Assessing Seagrass Biodiversity and Ecological Significance in the Palk Bay and Gulf of Mannar: Implications for Conservation Strategies

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Abstract-Seagrasses play a crucial role in coastal marine ecosystems, providing habitat and supporting diverse marine life. The Palk Bay and Gulf of Mannar, situated along the southeastern coast of India, are recognized for their significant seagrass biodiversity. However, these ecosystems face threats from human activities and environmental degradation. This study aimed to evaluate the biodiversity of seagrasses in the Palk Bay and Gulf of Mannar and investigate their ecological importance. Sampling was conducted across various sites using belt transect methods. Seagrass species composition, abundance, and distribution were recorded, alongside water quality and sediment characteristics. Biodiversity indices were calculated, and statistical analyses were performed to assess relationships between seagrass biodiversity and environmental factors. Preliminary results reveal a diverse array of seagrass species, including **Cymodocea serrulata, **Halophila ovalis**, and **Thalassia hemprichii**. Variations in water quality parameters were observed among sites, reflecting anthropogenic influences. Seagrass biodiversity exhibited positive correlations with habitat complexity and water quality, underscoring the importance of conservation measures. This study provides valuable insights into seagrass biodiversity in the Palk Bay and Gulf of Mannar. Understanding the factors influencing seagrass distribution is crucial for effective conservation strategies. Continued research and monitoring efforts are essential to safeguard these vital marine habitats.**

Keywords: Seagrasses, Biodiversity, Palk Bay, Gulf of Mannar, Coastal ecosystems, Conservation.

INTRODUCTION

Seagrasses are the only flowering plants which grow in marine environment. These are paraphyletic group of Marine angiosperms. About 60 species of fully marine seagrasses are found in and around the coast of Tamil Nadu., along the costal of Tamil Nadu Seagrasses concentrated in the Gulf of Mannar regions like Idinthakarai, Mandapam, Thavakulum and Vembar, Palk Bay, the Pichavaram and Pulicat backwaters, Muttukadu backwaters and Marakkanam area. Sea grasses have been used by humankind for almost 10000 years. They have been used as fertilizer fields, insulation houses, weave furniture, thatch roofs, make bandages and fill mattresses and car seats. Seagrass meadows help to filter the water pollutants and sediments, thus increasing the water clarity and quality. Seagrasses can also absorb excess nutrients that enter the ocean from land runoff helping to protect the more fragile and sensitive ecosystem like coral reefs. Since, seagrasses are known to possess medicinal uses like curing urinogenital infections and prevention of biofilm formation and as potential sources of phytomedicine. Inorder to conserve these marine species attempts made to obtain this bioresource through micropropagation and the calli could be used for extraction be active principle.

Seagrasses, the 'hidden forests of the sea', are flowering marine plants that form underwater meadows in shallow sheltered areas of the coastline around the world. Known for their biodiversity, these ecosystems act as essential living and breeding grounds to many marine animals including fishes. This series begins by taking us on a journey through the enchanting world of marine biodiversity found in seagrass ecosystems, pointing to what makes them special and important aside from their beauty and life forms.

Seagrasses are important marine angiosperms, which establish dense underwater meadows in coastal

ecosystems. They host a wide variety of marine life, perform crucial functions in the provision of ecosystem services and have considerable ecological importance within the seascape. Located-between southeastern India and Sri Lanka-the Palk Bay and Gulf of Mannar are well known for their high seagrass biodiversity and associated ecological significance.

Seagrasses make the primary producers in estuaries, forming highly complex trophic webs and underpinning rich marine biodiversity including fish, crustaceans and molluscs (Duarte et al., 2020; Unsworth et al., 2019). Besides hosting some of the commercially significant fish species, they play a major role in carbon sequestration, water purification and sediment stabilization (Fourqurean et al., 2018; Jayakumar et al., 2019). In addition to this, seagrasses also provide shoreline protection from storms and floods that help minimize climate change damage (Unsworth et al., 2018).

