Coral Restoration Consortium

Bleaching Guidance - Prepare, Act, Monitor

August 2023

Below are Coral Restoration Consortium (CRC)'s recommendations on how to prepare for, minimize damage to, rescue, and monitor corals during a bleaching event. Local conditions and regulations always take precedence, please check with your local regulator.

1. PREPARE - if the heat wave hasn't reached you yet.

- Check NOAA's Coral Reef Watch to see how much time you have.
- Speak with local authorities in advance if you require permission to move corals during extreme hot water events. Develop a regional rescue plan.
- Develop a monitoring plan. See below. Or, for the gold standard, see the CRC's Coral Reef Restoration Monitoring Guide - especially Restored Reef Areal Dimension (page 25) and colony fate tracking (page 34).

2. ACT - if the heat wave or bleaching has arrived in your region.

- CEASE restoration activities.
- PROTECT HIGH VALUE CORALS. Reduce stress at in-situ nurseries and high-value reefs. For example,
    - Move corals to deeper, cooler water
    - Reduce UV irradiation by moving to shaded locations or installing shade structures.
    - Remove predators.
    - Experiment and share

- RESCUE. Especially important in areas of or species with limited genetic diversity:
    - Ensure duplication of stock at more than one location (e.g. a mid-water floating nursery).
    - Move samples of all genetic material to a climate-controlled, land-based facility.
    - If conditions permit, collect samples of any wild, unrelated genets that are not yet in human care, and add to stock.

3. MONITOR loss and find resilient corals. Try to learn from this bleaching event. Document the species, individuals, and locations of dead, bleached, paling, and surviving corals. At the very least, The following are CRC's recommendations on how to survey or monitor your reefs and nurseries during a bleaching event and how to identify resilient corals for future restoration. The protocols below build upon each other. Depending on your capacity and the severity of the bleaching, follow the protocol that makes the most sense for you.

A. BASIC:

1. Snorkel around your nurseries, outplanting sites, and control sites.
2. If you know bleaching is coming, take "before" photos of your reefs. Then, as corals bleach, note which species, genus, or family of corals are paling or bleaching and which are not bleached. If bleaching is widespread, note the area of mass bleaching. Take photos.
3. Know what you are looking at. The difference between a bleached, pale, or dead coral can be hard to discern in the field and even harder to discern in an image.
    a. Check if tissue is present or absent to discern between bleached and dead.
    b. Check to ensure that you are not confusing turf algae on skeleton for live coral skeleton.

4. Survey frequency:
    a. If bleaching is severe, do this daily if feasible. If not, once per week minimum.
    b. If bleaching is mild or is predicted to start within a month, survey the reef weekly or every other week. Because bleaching can cause mortality quickly, we advise that surveys increase in frequency as the severity of bleaching increases. Continue monitoring until coral returns to normal color or dies.
5. Sampling:
    a. If this is a 90% bleaching event for certain genera, then use the opportunity to search widely for unbleached colonies of those genera. Cover as much reef area as possible for bleaching resistance. The goal is to secure a bit of everything that is most resistant.
    b. For selection plus collection purposes, it is best to scope the reef as soon as the water temperature begins to recede.
    c. Identify unbleached corals, collect samples right then and there, marking GPS positions on each sample. Note depth. Move the coral samples to heavy shade and tag them. (Once the partially bleached survivors recover, there will be no telling them apart from the few unbleached colonies.)
    d. The window of opportunity for collecting or tagging the bleaching resistant corals is about 4-6 weeks.
6. As bleaching subsides: Record predator interactions with corals and remove predators from the unbleached corals especially if many have died, causing a skewed predator to prey ratio. If left on their own after a mass mortality event has occurred, any surviving corals are in extreme danger from being wiped out by massively overabundant predators within weeks to months. This includes butterflyfish and parrotfish, so look out for bite and "kiss" marks.

B. PREFERRED (everything above, plus):

7. Record temperature on site by installing temperature loggers in shaded locations.
    a. HOBO ($159). These need to be calibrated before deployment.

b. HOBO MX ($69, more accurate but there are issues with flooding, particularly when torqued upon deployment.

8. Survey:

    a. Rather than anecdotal notes and photographs, use photo quadrats, photomosaics, line intercept transects to record what you see quantitatively.

    b. Record observations of other organisms during survey (e.g. bleached palythoa, bleaching or tissue sloughing of soft corals or anemones).

    c. Record percent of colony bleached (1-25%, 25-50% 50-75%, 75-100%), disease type and presence, % mortality. (This can be done via photo later.)

9. Tracking

    a. When temperatures and bleaching subsides, unbleached colonies and colonies recovered from bleaching should be identified as resilient by tagging or mapping, and collecting a fragment and GPS position. Reduce the effort of tagging each colony by either installing a central pin and mapping the colonies to the central pin using distance and bearing or running a temporary transect line from a permanent location and mapping colonies along the transect.

    b. Establish repeat monitoring locations at multiple sites including various habitats (reef crest, lagoon, slope) and depths to document changes over time.

10. Photograph:

    a. White balance camera prior to collecting images.

    b. Photograph tagged corals, preferably with a bleaching color chart in the frame of the photo. Place the color chart directly adjacent to the colony, capture the entire colony, and try to have consistent lighting across the colony (minimal shadows and bright spots).

    c. For branching or tabulate corals, the top can be 100% bleached while the underside 0% bleached- this is the most common partially bleached condition. Also common, ~10cm of the tips 100% bleached, while bases are not bleached at all. Either way, record the color code for the darkest and lightest portions of the colony.

11. Record the tag #, GPS coordinates, species, condition of the tagged coral, depth, date surveyed, and image files for reference.

C. ADVANCED (everything above, plus):

12. In order to characterize the nursery stock you have, take samples of bleached and non bleached colonies within and between species and preserve in 95% non-denatured ethanol, making sure that the final concentration of ethanol in the sample tube is >70%. Sample tubes need to be tightly sealed and stored as cold as possible to prevent evaporation. See this protocol for more detailed instructions (works for most coral species, dx.doi.org/10.17504/protocols.io.bec8jazw). Alternative preservation methods include liquid nitrogen, RNALater, and RNA/DNA Shield. Prior to putting the sample in ethanol, score bleaching level using the coral health chart visually and photograph (follow above methods). Include a white/color standard, a size standard and the colony tag in all photos. This protocol will allow you to associate phenotypes with genotypes, identify the genets (genotypes) that are resistant to bleaching, and document the symbiont species/genus associated with your identity resistant colonies. It can also be used to design a breeding program that maximizes thermal tolerance or genetic diversity.

13. Monitor for coral spawning and/or delayed onset of reproduction. If possible, cryopreserve sperm. See protocols here. You must have liquid nitrogen on hand before you begin. The recommended amount to collect is 5 ml of egg-sperm bundles over 5 mls of seawater for a total of 10ml in a 50ml tube. This can help preserve genetic diversity for future generations even if that coral genotype dies out in the wild.

14. Deploy photogrammetry methods (https://www.crc.world/resources-restoration-monitoring) to capture a larger reef area and a broader number of organisms.

CRC is here to help with the accumulation, analysis, and dissemination of this knowledge. Please e-mail info@crc.world if you need help synthesizing or sharing your experience. 💙