Background to monitoring mangrove forest health

1 Purpose and scope

This document provides background information on the measures of mangrove forest health.

2 Associated documents

Biological assessment: Monitoring mangrove forest health

3 Introduction

Mangroves comprise several species of trees and shrubs that grow along sheltered intertidal shorelines, predominantly in tropical and subtropical coastal environments. Mangroves are adapted to salt-water environments and grow in muds, silts, sand and anoxic marine sediments.

Mangrove forests commonly consist of several shoreward zones including *Rhizophora* (red mangrove) and *Avicennia* (grey mangrove) species (Figure 1). A number of mangrove species produce seeds which germinate whilst they are still attached to the tree (vivipary). In some species these seedlings may reach over 30cm in length before they separate from the parent plant and fall to the mud below or get carried by currents to root elsewhere. In the unstable coastal environments that they normally occur in, un-germinated seeds would be at a greater risk of being washed away if they had first to germinate on the ground and then anchor themselves to the substrate.

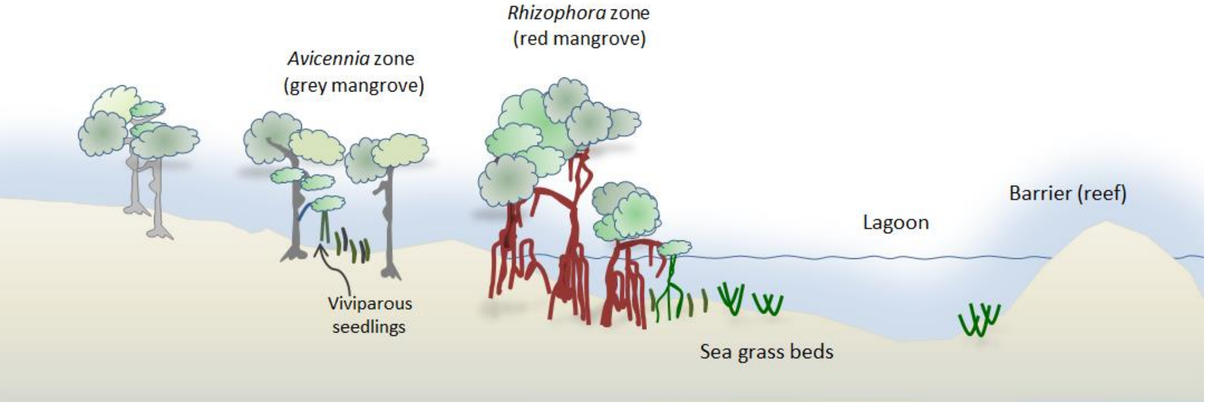

Figure 1: Schematic of mangrove zones

Dense mangrove forests located on shorelines protect the coastline from the impacts of storm waves and coastal erosion. They trap and bind sediments, capture effluents from terrestrial runoff and provide a buffer for nutrients, metals and other toxicants entering coastal waters, reducing coastal turbidity and improving water clarity.

Mangrove forest canopies and their extensive root systems are also a major source of primary productivity by providing a food source and habitats supporting both marine and terrestrial animals including fish, birds, invertebrates and insects. They are of particular economic importance, because they provide nursery habitats for commercially important fish and prawn stocks thus replenishing estuarine and coastal fisheries.

Monitoring changes to mangrove forest communities and mangrove forest health can help diagnose causes of environmental stress. Mangrove forests provide a means to monitor changes in coastal environments such as storm effects, sea level change, pollution, and sedimentation rates.

General guidance on the methods used to monitor mangrove forest health in Queensland are given below. However, it is recommended that expert advice be sought when designing a mangrove monitoring program.

4 Measures of mangrove health

4.1 Litter

Mangrove litter production is the shedding of vegetative and reproductive structures of mangroves (e.g. leaves and seeds). This may be caused by natural growth cycles, age, stress and/or mechanical factors, such as wind. This litter fall, which is part of the net primary productivity of a mangrove system, is the basis of detritus food chains.

