UNIVERSITÀ POLITECNICA DELLE MARCHE

DIPARTIMENTO SCIENZE DELLA VITA E DELL'AMBIENTE

Corso di Laurea Magistrale

BIOLOGIA MARINA

VALUTAZIONE DEI SERVIZI ECOSISTEMICI FORNITI DALLA PRATERIA DI CYMODOCEA NODOSA IN ABADES, TENERIFE

EVALUATION OF ECOSYSTEM SERVICES PROVIDED BY CYMODOCEA NODOSA SEAGRASS PATCH IN ABADES, TENERIFE

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Sessione Autunnale 2021

Anno Accademico 2020/2021

Cymodocea nodosa è la fanerogama più comune nelle Isole Canarie. In questo studio si è voluta caratterizzare l'area marina di Abades, per poter valutare i servizi ecosistemici che può fornirci la presente prateria. Per analizzarli, sono stati presi in considerazione diversi parametri: estensione e densità, biodiversità, turismo, attività di pesca, produzione e consumo di O_2 e CO_2, in modo da provare l'importanza di quest'area non ancona inclusa nelle Zone Speciali di Conservazione (ZSC).

La raccolta dati è stata condotta tra Maggio e Giugno 2021, tramite l'esecuzione di diverse metodologie per ogni obiettivo. L'estensione e la densità della prateria di *C. nodosa* sono stati studiati tramite la più recente cartografia REDMIC e l'applicazione di transetti a diverse profondità. La biodiversità è stata analizzata effettuando innanzitutto una lista contenente tutte le specie appartenenti alla fauna associata a *C. nodosa* in tutta l'area delle Isole Canarie, usando come fonte REDPROMAR, per poi andare a concentrare il lavoro sull'abbondanza delle specie nell'area marina di Abades tramite il posizionamento di un transetto fisso in modo da prendere nota di tutte le specie presenti. Per quanto riguarda l'attività di pesca, è stata stilata una lista di tutte le specie di interesse commerciale associate alle praterie di *C. nodosa* in modo da andare a ricercare in seguito i diversi costi per kg di prodotto.

Volendo analizzare il lato economico dei servizi ecosistemici forniti da *C. nodosa*, oltre alla sopra citata attività di pesca, ci si è focalizzati sul turismo, in particolar modo sull'attività subacquea, tramite la consegna di questionari a diversi Diving Centers con domande mirate sul loro ricavo grazie alle immersioni in Abades. In ultimo, sono stati consultati articoli scientifici riguardanti la produzione primaria di *C. nodosa* per poter stimare la produzione e il consumo di O_2 e CO_2.

I risultati hanno mostrato innanzitutto un'estensione della prateria di 83.437 m^2, presentando inoltre una media densità con un massimo di 928 n° fasci/m^2. Per quanto riguarda la biodiversità sono state numerate 26 diverse specie e un totale di 324 individui, tra giovanili e adulti. Sono inoltre state avvistate al di fuori dell'area del transetto, due specie a rischio di estinzione *Pteromylaeus bovinus* e *Squatina squatina.*

Tramite i questionari è stato valutato che quest'area è visitata in media 4 giorni a settimana, da circa 13 subacquei, raggiungendo un massimo di 20 subacquei e un minimo di 3. Inoltre, in media un'immersione in Abades ha un costo di 39,80 € e da questi, il ricavo effettivamente guadagnato è pari a 17,50 €, che in un anno può raggiungere circa 11.830 €.

Tramite la visita a numerose pescherie locali, si è potuto stimare in media il guadagno che si può ricavare con la vendita delle specie

associate a *C. nodosa.* Ad esempio, si è visto come tre specie avvistate durante lo studio con il transetto ovvero, *Sparisoma cretense, Pagellus erythrinus, Boops boops* siano vendute rispettivamente a 9,45 €, 8 € e 2 € al kg. La specie venduta a prezzo maggiore, pari a 12,60 €/kg è invece *Mullus surmuletus.* Infine, la consultazione di articoli scientifici incentrati sulla produzione primaria di *C. nodosa* ha permesso di stimare che l'O_2 prodotto dalla prateria presente in Abades corrisponde a 25.414,91 gO_2 mentre la CO_2 consumata è pari a 172,02 gC.

In conclusione, quest'area di studio dovrebbe essere considerata con priorità nella progettazione delle future strategie di conservazione della zona costiera locale, per evitare la perdita di biodiversità e garantire la fornitura a lungo termine dei relativi servizi ecosistemici.

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ABSTRACT

Cymodocea nodosa is the most common phanerogam in Canary Islands. In this study was analyzed the marine area of Abades in which is present a meadow, that can provide a lot of ecosystem services.

A characterization of the area was conduct, to evaluate the density, biodiversity, fishing activity, tourism promoter and the CO_2 consumption and O_2 production to make a proof of the importance of this area since it is not included in the Special Area of Conservation (SAC).

The data collection was conducted from May to June 2021, with different methodologies for each objective. Extension and density were studied through recent cartography and the application of transects lines that shown at the end a meadow with a medium density with a maximum of 928 n° bundles/ m^2.

Biodiversity was analyzed doing a list of all species associated to *Cymodocea nodosa*, using as source REDPROMAR database, and with transects lines that were conducted once a week in which a total of 26 different species and a total of 324 individuals were found. Some of these species were also of fishing interest, for this reason a list of all species of fishing interest associated to *Cymodocea nodosa* was made to assess the economic side that can provide to as this seagrass. To analyze

if Abades is a frequented area by tourism, questionnaires were sent to different Diving Centers of the island to calculate how much money they can earn from diving in that area, resulting that the profit form a single dive is in average of 17,50€. The consultation of specific scientific papers about *C. nodosa*'s primary production was done to estimate the CO_2 consumption and O_2 production carried out by this phanerogam, which corresponds to 172,02 gC and 25.414,91 gO_2 respectively.

INTRODUCTION

1. WHAT ARE ECOSYSTEM SERVICES?

The term ecosystem services include all those benefits and goods that are obtained from the environment that performs various functions.

One of the first definitions was that of Roberto Costanza which says "ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza et al. 1997).

Three international classification systems have been proposed to define the typology of ecosystem services:

- **MA** system (*Millennium Ecosystem Assessment*);
- **TEEB** system (*The Economics of Ecosystems and Biodiversity*);
- **CICES** system (*Common International Classification of Ecosystem Services*).

The *Millennium Ecosystems Assessment* (MA) is a United Nations initiative undertaken in the 2000s with the aim of assess the consequences of ecosystem change for human well-being. The MA wants to increase the conservation and sustainable use of ecosystems and proposes to define Ecosystem Services as "benefits people obtain from

ecosystems" (MA, 2003), dividing them into four macro categories corresponding to their respective functions:

- *support services*, such as photosynthesis, nutrient cycling;
- *provisioning services*, such as food, wood, water;
- *regulating services*, such as water purification, climate regulation, carbon sequestration;
- *cultural services*, that provide recreational, aesthetic, and spiritual benefits.

The diagram in Figure 1 summarizes the relationships between ecosystem services and well-being for humans:

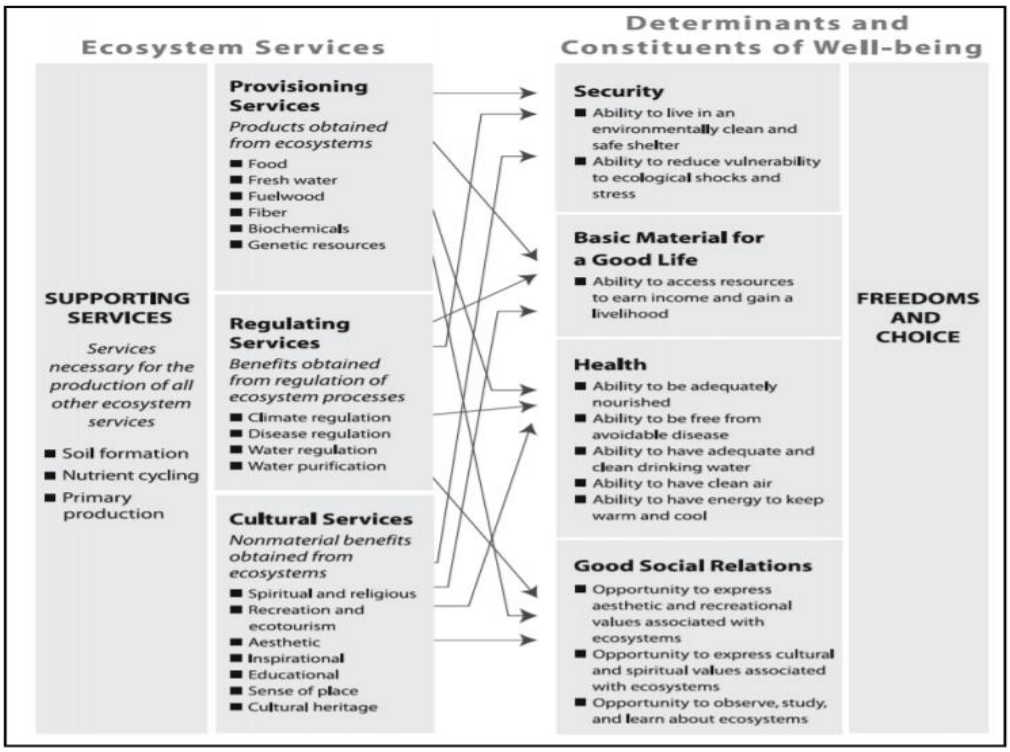


Figure 1. Influences of ecosystem services and well-being

Source: Ecological Economics, 2010

TEEB (*The Economics of Ecosystems and Biodiversity*) proposes a typology of 22 ecosystem services divided in 4 main categories, mainly following the MA classification:

- *provisioning services;*
- *regulating services;*
- *habitat services;*
- *cultural and amenity services.*

An important difference TEEB adopted was the omission of *supporting services*, which are seen as a subset of ecological processes. Instead, *habitat services* have been identified as a separate category to highlight the importance of ecosystems to provide habitat for migratory species (e.g., as nurseries) and gene-pool "protectors" (e.g., natural habitats allowing natural selection processes to maintain the vitality of the gene pool). (Maes et al. 2013).

CICES (*Common International Classification of Ecosystem Services*) proposed a classification system for ecosystem services, to enable people to move more easily between them and to understand more clearly how the people are measuring and analyzing information.

CICES developed a hierarchical structure (Figure 2) organized into three **sections** corresponding to the macro categories of *provisioning*, *regulating* and *cultural services*, without considering the "*supporting services*" originally defined by the MA; under sections we have the **divisions** or the main outputs; then the **groups**; the **classes** that identify individual entities, and provide indicators for measuring ecosystem services; and the **class type**.

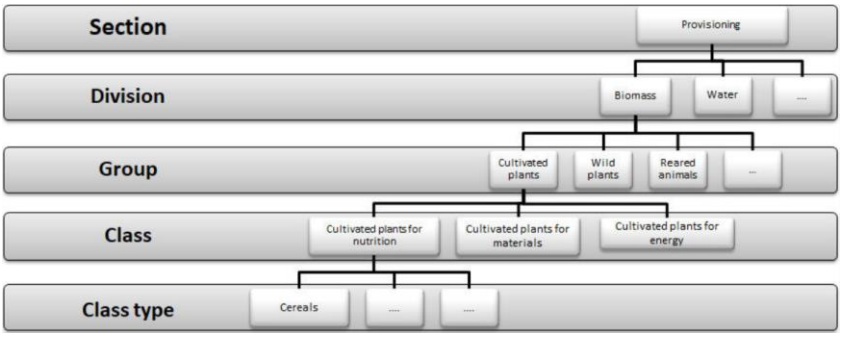


Figure 2. Structure of the CICES classification system

Source: https://cices.eu/cices-structure/

This kind of classification offers the advantage of avoiding the risk of evaluating an ecosystem service twice. In fact, the *double counting* is a problem that can arise when both the process and the result of the process are evaluated for a service. For example, there are studies reporting the value for water flow as a service (Elena Ojea 2011). The outcome of that process (water flow) could be for instance hydropower generation. If additional value is given to hydropower (as a provisioning service) we would be double counting (Elena Ojea 2011).

Another source of risk of double counting arises when the service valued can fit into two different MA categories, but it can be considered as an output of the same nature (Elena Ojea 2011). Figures 3 and 4 compare the structure of the various categories in the three systems.