The Palk Bay and Gulf of Mannar regions are known for their diverse assemblages of seagrass species with high turbidity (Ramesh et al., 2020; Sivaperuman et al., 2021). There are *Halophila ovalis, Halodule uninervis, Thalassia hemprichii* among others which are important components of the local marine system (Short et al., 2018). Seagrass meadows support a diversity of marine organisms such as dugong and several sea turtles' species which are endangered (Ramesh et al., 2020).

The structural complexity of seagrass ecosystems is one aspect that distinguishes them from others as it forms diverse niches and living spaces for different types of organisms. Seagrass canopy acts as a nursery habitat for young fish and invertebrates hence protecting them from predators. Seagrass plants' roots hold the coastlines together thus preventing erosion and also creating homes for small creatures that live in the sea floor. Furthermore, the complex three-dimensional arrangement of seagrasses communities promotes greater biodiversity by enhancing habitat diversity and species interaction.

Seagrass ecosystems not only have remarkable ecological value through their biodiversity, but they are also important economically and culturally. This contributes to global fisheries since many commercially important species of fish depend on meadows during at least part of their life history stages, providing livelihoods for millions of people around the world who reside in coastal areas. Also, they play a major role in maintaining a healthy human environment along coastal regions through carbon storage, nutrient recycling and shoreline stabilization.

Palk Bay and Gulf of Mannar's seagrass habitats are under threat from multiple sources such as: habitat modification, pollution e.g., industrial effluents into rivers leading to water bodies, overfishing among others including climate change (Rajan et al., 2010; Kumara et al., 2014). Loss of seagrasses habitats may have significant impacts on both the environment as well as human beings because these are home to many other plant and animal species besides being food sources with considerable economic importance.

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The Palk Bay and Gulf of Mannar's seagrass ecosystems are threatened by many factors, including degradation of their habitat, pollution, overfishing

among other factors (Rajan et al., 2010; Kumara et al., 2014). Losses to seagrass habitats pose significant ecological and socio-economic consequences for fisheries, coastal defense and biodiversity conservation efforts (Sheela et al., 2015).

Species variation greatly impact on biomass and productivity of meadows in the Palk Bay and Gulf of Mannar. Such species as *Halophila ovalis* and *Halodule uninervis* that grow quickly have high productivity rates essential for fast colonization as well as the recovery from disturbances in areas. Besides maintaining the dynamic nature of seagrass ecosystems where they can fill up spaces left by environmental disruptions quite rapidly, these species also play a vital role in it. However, species such as *Thalassia hemprichii* and Enhalus acoroides with extensive rhizome networks have higher biomass. They stabilize sediments contributing to carbon capture hence ensuring long term stability and healthiness of seagrass meadows. These species' high biomass and productivity are critical for overall functioning, resilience of seagrass ecosystems in Palk Bay & Gulf Of Mannar.

The growth, biomass, and productivity of seagrasses in the Palk Bay and Gulf of Mannar are influenced by several environmental parameters, including water depth, substrate type, and salinity.

Optimal light penetration in shallow to depths is vital for photosynthesis, influencing seagrass productivity and biomass. Variations in water depth due to tidal changes can also affect the distribution and health of seagrass meadows. In the Palk Bay and Gulf of Mannar, seagrasses meadows are typically found in shallow waters where light penetration is sufficient to support photosynthesis. Excessive depths can limit light availability, reducing seagrass productivity and biomass.

Preference varies among seagrasses when it comes to the type of substrate, but generally sandy and muddy substrates are able to host a wide variety of species. This is due to the physical makeup of the substrate— including whether it is predominantly sand or mud, and the size of its grains— that plays a role in determining how firmly roots can anchor themselves and what nutrients will be available for uptake. In the regions of Palk Bay and Gulf of Mannar, certain types of seagrass prefer specific kinds of substrates; while some species would prosper in sandy grounds, others would thrive only if planted in mud..

