three 25 meter transects at your chosen depth
4. Observer 1 counts every coral colony on a 1 meter wide belt along the transect and marks it as bleached (note severity) or unbleached. Identify coral to the lowest taxonomical ID possible: species, genus, functional group (e.g. Montipora encrusting, Porites mounding, Acropora table, etc.). Other notable observations of disturbances such as excessive algae cover and occurrence of disease should also be recorded.
5. Observer 2 takes photos using a monopod every 1 meter along the transect. **Note:** On reef slopes use a 1 meter long monopod; On reef flats and pools use a 0.75 meter monopod)
6. If additional observers are available to participate in the surveys, take photos and video footage as described for Observers 3 and 4 in the Tier 2 method. Alternatively, additional observers can conduct other research as suggested below.

Assessment Scales. Adapted from Oliver et al. 2004.

Coral Cover – *what is the % of live hard coral present in the survey area?*

Category	% Visual assessment
0	< 1
1	1 – 10
2	10 – 50

3	50 – 90
4	> 90

Bleaching Extent – *of the live coral present in the survey area what % are affected?*

Category	%	Visual assessment
0	0	No bleaching
1	< 1	No bleaching observed or occasional scattered bleached colonies (< 2 per dive).
2	1 – 10	Only a few corals are bleached. Bleached colonies seen occasionally but vast majority of colonies not bleached.
3	10 – 50	Bleached colonies frequent but less than half the corals are bleached.
4	50 – 90	Bleaching very frequent and most corals bleached all colonies.
5	> 90	Almost all corals are bleached, unbleached colonies not common. Whole reef looks white.

Bleaching Severity – *how severe are the coral colonies being affected?*

Category	Visual assessment
0	No bleaching
1	Partially bleached (surface / tips pale but not white) <50% of colony affected
2	Partially bleached (surface / tips pale but not white) >50% of colony affected
3	Completely bleached (bright white)
4	Completely bleached + partly dead
5	Recently dead

Functional group categories (also growth forms) – *include photo ID guide*

Functional groups
Acropora table
Acropora branching
Acropora arborescent – need to define
Acropora staghorn
Porites massive / mounding
Montipora encrusting
Other encrusting
Other massive / mounding
Other branching
Plating / foliose
Free-living / fungia
Mix -> Porites rus

Example Datasheets

1. Datasheet for Tier 1 Tow # 1

Notes:

4. Datasheet for Tier 3

Site _____ Date/Time _____ Observer _____
Depth _____

Genus / Growth Form	Bleaching Frequency (scale 0-5)	Bleaching Severity (scale 1-4)									

Notes: