

# A Simple, Rapid Protocol to Assess Coral Bleaching



E. Darling / WCS

## Why monitor coral bleaching?

Climate change and unusually warm ocean temperatures threaten reef-building corals around the world. Due to the ongoing 2015-2016 El Niño and Global Mass Coral Bleaching Event, coral bleaching is expected to intensify between February and May 2016, and could extend into 2017<sup>1</sup>. **Here, we describe a simple, standardized, rapid assessment field method that can be used to quantify coral bleaching.** Evaluating the global impacts of bleaching, and the variability in bleaching impacts, is critical for future predictions of coral diversity and productivity under climate change. Use of this published methodology contributes to existing datasets from the Western Indian Ocean and Australia<sup>2</sup> and has been found to be a straightforward and efficient method to assess bleaching that can be conducted by a single observer with minimal equipment<sup>3</sup>.

This protocol was developed in the field as a simple but useful method to assess coral bleaching. It uses a haphazard, roving observer approach to evaluate replicate quadrats at each survey location. Only one observer on snorkel or SCUBA is needed with an underwater slate<sup>4</sup>. Ideally, ~20 quadrats are recorded on a ~40-minute dive, although the number of quadrats can be readily adjusted to the available survey effort.

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<sup>1</sup> El Niño prolongs longest global coral bleaching event. *Science Daily*, 23 February 2016.

<https://www.sciencedaily.com/releases/2016/02/160223132730.htm>

<sup>2</sup> McClanahan, Baird & Marshall 2004, *Mar Poll Bull* 48: 327-335; McClanahan et al. 2005, *MEPS* 298: 131-142; McClanahan et al. 2014, *PLOS ONE* 4: e93385.

<sup>3</sup> There are many methods to monitor bleaching, a complete list can be found at <http://coralreefwatch.noaa.gov/satellite/education/monitoring.php>. The advantage of this protocol is that it is fast, simple and cheap, and provides a useful metrics of bleaching severity by coral genus or life form, total % coral cover, genera richness and community composition. Other protocols offer other benefits - belt transects, for example, also provide information on bleaching by colony size.

<sup>4</sup> On SCUBA, don't forget to take a buddy. For example two divers conducting this survey or one diver conducting a bleaching survey and another conducting a fish or benthic transect.

During the bleaching event, global datasets of bleaching location and severity are critical to understanding how corals are responding to thermal stress and climate change. ***Completed surveys can be submitted to [edarling@wcs.org](mailto:edarling@wcs.org) as part of a global dataset.*** All data contributors will be recognized as co-authors and offered the opportunity to contribute to a summary report and/or scientific publication tracking the impact of the ongoing bleaching event. All code and summary outputs (e.g., a map of survey sites, summary information on number of colonies and general survey data) will be available on open-source platforms, such as GitHub<sup>5</sup>.

## METHODS

### 1. Site information

An observer visits a coral reef location (“site”) and records the date, site name, depth (m), water temperature at depth of dive, GPS coordinates and any other notes or observations about the site (e.g., management, exposure, tide, habitat complexity, etc.).

This method is intended for temperature-associated coral bleaching. If there is a crown-of-thorns (COTS) seastar outbreak or other stressor potentially associated with bleaching and colony mortality, please record this in the site notes.

### 2. Identifying a quadrat

An observer descends to the benthos, records the depth, and visually estimates a quadrat. A single quadrat between 1 and 2m<sup>2</sup> is then estimated on the substrate using flags, meter sticks, actual quadrat squares, or simply ‘eyeballing’ the estimated quadrat boundaries without any equipment (we recommend measuring your arm span with a measuring tape, which can help you estimate the quadrat underwater).

Different surveyors might prefer to use different quadrat sizes. We recommend that a single quadrat size should be chosen, agreed to, and used on all your surveys. All quadrats in a survey should be recorded at a consistent depth. To compare bleaching at different depths, conduct two different surveys with each survey at a different depth.



Source:  
[www.noaanews.noaa.gov](http://www.noaanews.noaa.gov)

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<sup>5</sup> <https://github.com/esdarling/bleaching-surveys>

### 3. Data collection

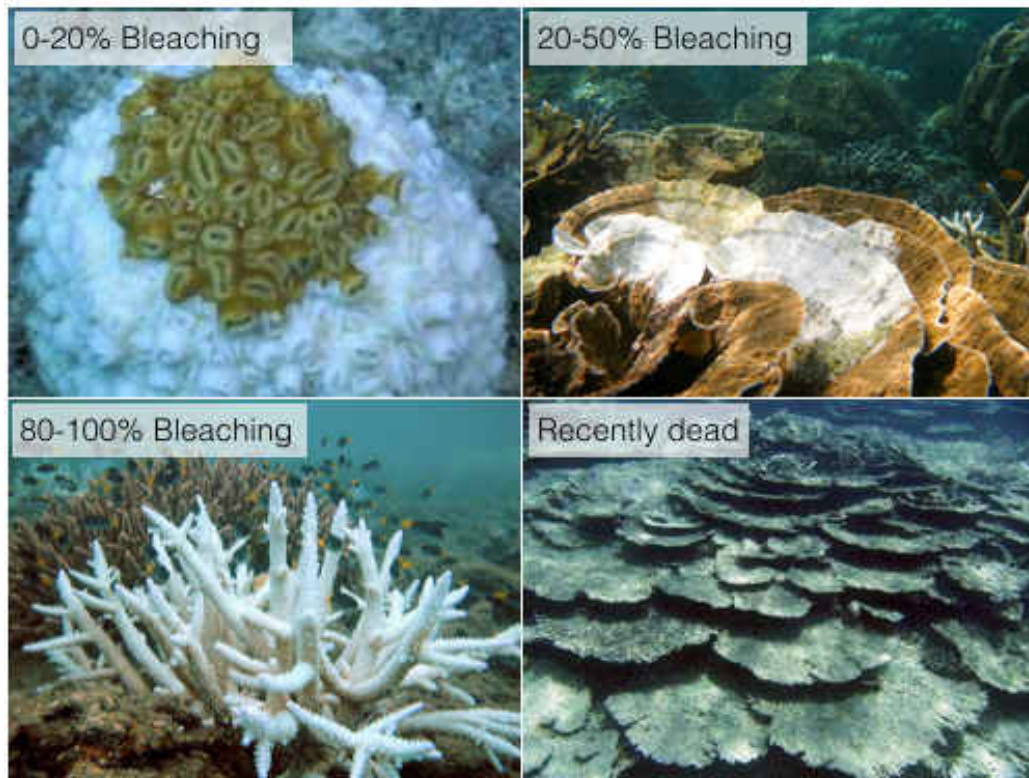
Within a quadrat, the observer identifies and counts each individual hard coral colony with a maximum diameter greater than 5 cm. There are two different approaches depending on how your team prefer to identify corals – by **Genus** or **Life Form**. Genus-level identification is the preferred standard.

#### (A) *Genus Identification*

On each quadrat, all hard corals (with a maximum diameter greater than 3 cm) are identified to genus, including non-scleractinians *Millepora*, *Heliopora*, *Tubipora*. The genus *Porites* should be identified as '*Porites* branching', '*Porites* massive' or subgenus *Synarea*.

Each colony is recorded within the following **categories of bleaching severity**:

1. Normal (unbleached)
2. Pale
3. 0-20% bleaching
4. 20-50% bleaching
5. 50-80% bleaching
6. 80-100% bleaching
7. Recently dead (i.e., skeleton covered in recent turf growth)



sources, clockwise from top left: peopleandtheplanet.com, E. Darling, [wikipedia.org](https://www.wikipedia.org), A. Baird

On your underwater slate, information from all the quadrats surveyed is combined together. This means that the colony counts are recorded for the first quadrat (shown below in black), and then the counts from the second quadrat (shown in red) is added onto the count, and then the third quadrat (shown in blue) is added on, etc. If many colonies are grouped together and you are not sure what is or is not an individual colony, use a simple rule that individual colonies should be separated by >3 cm.

	normal	0-20% bleached	20-50% bleached	50-80% bleached	80-100% bleached	recently dead
Acropora	       					
Pachyseris						
Porites massive						
Porites branching						
etc..						

For surveys to coral genus, we recommend writing the genera you observe underwater on your slate in the order that you see them, as opposed to using a pre-made dive sheet.