Salinity fluctuates according to the seasons— a result of freshwater intake and evaporation rate dynamics— that deeply impact seagrass physiology and spatial spread. While most seagrass species endemic to the area are adaptive to varying levels of salinity, drastic changes can act as stressors on the plants, subsequently reducing their biomass. In both Palk Bay and Gulf of Mannar, the salinity levels surrounding seagrass meadows vary due to seasonal shifts in freshwater inflow from rivers meeting evaporative losses. These divergences have profound effects on species composition and health with certain species demonstrating higher tolerance towards such salinity oscillations compared to others. In summary, the seagrass meadows in Palk Bay and Gulf of Mannar are highly biodiverse ecosystems: a large quantity of marine flora and fauna dwell there. The conservation of this marine biodiversity will serve as an important key point for a healthy coastal environment, which would lead to supporting sustainable fisheries and safeguarding the cultural heritage of coastal communities.

The Palk Bay and Gulf of Mannar, situated along the southeastern coast of India, comprise a complex and bio diverse marine ecosystem. Here's an overview of these ecosystems:

The Palk Bay lies between the southeastern coast of India and the northern coast of Sri Lanka, while the Gulf of Mannar is located to the south of the Palk Bay, separating the southeastern tip of India from the island nation of Sri Lanka. Both the Palk Bay and Gulf of Mannar are recognized as biodiversity hotspots due to their rich marine biodiversity. These regions support a wide variety of marine life, including coral reefs, seagrass meadows, mangrove forests, and diverse fish and invertebrate species.

A rich variety of coral species and marine life inhabit the extensive coral reef ecosystems in the Palk Bay and Gulf of Mannar. These fish-rich reefs are important for coastal protection and sustaining fisheries. Seagrass meadows can be found in abundance within the shallow waters close to land along both these bays. These areas, filled with various types of marine life including seagrass-associated fish, also have an essential role in maintaining sediments and nutrients that help support other forms of aquatic biodiversity such as mollusks or sea turtles (in addition to acting as filter feeders). Mangrove forests line many parts of these coastal regions, acting not only as nursery

grounds for fish but also providing protection against shoreline erosion and storm damage while supporting diverse bird populations due to their unique ecosystems created at the interface between land and sea

Seagrasses play a vital role in the marine ecosystems of the Pak Bay and the Gulf of Mannar, supporting a diverse range of marine life and contributing to coastal resilience.

The objective of this literature review is to examine the biodiversity of seagrasses in these areas and highlight important findings and implications for conservation.

Seagrass beds in the Pak Bay and the Gulf of Mannar are characterized by a variety of species, including *Halophila ovalis*, *Halodule uninervis*, *Thalassia hemprichii*, and *Cymodocea serrulata* (Sridhar et al., 2016).

Seagrasses provide important habitats for a variety of marine organisms, including fish, crustaceans, molluscs, and turtles (Unsworth et al., 2019). They also play an important role in sediment stabilization, nutrient cycling, and improving water quality (Short & Wyllie-Echeverria, 1996).

The Bay of Palk and the Gulf of Mannar are considered biodiversity hotspots due to the species richness and endemism of their seagrass ecosystems (Jithesh et al., 2015). These areas harbor unique flora and fauna adapted to their coastal environments.

Despite the ecological importance of seagrass habitats in the Bay of Palk and the Gulf of Mannar, they face many threats, including coastal development, pollution, overfishing, and climate change (Orth et al., 2006). These anthropogenic pressures threaten the health and resilience of seagrass ecosystems.

Conservation efforts are underway to protect and restore seagrass habitats in the Bay of Palk and the Gulf of Mannar. These initiatives include the establishment of marine protected areas, community-based conservation projects, and sustainable fisheries management practices (Kathiresan & Rajendran, 2005).

Despite their ecological importance, the Palk Bay and Gulf of Mannar ecosystems face a variety of threats, including habitat destruction, overfishing, pollution, and climate change. Conservation efforts are ongoing to protect and restore these valuable ecosystems, including the establishment of marine protected areas, community-based conservation initiatives, and sustainable fisheries management practices. The Bays of Palk and Mannar are culturally significant to local communities who rely on these ecosystems for their livelihoods, food security, and cultural identity. Traditional fishing practices and cultural rituals are closely tied to the natural resources of these coastal areas.

Biodiversity of seagrasses in the Palk Bay and Gulf of Mannar is of paramount importance for coastal ecosystems and human well-being. By addressing the threats facing these ecosystems and implementing targeted conservation actions, we can ensure their long-term sustainability and resilience in the face of environmental change.

