Chapter 2

The Monitoring Process

2.1. What is monitoring?

Monitoring is the repeated observation of a system, usually to detect change. Environment monitoring programs which are designed to detect realistic levels of change enable coastal management agencies to make decisions with greater confidence. The level of change and accuracy of the detection will vary according to the methodology. Environmental monitoring programs should ideally be designed to quantify the causes of change; examine and assess acceptable ranges of change for the particular site; and to measure levels of impacts. Intensive monitoring of large areas or large suites of parameters is often prohibitively expensive and requires considerable expertise in the systems being studied. Monitoring is easiest to apply in a specific environment of concern, as the change likely to occur in seagrass meadows resulting from a particular port or harbour development.

2.2. Why monitor?

Environment monitoring programs provide coastal management agencies with information and assist them to make decisions with greater confidence. Seagrasses are often at the downstream end of catchments, receiving runoff from a range of agricultural, urban and industrial land-uses. Their ecological values and location in areas likely to be developed for harbours and ports have made seagrasses a likely target for assessing environmental health and impacts on coastal systems. The ideal “bio-indicator” must, however, show measurable and timely responses to environmental impacts. Seagrass habitats are composed of sessile plants - individuals, populations and communities - which can all be easily measured. Seagrass plants generally remain in place so that the prevailing anthropogenic impacts can be monitored.

Altered seagrass depth distributions in Chesapeake Bay (Dennison *et al.*, 1993) was the “indicator” when runoff-impacts on water quality caused changes in light penetration and consequently affected seagrass abundance and distribution patterns. Improved knowledge of the relationships between various seagrass growth characteristics and environmental parameters such as light and nutrients (eg., Dennison *et al.*, 1993; Short, 1987) provide very useful tools for monitoring environmental impacts on coastal seagrass systems.

Coastal zone managers increasingly recognise the importance of seagrasses in coastal marine communities for supporting diverse flora and fauna, in supporting coastal fisheries productivity (Coles *et al.,* 1993; Watson *et al.* 1993), in stabilising sediments and maintaining coastal water quality and clarity (Fonseca and Fisher, 1986). In the tropics, turtles and sirenians (*Dugong dugon*) are direct grazers of seagrasses (Lanyon *et al.* 1989). The importance of these endangered species and the demonstrated value to fisheries has ensured ongoing management for seagrass conservation in north eastern Australia.

2.3. Measuring Change in Seagrass Meadows.

The expected use of the data, the questions likely to be asked of the data, and the accuracy and precision of the answers required determine the type of information we collect from coastal seagrass habitats. Government agencies and coastal zone managers need to know the extent of natural change in seagrasses. The impacts - particularly habitat losses - from catchment and human activities can then be separated from normal background variation.

Seagrass meadows can change in several ways. There can be a change in biomass without a change in area; a change in area, or shape, depth or location of a meadow; a change in species composition, plant growth and productivity, seed banks, the fauna and flora associated with the meadow, or a combination of some or all of these. These changes will also occur naturally and on a regular seasonal basis. Environment monitoring programs require knowledge of these patterns of natural change. They also require cost-effective data collection, selection of appropriate parameters and scales, and measures of change which are statistically appropriate for determining if management action is required.

Choosing the most efficient and appropriate parameter(s) to monitor is equally important. Seagrass species composition and its abundance, e.g., above-ground biomass, total area, available seed bank or percent ground cover, can be measured quickly and these have been the most commonly chosen parameters. Other seagrass parameters (e.g., plant growth rates, plant tissue C:N:P, carbohydrate composition) are proving useful for obtaining insight into the causes and mechanisms of change in seagrass abundance. Physical parameters measured usually include depth (below MSL) and sediment composition. Turbidity, light (PAR), salinity and temperature should ideally be included in monitoring, but require more frequent measurements according to the time periods over which they vary and affect seagrass growth and survival (Dennison *et al*., 1993). Depth at which seagrasses occur can be a useful indicator of impact (Dennison *et al*., 1993) and may change according to light attenuation in the water column.

We suggest that a hierarchy of information is required. First to scope the extent of the existing resource, aerial photography images combined with ground surveys are an ideal start. Locations and areas which support seagrass resources or areas for which more information is required can be identified. For most localities baseline maps of seagrass resources either do not exist, or do not provide sufficient detail to enable reliable detection and assessment of change.

The next step is to choose biological and physical parameters that are relevant and logistically possible to measure. Then to design a sampling program which enables the minimum monitoring effort required to detect changes which are statistically and biologically meaningful. Useful collecting methods and approaches for designing monitoring programs include that adopted recently by the ASEAN-Australia Marine Science Project: Living Coastal Resources (English et al., 1994). This details physical and biological parameters which can be monitored, field sampling designs, sampling methodology, sample processing, data recording, processing and analysis, with notes on safe procedures. Mellors (1991) and Long *et al.* (1994) provide sampling methods of particular use in mapping and monitoring seagrass abundance. A choice of seagrass research methodologies is provided in the recently published Global Seagrass Methods (Short and Coles, 2001). Continual advances in technology will enable improvements in sampling efficiency and design.

Methods and sampling designs will continue to be modified and improved and the approach described here is not intended as a standard suitable for all situations. We recognise that sampling designs are largely influenced by logistics, safety issues and resource limitations. There is still a great need to test the precision and efficiency of various sampling methods. Priority should be placed on selecting appropriate parameters for study, so that the study results and subsequent environmental assessments are ecologically meaningful.

Reasons that should prompt management responses include significant changes in species composition, seagrass growth characteristics, or depth distribution, or a trend in one direction for any one of these parameters over three successive sampling periods (Coles et al., 1995). Measures of change in these coastal resources need to be presented along with advice on legislative measures for protection of seagrasses. Marine environment planning and management processes with community consultation, legislative power, and support from education and enforcement will help to maintain community and government concern for the protection of our limited seagrass resources. Increased requirements for accountability in coastal management decisions has caused a greater need for statistical rigour in design of sampling programs for monitoring environmental impacts.

Further Reading:

Short, F.T. and Coles, R.G. (eds) (2001). Global Seagrass Research Methods. Elsevier Science B.V., Amsterdam. 473pp.