HANDBOOK FOR MONITORING AND RESEARCH OF THE SEA GRASS AREA IN THE ADRIATIC SEA USING STANDARD AND AFFORDABLE METHODS

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Content

INTRODUCTION

Seagrass ecosystems are widely known as key coastal ecosystems for a complete marine ecosystem (Hemminga & Duarte, 2000). Grasses are plants adapted to life on land and several hundred thousand species inhabit the Earth. However, few of their relatives live in the sea. Seagrasses members of the clade *Angiospermae*, i.e. angiosperms and have a limited range. (sensu Burt, 2001) Seagrasses are plants that have fully adapted to life in the sea. Only approximately fifty species of seagrasses have been recorded in the world's seas. Seagrasses are monocotyledons, and their distribution is limited to infralittoral beds where sufficient light is available for photosynthesis. The roots absorb nutrients from the substrate, which is why we find them only on sedimentary floors.

The living environment inhabited by seagrasses is really interesting and challenging, such as salinity but also changes in it, looseness and instability of the substrate, poorer diffusion of gases in water versus air, lack of light required for photosynthesis (the maximum depth at which seagrasses can be found is 90 m).

On the sea floor, seagrasses form meadows that in temperate latitudes consist of only one, and in tropical latitudes of several species. Plants expand by growing and branching a horizontally laid rhizome, which makes each subsequent part a clone of the previous one and it has been recorded that these clones can reach an enviable age of 1,000 years. The rhizome on certain parts has a kind of anchoring roots that fasten it to the substrate and thus retain and reduce the mobility of the sediment, which indirectly reduces the flow of water passing through the surfaces covered by rhizome. In addition, it allows the retention of particles in the water. Rhizome is also used for vegetative reproduction since very little energy is used for sexual reproduction.

Flowers, if any are present, are dioecious and small. It is estimated that as much as 50 – 60% of seagrass biomass is found in the root and rhizome. In addition to adaptations to the substrate, another important adaptation is to the specific photosynthesis conditions, which is the main source of primary production of the system seagrasses are a part of. In order for photosynthesis to take place properly, an uninterrupted supply of light and exchange of gases between the environment and the plant is required.

What makes the situation complicated is the reduction of the amount of light depending on depth due to its absorption in water, which leaves the plants with approximately 11% of the light compared to the amount present on water surface. Unlike terrestrial plants, where gas exchange takes place through stoma, such an organization is not necessary for seagrasses (they do not have stoma).

In seagrasses, transpiration does not occur and all gas exchange takes place through a thin cuticle that coats the surface of the leaves connected via mesh-shaped lacunae that transfer gases in a plant. In addition to helping gas transportation, such a system allows leaves to float, thus placing the photosynthetic apparatus in a favourable position.

Furthermore, salinity is also a factor affecting the distribution of species not only in terms of tolerance to salinity level, but also how well the plant copes with changes in salinity. Although most species are euryhaline, hyposalinity conditions (45 ‰) cause stress that can result in death. In addition, the need for nutrients is also different and only a small part of what is needed by terrestrial plants is important to those plants.

Seagrasses are important for the protection against waves, currents and predators that they provide to fish and small invertebrates, making seagrass meadows into centres of biodiversity and nurseries for juvenile forms. Habitats composed of seagrasses are regularly richer in life compared to those without them. In addition to free-swimming forms, algae overgrowths, bacteria and sessile animals are also present in large numbers.

Four species of seagrasses inhabit the Adriatic Sea – *Cymodocea nodosa* (Urica) *Ascherson*, *Posidonia oceanica* (L.) Delile, *Zostera marina* (L.) and *Zostera noltii Hornemann*. In the Adriatic, seagrass meadows of *P. oceanica* are most important. The specie is endemic to the Mediterranean Sea and is called the "lungs of the sea" due to its ability to enrich the sea with oxygen in an enviable amount of 14 litres a day. Posidonia meadows, as well as meadows of other species, are vulnerable due to their slow growth and slow recovery rate. Human activity plays an important role in habitat loss and meadows' degradation in the form of trawling, marine farming, construction in the coastal area, and agriculture, which cause increased eutrophication, covering of plants with soil and physical and physiological stress.