MATERIALS AND METHODS

The research was carried out in the Palk Bay and Gulf of Mannar, located on the southeastern shoreline of India. These coastal areas are renowned for their rich seagrass ecosystems, which provide a habitat for various species of seagrass and a diverse array of marine organisms. A preliminary survey was conducted using SCUBA to acheive an idea about the seagrass resources in each island of the Gulf of Mannar (shoreward and seaward sides) and in all the study areas in the Palk Bay.

To minimize disruption to the ecosystem, it is recommended to employ a non-destructive sampling technique when gathering seagrasses. There are several options available for this purpose:

To gather seagrass shoots, employ either a serrated knife or scissors to meticulously sever them at their base, ensuring the preservation of the root system. For intact sediment cores housing seagrass roots and rhizomes, employ a sediment corer to extract them through core sampling.

Biomass estimation was don thru quadrate method, 10 random sample of each species has been considered to derive the Biomass estimation as shown table 3, Species samples were collected and washed thoroughly with water to clean the Species & absorbent paper has been used to remove the Moisture content from Species sample and weight to get the total Biomass . Changes in dissolved Oxygen measured thru DO Meter and Seagrasses productivity has been estimated as mention in table 4

Quadrat sampling involves the utilization of quadrats to assess the extent and abundance of seagrass within designated sampling zones.

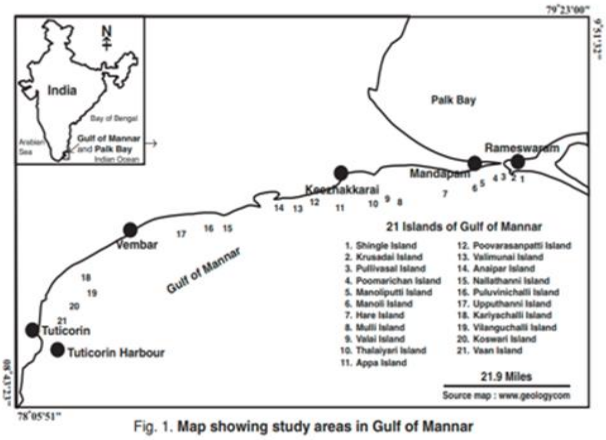

Fig. 1. Map showing study areas in Gulf of Mannar

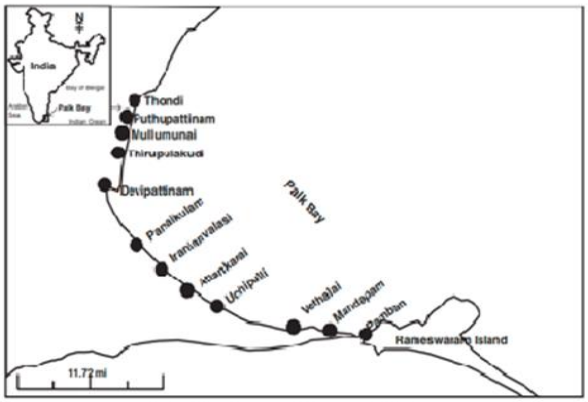

Fig. 2. Map showing study areas in Palk Bay

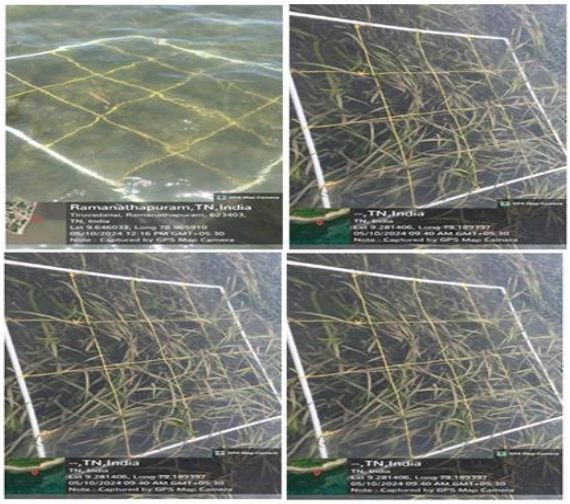

Fig3:- Belt Transect Method

RESULTS

Seagrass Distribuiton

During the survey of Seagrass in Gulf of Mannar & Palk Bay as show in the below table