MA categories	TEEB categories		CICES v4.3 group[†]
Food (fodder)	Food	Provisioning services	Biomass [Nutrition]
			Biomass (Materials from plants, algae and animals for agricultural use)
Fresh water	Water		Water (for drinking purposes) [Nutrition]
			Water (for non-drinking purposes) [Materials]
Fibre, timber	Raw Materials		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Genetic resources	Genetic resources		Biomass (genetic materials from all biota)
Biochemicals	Medicinal resources		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Ornamental resources	Ornamental resources		Biomass (fibres and other materials from plants,

Figure 3. Comparison between the MA, TEEB and CICES system

Source: Maes et al., 2003

MA categories	TEEB categories		CICES v4.3 group[†]
			algae and animals for direct use and processing)
			Biomass based energy sources
			Mechanical energy (animal based)
Air quality regulation	Air quality regulation	Regulating services (TEEB) Regulating and supporting services (MA) Regulating and maintenance services (CICES)	[Mediation of] gaseous/air flows
Water purification and water treatment	Waste treatment (water purification)		Mediation [of waste, toxics and other nuisances] by biota
			Mediation [of waste, toxics and other nuisances] by ecosystems
Water regulation	Regulation of water flows		[Mediation of] liquid flows
	Moderation of extreme events		
Erosion regulation	Erosion prevention		[Mediation of] mass flows
Climate regulation	Climate regulation		Atmospheric composition and climate regulation
Soil formation (supporting service)	Maintenance of soil fertility		Soil formation and composition
Pollination	Pollination		Lifecycle maintenance, habitat and gene pool protection
Pest regulation	Biological control		Pest and disease control
Disease regulation			
Primary production Nutrient cycling (supporting services)	Maintenance of life cycles of migratory species (incl. nursery service)		Lifecycle maintenance, habitat and gene pool protection
			Soil formation and composition
			[Maintenance of] water conditions
	Maintenance of genetic diversity (especially in gene pool protection)		Lifecycle maintenance, habitat and gene pool protection
Spiritual and religious values	Spiritual experience	Cultural services	Spiritual and/or emblematic
Aesthetic values	Aesthetic information		Intellectual and representational interactions
Cultural diversity	Inspiration for culture, art and design		Intellectual and representational interactions
			Spiritual and/or emblematic
Recreation and ecotourism	Recreation and tourism		Physical and experiential interactions
Knowledge systems and educational values	Information for cognitive development		Intellectual and representational interactions
			Other cultural outputs (existence, bequest)

Figure 4. Comparison between the MA, TEEB and CICES system

Source: Maes et al., 2003

The availability of the ecosystem services listed above is therefore a fundamental factor of human well-being. Ecosystems are shaped by the interaction of communities of living organisms with the abiotic environment. Biodiversity plays a key role in the structural set-up of ecosystems which is essential to maintaining basic ecosystem processes and supporting ecosystem functions (Maes et al. 2013).

The focus on benefits implies that ecosystem services are open to economic valuation. However, not all benefits to people from ecosystems can be measured in monetary terms. Therefore, it is important to include other values as well, such as health value, social value or conservation value (Figure 5) (Maes et al. 2013).

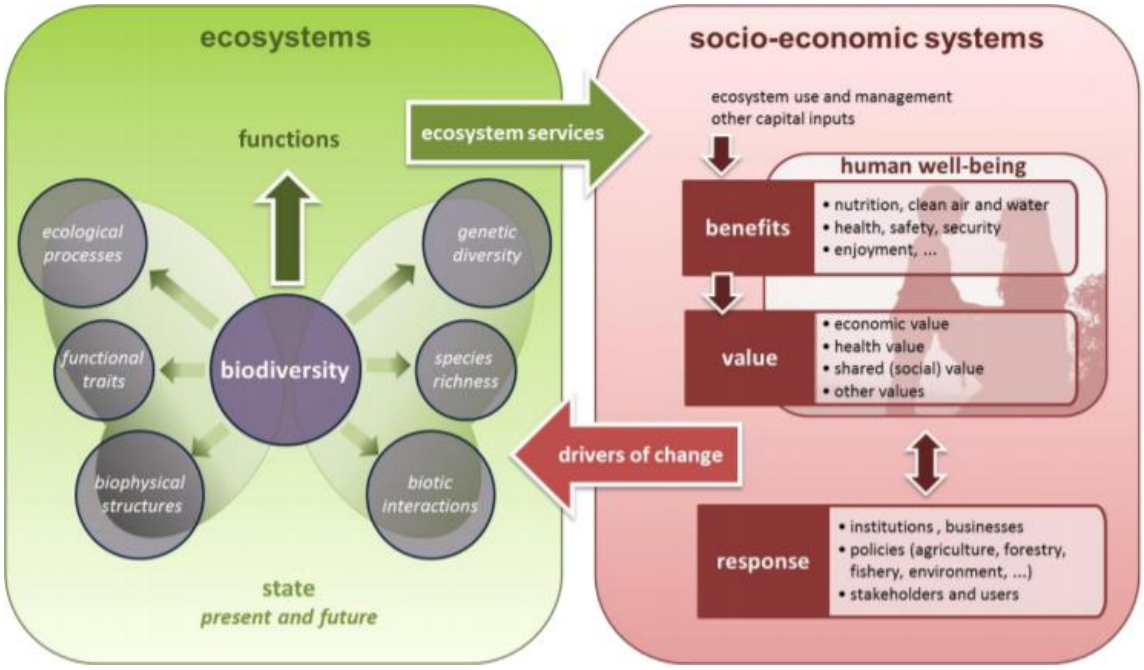


Figure 5. Relationship between the ecosystem and the socio-economic system

Source: Maes et al., 2013

2. ECOSYSTEM SERVICES PROVIDED BY SEAGRASS MEADOWS

Seagrass meadows perform a wide variety of essential functions and services for coastal ecosystems, including their ability to fix carbon and thus mitigate the effects of CO_2 emissions from human activities, their protection role against coastal erosion, by reducing hydrodynamics and sediment accumulation (Espino et al. 2008). However, despite the importance of the functions they perform in ecosystems, they are in clear regression at the world level, with a 0.9% decrease in their surface each year, these trends being more evident on longer time scales, with a 29% loss of coverage throughout the period 1879 and 2006, and a 7% regression since 1990 (Waycott et al. 2009). This regression is mainly due to human activities, such as water pollution, increased turbidity and eutrophication, coastal work, and direct physical damage to grasslands, such as boat moorings (Bay et al. 2005).

2.1 Types of seagrasses in the Canary archipelago

In the Canary archipelago there are three species of phanerogams: *Zostera noltii*, *Halophila decipiens* and *Cymodocea nodosa*. *Zostera noltii* is located in a very limited coastal sector, in the Arrecife belt (Lanzarote) where its survival is threatened by the increase in anthropogenic pressures in the area. *Halophila decipiens* can be found along the islands of El Hierro, La Palma, La Gomera, Tenerife and Gran Canaria. *Cymodocea nodosa* is the most abundant in the Canary Islands, distributed along all the islands of the archipelago, forming large meadows in Lanzarote, Fuerteventura, as well as in the south of Gran Canaria and Tenerife (Espino et al. 2008) (Figure 6).

Figure 6. *Cymodocea nodosas'* meadow.

3. *CYMODOCEA NODOSA* (Ucria) Ascherson, 1870

3.1 Distribution and habitat

Cymodocea nodosa is widely distributed along the Mediterranean coasts, the North Atlantic coast of Africa reaching the coasts of Senegal and the Canary Islands (Figure 7), where its popularly called "seba". It lives on well-lit and calm sandy or muddy bottoms, from 5 to 20 m deep with a salinity of more than 30 PSU (Consejo Insular de Aguas de Tenerife, 2015) it can colonize the dead matte of *Posidonia oceanica*.

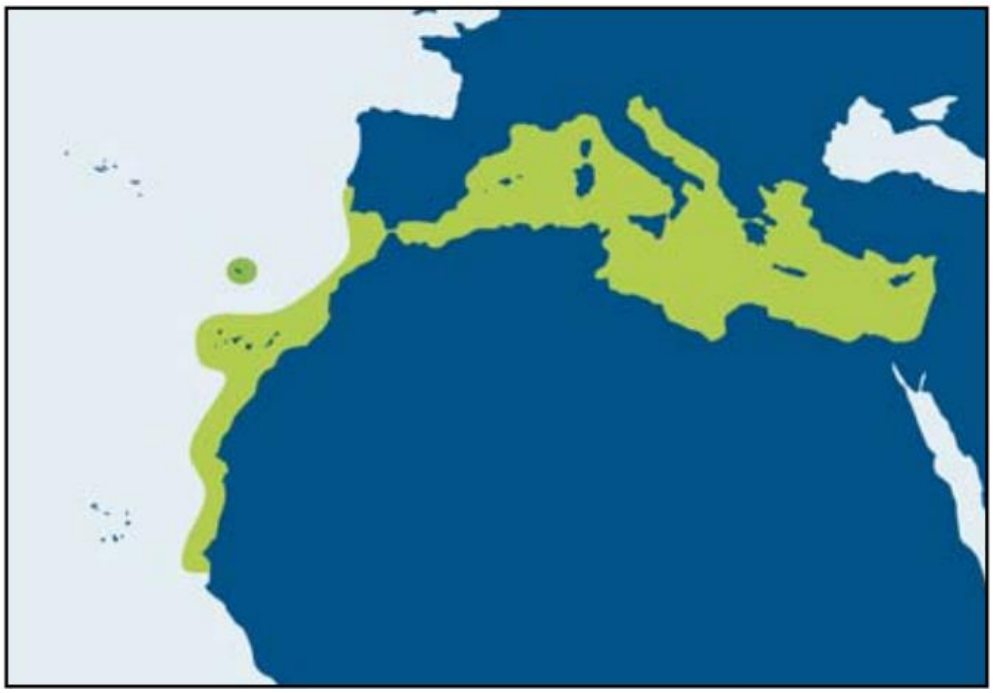


Figure 7. Distribution of *Cymodocea nodosa*.

Source: Los sebadales de Canarias, praderas de fanerógamas marinas

3.2. Morphology and anatomy

Cymodocea nodosa is a perennial herb plant; the stem is creeping (rhizome), which at regular intervals (between 1 and 6 cm) has nodes and internodes from which the roots start downwards and the small stems upwards, from which bundles of leaves and flowers are born (Figure 8).

The rhizome has a cylindrical section, with a diameter of 2 to 4 millimeters and is pink to reddish in color. The plant has two types of rhizomes: plagiotropic rhizomes (horizontal growth) and orthotropic rhizomes (vertical growth); the first are generally longer than the latter. The leaves have a light green color and appear grouped in bundles, which are located at the ends of the rhizomes. Each bundle is formed by a variable number of leaves, depending on the time of year, almost always 2 or 4, but sometimes it can reach up to 10. The leaves are tapered, elongated and narrow; their length in the Canary Islands can vary from 10 cm to more than 70 cm, while the width is about 4 mm. When the leaves die off, they break off leaving their mark in the rhizome called the “leaf scar”, which results in a node. The number of these marks can be used to study the age of the plant, knowing that it can produce an average of 13 new leaves per year (Reyes, Sansón, and Afonso-Carrillo 1995).

The roots are inserted both in the horizontal and vertical rhizomes at the level of the nodes.

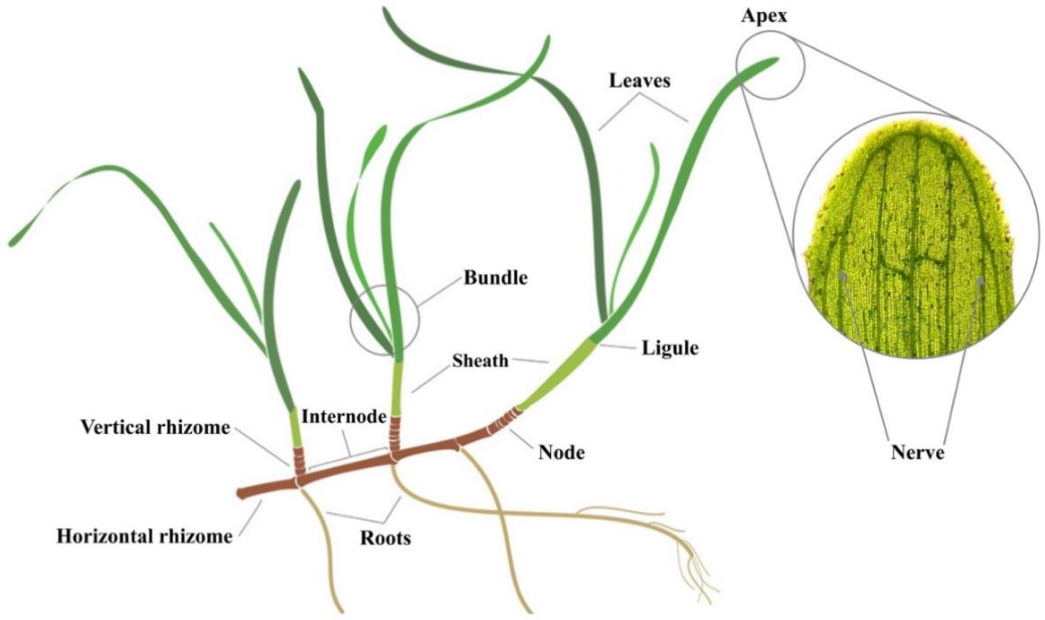


Figure 8. Cymodocea nodosa

Source: Spatial and temporal variability of "Cymodocea Nodosa" meadows on Gran Canaria Island

The reproduction of this plant is mainly vegetative, while the sexual reproduction occurs through the production of solitary dioecious flowers.

3.3. Ecology

Cymodocea nodosa has characteristics that make it an excellent pioneer marine plant, capable, if the suitable conditions for the survival are restored, to colonize extensive underwater areas over time.

The main ecological functions are: (Espino et al. 2008)

- Cushion the effect of the waves and sea currents on the bottom, stabilizing the sediments thanks to its root system and rhizomes. These two characteristics are of great importance for the stabilization and conservation of the beaches, avoiding coastal erosion.
- Improving the quality of the water, increasing its transparency and constituting a biological indicator of the good state of conservation of the coast.
- They are a highly productive ecosystem, which exports organic matter and enriches other coastal ecosystems.
- Increasing biodiversity as they are home to a greater number of biological species. They constitute a physical support for a large number of species of algae and invertebrates.
- Creating a diversity of microhabitats both in leaves, rhizomes, roots, and in sediments.
- Providing food to various species.
- Spooning area and refuge for numerous species. They constitute areas

of recruitment, breeding of juveniles of many animal species, some of which are of commercial and recreational importance.