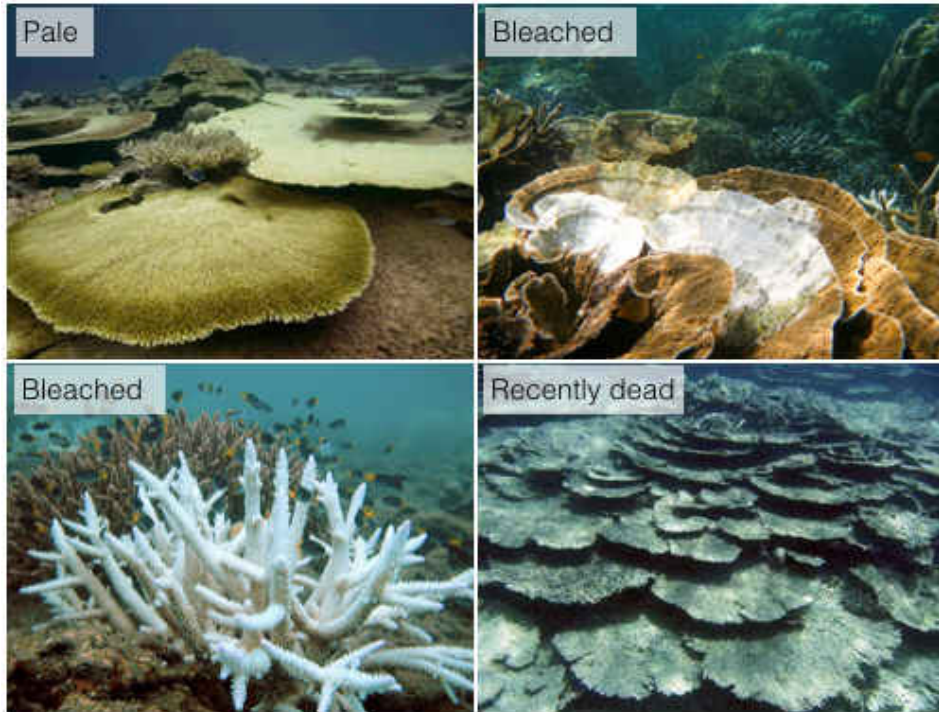
### **(B) Life Form Identification**

On each quadrat, individual coral colonies are recorded to 10 common life forms, separating *Acropora* from other corals. Photographs for each life form are provided in Appendix 1

- *Acropora* branching (ACB)
- *Acropora* table (ACT)
- *Acropora* submassive / *Isopora* (ACS)
- *Acropora* encrusting (ACE)
- Coral branching (CB)
- Coral foliose (CF)
- Coral submassive (CS)
- Coral massive (CM)
- Coral encrusting (CE)
- Coral mushroom (CMR)

For life form, bleaching severity is recorded using simplified categories:

1. Normal (unbleached)
2. Pale
3. Bleached
4. Recently dead



sources, clockwise from top left: climatechangenews.com, E. Darling, [wikipedia.org](http://wikipedia.org), A. Baird

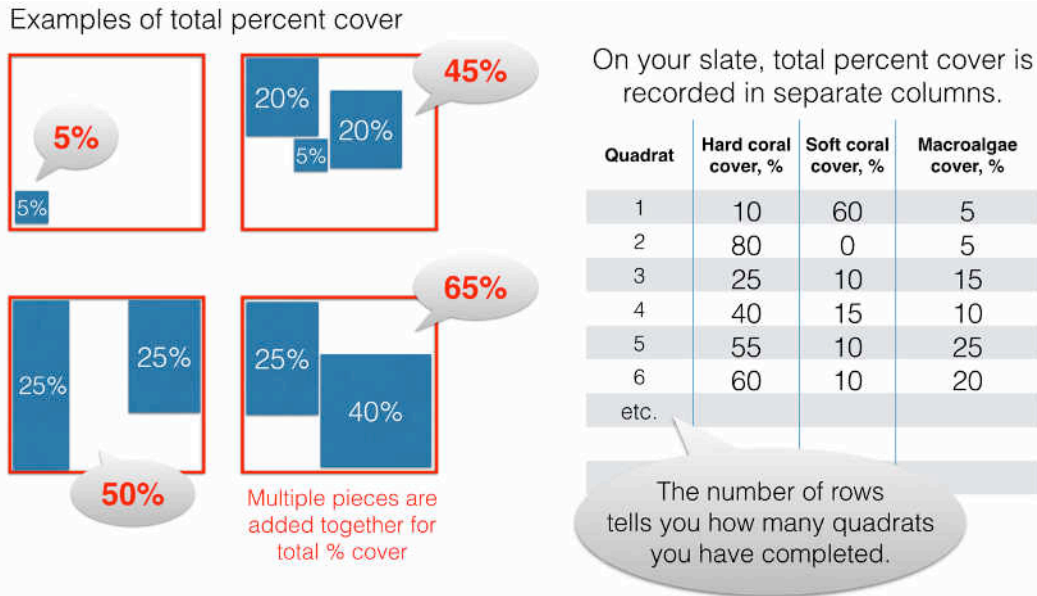
Sample underwater data sheet for coral life form:

	normal	pale	bleached	recently dead
Acropora branching (ACB)	 		 	
Coral foliose (CF)				
Coral branching (CB)	 			
Coral massive (CM)				
etc..				

For life form, an underwater dive sheet is provided as an Excel file that you can transcribe onto your slate, or print out on underwater paper.