SEAGRASSES OF THE ADRIATIC

Under optimal conditions, seagrasses produce large amounts of biomass that can be compared to biomass in more important agricultural species. Production can be transferred to secondary herbivores, microorganisms and sedimentators. The tissues above the sea floor provide a substrate for epiphytic organisms, which further increases the productivity of the system. According to the analysis and literature of Hogarth (2007), Hemming and Duarte (2000), we divided the seagrass of the Adriatic Sea;

P. oceanica or Neptune grass

Description: It consists of roots, rootstock (stems) and leaves. The plant has vining, laid or erect stems (rhizomes) that are attached to the substrate by roots. Rhizomes grow at an average rate of approximately 1 cm per year, thus creating thick layers called "matte" over the decades, and the top of the rhizome is constantly being buried by particles that fall to the sea floor. The rhizome is vining, and can be partially upright, approximately one centimetre thick. The rhizome on some parts has a kind of anchoring roots via it is attached to the substrate and thus retains and reduces the mobility of the sediment. A tuft consisting of 8 to 9 leaves grows from rhizome that are composed of a base of leaves and a leaf blade. Each leaf lives for approximately a year. When leaves die, only the blade falls off, which happens every fall. Then leaves float in a huge mass on the surface, float in a column of water or lie on the sea floor. A plant with 30-140 cm long and up to 1 cm wide, dark green leaves. The leaves are banded, obtuse or slightly rounded at the apex, with 13-17 parallel veins. They grow in bunches of 5-8 leaves. In autumn, the old leaves fall off, and the sea often throws them out on the beaches in the form of brown clumps.

The plant reproduces asexually, by tearing and rooting the rhizome and sexually by means of flowers and fruits. It forms large underwater meadows.

Habitat: Sedimentary floors, also often on rocky floors, in bays and in exposed areas from 1 m to approximately 40 m deep. In our country, it is spread around the southern islands and in the channels from Dalmatia to Lošinj, while in the north it is rarer, and can be found in the vicinity of the islands of Rab, Sv. Grgur, the southern coast of Krk, Cres and around southern Istria.

Z. marina or Common eelgrass

Description: A plant with 30-100 cm long and 3-9 mm wide, bright green leaves. In ideal conditions it can grow almost as much as Posidonia oceanica. The leaves are thin, banded, elastic, with 3-5- (11) veins. The ends of the leaves are rounded and hairy, not serrated. This is a relatively rare seagrass that is most common in the colder shallow and sandy-muddy shores of the north-western Adriatic. It prefers brighter habitats, so it grows mostly at depths of one to fifteen meters. Due to their similarity, most people mix common eelgrass with young Posidonia, but we can distinguish them by the fact that common eelgrass is narrower and smaller compared to Posidonia.

Habitat: Muddy-sandy floors under influenced by fresh water, from the upper infralittoral zone to a depth of 3 m. In the Adriatic, it can be found along the north-western coast of Istria, in the Bay of Rijeka and the Velebit Channel, in the area of the Novigrad and Karin Seas, and at the mouths of the Cetina and Neretva Rivers.

Z. noltei or Dwarf eelgrass

Description: A plant with 5-30 cm long and 1 mm wide, light to dark green leaves. The leaves are very narrow, elastic, heart-shaped at the tips with 1-3 parallel veins of which the central one is somewhat stronger and more pronounced, while the other two are less pronounced. It is extremely sensitive to wave hydrodynamics, so it mainly grows in shallow muddy bays, calm stagnant lagoons and estuaries, and can often be found on the shore during low tides.

Habitat: Sandy-muddy floors influenced by fresh water; from the surface to a depth of 5 m. Dwarf eelgrass is quite rare on the open shores of the Atlantic and Mediterranean, and most often forms dense meadows in closed and semi-saline seas such as the Baltic, Aral, etc.

C. nodosa or little Neptune grass

Description: It prefers similar habitats as Posidonia. This seagrass has a much higher resistance to pollution, a greater amount of organic matter, in addition to tolerating smaller amount of light much better than Posidonia; so there is competition for habitat, which threatens the prevalence of Posidonia. This plant features 15-40 cm long and 3-4 mm wide, light to dark green leaves. The leaves are banded, narrow, with 7-9 parallel veins and serrated edges at the tip. The stem develops parallel to the seabed, often covered with sediment, 3-4 mm thick, flexible and smooth. Densely formed "knots" are characteristic on the stem. The root is just a few millimetres thick.

Habitat: Sandy-muddy floors with organic residues; from the sea surface to a depth of 10 m. In some places, it forms underwater meadows together with *Zostera noltei*. It can tolerate a certain amount of organic load.

ENDANGERMENT LEVEL OF SEAGRASSES

Today, seagrass meadows are extremely endangered in the Adriatic. Many human activities have led to an almost irreversible loss of meadows. Any destruction of seagrass meadows is an irreversible process considering the lifespan of one generation of people. Since *P. oceanica* rhizome grows at an average rate of approximately 1 cm per year, it takes several centuries to restore a meadow with a diameter of just ten meters.