3.4. Impacts

Seagrasses need specific environmental conditions for development, when these conditions change and reaches values that exceed seagrasses' tolerance range, they can suffer environmental stress and even die, causing the disappear of the meadow. When that happens, all the services that they offer are lost, such as productivity, biodiversity and coastal protection.

However, seagrass beds are regressing on a global scale, estimating the annual loss rate between 2% and 5% (Duarte & Gattuso, 2008). The main cause of the loss of seagrass beds in the world is the reduction of water transparency, as a consequence of the increased nutrient load and turbidity (Duarte et al., 2004)

By the way, impacts on seagrass beds can be classified into two types:

- Natural impacts
- Anthropogenic impacts.

3.4.1 Natural impacts

Storms, through the associated strong waves, give rise to massive movements of sediments, causing the emergence of rhizomes and roots. In these cases, turbidity and lack of light penetration can cause alterations in the photosynthetic activity of marine plants, reducing their vitality and making them more vulnerable. In the most extreme cases, portions of meadow can be uprooted and moved ashore.

Another type of natural impact can be caused by the presence of an excess of herbivorous animals, generally as a consequence of the disappearance of natural predators.

3.4.2 Anthropogenic impacts

In general, human impacts are the ones that occur most frequently, being responsible for most of the cases of disappearance of seagrasses.

In the last two decades, it is estimated that the loss of seagrass beds due to direct and indirect human actions is 33,000 km^2, which is equivalent to 18% of the total seagrass beds that have been documented worldwide (Duarte et al., 2004).

Among the impacts caused by human activities, the construction of commercial and industrial ports, artificial beaches, wastewater discharges, badly positioned aquaculture cages, trawling and the introduction of invasive species should be noted. Each of these activities

can generate the deterioration and loss of seagrass beds (Espino, 2004.)

The pollution produced by discharges on the coast is one of the main impacts on the Canary seagrass, as they produce numerous discharges of wastewater, both direct (on the coast) and through submarine emissaries.

In Figure 9 is showed the presence of authorized and non-authorized submarine emissaries in Tenerife Island:

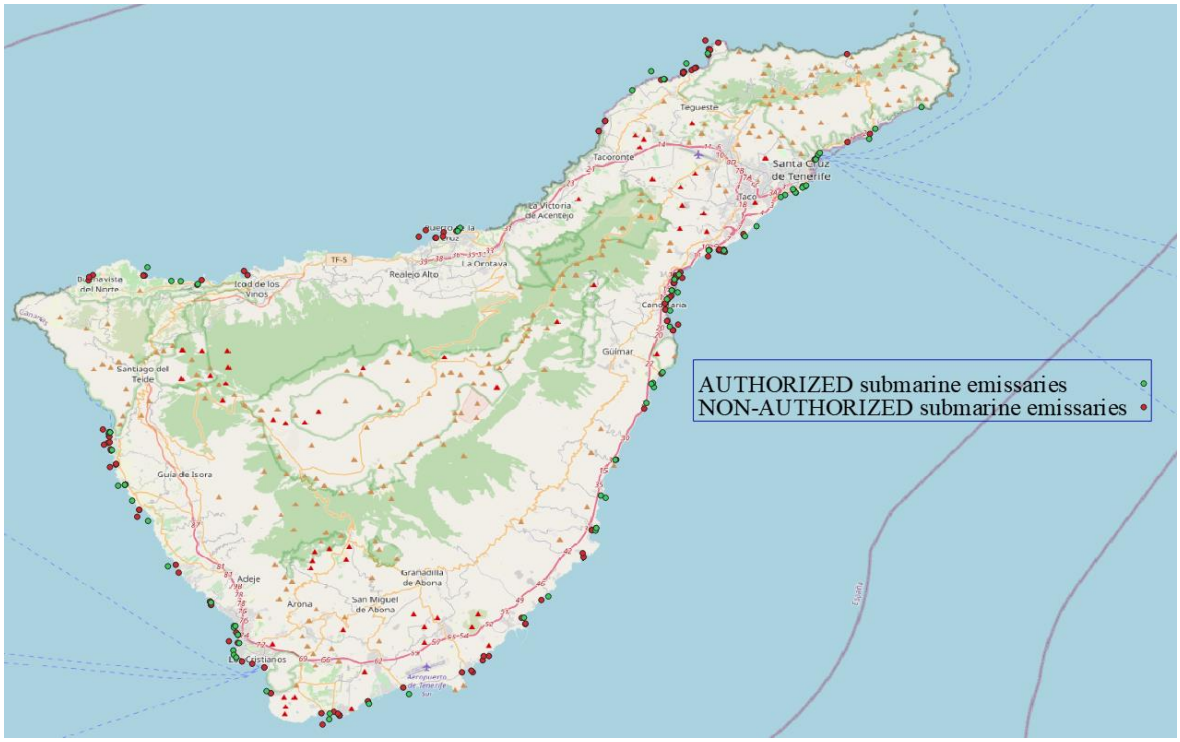


Figure 9. Authorized and non-authorized submarine emissaries in Tenerife Island

There is also, a non-authorized emissary in Abades area (Figure 10), right in the *Cymodocea nodosa's* patch (Figure 11):

Figure 10. Non-authorized emissary in Abades area

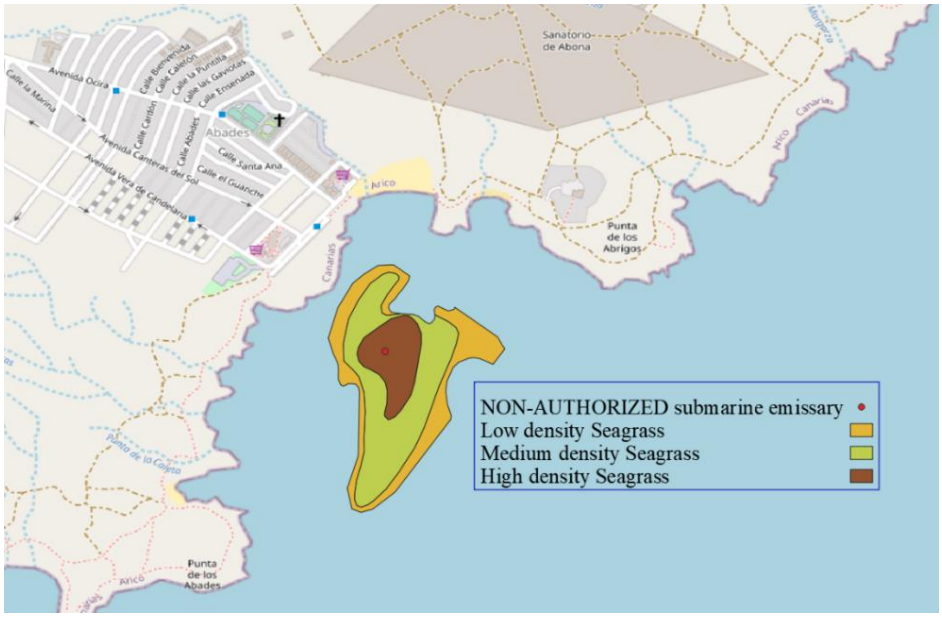


Figure 11. Picture from QGIS of the non-authorized emissary in the seagrass patch in Abades area

These discharges, in which most of the discharged water is not properly treated, introduce excess nutrients and organic matter into the marine environment. At the discharge points, the seagrass meadow disappears, and a clear gradient is observed as we move away from these points. When the meadows of *Cymodocea nodosa* are deteriorate, there is a colonization of the green algae *Caulerpa prolifera*, which is more resistant.

Figure 12. *Caulerpa prolifera* in *Cymodocea nodosas'* meadow

When the impacts are severe, *Caulerpa prolifera* also disappears, leaving the substrate devoid of vegetation.

3. STUDY AREA

Abades is located in the south-east part of the Tenerife Island (Figure 13). Is a protected bay from the N-E winds, that makes it suitable for diving most of the part of the year (Figure 14). In the shallow waters there is rocky bottom, while in the deeper waters is sandy.

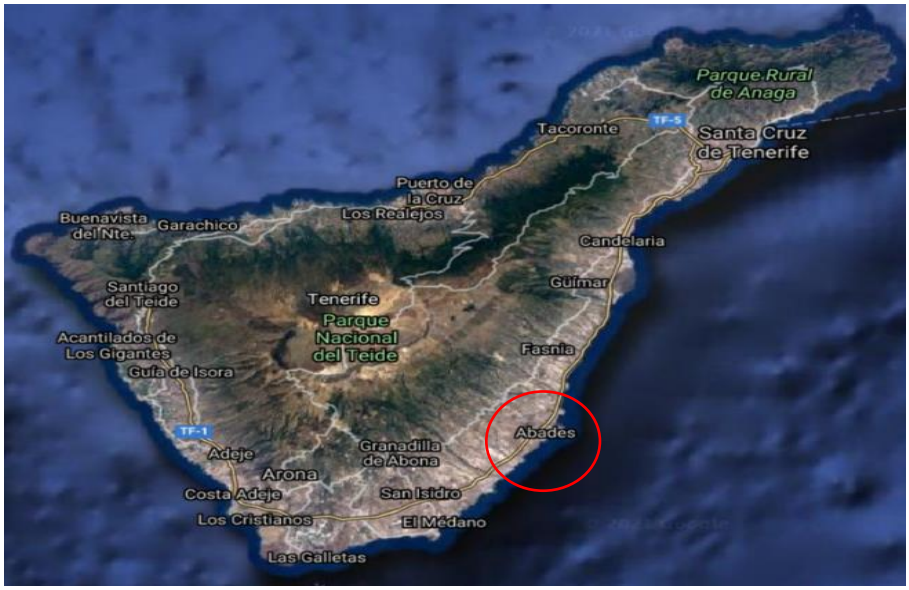


Figure 13. Abades in the S-E of the island.

Source: Google Earth

Figure 14. Bay of Abades

Source: Google Earth

Despite the presence of a *Cymodocea nodosa*'s meadow, which attracts great levels of biodiversity, Abades is not included in the SAC (Figure 15).

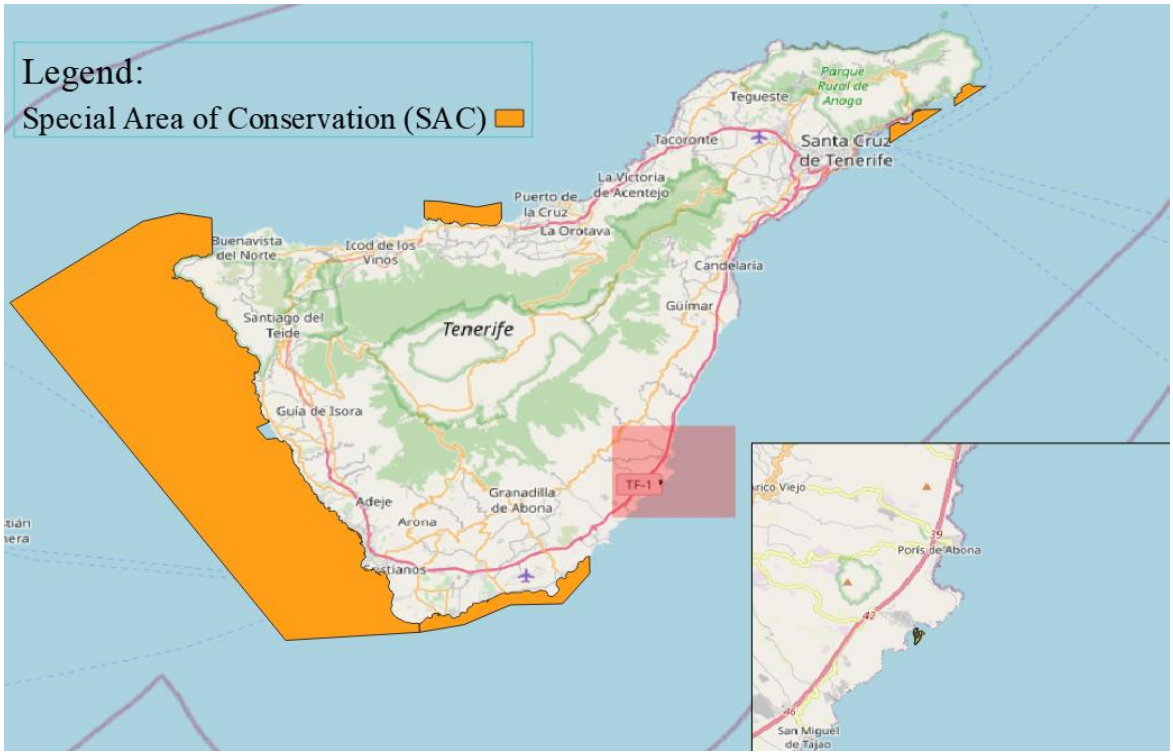


Figure 15. Special areas of Conservation in Tenerife Island

A **Special Area of Conservation** (**SAC**) is defined in the European Union's Habitats Directive (92/43/EEC), also known as the *Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora*. Their purpose is to protect habitats and species listed in annex I and II of the Habitat Directive which are considered to be of European interest. They are chosen from the Sites of Community Importance (SCI) by the member states.

