4. SEA SURFACE TEMPERATURE PATTERNS OF THE BHS

MANAGEMENT PRIORITIES: MPA MANAGEMENT

BACKGROUND

Sea surface temperatures that are beyond an organism's normal tolerance can be a significant source of stress. High sea surface temperatures can be dangerous to coral reefs if they stress *Zooxanthellae* into leaving the coral polyps where they normally live. *Zooxanthellae* are single-celled algae that live inside coral tissues, and give them their color, sugar, and extra energy to form reefs. Without this delicate relationship corals turn white in a process called coral bleaching and generally die of starvation, leaving fleshy algae to invade the area and transform it into a habitat that does not appeal to many coral reef inhabitants including fish. Coral stress and bleaching are less common in areas with some exposure to cooler waters, and areas with varieties of *Zooxanthellae* that can tolerate higher temperatures.

Since 2005, scientists from Universitas Negeri Papua (UNIPA) and CI have maintained 78 temperature loggers placed throughout the BHS in areas with live coral, at depths of 1-3m and 15-20m. These loggers record temperature every fifteen minutes. The practical goals of this initiative are 1) to describe the temperature tolerance of living corals, and 2) identify areas with temperature conditions that are good for long-term coral reef survival, namely conditions leading to selection for warm-water tolerant populations, or upwelling and/or frequent but brief cooling events that help prevent coral stress and bleaching. These areas should be considered high priority refugia that may survive adverse oceanographic events and re-seed the recovery of more heavily impacted areas.

THREATS

1. Climate change is causing increases in sea surface temperature and changes in oceanographic conditions worldwide that are associated with more frequent and more severe coral-bleaching.
2. Coral bleaching can lead to the death of coral reefs, especially if they are also stressed in other ways, such as by sedimentation, and/or algal overgrowth because there are not enough herbivorous fish, grazing snails, and sea-cucumbers to maintain ecosystem balance.

KEY FINDINGS AND INPUTS

1. Numerous sites in the BHS experienced upwelling and seasonal cooling that may be associated with a lower tendency for temperature-induced coral bleaching. Notable upwelling areas (with temperatures as low as 19.3°C) include Southeast Misool (particularly Fiabacet chain of islands, along the southern continental shelf break), Northwest Misool, the Sagewin Strait, the Dampier Strait (especially the eastern end), the Bougainville Strait in Northwest Waigeo, and Triton Bay in Kaimana. Seasonal cooling related to the southeast monsoon was generally an annual phenomenon that most reefs in the BHS experienced from April to August, with coolest temperatures normally recorded in July/August.
2. Many corals living in enclosed habitats in the BHS experienced especially high temperatures (up to 36°C, which is generally considered lethal to corals) that would often fluctuate dramatically with daily tidal changes. Noteworthy sites for frequent but temporary exposure to high temperatures (and thus exhibiting high temperature tolerance) include the lagoonal areas in Kofiau's Walo and Gebe islands, Wayag lagoon, the Mesempta karst channels of Southeast Misool, the "blue water mangrove" channels in Nampale and Gam, the nearly-enclosed Mayalibit Bay, and the intertidal coral reef flat on Kri Island in Raja Ampat.
3. Many of the monitored sites experienced repeated, extreme temperature variations with a 6-12°C range over all years. Sites that were particularly noteworthy for their dramatic temperature variations included the Kofiau Walo lagoon, the Kri reef flat, Cape Kri, the blue water mangroves of Nampale and Gam, and Triton Bay's two sites (Saruenus and Mauwara Islands).

4. In strong contrast to the moderate to extreme temperature variation experienced by almost all reefs monitored in Raja Ampat, Kaimana and the northern Bird's Head, the reefs in Cendrawasih Bay were shown to live in an extremely stable temperature environment with little daily, monthly or even seasonal variation—temperatures generally stayed within the range of 28-30°C.

Coral with white ("bleached") tips resulting from the loss of symbiotic Zooxanthellae that normally inhabit hard coral tissues. Photo: ©Crissy Huffard/CI

KEY RECOMMENDATIONS

1. Because periods of cooler-water inundation may provide corals relief from stress and reduce the chances of coral bleaching, all MPAs in the BHS network should site no-take zones in areas with the strongest upwelling (identified previously).
2. Because reefs with frequent exposure to abnormally warm (31-36°C) water may be more tolerant of future oceanographic conditions, corals in these areas (identified above) should also be prioritized for inclusion in no-take zones. Additionally, healthy intertidal reef flats should also be included in no-take zones and especially protected from trampling and gleaning.
3. Because biodiversity (and thus recovery from perturbation) can be strongly linked to habitat variation including temperature environment, MPAs and no-take zones should protect a variety of temperature regimes and habitat types.
4. The reefs of Cendrawasih Bay, with their generally stable temperature regime, may prove to be particularly susceptible to temperature variations caused by climate change. As such, these reefs require extra attention to minimize the other potential stressors to which they are exposed (including destructive and overfishing and sedimentation from land clearing in surrounding watersheds) in order to maximize their likelihood of adapting to future temperature changes. Under no circumstances should mining tailings or other industrial waste be discharged into Cendrawasih Bay.

REFERENCES

- Purba, G.Y.S., R. Bawole, M.V. Erdmann, C. Rotinsulu, M.E. Lazuardi, T. Pattiasina, 2009.Sea surface temperature as a criterion for establishing a sea conservation area at Cendrawasih Bay, Papua. *World Oceans Conference, Manado, Indonesia.* 8 pages.