The consequences of the destruction and loss of seagrass meadows are manifold: the biodiversity of the area is reduced as the species that live, find shelter or breed there disappear; the amount of oxygen in the sea water decreases and the oxygenation of the sediment decreases; seabed erosion increases, which destroys the natural habitat of seagrasses.

Certain fishing tools also have a very negative impact on sea floor habitats and marine sediment. The impact on the endangerment of seagrass meadows are primarily of anthropogenic origin such as coastal urbanization, industrial development, fishing (trawling and dredging), aquaculture, anchoring. In the long run, industrialization leads to eutrophication, i.e. an increase in the amount of nutrients, which results in an increase in primary production, and consequently a decrease in water transparency and habitat degradation.

From 1959 to 2005, Ardizzone et al. (2006) report a 60% loss of *P. oceanica* in the Mediterranean. Marine farming, i.e. cage fish farming in the immediate vicinity or above seagrasses, leads to immediate and absolutely irreversible damage. Fishing activities cause mechanical damage and the immediate loss of seagrass meadows. Namely, the recovery of seagrass communities is a long-term process and is difficult to achieve.

Aquaculture also indicates a major problem since the cultivation of various species of aquatic organisms (Pergent et al., 1999; Dimech, 2000; Borg et al., 2006; Pergent-Martini et al., 2006) causes an aggressive reduction in seagrass meadows, especially in the immediate vicinity of cages, but also up to 300 m from cages (Pergent – Martini et al., 2006). Due to cultivation, the amount of dissolved nutrients and organic matter in the sea and sediment increases, a high proportion of organic matter leads to the formation of epiphytes that prevent the penetration of light to seagrasses. Degradation of seagrasses is associated with lack of light due to cages that cast shade on seagrass meadows and with a high concentration of organic matter in the sediment caused by the fall of organic particles on the sea floor.

In addition to all the above, the degradation of seagrasses can also be attributed to the increased carbon deposition. Carbon released from farms eventually accumulates in the sediment and can lead to system anoxia, thus preventing physiological processes in a plant and increasing mortality of individual plants.

Today, coastal areas are the most densely populated and most heavily utilized areas on Earth. Natural resources and favourable conditions are the basis for a number of concentrated activities: from industry and production, through fisheries, marine farming and tourism. Finally, all coastal activities put significant pressure on the environment in which they operate, leading to its increasingly significant degradation. The range occupied by seagrasses is extremely important due to coastal ecosystems. Seagrasses are exposed to a pronounced anthropogenic impact, which leads to the degradation of seagrass meadows and, consequently, to the disruption of marine ecosystem functioning.

Monitoring process

What is monitoring?

Monitoring is a continuous observation of a system, in this case seagrasses, with an aim of detecting changes caused by various factors. The accuracy of detecting changes and the level of change depends on the methodology used. When monitoring the environment, it is important to identify the causes that lead to changes, it is necessary to observe and assess the range of changes that occur in a particular habitat. At the same time, environmental parameters that may have an impact on the observed habitat are collected. For the purpose of this monitoring, changes in the composition, length structure and biomass of seagrass populations in critical areas would be monitored. Today, there is a growing interest in monitoring and researching seagrasses due to their ecological role, but also due to the drastic decline in the cover and populations of seagrasses (Costanza et al., 1997; Orth et al., 2006; Short et al., 2006).

Why to monitor?

Monitoring programs provide important information to coastal management organizations. Seagrass meadows are extremely important for the functioning of marine ecosystems, their monitoring is important in order to assess the condition and health of the environment and the impact on coastal systems.

The ideal "bio indicator" must show measurable and timely responses to developments that affect changes in the environment. Seagrass habitats respond very quickly to any changes that occur in the marine ecosystem and the changes that occur then are easily recorded and measurable.

Coastal zone management is increasingly taking into account the importance of seagrasses as a system that provides habitat for various marine organisms, food source, and spawning grounds for fish and other organisms (Coles et al., 1993).

In addition, seagrass stabilizes sediment, prevents it from being carried away by waves, and maintains water quality (Short and Short, 1984).

Coordinated monitoring, systematic monitoring and control of the condition of seagrasses are extremely important, as well as control of the occurrence of significant changes in order to act in a timely manner. It is through such monitoring and observation that we define a system for the continuous assessment of the condition of seagrasses.