5. OBJECTIVES OF THE STUDY

The objectives of the study are based and developed in order to provide scientific support for the development of adequate measures of protection of the marine area of Abades. To do this, the research is focused on the evaluation of some ecosystem services provided by *Cymodocea nodosa*. For fist the seagrass meadow was analyzed by studying the density and the extension. From here, the study is focused on biodiversity, both in terms of species richness and abundance, as the presence of this plant provides numerous services and benefits to marine organisms, such as, nursery area, foraging areas, reproduction area etc. A further objective was then, to evaluate in monetary terms the income thanks to this marine area considering, in the species associated with *Cymodocea nodosa*, those of commercial/fishing interest. Also, the tourist side was analyzed, in terms of diving activity.

The production of O_2 and the capture of CO_2 have been taken into account as the phanerogams are one of the most efficient organisms in this type of activity.

MATERIALS AND METHODS

All the analyses were conducted in the period of May - June 2021.

1. EXTENSION AND DENSITY OF SEAGRASS MEADOW

This was the first step in order to calculate ecosystem services. This because since we have conducted the study in a small part of the marine area of Abades, knowing the extension we were able to calculate the different ecosystem services for the whole seagrass patch.

1.1 Extension

To know the extension of the *Cymodocea nodosa* meadow was used the most recent cartography from REDMIC.

1.2 Density

Density is expressed as the number of bundles per unit area, and to evaluated it a non-destructive method has been conducted since it allows to obtain a greater number of replicas, it's easy to apply, and it don't cause environmental damage. It has been used a metric line to make the transect, a PVC quadrant of 25cmx25cm (which is equivalent to an area of 625 cm^2), a tape measure, and a white slate to take notes (Figure 16).

Figure 16. Measurement of density

The transects of 25m long were carried out at three different depths, 5m, 10m and 15m. Once placed, four 25cmx25cm quadrats were randomly collocated on the side of the metric line, at 5m, 10m, 15m and 20m along it, alternating left and right. From each quadrat was estimated (Figure 17):

- Percentage of coverage;
- Number of bundles;
- Number of leaves of five random bundles;
- Length of the longest leaf of each bundle previously random chosen.

Figure 17. Quadrant along the transect

1.2.1 Percentage of coverage

Percentage of cover is the percentage of the meadow that occupies substrate. This parameter was identified taking a picture of each quadrat and then outside of the water, comparing all the pictures to estimate the percentage of coverage.

1.2.2 Number of bundles

This parameter was established by counting every bundle in the entire area of the quadrat, taking notes on a white slate.

1.2.3 Number of leaves and measurement of length

The number of leaves and measurement of length are two parameters, that are not cited in the literature as elements used for the characterization of meadows. However, there are seasonal variations in the length of the leaves so, in the long term, these can be interesting biometric parameters and provide information on possible changes. (Delgado et al. 1993) use the length of the leaves as a parameter to track an impact on seagrass beds in Menorca (Balearic Islands). According to these authors, the degradation process begins with a progressive shortening of the leaves, both in *Cymodocea nodosa* as in *Posidonia oceanica*.

The number of leaves was calculated by counting the leaves of five different random bundles in the entire area of the quadrat.

The measurement of length was conducted by measuring with a tape measure, the length of the longest leaf in each random bundle which was previously choose for counting the leaves.

2. BIODIVERSITY

For the study of this ecosystem service, two parameters were analyzed:

- Species richness;
- Species abundance.

2.1 Species richness

For the species richness was done a bibliography research and consequently a list, of species associated to *Cymodocea nodosa* seagrass using Red Promar. From this list, further information was obtained:

- Species of fishing interest;
- Species that feed on the seagrass;
- Species that use the seagrass as habitat;
- Species that use the seagrass as a nursery area.

2.2 Species abundance

For species abundance was conducted a transect survey using a 50m metric line and a white slate to take notes of every organism that was encountered. This kind of study was done once a week, for 7 weeks. The transect was fixed at coordinates 28°08'23. 1"N, 16°26'24.3"W (Figure 18).

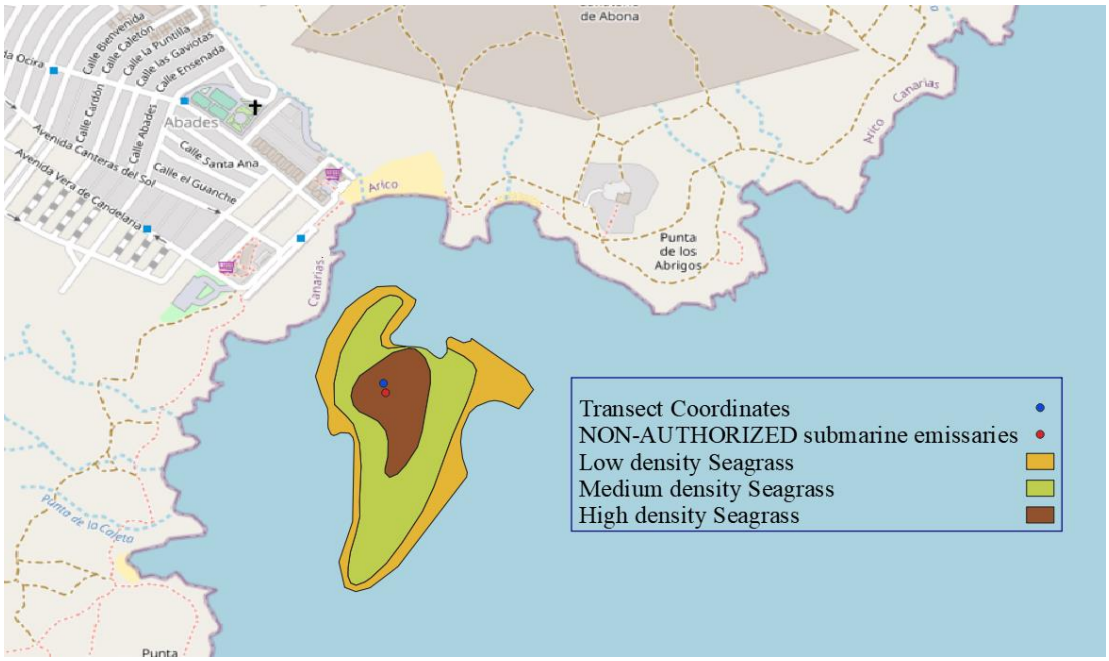


Figure 18. Transect coordinates

For each metric line of 50m were obtained two transepts of 20m since 5m gap was in the middle (20-25m) and in the end (45-50m).

In every dive the data were collected by two divers, taking notes, on the way of the transects, of every vertebrate organism, and on the way back, of every invertebrate organism. In this way, at the end have been conducted 24 transects for vertebrates, and 22 for invertebrates, for a total of 46 transects. At the end of the survey the area was explored, and any endangered species encountered outside of transect was noted down and reported to Red Promar.

When at fieldwork, a logbook was created with:

- Date
- People monitoring
- Weather
- Depth of transept
- Ocean conditions (visibility, surface, current)
- Water Temperature
- Air temperature
- Time in diving
- Time out diving
- Number of people fishing in the area during the time at Abades
- Number of divers in the area during the time at Abades

At the end, Simpson Diversity Index has been applied:

$$D = 1 - (\sum n(n-1)/N(N-1))$$

3. TOURISM PROMOTER

Abades is an area where diving activities are very frequent. For this reason, to evaluate how much money diving centers can earn from this area, a questionnaire was submitted, with the following questions:

1. Do you bring divers to Abades?
2. How much cost a dive in Abades?
3. Of this money, how much do you save? (Leaving the money spent on petrol to get to the site, salary, ecc.)
4. How many days a week do you visit the site?
5. How many divers do you bring there on average? (In a week)

Also, during fieldwork days, have been taken into account, how many people were diving in that area.

4. FISHING SOURCE

To evaluate how much money can be earn from fishing activity in that area, for first during fieldwork days in Abades, have been considered how many people were fishing. Meanwhile a list of species of fishing interest associated in the seagrass in the Canary Islands was create. To know the price/kg of every species, the data were provided by visiting fish market/supermarket.

5. CO_2 CAPTURE AND O_2 PRODUCTION

This ecosystem service was evaluated through a bibliography research in order to find the values of primary production for *Cymodocea nodosa* and multiply them for the extension of the seagrass patch in Abades.

RESULTS

1. EXTENSION AND DENSITY

1.1 Extension

REDMIC cartography updated to 09/10/2018 report an area of seagrass patch of 83.437 m^2 (0,083437 km^2) with a perimeter of 1.708 m (1,708 km) (Figure 19).

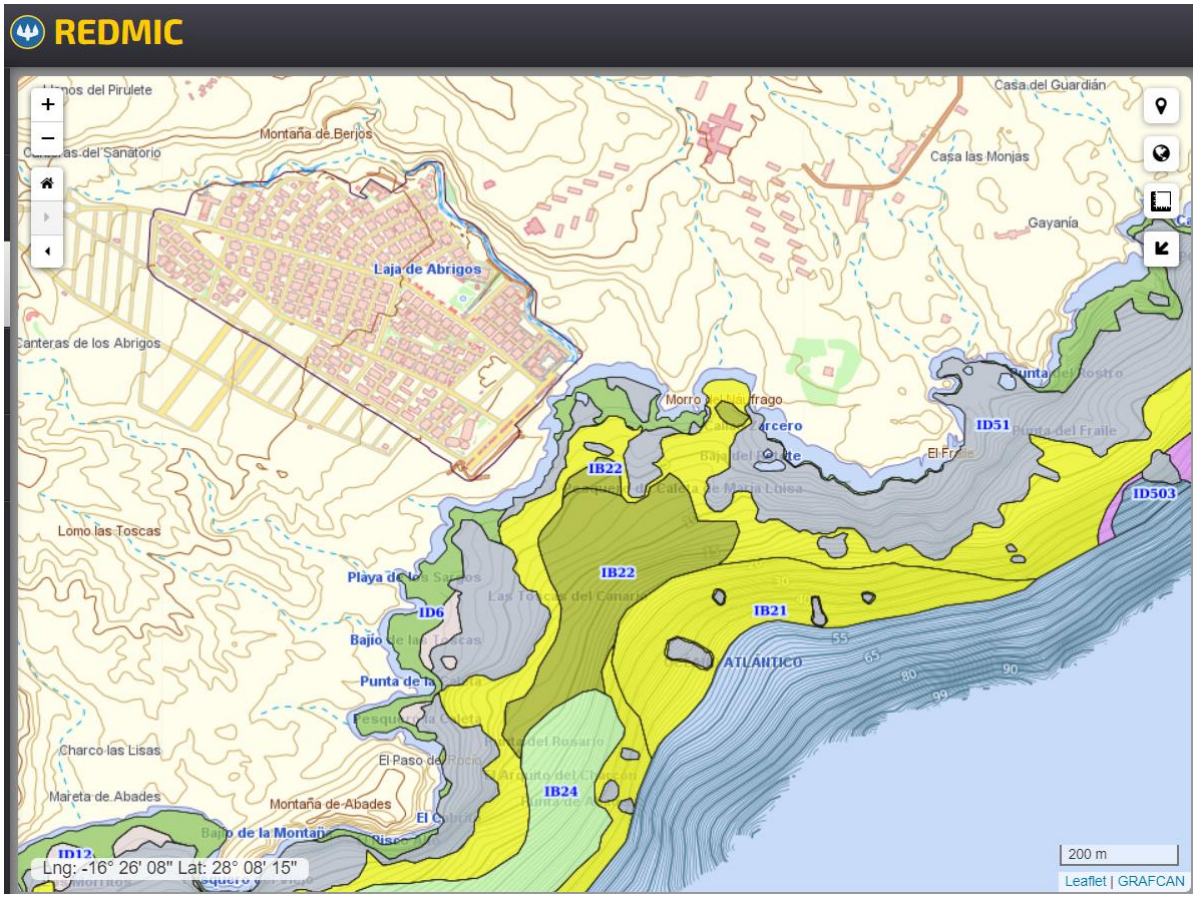


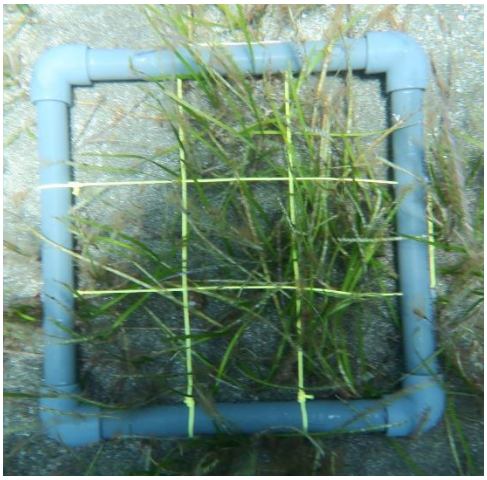
Figure 19. Abades cartography

Source: REDMIC

1.2 Density

Here are provided pictures took on field, of each quadrat at different depths.

