

Rapid reef health assessment by volunteers in North Sulawesi, Indonesia

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Introduction

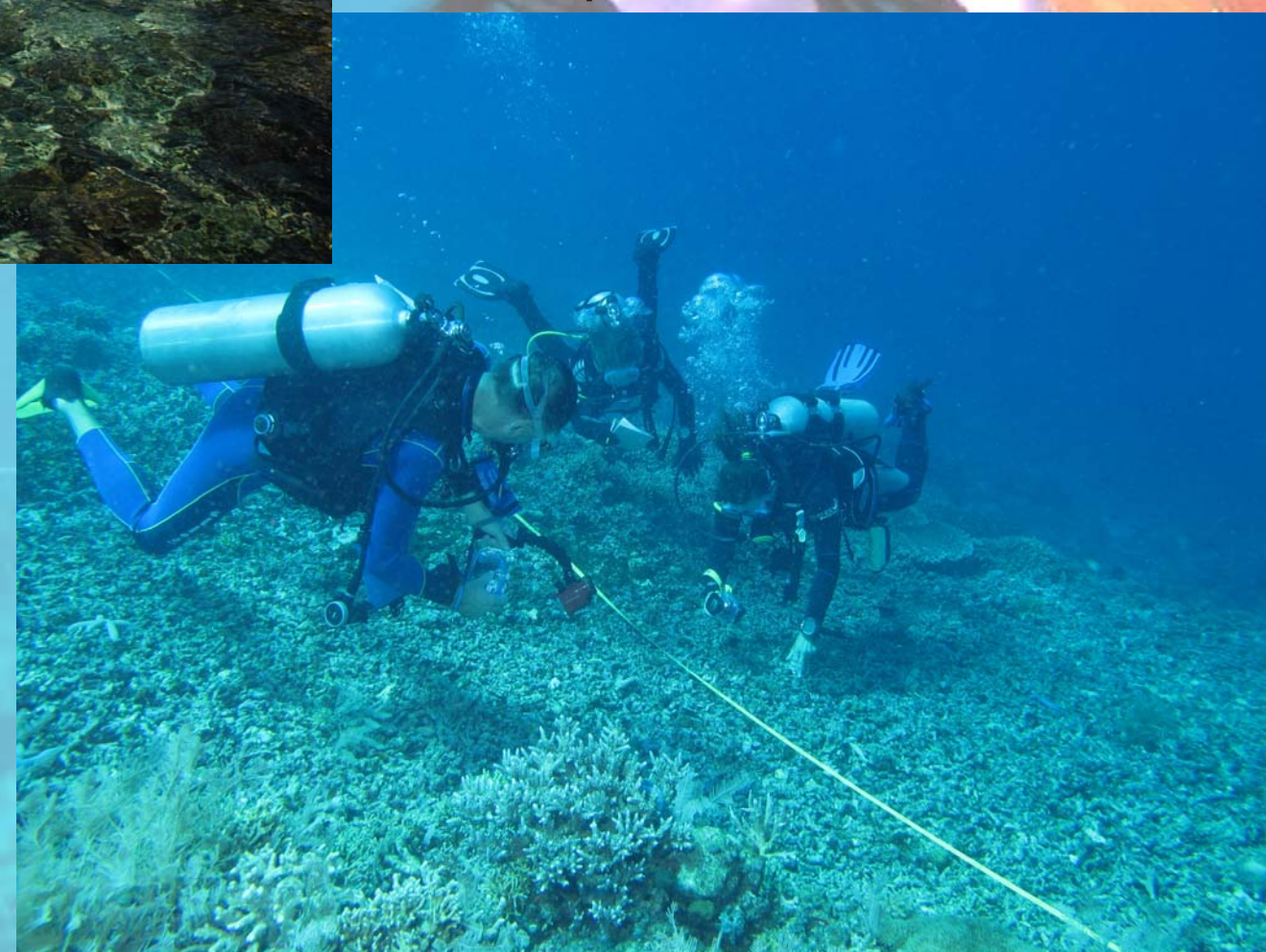
Bangka & Gangga islands are located at the northern end of Sulawesi. Currents and geomorphological features lead to the production of peculiar floro-faunistic assemblages, merging seascapes similar to those present in the nearby Bunaken marine park (with steep and deep walls) with those known for the neighboring Lembeh strait (with shallow volcanic sandy bottoms) (de Vantier & Turak, 2004).

