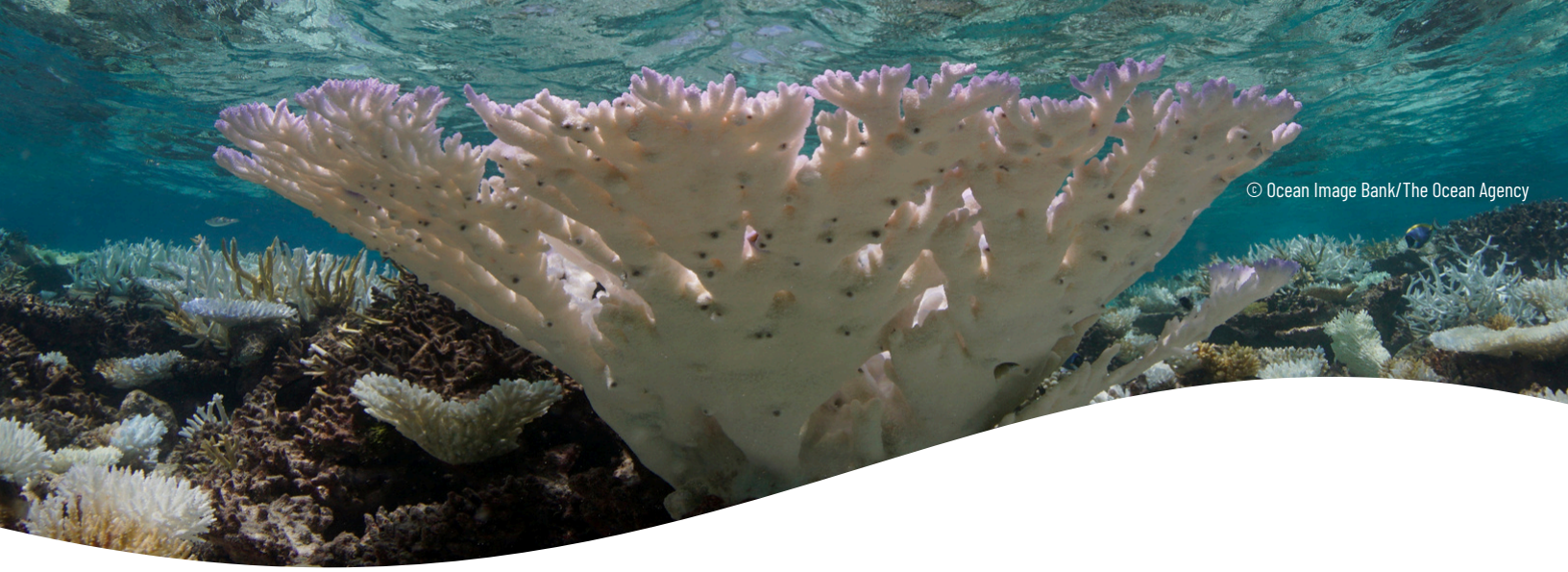

How to Prepare a Restoration Project for Coral Bleaching

A Checklist for Restoration Practitioners

1 Set Up Your Early Warning System

- Track for thermal stress before it arrives, using early-warning platforms like NOAA Coral Reef Watch (5-km bleaching alerts, Degree Heating Weeks, and outlook products). Use the Allen Coral Atlas to support reef mapping and bleaching detection.
- Subscribe to NOAA's Satellite Bleaching Alerts for your Regional Virtual Station(s) to receive an automatic email when the bleaching heat-stress status changes.
- Deploy or check local temperature loggers (e.g., HOBO loggers) at monitoring sites. Satellite sea-surface temperature can miss fine-scale reef or lagoon variability that matters for decisions.
- Set alert-level thresholds in advance that trigger each stage of your response. For example, at NOAA Coral Reef Watch's "Bleaching Watch" alert level, managers pick the virtual station most relevant to them and look at the 'Alert and Gauges Outlook" 12-week outlook:
  - If forecasts indicate increasing bleaching alert levels, initiate response actions (e.g., enforce closure, move colonies to a cooler location).
  - If forecasts indicate decreasing bleaching alert levels, continue monitoring conditions week by week.

2 Review Your Restoration Bleaching Response Plan

- Develop or refresh a marine bleaching response plan.
- Revisit nursery-specific protocols, including evacuation routes for coral stock, backup holding capacity, and thresholds for when to intervene.