Depth 5m →



Depth: 5m

Distance along the transect: 5m

Depth: 5m

Distance along the transect: 10m

Depth: 5m

Distance along the transect: 15m

Depth: 5m

Distance along the transect: 20m

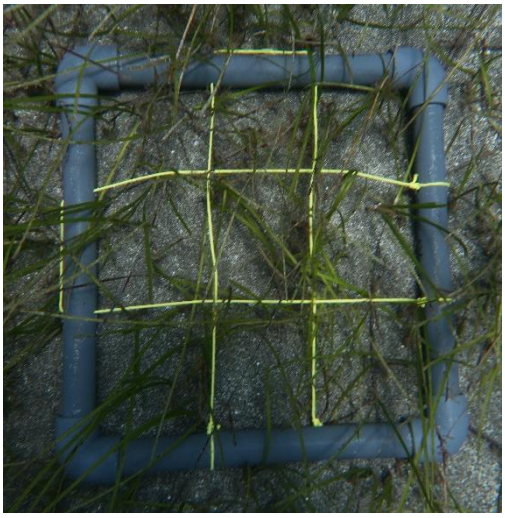
Depth 10m →

Depth: 10m

Distance along the transect: 5m

Depth: 10m

Distance along the transect: 10m



Depth: 10m

Distance along the transect: 15m

Depth: 10m

Distance along the transect: 20m

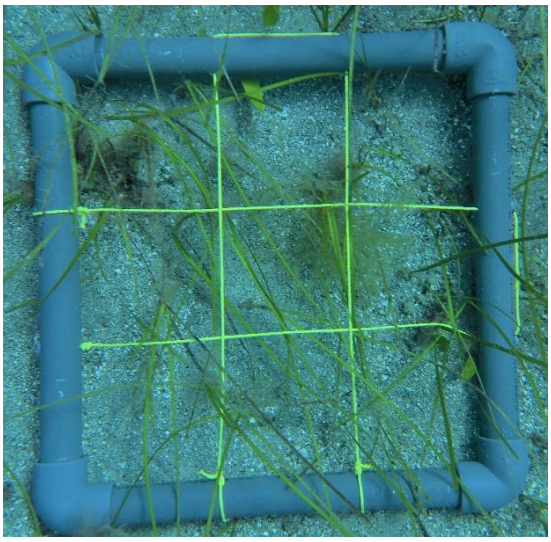
Depth 15m →

Depth: 10m

Distance along the transect: 5m

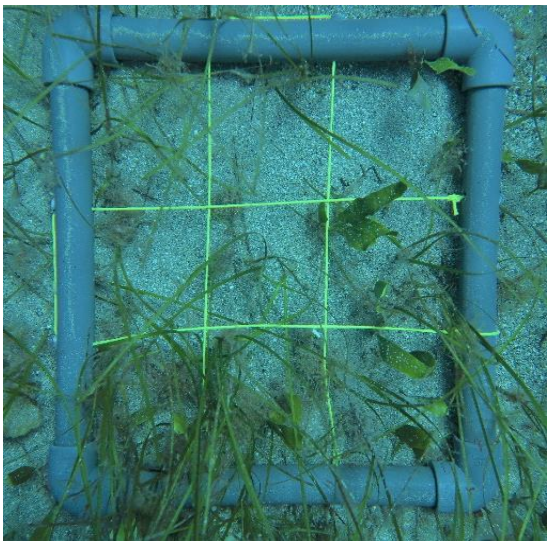
Depth: 15m

Distance along the transect: 10m



Depth: 15m

Distance along the transect: 15m



Depth: 15m

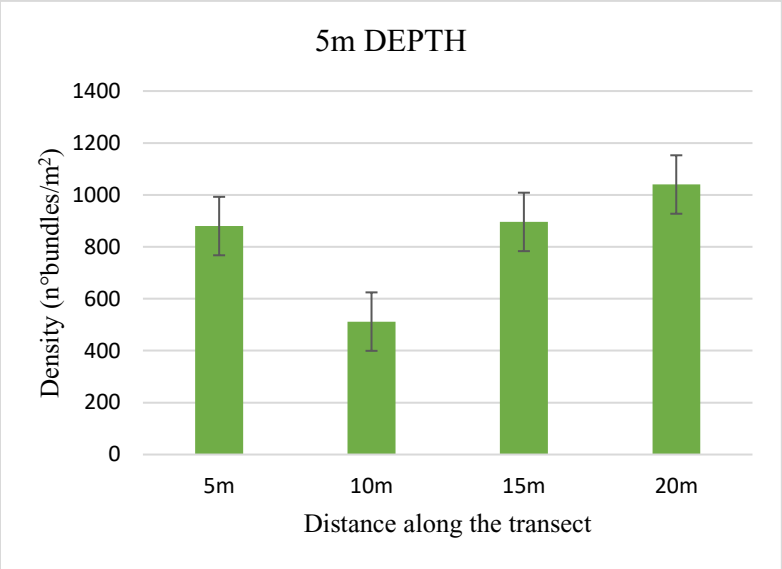
Distance along the transect: 20m

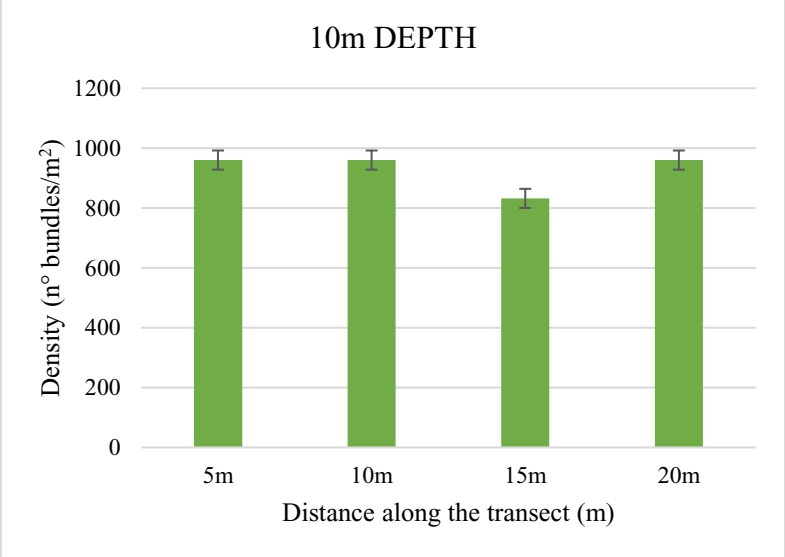
Density, varied between sampling points. The minimum density average value has been recorded at 15m depth, which obtained an average of 464 n°bundles/m^2. The maximum density value was obtained at 10m depth with 928 n° bundles/ m^2.

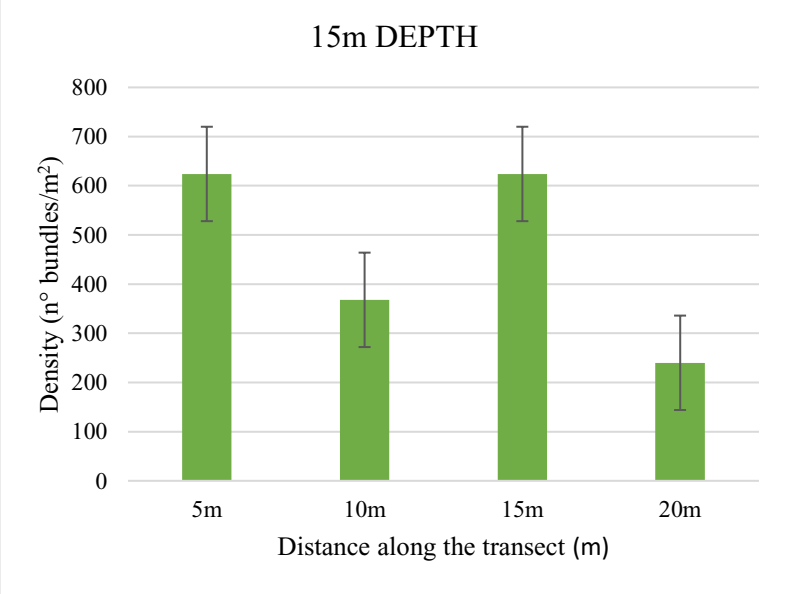
	DISTANCE ALONG THE TRANSECT	N° OF BUNDLES	AREA OF THE QUADRAT IN M^2	DENSITY	AVERAGE
DEPTH = 5m	5m	55	0,0625	880	832
	10m	32		512	
	15m	56		896	
	20m	65		1040	

	DISTANCE ALONG THE TRANSECT	N° OF BUNDLES	AREA OF THE QUADRAT IN M^2	DENSITY	AVERAGE
DEPTH = 10m	5m	60	0,0625	960	928
	10m	60		960	
	15m	52		832	
	20m	60		960	

	DISTANCE ALONG THE TRANSECT	N° OF BUNDLES	AREA OF THE QUADRAT IN M^2	DENSITY	AVERAGE
DEPTH = 15m	5m	39	0,0625	624	464
	10m	23		368	
	15m	39		624	
	20m	15		240	


5m DEPTH
1400
1200
1000
800
600
400
200
0
Density (n°bundles/m²)
5m
10m
15m
20m
Distance along the transect


10m DEPTH
1200
1000
800
600
400
200
0
Density (n° bundles/m²)
5m
10m
15m
20m
Distance along the transect (m)


15m DEPTH
800
700
600
500
400
300
200
100
0
Density (n° bundles/m²)
5m
10m
15m
20m
Distance along the transect (m)

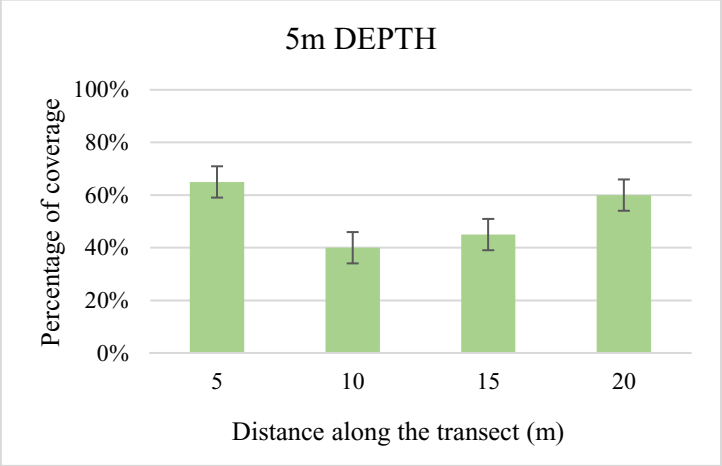
1.2.1 Percentage of coverage

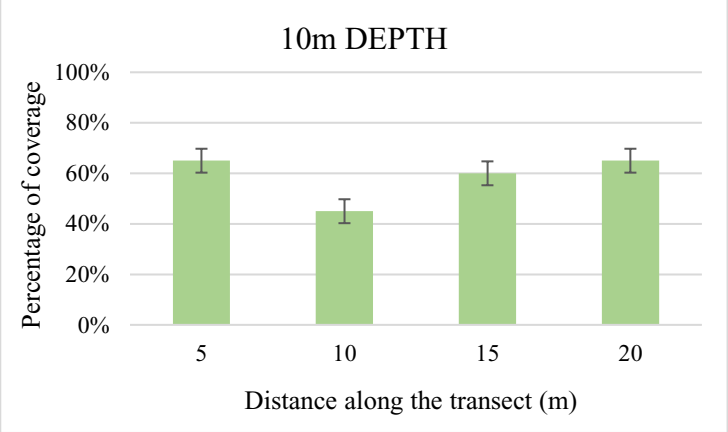
In general, the coverage values were characterized by being average in most of the sampled points, recording the maximum at 10m depth which achieved 59% coverage on average, followed by the station at 5m depth. At 15m, however, a decrease in coverage has been noted, characterized by an average of 25%.

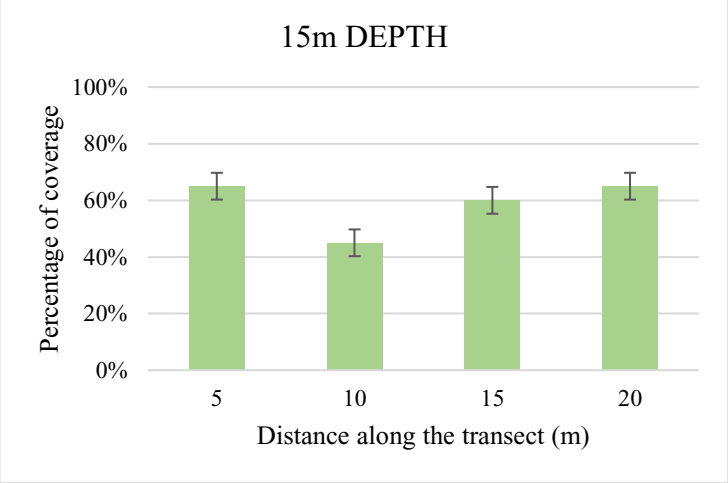
	DISTANCE ALONG THE TRANSECT	COVERAGE	AVERAGE
DEPTH = 5m	5m	65%	53%
	10m	40%	
	15m	45%	
	20m	60%	

	DISTANCE ALONG THE TRANSECT	COVERAGE	AVERAGE
DEPTH = 10m	5m	65%	59%
	10m	45%	
	15m	60%	
	20m	65%	

	DISTANCE ALONG THE TRANSECT	COVERAGE	AVERAGE
DEPTH = 15m	5m	35%	25%
	10m	20%	
	15m	20%	
	20m	25%	


5m DEPTH
Percentage of coverage
100%
80%
60%
40%
20%
0%
5
10
15
20
Distance along the transect (m)


10m DEPTH
Percentage of coverage
100%
80%
60%
40%
20%
0%
5
10
15
20
Distance along the transect (m)


15m DEPTH
Percentage of coverage
100%
80%
60%
40%
20%
0%
5
10
15
20
Distance along the transect (m)

