Monitoring physical conditions G5

Physical conditions of the marine environment have a major impact on species and ecosystems. A good monitoring programme is therefore essential in an MPA to evaluate ecological changes that may relate to changes in weather, water quality or other aspects of the physical environment. This sheet outlines some of the main parameters to consider.

Physical conditions may change on a daily basis or over much longer time periods, and may have natural (e.g. weather), or human causes (e.g. sedimentation from coastal construction or deforestation). There may be several sources (e.g. nutrient increases could be due to sewage discharge or fertiliser run-off) and care must therefore be taken in interpretation.

Simple methods for monitoring are available that can be used by MPA personnel and/or local stakeholders with appropriate training. Depending on the parameter, data collection will need to be on a weekly, monthly or annual basis, and, as seasonal changes can have a major impact, sampling should be consistent throughout the year.

Monitoring of the physical environment should be linked with ecological monitoring (see sheets G3 and G4), with a focus on sites:

- That represent particular communities or habitats;
- Where other monitoring activities (e.g. of coral reef health) are carried out;
- Adjacent to locations where human activities may affect the MPA (e.g. construction work, vegetation clearing or dredging).

Water parameters that can be measured include temperature, sedimentation rate, turbidity or visibility, salinity, dissolved oxygen, pH, nutrient loading, and pollutant levels. Some parameters require the collection of samples whereas others can be measured directly from a boat or while in the water. Weather parameters include air temperature, relative humidity, wind strength and direction, cloud cover, rainfall and air pressure. A small weather station can be installed, but it may be preferably to partner with a local airport or technical institution that is collecting more comprehensive data. Similarly, where specialised equipment is needed (e.g. for monitoring heavy metals), collaboration with a research institute or government agency that has the necessary skills, expertise and equipment, is usually best.

WATER TEMPERATURE

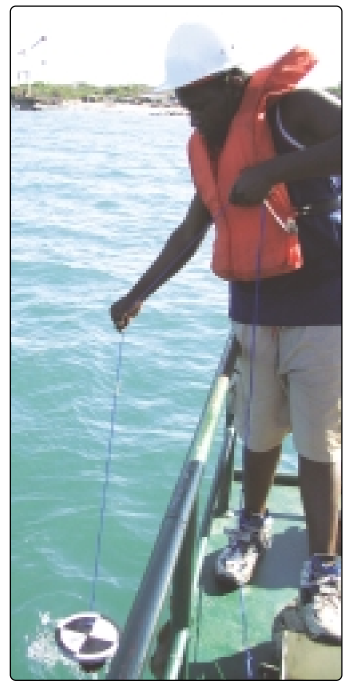
A marine-rated mercury thermometer in a protective casing should be used and recordings taken just below the surface (30cm) and at other depths depending on other data collection programmes and the presence of a thermocline or stratification. Retrievable temperature loggers are very useful for obtaining long-term data sets (see case study).

SALINITY

Water samples should be taken 30cm below the surface and at specific depths as required. Salinity is measured with a refractometer, which is a relatively inexpensive piece of equipment. Near freshwater discharges, such as river mouths, a series of readings may be needed to determine the gradient, bearing in mind that the state of the tide will affect salinity, as does rainfall and evaporation rate.

LIGHT CONDITIONS, TURBIDITY AND VISIBILITY

Suspended particles influence water clarity (turbidity) and light penetration, parameters that are particularly important in processes such as coral bleaching. A Secchi disc is used to measure water clarity. It is lowered over the side of a boat or jetty to the depth at which it is no longer visible and then pulled slowly back until it is just visible, the depth being recorded from graduations on the rope. A light meter may be more accurate when the water is shallow or very clear. Measurements should be taken on clear days, around midday when the sun is high.


M. Richmond

Using a Secchi disk.

Relative differences in light condition at different depths can be estimated using a photometer, or by pairs of divers making underwater horizontal Secchi disk readings. Cloud cover is important to record (it can be recorded in 'oktas', or the number of eighths of sky that are covered by cloud).

SEDIMENTATION

The settlement of suspended particles onto the seabed, called sedimentation, can have a major impact on benthic filter feeders and species dependent on light for photosynthesis. Sedimentation rates are measured using a series of pipes, closed at one end, that are attached vertically to the substrate and are collected after a fixed period of time. The sediments that accumulate in the pipes are washed out, dried and weighed.