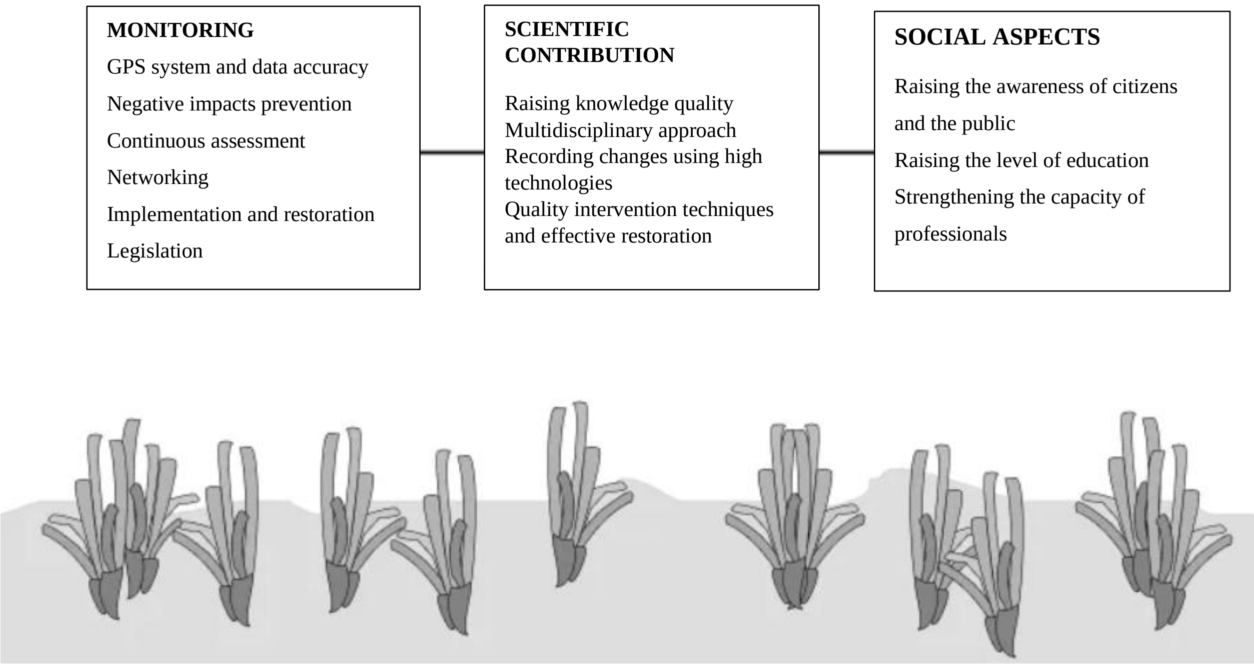

Figure 1 Schematik review of seagrass monitoring importance *Source: Author*

How to record changes in seagrass meadows?

The most common changes in seagrasses are the following:

- change in seagrass biomass;
- change in the area of seagrass meadows; change in the shape, surface, depth or position of the meadows themselves;
- change in the composition of seagrass species, growth rate and productivity;
- change of flora and fauna that is closely linked to seagrass meadows,
- change that may contain more than one of the above parameters.

It is important to note that some of these changes occur naturally and seasonally, and monitoring must be carried out over a multi-year period

All natural changes must be taken into account.

Monitoring itself requires cost-effective data collection, selection of appropriate parameters for observation and measurements that are suitable for statistical processing. The most common parameters monitored are the following: composition of seagrass species (biomass – aboveground and underground), total area or percentage of sediment coverage.

Measurement and analysis of the aforementioned parameters is very simple and fast. Seagrass growth rate has proven to be very useful for providing insight into patterns and mechanisms that lead to changes in seagrass meadows. At the level of seagrass meadow observations, the composition of seagrass is observed and mean values and variances for parameters such as biomass or sediment coverage percentage are estimated.

Monitoring includes measurement of physical parameters: depth, sediment type, visibility, salinity, temperature etc. Measurements should be frequent according to periods in which they vary and affect the growth and survival of seagrasses (Dennison et al., 1993). The depth at which seagrasses appear may be directly influenced by the amount of light penetrating through the water column.

The selection of relevant biological and physical parameters allows the design of simple and effective monitoring methods, with minimal effort, and allows the detection of changes that are statistically and biologically significant. The precision and accuracy required in monitoring determines the type of data that needs to be collected.

Monitoring site selection and mapping

The most important step of monitoring is site selection. The location must include the same species of seagrasses that are found throughout the meadow, reflect the range of depths at which these same seagrasses are usually found, i.e. the location must not differ in any characteristics from the entire area.

The homogeneous area of seagrasses has a fairly even distribution of seagrass, without large empty spots or any interference. Such an area allows the collection of samples that reflect the natural conditions of the site without significant interference. This means that there are no significant deviations in variability and allows us to record long-term changes.