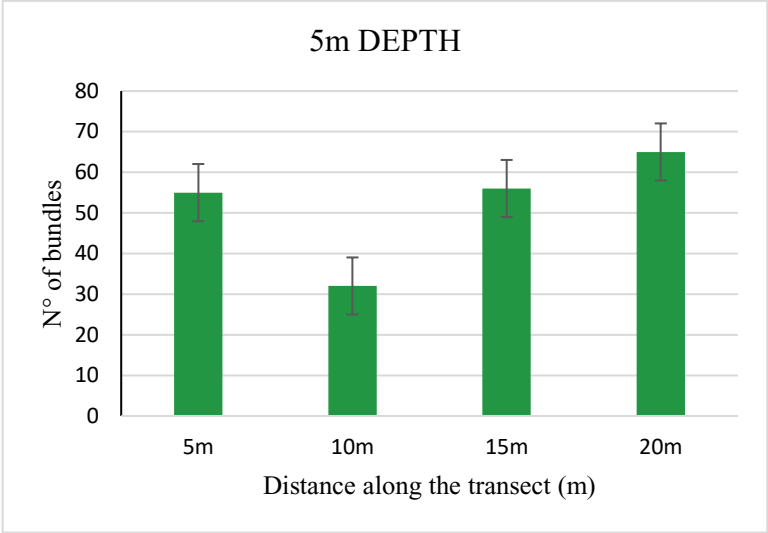
1.2.2. Number of bundles

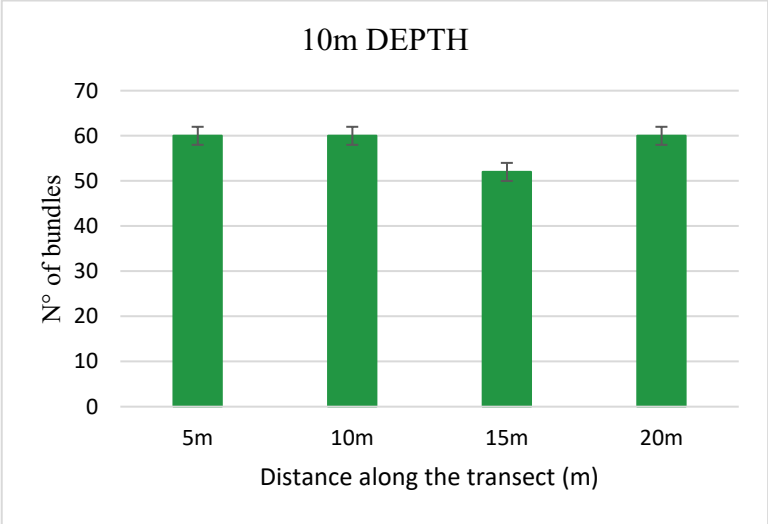
The number of bundles is characterized by a large decrease with depth since in the shallow water has been noticed more than 50 bundles per quadrat, rather than in deep water, 15m, where have been registered 29 bundles per quadrat in average.

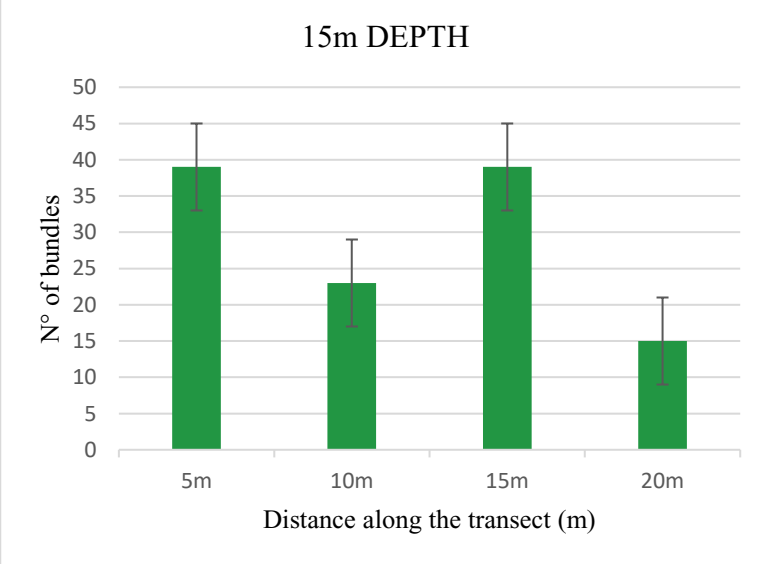
1° TRANSECT (25m)	DEPTH = 5m	DISTANCE ALONG THE TRANSECT	N° OF BUNDLES	AVERAGE
		5m	55	52
		10m	32	
		15m	56	
		20m	65	

2° TRANSECT (25m)	DEPTH = 10m	DISTANCE ALONG THE TRANSECT	N° OF BUNDLES	AVERAGE
		5m	60	58
		10m	60	
		15m	52	
		20m	60	

3° TRANSECT (25m)	DEPTH = 15m	DISTANCE ALONG THE TRANSECT	N° OF BUNDLES	AVERAGE
		5m	39	29
		10m	23	
		15m	39	
		20m	15	


5m DEPTH
N° of bundles
80
70
60
50
40
30
20
10
0
5m
10m
15m
20m
Distance along the transect (m)


10m DEPTH
N° of bundles
70
60
50
40
30
20
10
0
5m
10m
15m
20m
Distance along the transect (m)


15m DEPTH
N° of bundles
50
45
40
35
30
25
20
15
10
5
0
5m
10m
15m
20m
Distance along the transect (m)

1.2.3. Number of leaves and length

First, are provided the results for the number of leaves.

	DISTANCE ALONG THE TRANSECT	N°LEAFES IN 5 RANDOM BUNDLES					AVERAGE
DEPTH = 5m	5m	3	3	3	3	3	3
	10m	5	3	4	4	4	4
	15m	3	4	3	2	3	3
	20m	2	4	3	2	4	3

	DISTANCE ALONG THE TRANSECT	N°LEAFES IN 5 RANDOM BUNDLES					AVERAGE
DEPTH = 10m	5m	3	3	2	3	3	2,8
	10m	3	2	4	3	3	3
	15m	3	3	2	4	2	2,8
	20m	3	2	3	4	4	3,2

	DISTANCE ALONG THE TRANSECT	N°LEAFES IN 5 RANDOM BUNDLES					AVERAGE
DEPTH = 15m	5m	3	3	2	3	3	2,8
	10m	2	3	3	2	2	2,7
	15m	3	3	3	3	3	3
	20m	3	3	2	3	3	3

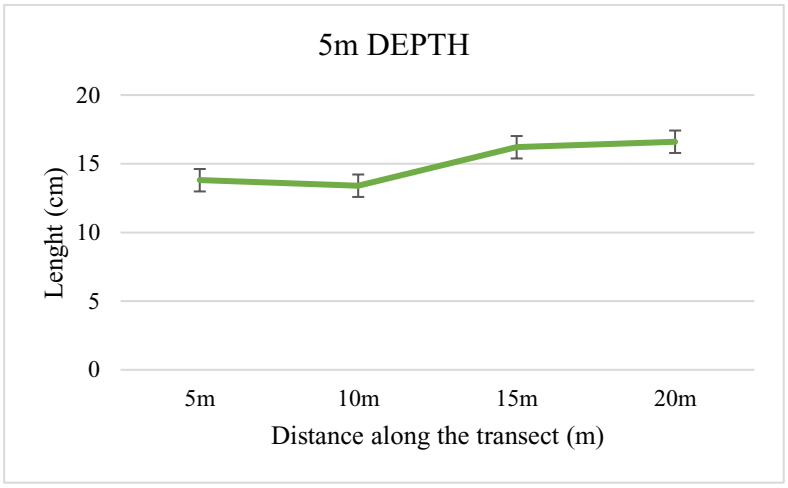
We can see that in average the number of leaves/bundle is 3, with a maximum of 4 leaves/bundle.

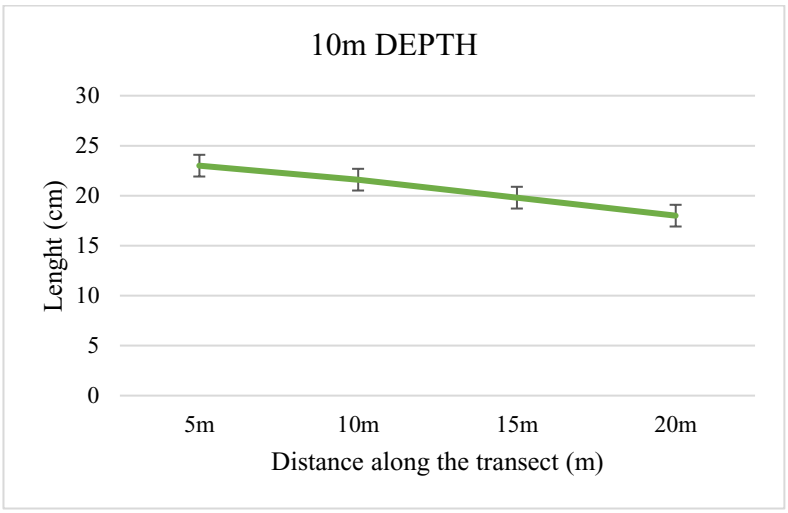
The length of leaves, instead, showed high variability between different depths. Its range is from a minimum of 10 cm (depth 5m) to a maximum of 41 cm (depth 15m).

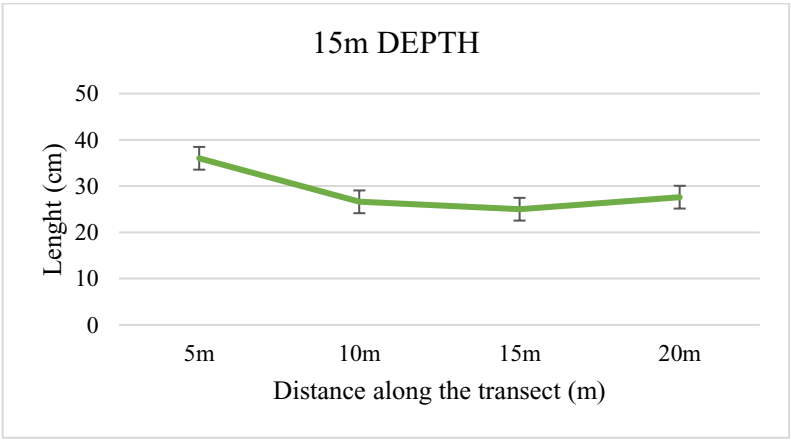
	DISTANCE ALONG THE TRANSECT	LENGHT LONGEST LEAFE (cm)					AVERAGE (cm)	TOTAL AVERAGE (cm)
DEPTH = 5m	5m	17	11	13	14	14	13,8	15
	10m	10	10	14	18	15	13,4	
	15m	16	24	14	16	11	16,2	
	20m	18	13	16	21	15	16,6	

	DISTANCE ALONG THE TRANSECT	LENGHT LONGEST LEAFE (cm)					AVERAGE (cm)	TOTAL AVERAGE (cm)
DEPTH = 10m	5m	24	31	19	21	20	23	20,6
	10m	13	16	25	16	38	21,6	
	15m	23	18	22	19	17	19,8	
	20m	20	18	19	23	10	18	

	DISTANCE ALONG THE TRANSECT	LENGHT LONGEST LEAFE (cm)					AVERAGE (cm)	TOTAL AVERAGE (cm)
DEPTH = 15m	5m	37	33	34	35	41	36	28,8
	10m	22	28	25	32	26	26,6	
	15m	23	25	23	23	31	25	
	20m	26	30	25	29	28	27,6	


5m DEPTH
20
15
10
5
0
Lenght (cm)
5m
10m
15m
20m
Distance along the transect (m)


10m DEPTH
30
25
20
15
10
5
0
Lenght (cm)
5m
10m
15m
20m
Distance along the transect (m)


15m DEPTH
50
40
30
20
10
0
Lenght (cm)
5m
10m
15m
20m
Distance along the transect (m)

2. BIODIVERSITY

2.1. Species richness

A list (tables) of species associated to *Cymodocea nodosa* is provided.

