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A Comparative Study on the Diversity of Seagrass Species in Selected Areas of Puttalam Lagoon in Sri Lanka

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Abstract

Seagrasses are aquatic angiosperms located in shallow marine and brackish water environments and considered as a key environmental resource. Seagrasses are not only important as primary producers in aquatic environment but also they are important to protect coastal environment from erosion and provide environment to large number of species. This study was carried out to investigate the distribution of seagrass species in selected areas of Puttalam lagoon. Point transect method was used for data collection. Sites were randomly selected and three lines transects, perpendicular to shore were laid. Water quality parameters including water temperature (°C), pH, salinity (ppt), conductivity (mS/cm) and dissolved oxygen (mg/L) were also measured. Shannon-Wiener diversity index was used and Minitab14 statistical software is performed for data analysis. There was a significant relationship between relative abundance of *Halodule uninervis* (Narrow) and *Syringodium isoetifolium* with water temperature respectively. Shannon-Wiener diversity index values indicated that diversity of Kalpitiya region and Kuringipitiya region was closely related whereas diversity of Paliwasalthurai was closely related to the diversity of Kandakuda. Zero diversity was recorded in Palavi which is composed of only *Halophila ovalis*. Moreover, it has been shown a relationship between of water quality and distribution of the seagrass species.

Keywords: Seagrass; Puttalam lagoon; Distribution; Shannon-Wiener diversity index

Abbreviations: ANOVA: Analysis of Variance, SE: Standard Error.

Introduction

Seagrasses are aquatic angiosperms which are wide spread in shallow marine environments [1]. Seagrasses have been identified as a key environmental resource [2], because they are the one of main organisms which contributes to the primary production of aquatic environment. The aim of the present study was to compare changes of seagrass distribution with the water quality of selected locations of Puttalam lagoon. Further, seagrass beds provide habitat grounds for a large number of fish and shellfish species which are environmentally and economically important [2,3], act as a large carbon sink [4], the leaves provide shelter for epiphytic organisms, provide feeding ground for many organisms such as manatees, sea turtles and other wildlife [2], protect microbial flora live in the sediment and the sediment-water interface [4] and stabilizing the sea bottom [2,4]. Puttalam lagoon was selected as studing area which is located in Puttalam district of North Western Province of Sri Lanka. This is one of the large and productive lagoons which covers 32 700 ha [5]. The entire lagoon system is very shallow with 1 m to 2 m depth except deep channels where the depth is around 4 m to 5 m [6]. Several ecosystems such as tidal flats, seagrass beds, sand dunes and coral reefs are other coastal ecosystems in the Puttalam lagoon area. The estuarine system of Puttalam lagoon and adjacent coastal waters support a very large number of species of fish and invertebrate fishery and seagrass communities play a major role in increasing the productivity of Puttalam lagoon [7]. Although there are good biodiversity, due to several anthropogenic activities these ecosystems including seagrass beds have been degraded during few decades [8]. The records indicates that 60 seagrass species within 12 genera and four families worldwide [9]. Out of that fifteen seagrass species was recorded in Sri Lanka which belongs to 2 families, 12 genera and 49 species [1]. Previous studies recorded that eight species of seagrasses are in Puttalam lagoon; *Enholus acroides* (I.F.) Royle, *Thalassia hemprichii* (Ehrenb.) Aschers., *Halodule uninervis* (Forsk.) Aschers in Bossiser, *Syringodium isoetifolium* (Aschers.) Dandy, *Cymodocea rotundata* Ehrenb. et Hempr. Ex Aschers., Cymodocea *serrulata* (R. Br.) Aschers, and Magnus, *Halophila ovalis* (R. Br.) Hook. F. and *Halophila decipiens* Ostenfeld [8]. Physical parameters such as temperature, salinity, waves, currents, depth, substrate and day length are the factors affect on distribution of these species of seagrasses [9]. Moreover, anthropogenic activities such as nutrient loading loading are confined the access to availability of resources [8,9]. Thus the various combinations of physical parameters, natural phenomena and anthropogenic inputs like parameters influence on encouraging or eliminating of seagrasses from a specific location [2]. The distribution pattern and abundance of seagrasses might be varying with the time, with the variation of water quality parameters because they are sensitive to water quality changes [2]. Early detection of changes of marine resources allows successful results of management practices

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and remedial actions to adjust them. Recent studies were done to map out the distribution of various species of seagrasses in Negombo lagoon [10] to find out substrate characteristics and species diversity of marine angiosperms in a micro-tidal basin estuary on the west coast of Sri Lanka [11] and to find out the species composition, abundance and the distribution of seagrass communities in Puttalam lagoon [12]. During this study, the distribution pattern was changed from 1991 to 2013 with human activities and the ecologists were said decreasing that the biodiversity of the lagoon during two decades.