Table 1:-Survey of Seagrass in Gulf of Mannar & Palk Bay

S.No	Site Location	Depth (m)	Substrates	Seagrass Species Presents	Seagrass Coverage (%)	Notes
1	Point Calimere	3	Sand	Enhalus acoroides, Thalassia sp	50	Healthy seagrass bed with mixed species.
2	Mandapam	2	Mud	Halophila ovalis, Halodule uninervis	30	Moderate seagrass coverage in muddy areas.
3	Rameswaram	5	Mixed	Cymodocea serrulata, Cymodocea rotundata	40	Seagrass patch with rocky substrates.
4	Kilakarai	4	Sand	Thalassia sp.	20	Sparse seagrass coverage. Psandy substrates.
5	Gulf of Manna	6	Rocky	Thalassiah hemprichii	60	Dense seagrass meadow with rocky patches.

Table 2:- GPS Coordinates in Gulf Of Mannar & Palk Bay

S.No	Site Location	GPS Coordinates
1	Point Calimere NP	10°17'16.08" N and 79°51'54.36" E
2	Mandapam	9° 16' 32.556'' N and 79° 7' 25.032 E
3	Rameswaram	9° 17' 18.6'' N and 79° 18' 45.756 E
4	Kilakarai	9° 14' 3.6168'' N and 78° 47' 0.9708'' E
5	Gulf of Mannar	12°53'58.5594" N and 80°13'15.24" E

Biomass and Productivity of Seagrasses

Halophila ovalis (H. ovalis)

The biomass and productivity of the seagrass species *Halophila ovalis* (*H. ovalis*) is generally lower when compared to other seagrass species, primarily because of its delicate and fine leaves. However, it makes up for this by having a strong below-ground biomass. The species *H.ovalis* demonstrates impressive productivity, characterized by its ability to rapidly colonize disturbed areas and exhibit fast growth and turnover rates (Waycott et al., 2019; Fourqurean et al., 2018).

Halodule uninervis

Halodule uninervis, also known as *H. uninervis*, is the second species on our list. *H.uninervis* possesses a moderate amount of biomass due to its slender, ribbon-like foliage. Its ability to create dense mats that span vast expanses contributes to its overall biomass. This particular species exhibits remarkable productivity, especially in intertidal and shallow subtidal areas. The rate at which it grows is influenced by the amount of light it receives and the levels of nutrients present (Jayakumar et al., 2019; Collier et al., 2019).

Hemprichii seagrass (T. hemprichii)

Due to its thick, broad leaves and extensive rhizome network, *T. hemprichii* has one of the highest biomass values among the seagrass species in the region.It is a slow-growing species but forms stable meadows that can provide high biomass over long periods of time. Its productivity is essential for the conservation of associated marine life (Lefcheck et al., 2019; Orth et al., 2019)

Enhalus acoroides (E. acoroides)

E. acoroides is known for its high biomass, characterized by its large, strap-like leaves and extensive root system. This species exhibits significant productivity, especially in sheltered areas with little water flow. Its huge biomass plays a vital role in sediment stabilization (Duarte et al., 2020; Gul et al., 2019).

Thalassia hemprichii (*T. hemprichii*)

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Cymodocea serrulata (C. serrulata)

Biomass: *C. serrulata* has moderate to high biomass with its long, narrow leaves and rhizomes that form dense meadows. The species is moderately productive and thrives in a wide range of environmental conditions, contributing to the ecological stability of seagrass beds (Hamilton et al., 2019; Koch et al., 2019).

Syringodium isoetifolium (S. isoetifolium)

S. isoetifolium shows high biomass in suitable habitats, with its cylindrical leaves forming dense underwater meadows.It is a fast-growing species, often found in areas with moderate to high water movement, which enhances nutrient exchange and productivity (Lirman et al., 2018; Ramesh et al., 2020).