The islands are also surrounded by mangroves and seagrass meadows attended by dugongs. Unfortunately the overfishing activities well known for the area compromise a very high percentage of the reef surrounding the islands, with wide portions of damaged corals (Fava et al., 2009).



Bangka Island.

Volunteers involved in a survey, supervised by an expert marine biologist, according to the Reef Check protocol.



Study area and sampling sites (blue stars).

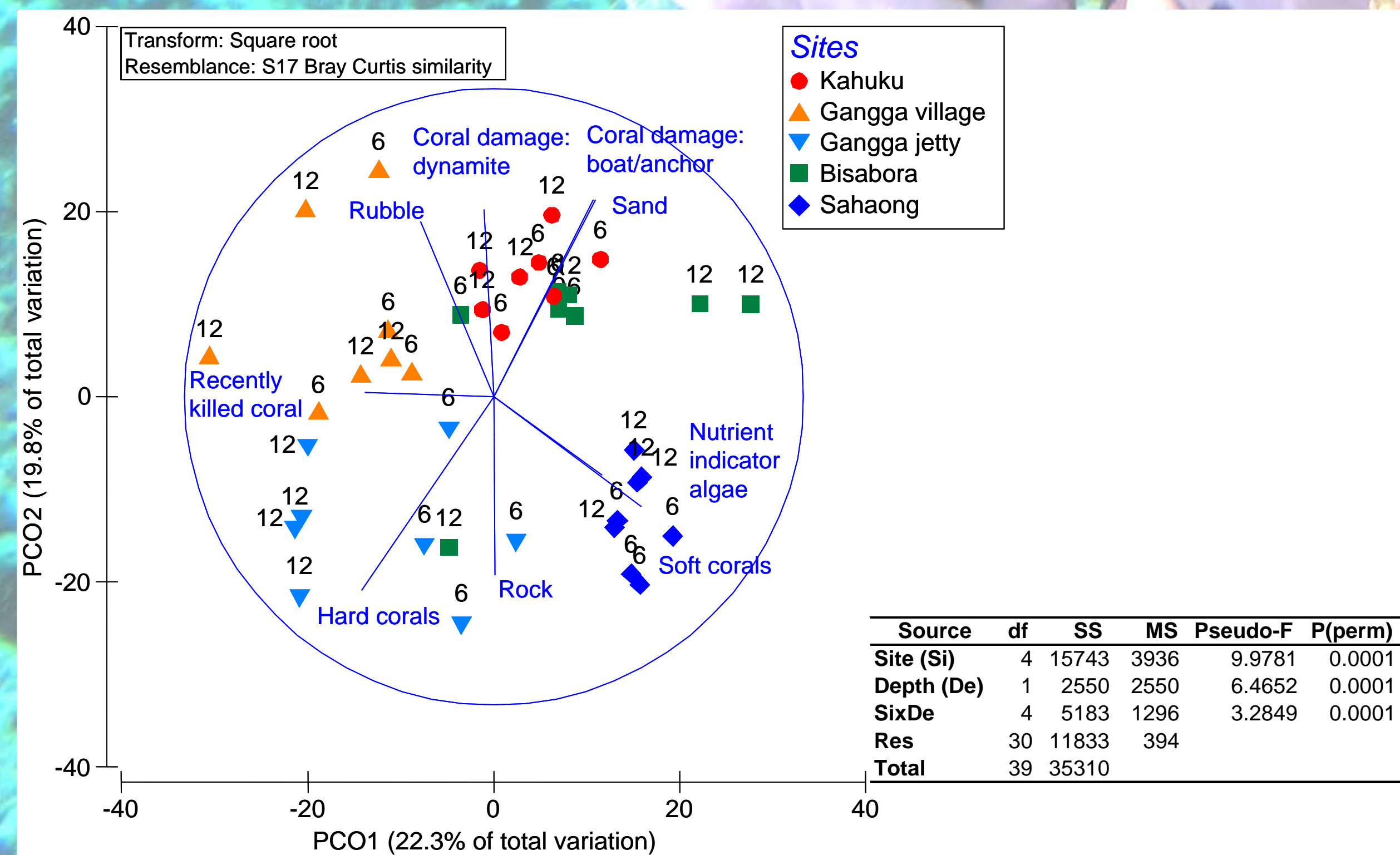
Materials and Methods

Surveys have been performed, by volunteers and university students in marine biology, in five sites at 6 and 12 m in depth following the Reef Check protocol (Hodgson, 2001). The sites have been selected after interviews with local people to cover the full range between heavily damaged and almost pristine sites:

- **Bisabora:** Bangka Island (1°44'23"N 125°8'39"E) Near a small village of fishermen dedicated to invertebrates harvesting, set close to a little creek.
- **Gangga village:** Gangga Island (1°46'11"N 125°2'48"E) Situated in front of the largest village of the area, it is influenced by invertebrates harvesting and recreational diving.
- **Gangga jetty:** Gangga Island (1°46'29"N 125°2'53"E) Not so far from the Gangga village, nevertheless it is less affected by fishing and recreational activities.
- **Kahuku:** Bangka Island (1°47'30"N 125°7'15"E) Situated near a small river and a small village, it showed a relevant anthropogenic impact due to blast fishing, invertebrates harvesting and recreational activities.
- **Sahaong:** Bangka Island (1°44'15"N 125°9'7"E) Almost pristine site occasionally influenced by siltation events due to the nearby river, it is mildly exploited for fishing activities, collecting invertebrates and tourism.

Results and discussion