GROUP		SPECIES	CANARIAN COMMON NAME	ENGLISH COMMON NAME	FREQUENCY
Flora		*Cymodocea nodosa*	Seba	Slender seagrass	Frequent
Algae		*Caulerpa prolifera*	Caulerpa	Caulerpa	Frequent
Fauna	Testudines	*Chelonia mydas*	Tortuga verde	Green turtle	Rare
Fauna	Testudines	*Caretta caretta*	Tortuga boba	Loggerhead sea turtle	Occasional
Fauna	Testudines	*Eretmochelys imbricata*	Tortuga carey	Hawksbill turtle	Rare
Fauna	Chondrichthyes	*Myliobatis aquila*	Ratòn	Common eagle ray	Occasional
Fauna	Chondrichthyes	*Aetomylaeus bovinus*	Obispo	Bull ray	Occasional
Fauna	Chondrichthyes	*Dasyatis pastinaca*	Chucho amarillo	Common stingray	Occasional
Fauna	Chondrichthyes	*Bathytoshia centroura*	Chucho de clavos	Roughtail stingray	Occasional
Fauna	Chondrichthyes	*Taeniurops grabata*	Chucho negro	Round fantail stingray	Occasional
Fauna	Chondrichthyes	*Torpedo marmorata*	Torpedo	Spotted torpedo	Occasional
Fauna	Chondrichthyes	*Squatina squatina*	Angelote	Angelshark	Frequent
Fauna	Chondrichthyes	*Mustelus mustelus*	Cazòn	Smooth-hound shark	Frequent
Fauna	Chondrichthyes	*Atherina presbyter*	Guelde blanco	Sand smelt	Frequent
Fauna	Osteichthyes	*Sphyraena viridensis*	Bicuda	Yellowmouth barracuda	Frequent
Fauna	Osteichthyes	*Hippocampus hippocampus*	Caballito de mar	Short-snouted seahorse	Occasional
Fauna	Osteichthyes	*Trachurus picturatus*	Chicharro	Atlantic horse mackerel	Frequent
Fauna	Osteichthyes	*Sardinella aurita*	Alacha	Round sardinella	Frequent
Fauna	Osteichthyes	*Sardina pilchardus*	Sardina	European pilchard	Frequent
Fauna	Osteichthyes	*Pseudocaranx dentex*	Jurel	White trevally	Frequent
Fauna	Osteichthyes	*Dicentrarchus labrax*	Lubina	European seabass	Frequent
Fauna	Osteichthyes	*Chelon labrosus*	Lebrancho	Golden grey mullet	Frequent
Fauna	Osteichthyes	*Chelon auratus*	Lisa	Golden grey mullet	Frequent
Fauna	Osteichthyes	*Pagrus auriga*	Sama roquera	Redbanded seabream	Frequent
Fauna	Osteichthyes	*Pagrus pagrus*	Bocinegro	Common seabream	Frequent
Fauna	Osteichthyes	*Dentex dentex*	Sama dorada / Denton	Common dentex	Rare
Fauna	Osteichthyes	*Pagellus acarne*	Besugo	Axillary seabream	Frequent
Fauna	Osteichthyes	*Pagellus erythrinus*	Breca	Common pandora	Frequent

GROUP		SPECIES	CANARIAN COMMON NAME	ENGLISH COMMON NAME	FREQUENCY
Fauna	Osteichthyes	*Diplodus vulgaris*	Seifia	Common two-banded seabream	Frequent
Fauna	Osteichthyes	*Oblada melanura*	Galana	Saddled seabream	Frequent
Fauna	Osteichthyes	*Diplodus annularis*	Mojarra	Annular seabream	Frequent
Fauna	Osteichthyes	*Serranus atricauda*	Cabrilla negra	Blacktail comber	Frequent
Fauna	Osteichthyes	*Opeatogenys cadenati*	Chupasangre de seba	///	Frequent
Fauna	Osteichthyes	*Diplodus puntazzo*	Sargo picudo	Sharpsnout seabream	Frequent
Fauna	Osteichthyes	*Diplodus cadenati*	Sargo	Moroccan white seabream	Abundant
Fauna	Osteichthyes	*Lithognathus mormyrus*	Herrera	Striped seabream	Frequent
Fauna	Osteichthyes	*Sarpa salpa*	Salema	Saupe	Frequent
Fauna	Osteichthyes	*Pomadasys incisus*	Roncador	Bastard grunt	Frequent
Fauna	Osteichthyes	*Boops boops*	Boga	Bogue	Abundant
Fauna	Osteichthyes	*Spondyliosoma cantharus*	Chopa	Black seabream	Frequent
Fauna	Osteichthyes	*Synodus synodus*	Lagarto capitan	Diamond lizardfish	Occasional
Fauna	Osteichthyes	*Synodus saurus*	Lagarto	Atlantic lizardfish	Frequent
Fauna	Osteichthyes	*Trachinus draco*	Arana	Greater weever	Frequent
Fauna	Osteichthyes	*Trachinus radiatus*	Arana de hondura	Starry weever	Occasional
Fauna	Osteichthyes	*Uranoscopus scaber*	Pez rata	Atlantic stargazer	Occasional
Fauna	Osteichthyes	*Scorpaena porcus*	Rascacio negro	Black scorpionfish	Occasional
Fauna	Osteichthyes	*Serranus cabrilla*	Cabrilla rubia	Comber	Occasional
Fauna	Osteichthyes	*Serranus scriba*	Vaquita	Painted comber	Occasional
Fauna	Osteichthyes	*Symphodus trutta*	Romero	Wrasse	Frequent
Fauna	Osteichthyes	*Symphodus mediterraneus*	Romero	Axillary wrasse	Occasional
Fauna	Osteichthyes	*Coris julis*	Doncella	Mediterranean rainbow wrasse	Frequent
Fauna	Osteichthyes	*Thalassoma pavo*	Pejeverde	Ornate wrasse	Abundant
Fauna	Osteichthyes	*Sparisoma cretense*	Vieja	Parrotfish	Abundant
Fauna	Osteichthyes	*Xyrichtys novacula*	Pejepeine	Pearly razorfish	Abundant
Fauna	Osteichthyes	*Mullus surmuletus*	Salmonete	Striped red Mollet	Frequent
Winte	Osteichthyes	*Chelidonichthys lastoviza*	Rubio	Streaked gurnard	Occasional

GROUP		SPECIES	CANARIAN COMMON NAME	ENGLISH COMMON NAME	FREQUENCY
Fauna	Osteichthyes	*Stephanolepis hispidus*	Gallito verde	Planehead filefish	Frequent
Fauna	Osteichthyes	*Abudefduf luridus*	Fula negra	Canary damselfish	Abundant
Fauna	Osteichthyes	*Canthigaster capistrata*	Gallinita	Macaronesian sharpnose-puffer	Frequent
Fauna	Osteichthyes	*Sphoeroides marmoratus*	Tamboril	Guinean puffer	Frequent
Fauna	Osteichthyes	*Gobius niger*	Chaparrudo	Black goby	Frequent
Fauna	Osteichthyes	*Microchirus azevia*	Lenguado negro	Bastard sole	Abundant
Fauna	Osteichthyes	*Bothus podas*	Tapaculo	Wide-eyed flounder	Frequent
Fauna	Osteichthyes	*Myrichthys pardalis*	Carmelita	Leopard eel	Occasional
Fauna	Osteichthyes	*Macroramphosus scolopax*	Trompetero	Longspine Snipefish	Frequent
Fauna	Osteichthyes	*Syngnathus typhle*	Pejepipa	Broad-nosed pipefish	Frequent
Fauna	Echinoderms	*Sphaerechinus granularis*	Erizo de puas romas	Violet sea urchin	Occasional
Fauna	Molluscs	*Callistoctopus macropus*	Fabiana	White spotted octopus	Occasional
Fauna	Molluscs	*Sepia officinalis*	Choco	Common cuttlefish	Frequent
Fauna	Molluscs	*Limaria hians*	Lima	File shell	Occasional
Fauna	Molluscs	*Aplysia fasciata*	Vaca de mar	Black sea hare	Occasional
Fauna	Molluscs	*Aplysia dactylomena*	Vaca de mar	Annulated sea hare	Frequent
Fauna	Crustaceans	*Maja brachydactyla*	Centollo	Great spider crab	Occasional
Fauna	Crustaceans	*Portunus hastatus*	Cangrejo cornudo	Lancer swimming crab	Occasional
Fauna	Crustaceans	*Cronius ruber*	Cangrejo remador	Blackpoint sculling crab	Occasional
Fauna	Crustaceans	*Stenorhynchus seticornis*	Cangrejo flecha de línea amarilla	Yellowline arrow crab	Occasional
Fauna	Crustaceans	*Cryptosoma cristatum*	Cangrejo de arena	Lesser-spoted hame-faced crub	Occasional
Fauna	Polychaetes	*Diopatra neapolitana*	Gusano de tubo	Periscope tube worm	Frequent
Fauna	Polychaetes	*Myxicola infundibulum*	Gusano de funda	Mud tube-worm	Occasional
Fauna	Polychaetes	*Bispira viola*	Gusano empenachado	Peacock worm	Occasional
Fauna	Polychaetes	*Eurythoe complanata*	Gusano de fuego	Orange fireworm	Frequent
Fauna	Polychaetes	*Hermodice carunculata*	Gusano de fuego	Bearded fireworm	Frequent
Fauna	Cnidarian	*Aglaophenia pluma*	Pluma de mar	Sea ferns	Frequent
Fauna	Cnidarian	*Macrorhynchia philippina*	Hidroideo urticante	Stinging hydroid	Occasional

SPECIES	SEASONALITY	IUCN CATEGORY	NATIONAL CATEGORY	CANARIAN ISLAND CATEGORY
Cymodocea nodosa	All year	Least concern	Vulnerable	Interest for the canarian ecosystem
Caulerpa prolifera	All year	///	///	///
Chelonia mydas	All year	Endangered	Special protection	Special interest
Caretta caretta	All year	Vulnerable	Vulnerable	Special interest
Eretmochelys imbricata	All year	Critically endangered	Special protection	Special interest
Myliobatis aquila	All year	Critically endangered	Not contemplated	Not contemplated
Aetomylaeus bovinus	All year	Critically endangered	Not contemplated	Not contemplated
Dasyatis pastinaca	All year	Data deficient	Not contemplated	Not contemplated
Bathytoshia centroura	All year	Vulnerable	Not contemplated	Not contemplated
Taeniurops grabata	All year	Data deficient	Not contemplated	Not contemplated
Torpedo marmorata	All year	Data deficient	Not contemplated	Not contemplated
Squatina squatina	Winter to Spring	Critically endangered	Critically endangered	Not contemplated
Mustelus mustelus	Summer to Winter	Vulnerable	Not contemplated	Not contemplated
Atherina presbyter	All year	Least concern	///	///
Sphyraena viridensis	All year	Least concern	///	///
Hippocampus hippocampus	All year	Data deficient	///	///
Trachurus picturatus	All year	Data deficient	///	///
Sardinella aurita	All year	Least concern	///	///
Sardina pilchardus	All year	Least concern	///	///
Pseudocaranx dentex	All year	Least concern	///	///
Dicentrarchus labrax	All year	Least concern	///	///
Chelon labrosus	All year	Least concern	///	///
Chelon auratus	All year	Least concern	///	///
Pagrus auriga	All year	Least concern	///	///
Pagrus pagrus	All year	Least concern	///	///
Dentex dentex	All year	Vulnerable	///	///

SPECIES	SEASONALITY	IUCN CATEGORY	NATIONAL CATEGORY	CANARIAN ISLAND CATEGORY
Pagellus acarne	All year	Least concern	///	///
Pagellus erythrinus	All year	Least concern	///	///
Diplodus vulgaris	All year	Least concern	///	///
Oblada melanura	All year	Least concern	///	///
Diplodus annularis	All year	Least concern	///	///
Serranus atricauda	All year	Data deficient	///	///
Opeatogenys cadenati	///	Data deficient	///	///
Diplodus puntazzo	All year	Least concern	///	///
Diplodus cadenati	All year	Data deficient	///	///
Lithognathus mormyrus	All year	Least concern	///	///
Sarpa salpa	All year	Least concern	///	///
Pomadasys incisus	All year	Least concern	///	///
Boops boops	All year	Least concern	///	///
Spondyliosoma cantharus	All year	Least concern	///	///
Synodus synodus	All year	Least concern	///	///
Synodus saurus	All year	Least concern	///	///
Trachinus draco	All year	Least concern	///	///
Trachinus radiatus	All year	Least concern	///	///
Uranoscopus scaber	All year	Least concern	///	///
Scorpaena porcus	All year	Least concern	///	///
Serranus cabrilla	All year	Least concern	///	///
Serranus scriba	All year	Least concern	///	///
Symphodus trutta	All year	Least concern	///	///
Symphodus mediterraneus	All year	Least concern	///	///
Coris julis	All year	Least concern	///	///
Thalassoma pavo	All year	Least concern	///	///
Sparisoma cretense	All year	Least concern	///	///
Xyrichtys novacula	All year	Least concern	///	///

SPECIES	SEASONALITY	IUCN CATEGORY	NATIONAL CATEGORY	CANARIAN ISLAND CATEGORY
Mullus surmuletus	All year	Least concern	///	///
Chelidonichthys lastoviza	Winter to Spring	Least concern	///	///
Stephanolepis hispidus	All year	Least concern	///	///
Abudefduf luridus	All year	Least concern	///	///
Canthigaster capistrata	All year	Least concern	///	///
Sphoeroides marmoratus	All year	Least concern	///	///
Gobius niger	All year	Least concern	///	///
Microchirus azevia	All year	Data deficient	///	///
Bothus podas	All year	Least concern	///	///
Myrichthys pardalis	All year	Least concern	///	///
Macroramphosus scolopax	All year	Least concern	///	///
Syngnathus typhle	All year	Least concern	///	///
Sphaerechinus granularis	All year	Data deficient	///	///
Callistoctopus macropus	All year	Least concern	///	///
Sepia officinalis	All year	Least concern	///	///
Limaria hians	All year	Data deficient	///	///
Aplysia fasciata	All year	Data deficient	///	///
Aplysia dactylomena	All year	Data deficient	///	///
Maja brachydactyla	All year	Data deficient	///	///
Portunus hastatus	All year	Data deficient	///	///
Cronius ruber	All year	Data deficient	///	///
Stenorhynchus seticornis	All year	Data deficient	///	///
Cryptosoma cristatum	All year	Data deficient	///	///
Diopatra neapolitana	All year	Data deficient	///	///
Myxicola infundibulum	All year	Data deficient	///	///
Bispira viola	All year	Data deficient	///	///
Eurythoe complanata	All year	Data deficient	///	///
Hermodice carunculata	All year	Data deficient	///	///
Aglaophenia pluma	All year	Data deficient	///	///
Macrorhynchia philippina	All year	Data deficient	///	///