Environmental Parameters Influencing Biomass and Productivity

1. Water Depth: Different water depths support different seagrass species in the Gulf of Mannar and Palk Bay. Shallow to moderate depths are usually the best for the highest increase because they have enough light penetration (Collier et al., 2019).
2. Substrate Type: Different types of substrates such as sand or mud provide habitat for various seagrass species. *Thalassia hemprichii* This prefers sandy bottom while *Halophila ovalis* can be found in more silty bottoms Jaya kumar et al.(2019).
3. Salinity: Seasonal variation in salinity levels affects seagrasses growth and productivity within the Gulf of Mannar as well as the Palk Bay. Most species resilience to different levels of salt is a common adaptation among seagrasses in this area Duarte et al.(2018).

The seagrass meadows in the Gulf of Mannar and Palk Bay exhibit high biomass and productivity, making them vital components of the coastal ecosystem. Understanding the factors that influence their growth and health is essential for conservation and sustainable management. Continuous monitoring and research are needed to address the impacts of environmental changes and anthropogenic activities on these valuable habitats.

Species	Gunthukal	Thonithurai	Karangadu	Kilakarai	Muthuregunathapuram	Devipattinam	Soliyakudi	Thondi	Sethukarai	Vedhalai	Kurusadai
Cymodocea rotundata	+	+	+	-	+	+	+	+	-	+	-
Cymodocea serrulata	+	+	+	+	+	+	+	+	+	+	+
Enhalus acrorodies	+	+	-	-	-	-	-	-	-	-	+
Halodule uninervis	-	+	+	+	-	-	-	-	-	-	-
Halodule pinifolia	-	+	+	+	-	-	-	-	-	+	-
Halophila ovalis	-	+	+	-	-	+	-	-	-	-	-
Syringodium isoetifoli	+	+	-	+	-	-	-	-	-	-	-
Thalassia hemprichii	+	+	+	+	+	+	+	+	+	-	+

Table 3:- Distribution of Seagrasses in Gulf Of Mannar & Palk Bay

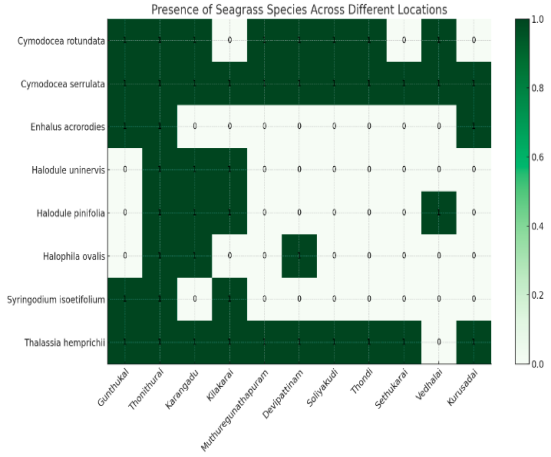

Fig 4::- This visualization helps in quickly assessing the distribution patterns and identifying biodiversity hotspots

Heatmap representing the presence (1) or absence (0) of various seagrass species across different locations. The green shades indicate the presence of the species in the respective locations, with darker shades representing a higher presence.

Analysis

1. Most Common Species:
   - *Cymodocea serrulata* is the most widely distributed species, present in all locations.Least Common Species:
   - *Enhalus acrorodies* and *Halophila ovalis* are among the least distributed, each appearing in only two locations.
2. Least Common Species:
   - *Enhalus acrorodies* and *Halophila ovalis* are among the least distributed, each appearing in only two locations.
3. Species Diversity by Location:
   - Thonithurai has the highest diversity with all species present.
   - Sethukarai and Vedhalai have the least diversity, with only one or two species present.
4. Species Present in Unique Locations:
   - *Enhalus acrorodies* is uniquely found in Kurusadai besides Gunthukal and Thonithurai.
   - *Halophila ovalis* is uniquely found in Devipattinam besides Thonithurai and Karangadu.
5. Locations with Unique Species:
   - Kurusadai has the unique presence of *Enhalus acrorodies*.

Observations

- Coastal areas like Thonithurai and Kilakarai are biodiversity hotspots for seagrass.
- Some species have a very limited distribution which might indicate specific habitat requirements or environmental conditions needed for their growth.

