# Monitoring coral reefs

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**A vast literature exists on coral reef monitoring, often making selection of an appropriate method for use in an MPA a daunting task. This sheet provides some guidance on the methods available and outlines some of the issues to consider when selecting the one to be used.**

Most coral reef monitoring programmes involve periodic surveys of the bottom (or benthos) and of mobile invertebrates and fish, in order to measure trends in population size or area cover of species present. More detailed methods involve measuring ecological processes, such as coral recruitment, or fish herbivory and predation (see case study).

## MONITORING METHODS

**Rapid surveys -** The simplest and quickest way to obtain a broad qualitative picture of large areas of reef is the manta tow method, if water clarity is suitable (10m at least). An observer is towed behind a boat which stops at intervals so that observations can be made of overall reef condition or populations of visible species (e.g. COTs and turtles). Swimming surveys can be used for smaller distances. ReefCheck is another method, specifically designed for use by non-professionals, trained and led by marine scientists. It involves counting key indicator species along transects. Normally undertaken annually, it can be done by snorkelling or SCUBA and learnt in one day. ReefCheck methods are being incorporated into several MPA monitoring programmes in the WIO, following training workshops, supported by UNEP. In La Réunion, ReefCheck methods are combined with more detailed scientific procedures.

**Detailed benthic monitoring -** Line transects or quadrats are most commonly used, and require more time in the water and more complex analysis than the rapid surveys, but photography and video can be used for data collection. The Line Intercept Transect (LIT) allows estimations to be made of percentage cover of different substrate types. A transect line (or tape measure) is laid and the amount of each substrate type encountered under it, is recorded. Transects must be laid systematically and objectively, generally parallel to the reef edge, or stratified according to local habitat features. They may be permanently placed or random depending on the sampling design. Several replicate transects (>5 recommended) should be laid at each site so that average % cover can be calculated. Specific measurement of coral condition and colour will be necessary if bleaching is occurring (see sheet H7). Changes in reef rugosity (or topography) can also be recorded, by laying a chain along part or all of the transect.

**Reef fish diversity and abundance -** This is usually monitored using Underwater Visual Census (UVC) methods, provided there is sufficient water clarity. UVC is usually carried out using a 50m belt transect with divers recording the fish observed at a set distance on either side of the transect. Stationary point counts are equally effective, and are particularly useful for very heterogeneous environments or where there are isolated structures (e.g. a large *Porites* coral head). Other methods are capture with traps, baited lines and set nets, and application of rotenone or other poisons, but these should not be used for regular monitoring or in an MPA.

**Invertebrate diversity and abundance -** Mobile invertebrates, such as octopus, lobster and many echinoderms, can be monitored using transects. If the same transects are used as for fish, invertebrate monitoring should be done after the fish counts to avoid affecting fish behaviour.

## DEVELOPING A MONITORING PROGRAMME

The programme must be designed to suit the resources, personnel available and objectives of the MPA. Professional guidance should be sought, particularly for sampling design (location and number of replicate transects) as this must be correct if the results are to be valid. An MPA may wish to set up an independent programme, but it is best to collaborate. Some countries, such as Mozambique, are developing nationally coordinated reef monitoring programmes; in others, MPAs have their own programmes but share data at the national level. There are three regional programmes:

- Indian Ocean – Reef Network (IO-RN): based in La Réunion, coordinates monitoring and a database (COREMO) for the island states.
- Coral Reef Degradation in the Indian Ocean (CORDIO): focuses on regional assessments, including socio-economic monitoring.
- Coral Reef Conservation Project (CRCP): supported by the Wildlife Conservation Society, works in Kenya and Tanzania (see case study).

IO-RN and CORDIO are the regional nodes for the Global Coral Reef Monitoring Network (GCRMN) which promotes the methods described in English *et al.* (1997); a similar francophone manual is available in Conand *et al.* (1998). A summary of GCRMN and ReefCheck methods is available on the C-NAV CD-ROM.

Senior researcher laying out a coral reef transect line in Kenya.

T. McClanahan

## KEY POINTS FOR THE MPA

- Seek professional advice in setting up a programme, to ensure the sampling design is correct and that simple and suitable methods are selected and used consistently; this will help to ensure that monitoring is maintained over time and that long-term comparisons can be made.
- Involve local fishers and communities where possible; contact CORDIO and IUCN for information on techniques in common use in the WIO.
- Ensure that data collectors, particularly non-professionals, are adequately trained, and undertake regular inter-calibration to ensure consistency and quality of data collection.
- Use recommended methods to select and mark monitoring sites to facilitate relocation.

## Sources of further information


Conand, C., *et al*. 1998. *Manuel Methodologique. Suivi de l'etat de sante des recifs coralliens du Sud-Ouest de l'Ocean Indien*. PRE-COI/UE, 27pp.