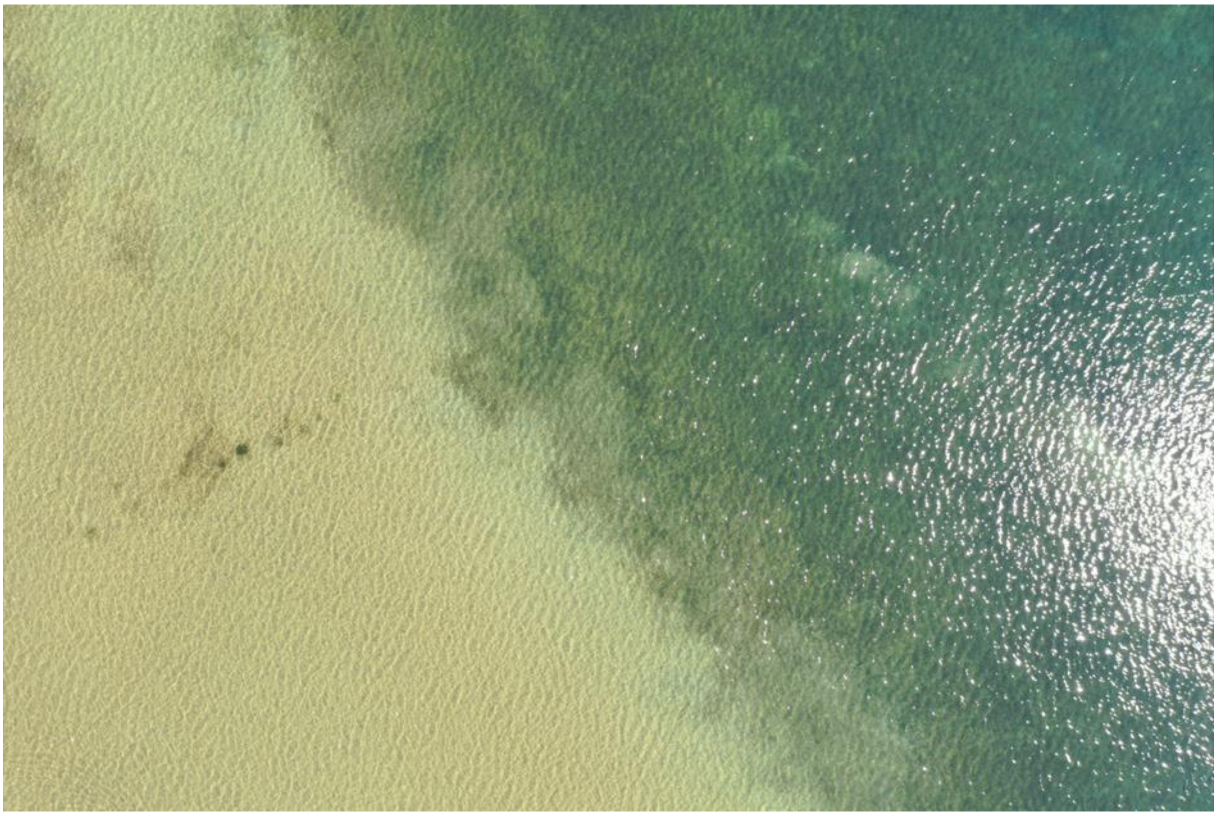

Figure 2 Homogenius area of seagrasses *Source: Author*

Access to the selected site should be simple, without any interferences, in order to allow long-term monitoring and return to the same site for sampling. In addition, it is necessary to ensure a sufficient distance from human activity and all external factors that can negatively affect seagrass meadows and lead to their reduction (Figure 3).

Figure 3 Accesible monitoring location *Source: Author*

Sampling area and determining GPS position

Activities of moitoring changes in the composition of seagrasses should include the collection of samples at as many selected sites in bays, canals and in the open sea. The proposed sites are located on different types of substrates at depths **up to 40 m**.

During the initial monitoring, after arriving at the measurement location, it is necessary to determine GPS position of the measurement location. It is important to accurately record GPS position of the measurement location. It is recommended to name measurement locations inside a GPS device with pre-agreed names / codes, and to inform everyone who participates in the monitoring regarding the name of the location where they performed the measurements and to write the name on a plate.

It is recommended that a GPS device be set to the original WGS84 coordinate system, in order to avoid later errors and data inconsistencies. Furthermore, it is recommended that in addition to the monitoring director, there is at least one other person present to hand the equipment, record GPS locations and inform regarding the name of individual measurement locations.

Seagrass community monitoring activities include mapping of communities in the mediolittoral and upper infralittoral zone along the entire coastline.

Sampling frequency

Sea floor condition monitoring based on seagrass condition monitoring in areas affected by fishing activities in channels between islands and in the open sea will be performed **once a year** during summer (June / July). Sea floor condition monitoring at shallower depths in the coastal area will be based on a survey of seagrass meadows condition in three-year cycles, which means that each station should be monitored at least once every **three years**. However, it is important to emphasize that more frequent monitoring allows easier monitoring of occurring changes, and thus their causes.

