How is seagrass habitat quality monitored?

Seagrass monitoring programmes can benefit from including variables on habitat quality in addition to seagrass indicators. Such variables affect the seagrasses, and information on their level may therefore help identify reasons for status and changes in seagrass indicators and suggest corrective measures.

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A wide range of variables of natural and human-induced origin affect the status of seagrasses. The variables include water- and sediment quality, climatic variables and biological interaction. Information on such variables may therefore help interpret results of seagrass monitoring by identifying probable causes of a given status or change in seagrass parameters. Moreover, such information may be used to isolate the effects of human pressure from those of natural variations in climate etc. and thereby help suggest corrective measures.

Water quality and climatic variables

Nutrient concentrations and light attenuation in the water column are the most important water quality parameters affecting seagrass growth. Another habitat characteristic, salinity, may also play a role (see chapter 4). These variables therefore constitute the primary list of variables to measure in connection with seagrass monitoring programmes:

- Light attenuation – can be measured simply by using a Secchi disc or more precisely using a light meter to measure actual light levels at different positions in the water column and then calculate the light attenuation per meter water column.

- Nutrient concentrations – inorganic concentrations are often low and difficult to detect in summer so it may be a better choice to measure inorganic nutrient concentrations in winter and/or total nutrient concentrations in summer.

- Salinity – can e.g. be measured automatically using a probe or manually using a refractometer.

More specific water quality variables can also be useful in special cases. Examples are listed below:

- Concentrations of particulate and dissolved organic matter – relevant if details on the main light attenuating variables are needed.

- Concentrations of O_2 and H_2S - relevant in connection with detailed analyses of reasons for sudden seagrass diebacks.

Figure 10.1. Benthic sediment trap deployed within a *Posidonia oceanica* bed. Photo: Carlos M. Duarte.

- Concentrations of toxic substances – relevant in case of suspicion of seagrass diebacks due to toxic substances.

Due to large temporal variability in water quality parameters, they must be measured frequently. It is not sufficient to measure them along with an annual seagrass sampling. In a routine monitoring programme, water quality can be measured at a site placed centrally in the bay or coastal lagoon of interest and representing the general water quality of the area. In a more detailed monitoring programme aiming at identifying spatial gradients in water quality and seagrass indicators within a given bay, more sampling sites are obviously needed.

Several climatic variables may also affect seagrass growth (see chapter 4) and may therefore provide useful information in the interpretation of monitoring results. The most relevant climatic variables to include are:

- Water temperature

- Rainfall or freshwater run-off

- Insolation

- Wind velocity/direction

Water temperature is usually measured along with the measurements of water quality while data on rainfall, insolation and wind may be obtained from meteorological institutes.

The classification of ecological status under the Water Framework Directive (WFD) is one example of a monitoring strategy that includes hydromorphological and physicochemical elements to support the biological elements.

Another example is the 'Helcom Combine Programme' for monitoring eutrophication and its effects in the Baltic Sea. The national Danish monitoring programme also includes both biological indicators, water quality variables and climatic variables. The programme attempts to correct the biological indicators for climatic influence in order to be able to relate trends in the biological variables more directly to changes in water quality. The idea is that e.g. an unusually sunny summer may have a positive effect on the vegetation indicators that may be misinterpreted as an indication of improved water quality. Analyses of climatic influence would allow correcting for this effect of climate so that any changes in biological indicators can be related more directly to changes in water quality.

Sedimentation

Human activities in the littoral zone increase the inputs of organic matter to the sediment and the growth and survival of seagrasses decrease as this input increases. Seagrasses growing on carbonate-rich, and iron deficient, sediments are particularly sensitive to sediment organic matter enrichment. In addition, high inorganic sediment accretion enhances vertical rhizome growth, in those species that possess them. Hence, knowledge on sedimentation rate of total and organic suspended particles will help to assess the status of seagrass meadows.

The rate of suspended particle deposition on seagrass sediments can be measured by deploying benthic sediment traps. There is a wealth of sediment trap designs; one is illustrated in Figure 10.1. In this model, each trap is built by a stainless steel bar supporting five cylindrical glass centrifugation tubes. The benthic sediment
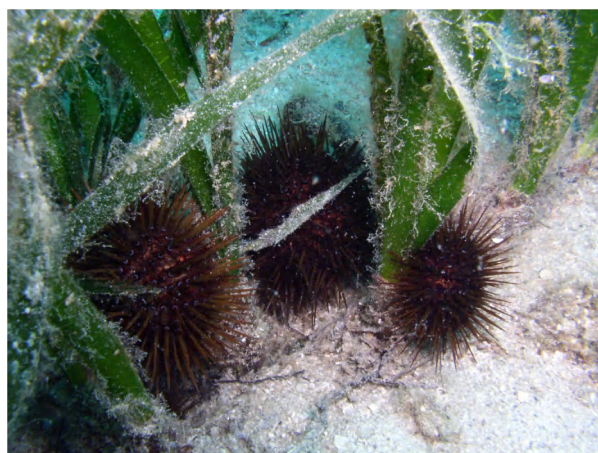

Figure 10.2. Epiphytes and macroalgal blooms covering *Zostera marina*. Photo: Michael Bo Rasmussen.