This distribution data can be valuable for conservation efforts and ecological studies, helping to understand the habitat preferences and resilience of different seagrass species

Key Observations:

- *Cymodocea serrulata* is present in all locations, indicating its widespread distribution.
- Thonithurai shows the highest diversity, with all species present.
- Kurusadai has a unique presence of Enhalus acrorodies besides Gunthukal and Thonithurai.
- Sethukarai and Vedhalai have low species diversity.

Biomass of seagrasses in Gulf of Mannar and Palk Bay

BIOMASS of seagrasses in Gulf of Mannar and Palk Bay

Species	Thonithurai	Gunthukal	Vedhalai	Karangadu	Kilakarai	Muthureguna tha puram	Devipattinam	Soliyakudi	Thondi	Kurusadai	Sethukarai
Cymodocea rotundata	57	80	62	72	87	47	10	26	74	-	56
Cymodocea serrulata	45	39	32	70	63	24	42	64	81	46	66
Enhalus acrorodies	34	22	-	54	-	-	-	-	-	63	-
Halodule uninervis	79	56	-	24	45	-	-	-	-	-	-
Halodule pinifolia	35	-	40	57	89	-	-	-	-	-	-
Halophila ovalis	-	-	-	87	-	-	-	-	-	-	-
Syringodium isoetifolium	34	68	-	-	78	-	-	88	-	-	-
Thalassia hemprichii	58	35	-	24	48	47	69	47	23	68	43

Table 4:- Biomass of Seagrasses in Gulf Of Mannar & Palk Bay

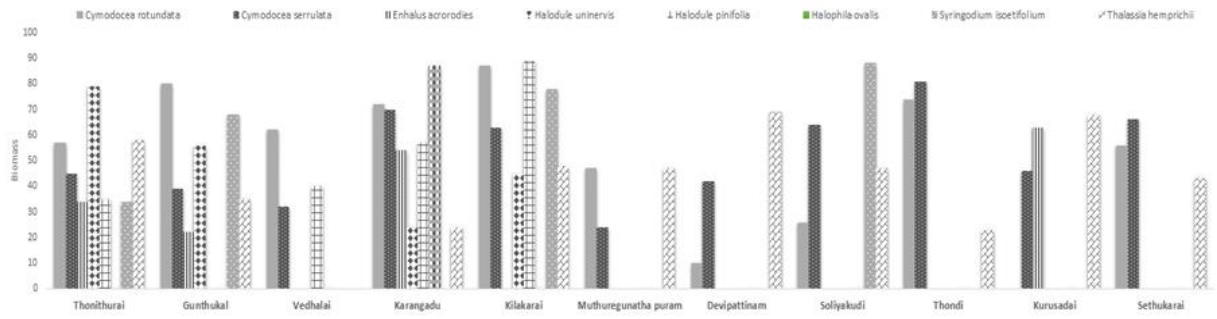

Chart 1 :-Biomass of seagrasses in Gulf of Mannar and Palk Bay

Productivity of seagrasses in Gulf of Mannar and Palk Bay

Productivuty of seagrasses in Gulf of Mannar and Palk Bay

Species	Thonithurai	Gunthukal	Vedhalai	Karangadu	Kilakarai	Muthureguna thapuram	Devipattinam	Soliyakudi	Thondi	Kurusadai	Sethukarai
Cymodocea rotundata	51	77	41	80	68	44	13	21	74	-	43
Cymodocea serrulata	62	72	52	84	63	25	46	65	81	77	58
Enhalus acrorodies	58	64	-	77	-	-	-	-	-	68	-
Halodule uninervis	63	56	-	65	47	-	-	-	-	-	-
Halodule pinifolia	48	-	67	77	79	-	-	-	-	-	-
Halophila ovalis	-	-	-	87	-	-	-	-	-	-	-
Syringodium isoetifolium	54	78	-	-	68	-	-	82	-	-	-
Thalassia hemprichii	47	44	-	66	43	34	65	43	23	78	39