Sampling, measurement and data processing methods

Seagrass monitoring methods include the analysis of nine parameters, however, in this simple and cost-effective modified version of monitoring, only two parameters are used: density and coverage (Table 1).

PARAMETERS	DESCRIPTION
Shoot density	Number of shoots in squares of 0.16 m (40 x 40 cm)
Meadows coverage	Percentage of substrate cover by shoots, using the LIT (Line Intercept Transect) method
Leaf area	Mean leaf area (cm^2)
Necrosis	Mean leaf necrosis (%)
Reserve substance (sucrose)	Sucrose content in rhizomes (% of dry mass)
Nitrogen isotope ratio (δ15N)	Nitrogen isotope ratio in rhizomes
Sulphur isotope ratio (δ34S)	Sulphur isotope ratio in rhizomes
Lead in the rhizome	Amount of lead in rhizomes (μg/g of dry mass)
Nitrogen in epiphytes	Amount of nitrogen in epiphytes collected from leaves (% of dry weight)

Table 1. Parameters included in POMI9

POMI

A combination of POMI9 method (Posidonia oceanica multivariate index) and a modified version of POMI monitoring method are used to monitor the condition of Posidonia oceanica seagrass meadows. POMI9 method is described in Romero et al. (2007), Benett et al. (2011).

The results of the analysis of the measured parameters (density, coverage, upper and lower edge) are used to assess the ecological status of seagrass meadows P. oceanica, all for the purpose of determining the good environmental status – GES (good environmental status) (Table 2). To determine the effectiveness of these methods, they will be compared with POMI method already used to determine coastal water quality under the Water Framework Directive (WFD)

In the first monitoring cycle, a modified POMI method is used on all meadows selected for monitoring. Meadows for which no GES has been determined – good maritime environmental state (OEK < 0.55) will be analysed in the next cycle using POMI9 method, while for meadows for which DSO monitoring has been achieved, a modified POMI method will be performed.

If the meadow on which the research is performed is not developed to the standard depth at which the measurement is performed within the POMI method (15 m), but dead rhizomes have been determined at that depth, it will be considered that no GES has been achieved for that meadow.

It is extremely important that all data from the field log are entered into the Microsoft Office Excel program and that graphical representations are made based on the entered data.

COVERAGE MARK	COVERAGE PERCENTAGE	INTERPRETATION
0	0%	0 coverage
1	1-25%	Up to one quarter of the sea floor covered in the quadrant
2	26-49%	Over a quarter but less than one half of the sea floor covered in the quadrant
3	50%	Exactly half of the sea floor covered in the quadrant
4	51-75%	Between half and up to three quarters of the sea floor covered in the quadrant
5	76-99%	Over three quarters put less than 100% of the sea floor covered in the quadrant
6	100%	100% coverage

Table 2 Percentage and interpretation of seagrass coverage

Fieldwork preparation

- Prior to going out in the field, make sure that all the necessary equipment is ready.
- Go to the location where the monitoring will be performed, make a sketch of the area with GPS coordinates and a short description of the location based on visual observation.
- In shallow areas, monitoring can be done by walking along the edge of a meadow, observing every 5 – 25 m, depending on the size of the area.
- It is necessary to take into account the orientation and make sure that in case there are seagrasses under them, to move in a direction from lower to greater depth or if there is sediment below them, move from greater to lower depth.
- It is recommended, in order to reduce air consumption, not to dive only along the sea floor but at a minimum depth from which it is possible to clearly see the sea floor and determine the location of the lower edge of a meadow.
- Placing a temporary marking on the inside (shore side) and on the outside (the open sea side).
- **Decide what is the best position for transect placement.**
- In the area suitable for monitoring, a temporary marking is placed in the sediment, inside an uninterrupted seagrass meadow (approximately 1 m from the inner edge), then walk or swim to reach the outer edge and place another temporary marking (1 m away from the outer edge).
- Recording of basic data immediately before the start of monitoring (Table 3).

LOCATION (name of bay, reef, island + name of the nearest town)	
TRANSECT NUMBER (each transect is marked separately)	
OBSERVER (data of the person in charge of fieldwork)	
SAMPLING DATE ABD TIME	
COMMENTS (special conditions or some special observations)	

Table 3. Basic data recorded at the start of fieldwork

Transect placing

One of the possible ways of placing transects for monitoring small changes in seagrass meadows is in places that are representative of much larger areas of meadows. The positioning of a transect is subjective and is based on the experience of scientists, researchers who perform monitoring. A minimum of two transects are placed, usually more, along lines that are subjectively selected to represent seagrass meadows. They should extend in different directions across a meadow so that the causes of changes can be more easily detected. The transect length depends on the size and uniformity of a seagrass meadow, with an emphasis on how certain transects should start in the shallowest parts of a meadow and end in the deepest parts.