Combining all the data obtained on substrate, target fishes and invertebrates, damages and diseases, it is evident that there were significant differences between sites, at each depth, while differences between depths within sites were less relevant. More preserved sites showed higher percentage of living corals and lower amount of coral rubble. The method is informative and the patchy distribution of damaged reefs suggests that prompt and effective measures of management and conservation could still allow a good level of recovery of the reef ecosystem. This first survey represents an important baseline for future monitoring we intend to perform in the next years thanks to the involvement of local people, volunteers and students.



PERMANOVA table and PCO ordination plot on multivariate data collected at each site (symbols) and depth (numbers) with correlation vectors of substrate and damages values.

Multivariate data was analysed by metric ordination plot obtained using the principal coordinate analysis (PCO; Gower, 1966), cluster analysis and permutational analysis of variance (PERMANOVA; Anderson and ter Braak, 2003).

Acknowledgments

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References

- Anderson, M.J., ter Braak, C.J.F., 2003. Permutation tests for multi-factorial analysis of variance. *J. Stat. Comput. Sim.* 73, 85-113.
- de Vantier, L., Turak, E., 2004. Managing marine tourism in Bunaken National Park and adjacent waters, North Sulawesi, Indonesia. *NRM III*, Jakarta, Indonesia.
- Fava, F., Ponti, M., Scinto, A., Calcinai, B., Cerrano, C., 2009. Possible effects of human impacts on epibenthic communities and coral rubble features in the marine Park of Bunaken (Indonesia). *Estuarine, Coastal and Shelf Science* 85, 151-156.
- Gower, J.C., 1966. Some distance properties of latent root and vector methods used in multivariate analysis. *Biometrika* 53, 325-338.
- Hodgson, G., 2001. Reef Check: The first step in community-based management. *B. Mar. Sci.* 69, 861-868.