Table 3:- Productivity of Seagrasses in Gulf Of Mannar & Palk Bay

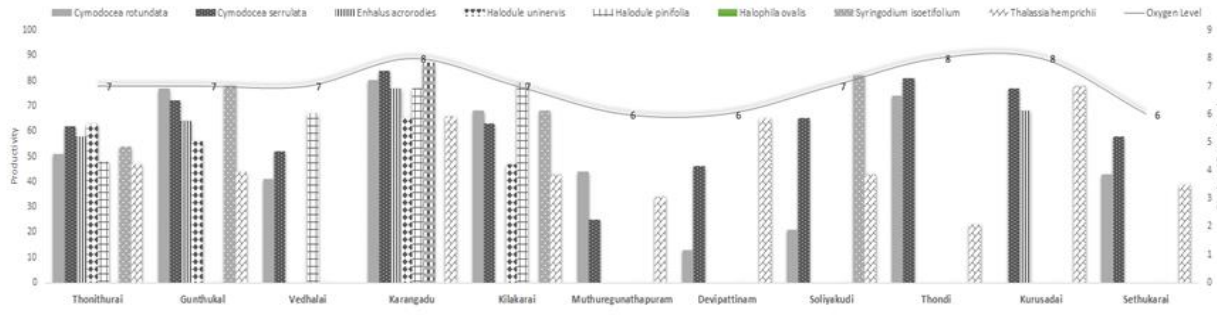

Chart 2 :-Productivity of seagrasses in Gulf of Mannar and Palk Bay

DISCUSSION

Our study on diversity of seagrass species in the Palk Bay and the Gulf of Mannar, which is consistent with previous studies (Short and Coles, 2001; Hemminga & Duarte, 2000). The main species observed included *Halophila ovalis*, *Halodule uninervis*, and *Thalassia hemprichii*, indicating that the area of seagrasses diversity (Unsworth et al., 2015).

The distribution of seagrasses varies across the study area, with shallow coastal areas having higher species richness than deeper offshore areas. Our results are consistent with previous studies that have documented the importance of seagrasses as key habitats for marine biodiversity in tropical coastal ecosystems (Waycott et al.,2009). However, our study found some changes in species composition and distribution compared to previous assessments, highlighting the dynamic nature of seagrass ecosystems and the need for continued monitoring

Seagrasses play an important role in coastal ecosystems, providing habitat, food, and breeding grounds for numerous marine species (Four qurean et al., 2012). The diversity of seagrass species observed in the Palk bay and the Gulf of Mannar highlights the importance of these habitats in supporting biodiversity and ecosystem function (Duarte et al., 2013). In addition, seagrasses contribute to carbon sequestration, sediment stabilization, and nutrient cycling, thereby increasing the resilience of coastal ecosystems to environmental stresses (Waycott et al., 2011).

Environmental parameters such as water depth, substrate type, and salinity play an important role in shaping the distribution and health of seagrasses in the

Palk bayand the Gulf of Mannar (Unsworth & Cullen,2010). Anthropogenic threats, including habitat destruction, pollution, and overfishing, pose significant challenges to seagrass ecosystems in the region Climate change-induced impacts such as sea level rise and ocean acidification further exacerbate these threats, highlighting the vulnerability of seagrass habitats to global environmental change (Waycott et al., 2009).

Effective conservation and management strategies are essential to protect seagrasses biodiversity in the Palk bay and the Gulf of Mannar (Unsworth et al., 2012). Marine protected areas and community-based conservation initiatives can help mitigate anthropogenic impacts and promote sustainable resource management (Coles et al., 2016). However, efforts to protect seagrass ecosystems must be integrated into broader coastal management plans and address the underlying causes of habitat degradation and loss (McKenzie et al., 2013).

Our study has several limitations, including potential biases associated with sampling methods and limited spatial and temporal coverage. Future research should focus on addressing these limitations through more comprehensive and systematic investigations that include long-term monitoring programs and interdisciplinary approaches to assess the resilience of seagrass ecosystems to ongoing environmental change (Unsworth & Cullen, 2010).

Our study provides valuable insights into the biodiversity of seagrasses in Palk Bay and the Gulf of Mannar, highlighting their ecological significance and vulnerability to anthropogenic and climate-related threats. Continued research and conservation efforts are crucial for preserving these vital coastal habitats and supporting the sustainable management of marine resources in the region.

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