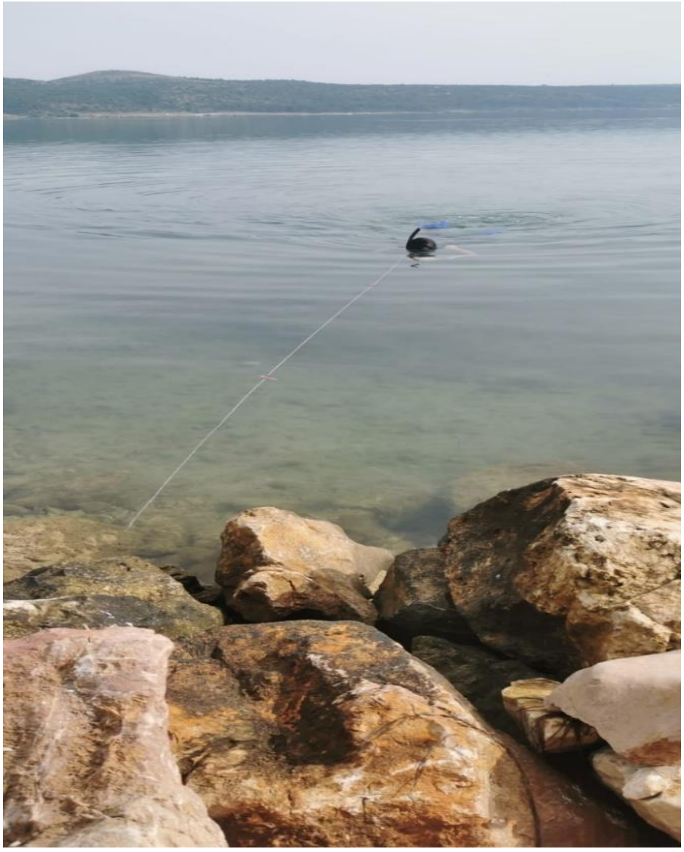

Figure 3 Placement of a transect in shallow water *Source: Author*

Placing a transect requires the presence of at least two people. One person stands in the shallowest part, facing the sea, holding a measuring tape. The other person takes the other end of the measuring tape and walks, swims or dives towards the open sea, i.e. in the direction in which a transect is to be laid. The goal is to create a flat transect that will be wedged into the sediment on both sides, only the markings (at the ends of a transect) will protrude a few cm above the sediment.

Biomass measurement using random quadrants

The quadrant method provides standardized data on the percentage of seagrass coverage, species composition and shoot density with the usual non-destructive method.

The coverage and composition of seagrasses can be quantified by a fast and non-invasive method at scales of 1-10 m by measuring the coverage and species within the replicated quadrants. If there is any change in a seagrass meadow, the same changes will be reflected in the change in biomass. Measurements should be done for a minimum of 3 years, as seasonal changed within a year are significant. Average biomass usually has a low coefficient of variation (> 20%), which is a useful monitoring measure. Medium biomass will respond quickly to changes and in sufficient quantity to quickly be statistically detected.

Sampling method and technique for biomass estimation is based on the following:

1) The size of the area where monitoring is performed,
2) Required accuracy,
3) Time and money available for monitoring,
4) Vegetation structure,
5) Vegetation components used for monitoring (Catchpole and Wheeler, 1992).

Aboveground seagrass biomass can be estimated by randomly selecting an appropriate number of quadrants in the size that will best estimate seagrass biomass within predetermined limits. Biomass is, in this case, the amount of aboveground plant material recorded in a particular area.

More than one site in the area should be selected to avoid pseudo replication. Within each location, the quadrants should be randomly placed on a meadow while swimming. The direction of a swim is randomised, and a quadrant is dropped onto a meadow at random distances. The quadrant is squared shaped and can be pushed into the sediment for stability. The aim of random sampling is to estimate the actual meadow biomass.

If there are no shoots inside a randomly placed quadrant, it is necessary to repeat the procedure until a shoot is visible inside a quadrant.

All shoots within a quadrant must be counted; each shoot consists of rhizomes and leaves. In cases where the shoot is divided into two parts, it is counted as two shoots. With a small number of shoots, counting can be done visually, but if there is a large number of shoots and in case of poor visibility, the shoots should be counted with your fingers to reduce the possibility of error.