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- Build redundancy. Distribute coral stock across nurseries, depths, and land-based backups. Secure priority genotypes through biorepository storage or cryopreservation before bleaching.
- Arrange permits and transfer agreements in advance, alongside receiving facilities if needed.
- Ensure you have funding to enact the response plan.

3 Confirm Your Monitoring Plan

Before thermal stress arrives, make sure you have:

- Baseline monitoring data for outplanting sites and control sites.
- Pre-, during-, and post-heatwave monitoring in place to track thermal resilience of individual colonies.
- Temperature loggers at nursery and outplanting sites providing local environmental data.

4 Prepare Your Nurseries

Field nurseries often contain a restoration program's key genetic resources, infrastructure, and equipment, so trained teams should be ready before conditions deteriorate. Prioritize a genetically representative subset of your nursery stock rather than all colonies. Many of the interventions below remain experimental, so treat them as potential tools rather than guaranteed solutions.

Focus on coral survival

- Pause non-essential handling of nursery corals.
- Defer fragmentation, propagation, and outplanting until conditions improve.
- Continue only essential nursery maintenance and monitoring needed to support coral survival.

Spread the risk

- Protect genetic diversity in your coral nurseries. Establish duplicate genotypes across multiple locations and systems and identify which stocks are most important to safeguard.

Feed corals through the heatwave

- Short, targeted exposure to nighttime lights can attract zooplankton, giving stressed and bleached corals an added food source when their algal partners provide less. Early research suggests enhanced feeding may improve survival and recovery, which may make this intervention worth testing in small, high-value nurseries.

Use temporary shade structures

- Bleaching severity depends on heat and light stress together, making shade one of the more widely used nursery interventions available.
- Shading reduces light stress but doesn't cool water or improve flow, so it isn't always sufficient on its own.
- Modular shade structures need to be built and ready before corals show heat stress, and require ongoing cleaning and maintenance.

Move deeper

- Identify and assess deeper locations before heatwaves so corals can be moved quickly if needed.

- Both light and temperature can attenuate at depth. Several studies support lowering nursery lines as a practical intervention. But, some species can only tolerate depth for a limited time.
- Monitor temperature at depth. During prolonged heatwaves, temperature can still rise several degrees.
- Prioritize genetic representation over biomass. Move one of each genotype rather than entire nursery stocks, especially once corals are already heat-stressed.
- Greater water flow at depth tends to improve outcomes; results are site-dependent.

Move to land-based nurseries

- Relocating vulnerable or high-value genotypes to established, temperature-controlled land-based facilities can be an emergency measure for severe events.
- Set up permits and emergency holding facilities before corals need to be moved.
- Line up aquarium or land-based nursery partners in advance to host additional corals.
- Ensure cooling systems are functional. Chillers or shaded, well-flushed raceways are the standard approach to holding temperatures below bleaching thresholds.
- Create a tagging plan to track which colonies go where, and a reintroduction plan for when corals can return to the field.

Consider exploring experimental approaches

- Where infrastructure allows, active or passive cooling may buy corals time during peak thermal stress.
- Controlled trials of artificial upwelling — brief daily pulses of cooler water drawn from 50–100 m depth — measurably slowed bleaching in multiple coral species, suggesting deep-water pumping as a promising but infrastructure-intensive tool.
- Many interventions are still at the proof-of-concept stage and more evidence is needed on their effectiveness, feasibility, and potential risk. Document and share outcomes.

5 Take Action After Bleaching

- Share lessons learned with other practitioners to help refine protocols.
- Plan how to resume normal restoration operations. Even after temperatures return to normal, wait until coral condition has stabilized and mortality rates have declined.
- Reverse temporary interventions — retrieve corals from land-based facilities, remove shade structures, and turn off supplemental cooling systems.
- Conduct post-bleaching monitoring to assess survival and identify heat-resistant colonies.
- Revise your emergency response plan based on lessons learned to be ready for the next event.

Bottom Line: No single intervention—shading, depth, relocation, or cooling—reliably works across every site and species. But a plan with clear triggers and roles, monitoring in place before bleaching starts, and coral stock spread across multiple depths, locations, and facilities gives you the best chance to act and learn, with no single point of failure.

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