The rate of litter production can indicate the health of a mangrove community. A healthy system will produce a stable monthly and/or yearly volume of litter as older leaves are shed and replaced with new ones. Declining production over time may indicate that a community is under stress.

The ratio of fallen leaves to stipules of *Rhizophora* species can also be used as an indicator of system health. Thus, in a healthy *Rhizophora* community, the ratio of leaves to stipules in the litter should be close to 1:1. If there are more leaves than stipules then this indicates that the plant is shedding leaves due to stress.

The main reasons for monitoring litter productivity are to:

- gain an understanding of the baseline litter productivity of a mangrove community
- indicate system health—as mangrove communities become under stress they are likely to be less productive, resulting in less litter production over time or alternatively, communities under stress produce a large amount of litter over a short period of time as the plants shed leaves
- look at unseasonably low litter production due to poor growth resulting in less detritus which may affect faunal communities.

4.2 Seedling regeneration

Seedling regeneration within a mangrove stand can lead to long term changes within mangrove communities. In addition seedling regeneration can give an indication of mangrove community health. The rate of growth of seedlings is a more important indicator than the number of seedlings present in a given area in determining likely long term community maintenance or change.

Long-term hydrological changes can result in sediment deposition or greater tidal and/or freshwater influence. This may result in colonisation by different species of mangroves from those that were originally present. For example, long-term sediment deposition may raise the elevation of a site, resulting in conditions more favourable for species normally found higher up the tidal gradient. Other hydrological changes, resulting in more tidal or freshwater influence, could create conditions favouring species normally found closer to the seaward or landward margin of the mangroves. Identifying what species of mangrove is replacing the previous forest can indicate whether climatic or hydrological changes have or are occurring.

4.3 Canopy cover and leaf area index

Leaf area index (LAI) provides an estimate of canopy cover. Since plants under stress tend to shed leaves, a reduction in canopy cover over time may indicate ecosystem stress or disturbance.

LAI is an estimate of the total area of leaf surface within a plant community relative to the ground area of that community. To calculate LAI, the intensity of full sunlight is measured (using a light meter), and this is compared with the light intensity measured under a mangrove canopy. LAI can be used to monitor short to long-term foliage patterns and changes in a mangrove stand (e.g. high rates of primary productivity during good seasons, or defoliation through storm damage, seasonal or drought-related leaf fall, insect attack, etc.).

4.4 Mangrove forest structure

Mangrove structure refers to the composition of a mangrove community in terms of canopy height, stem density, age, tree diameter and species present. It varies considerably between different forest types, and between the same forest types in different locations. Structure is also influenced by many natural factors including climate, tidal inundation, soil pH and salinity, sediment particle size and amount of freshwater the community is exposed to.

Mangrove structure is likely to be affected when any of these parameters are altered by human-induced impacts. Positive changes can result in greater forest vigour (increased diameter, canopy cover and stem density), while negative changes can stress the mangrove community, resulting in reduced canopy cover and stem density, tree mortality and, eventually, reduced basal area of trees and/or lower canopy height.

Higher proportions of dead versus live stems, and/or decline in the basal area of the trunks of mangroves in a stand may indicate stress or disturbance. Many aspects of mangrove structure tend to respond more slowly than other estuarine indicators and it can take several years before changes can be detected.

4.5 Crab burrow counts

Estuarine crabs break down much of the leaf and other organic matter produced by mangrove forests. Their burrows also increase the ratio of soil surface area to air, resulting in aeration and oxidation of the mostly anoxic mangrove soils. This oxidation can be important for the growth of mangrove plants. Consequently, changes to the crab population can affect the nutrient cycling and oxidation of intertidal soils, which in turn can affect the productivity of mangroves. Decreased crab populations and associated burrow density can lead to decreased nutrient cycling and soil aeration, and reduced production of surrounding plants.

Crabs can be sensitive to pollution. Their absence from a mangrove forest may indicate that the site is experiencing human-induced stress. Data on crab burrow density may complement leaf litter trapping or other mangrove monitoring programs.

5 References and additional reading

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