When counting, start from one corner of a quadrant, counted shoots are placed behind a hand, until the uncounted ones are placed in front of a hand. When counting shoots, the diver's concentration is important, if at any time a diver gets lost in the count, it is important to start counting again.

Fieldwork

- Fieldwork: two individuals
- Data processing: 1 individual per day
- Estimated time required: depends on location and weather conditions

Materials required

- one 50-meter long strip for transect marking,
- GPS,
- two PVC markings for securing the transect.

Fieldwork:

- quadrants for measuring coverage and density (50 x 50 cm quadrant for coverage and 25 x 25 for quadrant density or any other size that collects the best representative samples is recommended),

- a pen,

- a technical sheet on seagrass density or a camera for taking photographs of each quadrant.

Figure 4 Seagrass monitoring *Source: Author*

Video transect

A type of seagrass monitoring with the help of a video camera along a fixed-length line. The video material is later analysed on a computer. This method uses a video or photograph taken along the marked transect with the help of a camera located on a ROV and AOV (remotely operated underwater vehicle) or the camera, with the help of a bait, is towed from a ship or a boat. The camera is geo-positioned with the help of DGPS (modern navigation system) and / or underwater telemetry.

Video transect technique

Video transect technique consists of monitoring seagrass habitats in randomly selected transects. It consists of two phases:

1.) field data collection when images taken along the transect are recorded with a video camera,
2.) identification of seagrasses on a computer screen from recorded photos or videos.

This method provides the following advantages:

a) continuous monitoring of the condition obtained in the field, since the recorded photographs are kept, which allows for further tests,
b) accurate identification of seagrasses since photos can be viewed multiple times and sent to a specialist if necessary,
c) successful performance in water with poor visibility due to a short distance between a camera and seagrasses.

If you want to perform long-term observations of seagrasses, this method is very effective and can be used to document changes caused by natural conditions or human activities.

Data entry and analysis of video materials and photographs

When leaving the sea, on each fieldwork location, waterproof plates containing data are photographed to prevent the loss of the data.

After all measurements and completion of field work, all data must be correctly transcribed and entered into a database on a computer accompanied by all photographs and / or video materials. Each diver / field worker is responsible for the data they collect and for their correct entry into a database. All data must be entered on the same day, after the fieldwork, so that the material is not lost or mixed. The data entered into a database should be as simple and understandable as possible.

The analysis of video material and photographs is performed on a computer, starting with determining a seagrass, giving an estimate of its density – "low density", "medium density" or "high density", followed by observing the coverage of epiphytes, the position of the edge of the seagrass meadow in question and its health status.

The analysis of video material and photographs has attracted considerable attention mainly because it allows scientists to more easily collect detailed data over a longer period of time. In addition, no complex image processing algorithms are required, which requires significantly lower computing power. On the other hand, this approach requires more work and manpower as it involves determining certain physical checkpoints in underwater activities.

The development of computer, sensor and communication technology and the development of lightweight materials have caused increased interest in the application of such monitoring methods. As this field develops more and more, their application will become more frequent.

Conclusion

Throughout the previous century, the withdrawal of seagrass meadows has dominated due to the increasingly pronounced anthropogenic impact on coastal areas. Coastal restructuring, pollution, overfishing, tourism, invasive species, followed by rising temperatures and sea levels are affecting the fragmentation of seagrass meadows. Degradation of seagrass areas has a negative impact on species dependent on them but also on the maintenance of their populations, and potentially increases the risk of biodiversity loss.

Continuous monitoring and observation systems are important for the future strategy of control and protection of seagrasses. This manual is one of such tools. It was conceived in response to the identified need for simple and affordable methods for seagrass monitoring, which is available to everyone.

The monitoring results obtained within the initial phase of monitoring the situation are extremely important, as well as within the future coordinated monitoring program, which needs to be consolidated as a whole. In the previous and proposed monitoring, we can have a much wider user base. Precisely archived results of multi-year numerical simulations can be used in various environmental impact studies since they provide an insight into mean conditions of oceanographic parameters in the areas where calculations had been performed. As monitoring starts covering increasingly longer periods of time, estimation reliability based on its results will increase.

Consequently, the archived results of monitoring using simple and cost-effective methods for seagrass monitoring can be used as initial and threshold conditions, specifically in simulations on fine spatial scales for specific purposes involving coastline changes such as embankment impact assessment, pier construction, marine ecosystem risk assessment etc.

Coordinated monitoring can enable prognostic and verified model systems, and thus can help in strategic decisions related to the sea and marine environment with significant cost reductions. The results of the application of all models within the monitoring framework should be stored together with appropriate files in which the methods used during the monitoring are defined.

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