CHEMICAL AND BIOTIC PARAMETERS

Measuring chemical and pollution levels is important if land-based activities may be influencing the MPA, but this is often complex and advice from specialists should be sought. Oxygen levels, pH, and some nutrients (e.g. nitrates) can be measured with electrical probes, sensors, or chemical test kits, but are difficult to monitor accurately. Water samples can be screened for pathogens (faecal bacteria and viruses), hydrocarbons, heavy metals, pesticides, and other toxins. Samples must be clearly labelled and stored in refrigerated containers for rapid transfer to a qualified laboratory or test facility. Measurement of chlorophyll level gives an estimate of plankton quantities, which is an indicator of water quality; phytoplankton can be collected by towing a special net.

WATER MOTION

Tidal regime influences mangrove species distribution, abundance and growth, and simple methods are available to measure their inundation. Currents and waves influence the extent to which bleaching occurs and the speed of recovery. Plaster of Paris 'clod cards' can provide some information, as well as drifting current buoys and dye flow determination. Sea conditions can be determined according to the 'Beaufort Winds Scale and Sea Disturbance Table'.

KEY POINTS FOR THE MPA

- **It may not be essential to monitor all physical parameters, and priorities should be set according to the needs and capacity of the MPA; water temperature, visibility and salinity are among the more important.**
- **Assign specific MPA personnel to collect routine data, with a clearly defined schedule; provide training in the use and maintenance of any equipment involved.**
- **Involve local partners where possible and develop partnerships with national monitoring programmes.**
- **If the MPA has regular access to the Internet, follow global sea surface temperature monitoring programmes as it may be possible to get advance warning of a warming event.**
- **Ensure that data are logged promptly and accurately, and are analysed quickly so that if there are changes that may affect the MPA, expert advice can be sought quickly.**

Sources of further information

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

Jokiel, P.L. & Morrissey, J.I. 1993. Water motion on reefs: evaluation of the clod card technique. *Mar. Env. Prog. Ser.* **93**: 171-181.

Parsons, T.R., Maita, Y. & Lalli, C.M. 1984. *A Manual of Chemical and Biological Methods for Seawater Analysis*. Pergamon Press. 173pp.

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.

UNEP/IAEA/IOC 1991. Standard chemical methods for marine environmental monitoring. *Reference Methods for Marine Pollution Studies.* No. 50. UNEP, Nairobi.

United States Virgin Islands Coastal Zone Management Program 2001. *Coastal Water Quality Monitoring Manual: Parameters and Techniques*. Department of Planning and Natural Resources, Division of Coastal Zone Management, National Oceanic Atmospheric Administration, Washington D.C., USA.
www.ocrm.nos.noaa.gov/PDF/USVI_Monitoring_Manual.pdf

Information on data loggers from: Onset Computer Corporation: **www.onsetcomp.com;** International SeaKeepers Society: **www.seakeepers.org** Other suppliers: The Kiwi Group or ACR Systems, USA.

CASE STUDY

Automatic underwater temperature recording - a new technology for the WIO

The extensive coral bleaching in 1998 made MPA managers and scientists in the WIO appreciate the importance of understanding trends in seawater temperatures. A programme to install automatic temperature data loggers was therefore initiated by CORDIO, in partnership with scientists and MPAs. Those being installed in the WIO are small self-contained, battery-powered waterproof units that are tied to holes or projections on the reef. They are generally hidden to prevent theft and dislodgement by curious fish. A sketch map, noting obvious markers (such as a subsurface buoy or prominent coral heads) helps relocation. Most of the loggers have been placed in shallow lagoons and at 5-10m depth on fore reef slopes, with a few in deeper waters to monitor cooler waters and different habitats.

Before deployment, the data logger is connected to a personal computer and progammed with the parameters that are to be measured (e.g. temperature on an hourly basis). After a certain time (several months or a year), it is retrieved from the reef, and the data is off loaded and analysed. Some data loggers have a 'data shuttle' that can be used to retrieve the data *in situ*, so that the loggers stay in place for continuous recording. Data loggers cost about US$100 each, and the software and hardware, which can be used for many individual loggers, about US$300.

Many of the loggers are installed in MPAs and are managed by MPA staff. The longest *in situ* temperature records are from Kenya, La Réunion and Mayotte, which started records in 1998. By 2002 even remote islands such as Europa and Aldabra had temperature loggers. When matched with sea surface temperature data from satellites and other long term records, the WIO data allows prediction of local warming trends, and will enable MPA personnel and scientists to be better prepared for bleaching events.

Further information from CORDIO (cordio@cordio.info).