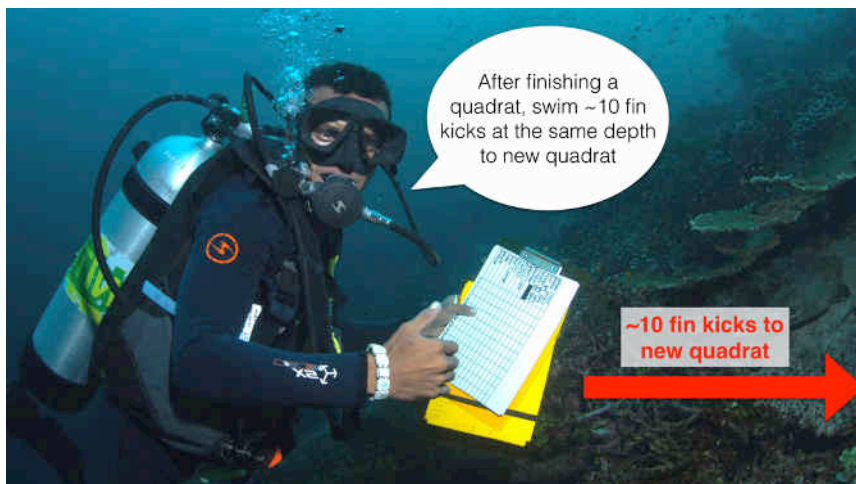
#### 4. Visually estimating percent cover

After all the colonies are counted and scored for bleaching, **visually estimate the total percent cover of hard corals, soft corals and macroalgae in the quadrat** to the nearest 5%. These values are recorded in a set of columns on your slate, which provides an easy way to count the number of quadrats you have recorded underwater. Note that the total cover by hard corals, soft corals and macroalgae do not need to total 100% since there are also likely other types of cover also in the quadrat (such as sand). But they shouldn't total more than 100%.



#### 5. Placing the next quadrat

After finishing a quadrat, swim ~10 fin kicks (or fin kick cycles) in a straight line at the same depth. Then, identify another haphazard quadrat and repeat the survey method. *Ideally, a 40-min dive will record ~18-20 quadrats<sup>6</sup>.*



source: E. Darling

<sup>6</sup> If you don't have time, you can conduct multiple surveys at a site to evaluate ~20 quadrats, or two observers can share the number of quadrats (e.g., each observer records 10 different quadrats, for a total of 20 quadrats).

## 6. Data entry

After the dive, please **enter the survey information into the Excel template**. Separate Excel files are provided for genus and life form methods. Each survey should be saved as a separate Excel file – rename the template with the Site Name of each survey. **Please do not change the structure of the template** (this makes it difficult to aggregate surveys together). If you want to add additional information, do not insert rows within the template but add columns to the right or rows to the bottom. Contact **Emily Darling** <[edarling@wcs.org](mailto:edarling@wcs.org)> with your completed surveys to contribute to a global effort to understand global patterns of coral bleaching.

## Frequently Asked Questions

### 1. Should quadrats be surveyed on sand or rubble? Or areas with low coral cover?

If your haphazard quadrat is largely composed of rubble, sand or seagrass, move on to a new quadrat. If your quadrat has low coral cover or only a few colonies, record it! On reef substrate, quadrats should be randomly selected – this provides an average estimate of total percent hard coral cover at a site. Values of the percent of soft coral cover and macroalgae cover also provide a coarse estimate of substrate composition.

### 2. When should this survey be used, compared to typical transect benthic surveys, or photo/video quadrats?

This survey provides a useful rapid assessment of coral community composition (to genus or growth form) and percent cover even in the absence of bleaching. This survey can also document baseline conditions ahead of expected bleaching, and compare the effect of bleaching before and after bleaching. Additionally, this survey provides documentation of sites with no bleaching, which are important to understand the variable global responses to the predicted bleaching event and El Niño conditions. **Ideally, one survey can be conducted before bleaching as a baseline, one or more surveys conducted during an actual bleaching event (or during predicted bleaching), and surveys conducted after any observed bleaching to document coral death or recovery.** However, all surveys are valuable – even without observed bleaching – to gain a better understanding of where and when bleaching is or is not occurring during the 2015-2016 El Niño.

### 3. Who can conduct these surveys?

Anyone! We welcome surveys from professional and citizen scientists. All surveyors should have training in coral identification to either genus or lifeform level. Resources for coral ID include the excellent Coral Finder ID book (<http://www.coralhub.info/cf/>), and Appendix 1 provides photographs for coral life form identification.

### 3. I still have more questions. Who do I contact?

Great, please be in touch. Contact information is below.