SPECIES	BERNA	BONN	CITES	D. HABITATS	REASON OF PRESENCE	FISHING INTEREST
Cymodocea nodosa	-	-	-	-	///	///
Caulerpa prolifera	-	-	-	-	///	///
Chelonia mydas	II	I	I	IV	Feeding	///
Caretta caretta	II	I	I	II, IV	Feeding	///
Eretmochelys imbricata	II	I	I	IV	Feeding	///
Myliobatis aquila	-	-	-	-	///	///
Aetomylaeus bovinus	-	-	-	-	///	///
Dasyatis pastinaca	-	-	-	-	///	///
Bathytoshia centroura	-	-	-	-	///	///
Taeniurops grabata	-	-	-	-	///	///
Torpedo marmorata	-	-	-	-	///	///
Squatina squatina	-	I, II	-	-	///	///
Mustelus mustelus	-	-	-	-	///	///
Atherina presbyter	-	-	-	-	Nursery role/Reproduction	Fishing interest
Sphyraena viridensis	-	-	-	-	///	///
Hippocampus hippocampus	-	-	-	-	Reproduction	///
Trachurus picturatus	-	-	-	-	///	///
Sardinella aurita	-	-	-	-	///	///
Sardina pilchardus	-	-	-	-	///	///
Pseudocaranx dentex	-	-	-	-	///	///
Dicentrarchus labrax	-	-	-	-	///	///
Chelon labrosus	-	-	-	-	///	///
Chelon auratus	-	-	-	-	///	///
Pagrus auriga	-	-	-	-	///	///
Pagrus pagrus	-	-	-	-	Nursery role/Reproduction	Fishing interest
Dentex dentex	-	-	-	-	Nursery role/Reproduction	Fishing interest
Pagellus acarne	-	-	-	-	Nursery role/Reproduction	Fishing interest
Pagellus erythrinus	-	-	-	-	Nursery role/Reproduction	Fishing interest

SPECIES	BERNA	BONN	CITES	D. HABITATS	REASON OF PRESENCE	FISHING INTEREST
Diplodus vulgaris	-	-	-	-	Nursery role/Reproduction	Fishing interest
Oblada melanura	-	-	-	-	Nursery role/Reproduction	Fishing interest
Diplodus annularis	-	-	-	-	Nursery role/Reproduction	Fishing interest
Serranus atricauda	-	-	-	-	Nursery role/Reproduction	Fishing interest
Opeatogenys cadenati	-	-	-	-	///	///
Diplodus puntazzo	-	-	-	-	///	///
Diplodus cadenati	-	-	-	-	///	///
Lithognathus mormyrus	-	-	-	-	///	///
Sarpa salpa	-	-	-	-	///	///
Pomadasys incisus	-	-	-	-	///	///
Boops boops	-	-	-	-	Nursery role/Reproduction	Fishing interest
Spondyliosoma cantharus	-	-	-	-	Nursery role/Reproduction	Fishing interest
Synodus synodus	-	-	-	-	///	///
Synodus saurus	-	-	-	-	Nursery role/Reproduction	///
Trachinus draco	-	-	-	-	///	///
Trachinus radiatus	-	-	-	-	///	///
Uranoscopus scaber	-	-	-	-	///	///
Scorpaena porcus	-	-	-	-	///	///
Serranus cabrilla	-	-	-	-	Nursery role/Reproduction	Fishing interest
Serranus scriba	-	-	-	-	Nursery role/Reproduction	Fishing interest
Symphodus trutta	-	-	-	-	Nursery role/Reproduction	///
Symphodus mediterraneus	-	-	-	-	Nursery role/Reproduction	///
Coris julis	-	-	-	-	///	///
Thalassoma pavo	-	-	-	-	Nursery role/Reproduction	///
Sparisoma cretense	-	-	-	-	Nursery role/Reproduction	Fishing interest
Xyrichtys novacula	-	-	-	-	///	///
Mullus surmuletus	-	-	-	-	Nursery role/Reproduction	Fishing interest
Chelidonichthys lastoviza	-	-	-	-	///	///

SPECIES	BERNA	BONN	CITES	D. HABITATS	REASON OF PRESENCE	FISHING INTEREST
Stephanolepis hispidus	-	-	-	-	Nursery role/Reproduction	Fishing interest
Abudefduf luridus	-	-	-	-	///	///
Canthigaster capistrata	-	-	-	-	///	///
Sphoeroides marmoratus	-	-	-	-	///	///
Gobius niger	-	-	-	-	Nursery role/Reproduction	///
Microchirus azevia	-	-	-	-	///	///
Bothus podas	-	-	-	-	Nursery role/Reproduction	///
Myrichthys pardalis	-	-	-	-	///	///
Macroramphosus scolopax	-	-	-	-	///	///
Syngnathus typhle	-	-	-	-	Nursery role/Reproduction	///
Sphaerechinus granularis	-	-	-	-	///	///
Callistoctopus macropus	-	-	-	-	///	///
Sepia officinalis	-	-	-	-	///	///
Limaria hians	-	-	-	-	///	///
Aplysia fasciata	-	-	-	-	///	///
Aplysia dactylomena	-	-	-	-	///	///
Maja brachydactyla	-	-	-	-	///	///
Portunus hastatus	-	-	-	-	///	///
Cronius ruber	-	-	-	-	///	///
Stenorhynchus seticornis	-	-	-	-	///	///
Cryptosoma cristatum	-	-	-	-	///	///
Diopatra neapolitana	-	-	-	-	///	///
Myxicola infundibulum	-	-	-	-	///	///
Bispira viola	-	-	-	-	///	///
Eurythoe complanata	-	-	-	-	///	///
Hermodice carunculata	-	-	-	-	///	///
Aglaophenia pluma	-	-	-	-	///	///
Macrorhynchia philippina	-	-	-	-	///	///

2.2. Species abundance

Total number of species and related number of individuals recorded in all 46 transepts are reported in the following tables. The total number of individuals found was 324.

VERTEBRATES	N° OF INDIVIDUALS
Boops boops	25
Bothus podas	20
Canthigaster capistrata	76
Mulloidichthys martinicus	2
Pagellus erythrinus	2
Pomadasys incisus	10
Sarpa salpa	3
Similiparma lurida	21
Sparisoma cretense	41
Sphoeroides marmoratus	29
Symphodus mediterraneus	2
Symphodus spp.	5
Synodus synodus	1
Xyrichtys novacula	49
Unknow	2

INVERTEBRATES	N° OF INDIVIDUALS
Bivalve	3
Cerithiidae	3
Conus spp.	6
Cryptosoma cristatum	3
Gastropodes	1
Hermodice carunculata	5
Holothuria sanctori	2
Octopus vulgaris	2
Sphaerechinus granularis	6
Stenorhynchus seticornis	1
Unknow	4

With these data, was also obtained a value about Diversity Simpson Index, which is 0,88.

Out of the transepts area, two endangered species were found, *Pteromylaeus bovinus* (Figure 20) and a juvenile of *Squatina squatina* (Figure 21).

Figure 20. *Aetomylaeus bovinus* - Bull ray

Figura 21. *Squatina squatina* - Angel shark

Here are also provided some pictures of the most common organisms that have been encountered during the exploring time after the transect survey:

Figure 22. *Hermodice carunculata* - Bearded firework

Figure 23. *Octopus vulgaris* - Common octopus

Figure 24. *Thalassoma pavo* - Ornate wrasse

Figure 25. *Dasyatis pastinaca* - Common stingray

Figura 26. Canthigaster capistrata –

Macaronesian sharpnose-puffer

Figura 27. *Pagellus erythrinus* - Common pandora

Figure 28. *Sepia officinalis* - Common cuttlefish

3. TOURISM PROMOTER

From questionnaire that was proposed to nine diving centers, was evaluated that in average one dive in Abades has a cost of 39,80 € and from these money they can earn effectively 17,50 €.

This site is visited in average 4 days a week, by 13 divers, maximum 20 to minimum 3 divers per week.

4. FISHING SOURCE

A table with species of fishing interest associated to *Cymodocea nodosa*, with their price/kg, in Canary Islands is provided.

SPECIES	CANARIAN COMMON NAME	ENGLISH COMMON NAME	PRICE/KG IN AVERAGE
Pagrus pagrus	Bocinegro	Common seabream	11,75 €
Dentex dentex	Sama dorada / Denton	Common dentex	11,15 €
Pagellus acarne	Besugo	Axillary seabream	8,00 €
Pagellus erythrinus	Breca	Common pandora	8,00 €
Diplodus vulgaris	Seifia	Common two-banded seabream	8,00 €
Oblada melanura	Galana	Saddled seabream	8,00 €
Diplodus annularis	Mojarra	Annular seabream	6,00 €
Serranus atricauda	Cabrilla negra	Blacktail comber	8,00 €
Boops boops	Boga	Bogue	2,00 €
Spondyliosoma cantharus	Chopa	Black seabream	6,00 €
Serranus cabrilla	Cabrilla rubia	Comber	8,00 €
Serranus scriba	Vaquita	Painted comber	6,00 €

SPECIES	CANARIAN COMMON NAME	ENGLISH COMMON NAME	PRICE/KG IN AVERAGE
Sparisoma cretense	Vieja	Parrotfish	9,45 €
Mullus surmuletus	Salmonete	Striped red Mollet	12,60 €
Stephanolepis hispidus	Gallito verde	Planehead filefish	7,00 €
Trachurus picturatus	Chicharro	Chincard d'Europe	3,89 €
Sardina pilchardus	Sardina	European pilchard	5,25 €
Dicentrarchus labrax	Lubina	European seabass	8,40 €
Diplodus sargus	Sargos	White sea bream	10,00 €
Pagrus auriga	Sama Roquera	Redbanded seabream	11,00 €

2. CO_2 capture + O_2 production

As reported by (Pérez and Romero 1992) in an area of 1.600m^2 the total Primary Production is 506 g dry weight m^{-2} year $^{-1}$. From that value, is possible to evaluate O_2 production and CO_2 capture through the assumption that 1 g dry weight=0.34 gC and 0.353 gC=1 gO_2 (1 mol 0_2=0.94 mol C) derived from elementary analysis (C:N:P content) by Perez (1989).

For an area as Abades, with an extension of 83.437m^2, the value of PP is 26.386 g dry weight m^{-2} year $^{-1}$, the O_2 production is 25.414,91 gO_2, and CO_2 capture is 172,02 gC.

DISCUSSIONS

This work has been based primarily on a cartography drawn up in 2018, for this reason, the various analyzes conducted may not fully describe the overview and conditions of the ecosystem today.

For the density study, originally it was thought to analyze *Cymodocea nodosa*'s meadow even at 20m depth, but this was not possible as the analysis was conducted on a day of low tide, and having limited time as the dives took place from the shore, it was not possible to reach this depth, widely far from the shore. Another limit is that this study was conducted for two months, May and June, spring-summer time, so we don't know how can change the structure of the seagrass meadow through the year.

However, thanks to the work of Espino et al. 2003, who classified the density into four groups as a function of the number of bundles per meter square, we can compare our results. From Espino et al. 2003, we have:

- **Very dense** seagrass meadow: >1500 bundles/m^2
- **Dense** seagrass meadow: 1000-1500 bundles/m^2
- **Medium dense** seagrass meadow: 500-1000 bundles/m^2
- **Low dense** seagrass meadow: <500 bundles/m^2

The result of this work therefore highlights how at 5m and 10m depth it is possible to find a medium dense area, while, going forward with the depth, we will have a meadow with decrease low density until it disappears to make space for garden eels (Figure 29).

Figure 29. *Dasyatis pastinaca* with Garden Eels (Subfamily: Heterocongrinae)

The length of the leaves with the number of leaves per bundle is in average. About the biodiversity, one limit was that the transect surveys have been conducted only in the morning, once a week, therefore it was not possible to describe the day/night shift of the population of the marine area.

The most numerous species found, in terms of individuals, were *Canthigaster capistrata, Similiparma lurida, Sparisoma cretense, Xyrichtys novacula, Sphoeroides marmoratus*, given by the fact that many individuals were juveniles so for that reason, we can deduct that this habitat constitutes, at least for spring and summer, a nursery habitat for these organisms, several of them commercially targeted. During dives, was also noticed that a great part of *Dasyatis pastinaca* individuals were pregnant (Figure 30), a fact for which the importance of this habitat, in which these animals spend their gestation period, is emphasized even more.

Figure 30. Pregnant *Dasyatis pastinaca*

The value of the Simpson Diversity Index is 0.88, which means that we have a great diversity of the population in the marine area.

Based on the various questionnaires proposed to diving centers, we can understand how important this area is also from an economic point of view. It is an area very popular by divers, who bring considerable income to the various diving centers. In fact, the total amount of money that in average a diving center can earn in one year is about 11.830€.

If we take into consideration the potential profit coming from the fishing industry, we note how many species associated with *Cymodocea nodosa* are target species for fishing, bringing significant gains in this sector as well.

About the CO_2 capture and O_2 production, we based our study on a paper from 1992 for this reason, more recent research should be conducted.

CONCLUSION

This study builds a new baseline for the marine biodiversity of Abades. More detailed studies will certainly have to take place in the future. For now, we know that the *Cymodocea nodosa* meadow in this area presents a particular ichthyofauna, characterized by sandy-bottom species that appear with small individuals and by exclusive organisms, and play an important role in maintaining the diversity of numerous species, providing a nursery habitat for juveniles of different fish species, many of commercial interest. The conservation in general of the canarian *Cymodocea nodosa*'s meadows is important for maintaining coastal productivity and ecological processes, for that reason we have been able to evaluate some ecosystem services and see how seagrass can provide to us and to the marine environment a lot of benefits.

In conclusion, the study area should be considered with priority in the design of future conservation strategies of the local coastal zone, to avoid biodiversity loss and guarantee the long-term provision of the related ecosystem services.

ACKNOWLEDGEMENT

I would like to thank Innoceana NGO for allowing me to conduct this research, for the support and help in these two months of work.

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