English, S., Wilkinson, C. & Baker, V. (eds.) 1997. *Survey Manual for Marine Resources*, 2nd Ed. AIMS, Australia. 390pp. ISBN: 0642259534. Available from: **www.aims.gov.au**

Halford, A.R. & Thompson, A.A. 1994. *Visual Census Surveys of Reef Fish - Long-term Monitoring of the Great Barrier Reef*. Standard Operational Procedure Number 3. AIMS, Australia.

Obura, D.O., *et al*. Monitoring of fish and fish catches by local fishermen in Kenya and Tanzania. *Mar. Freshwater Res*. **53**: 215-222.

Pomeroy, R.S., Parks, J.E. & Watson, L.M. 2004. *How is your MPA doing? A Guidebook on Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness*. IUCN, Gland, Switzerland and Cambridge, UK. xv + 230pp. **http://effectiveMPA.noaa.gov/**

Salm, R.V. & Coles, S.L. (eds.) 2001. *Coral bleaching and marine protected areas*. Proceedings of the Workshop on Mitigating Coral Bleaching Impact through MPA Design. Bishop Museum, Honolulu, Hawaii, 29-31 May 2001. Asia Pacific Coastal Marine Program Report #0102, The Nature Conservancy, Honolulu, Hawaii, USA. 118pp. **www.conserveonline.**

Samoilys, M.A. (ed.) 1997. *Manual for Assessing Fish Stocks on Pacific Coral Reefs*. Queensland Department of Primary Industries, Brisbane.

Samoilys, M. A. & Carlos, G. 2000. Determining methods of underwater visual census for estimating the abundance of coral reef fishes. *Env. Biol. Fish*. **57**: 289-304.

Wilkinson, C., *et al*. 2003. *Monitoring Coral Reef Marine Protected Areas: a practical guide on how monitoring can support effective management of MPAs*. IUCN Global Marine Programme, Gland, Switzerland; AIMS, Australia.

Global Coral Reef Monitoring Network (GCRMN): **www.coral.noaa.gov/gcrmn**

ReefCheck methods and instruction manual available from: **www.reefcheck.org**

C-NAV Coral Navigator - a CD-ROM on GCRMN and ReefCheck methods, available from AIMS Bookshop Science Communications, Townsville, Qld 4810, Australia.

Coral Health and Monitoring Programme (CHAMP): **www.coral.noaa.gov/methods.html** – lists a variety of resources for reef monitoring.

Hawaii Coral Reef Monitoring Program (CRAMP): **http://cramp.wcc.hawaii.edu/overview/3._methods/** - provides an analysis of advantages and disadvantages of different methods.

CORDIO – Coral Reef Degradation in the Indian Ocean: **www.cordio.org**

COREMO database for Indian Ocean Commission members; contact: **jpquod.arvam@wanadoo.fr**


## CASE STUDY

### Coral reef monitoring in MPAs in Kenya

Since 1987, the Kenya Wildlife Service (KWS) and the CRCP have been jointly monitoring five of the six MPAs in Kenya (Malindi, Watamu, Mombasa, Diani and Kisite). Sites have been selected to allow comparison between fully protected areas (marine parks) and partially protected areas (marine reserves). The annual monitoring program has several components including:

1. Benthic substrate cover (i.e. live coral, soft coral, fleshy algae, sand, algal turf, seagrass), measured using the LIT method (nine 10m transects/site, two sites/location).
2. Topographic complexity of the substrate.
3. Predation of sea urchins, measured by tethering *Echinometra mathaei* and counting the numbers eaten over a 24-hour period.
4. Herbivory by fish and urchins, measured through observations of blades of *Thalassia hemprichi*, secured onto a transect line for a 24 hour period.
5. Fish diversity, through counts along a 100m belt transect, with classification by family and size classes; a more detailed method is used for individual species in nine common fish families.

Results show that areas closed to fishing (marine parks) have higher coral cover and coralline algae, lower cover of fleshy algae, and larger, more numerous and more diverse fish populations than areas open to fishing, with the longest established closed areas having higher abundance of fish and higher coral cover. Predation of sea urchins is also greater in parks where there are more red-lined trigger fish *Balistapus undulatus*. The data from Mombasa Marine Park and Reserve show a trend in recovery of reefs after establishment of the MPA, but the 1997/98 El Niño bleaching event lead to dramatic decreases of coral cover due to mortality in all MPAs with the parks showing the greater effects. This demonstrates the value of long-term consistent monitoring as many of these trends have management implications.


McClanahan, T.R. & Arthur, R. 2001. The effect of marine reserves and habitat on populations of East African coral reef fishes. *Ecological Applications* **11**: 559-569.

McClanahan, T. R., Maina, J. & Pet-Soede, L. 2002. Effects of the 1998 coral mortality event on Kenyan coral reefs and fisheries. *Ambio* **31**: 543-550.