Figure 10.3. Seaurchins in seagrasses. Photo: Elvira Alvarez Pérez.

traps are placed at 20 cm above the sediment surface by SCUBA divers. Details on sampling methods can be found in e.g. Gacia et al. (2003)

Epiphytes and macroalgal blooms

Epiphytes and (particularly green) macroalgal blooms may be a prominent component of seagrass ecosystems when ambient nutrient concentrations are high (Figure 10.2). Abundance and species composition of seagrass epiphyte communities also depend on seagrass leaf life-span, which is species-specific (see chapter 3) and determines the age of the epiphyte substrate. Hence, macroalgal and epiphyte abundance and species composition in seagrass meadows, after taking into account the seagrass species involved, can be used as a proxy of nutrient richness in coastal waters. In addition, the presence of green macroalgae of the genus *Caulerpa*, which grow on organic rich sediments e.g in the Mediterranean, or of the widespread genera *Ulva* and *Enteromorpha* which also thrive under nutrient rich conditions can be used as an indicator of deterioration of sediment quality for seagrass growth. Macroalgal blooms and epiphytic biomass may vary markedly over time both because the organisms grow fast and because epiphyte biomass is regulated by wind exposure and can be decimated after a storm. When these organisms are included in monitoring programmes, sampling must therefore be repeated several times during the growth season to represent the site properly. This render sampling of epiphytes and macroalgal blooms costly. Details on methods for sampling epiphytes can be found in e.g. Borum (1985).

The abundance of macroalgal blooms can be measured either as cover or as biomass using the

Figure 10.4. Pinna (*Pinna nobilis*) in seagrass bed. Photo: Carlos M. Duarte.

same methods as described for seagrasses (see Chapter 8).

Key fauna

Seagrass meadows host a large number of animal species. Information on key fauna associated to the seagrass beds can be directly relevant for the interpretation of seagrass monitoring results in cases where the fauna grazes the seagrasses. Moreover, the fauna species associated with seagrass meadows often reflect plant health and may also add to the general understanding of the importance of seagrass beds for coastal biodiversity.

Relevant key fauna to measure in connection with seagrass monitoring programmes are listed below:

- Sea urchins – are often important grazers of seagrasses (Figure 10.3). Herbivory by sea urchin occasionally (overgrazing events) can be so intense that it may even result in the elimination of extensive seagrass patches. The density of sea urchins increases with increasing nutrient concentration in plant tissues, and, hence, in the environment. An increased grazing activity by sea urchin has for example been observed in *P. oceanica* meadows situated under fish cages. Sea urchins can be sampled with underwater visual census.

- Fish – there are fish species that are "permanent residents" in the seagrass meadows. Examples are pipefish and sea sticklebacks and in the Mediterranean also *Sarpa salpa* (L.). Exclusive feeding on living seagrass leaves is a rare feature; in general fishes that feed fresh leaves also depend on other food resources, such as epiphytes or small invertebrates. Fish can be sampled with underwater visual census.

- Molluscs – some big species, like the Mediterranean bivalve *Pinna nobilis*, are exclusively dependent on seagrasses (Figure 10.4), and are therefore affected by physical impacts on the meadows, e.g. boat anchoring. Presence of *P. nobilis* is a characteristic of healthy seagrass meadows. *Pinna nobilis* can be sampled with underwater visual census. Some snails (e.g. the genus *Rissoa*) are also frequent on seagrasses.

- Birds – can be major seagrass consumers in the intertidal zone, e.g. the mid-west

European coastal areas, with *Zostera marina* and *Z. noltii* populations are wintering areas of some species of birds: brent goose, pintail, widgeon and mallard. Swans also graze on seagrasses. The abundance of birds can be assessed by population density surveys.

The underwater visual census is a quantitative estimation of the abundance of fishes and large epibenthic invertebrates by transects in clear water environments. There are other techniques available for assessing the abundance and biomass of fishes and epibenthic invertebrates, such as gill nets, drop nets, etc., in turbid waters.

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