Methods

Study area

Puttalam lagoon is located in 070 55'-080 20' North and 790 43'-790 56' East of North Western province of Sri Lanka [8]. This is the largest lagoon in Sri Lanka which provides favorable conditions for the growth of seagrass communities [12]. Puttalam lagoon covers a water surface area about 32,750 ha [8] and is very shallow, with depths of 1-2 m, except in the deep channels with depths of 4-5 m within the Puttalam lagoon [6]. The northern end of lagoon opens to the sea whereas the southern end is connected to the northern end of Mundal lake by the Dutch canal [7].

Study site

The present study was carried out at the selected areas of Puttalam lagoon during the period of May to September in 2013. Puttalam lagoon was divided in to four main regions such as North Eastern region, North Western region, South Eastern region and South Western region. Kalpitiya, Kuringipitiya, Palliwasalthurai and Kandakuda areas were confined to North Western region, Ethalai, Mampuri and Norachcholai were confined to South Western region, Palavi and Puttalam were confined to South Eastern region and Seguwantive, Ambalama, Moongilaru, Eluwankulama and Karative were confined to North Eastern region [12]. Out of these regions North Western region and South Eastern regions were selected for data collection. Kalpitiya, Kuringipitiya, Palliwasalthurai, Kandakuda, Palavi and Puttalam were confined to those regions.

Sampling method

When a suitable site was identified, Geographic Position System (GPS) data of the sites were taken for the future reference. Only the positions of middle transect were recorded. Point transect method was used for the sampling. Three line transect of each location was taken after proper locating of middle transect to increase accuracy of data. Woody picket was knocked into the ground and 30 m rope marked at 3 m regular intervals was attached to the picket. Heading of transect were determine using a compass. Typically transect should be perpendicular to the shore. Rope was hold in right hand and transect rope was run out 30 m perpendicular to the shore and marked as transect number two. Sampling was always done in right hand side of the tape to avoid leaving of foot wholes in sampling side. Quadrant with 0.5 m × 0.5 m was positioned on the zero mark and on the right hand side of the tape. Cover of seagrasses within a quadrant was measured at every 3 m mark of the 30 m by walking and snorkeling until transect is completed. Transects were selected and procedure was carried out in such a way that as same as Jayasuriya 1991 conducted [12]. Then another two transects (transect one and three) were laid 10 m to the left and 10 m to the right and parallel respectively of transect two [9]. Procedure which was conducted in transect two was repeated in other two transects.

Water quality parameters including water temperature (°C), pH, salinity (ppt), conductivity (mS/cm) and dissolved oxygen (mg/L) were measured at the middle of transect two at 10 cm below to the sea surface using Multiparameter meter (Orion™ 5). GPS record of the location and the time was recorded for the future reference. Water quality testing was repeated at the same time in the same place once a month and recorded. Same procedure was repeated in other selected locations. During the survey, sea grass species were taken in to the laboratory for the identification. Seagrass species identification was done by using appropriate identification keys. Samples of each species of seagrasses were collected and herbarium sheets for each species were prepared.

Data analysis

Diversity of seagrass species of each sites were calculated using Shannon-Weiner diversity index. Percentage values of each species were calculated to compare with the values recorded [12]. Bar charts and one way analysis of variance (ANOVA) were used for the comparison. All water quality parameters recorded from six sites were compared using one way ANOVA. Linear regression was conducted to find out relationship between seagrass distribution and water quality parameters [11] using Minitab14 computer software.

Results

Eight species of seagrasses were encountered during the study period at the study area. Those were *Enhalus acroides*, *Thalassia hemprichii*, *Halodule uninervis* (narrow variety), *Halodule uninervis* (wide variety), *Siringodium isoetifolium*, *Cymodocea rotundata*, *Cymodocea serrulata*, *Halophila ovalis*, *Halophila decipiens*. Table 1 shows recorded seagrass species and the site where those were recorded. *Halophila decipiens* has been recorded only in Kalpitiya at very less quantities and *Halophila ovalis* was the only species which has been recorded in Palavi (Figures 1 and 2).

Almost all eight seagrasses species have been recorded in North Western region of Puttalam lagoon whereas nearly two species (*H. uninervis* and *H. ovalis*) have been encountered in South Eastern region. *E. acroides* was the most abundant species in Nothern Western region of Puttalam lagoon (Table 1).

Some species which had been recorded in 1991 were exclusively not recorded at few sites during present study. *S. isoetifolium* have been recorded although it had not been recorded in 1991 in Kandakuda. Comparison of percentage abundance values of seagrasses in 1991 and 2013 in North Western region and South Eastern region indicated that there was a statistical significant different ($p<0.05$) between seagrass distribution in 1991 and 2013 in both regions. Although *E. acroides*, *T. hemprichii*, *S. isoetifolium*, *C. rotundata*, *C. serrulata*, had been recorded in 1991 in South Eastern region those have not been recorded during present study (Table 2 and Figure 3).

Statistically significant difference of diversity among six sites has been recorded. Highest seagrass diversity was recorded at Kalpitiya (1.619) whereas zero diversity index value was recorded at Palavi since only one sea grass species has been recorded. The evenness for Kalpitiya (0.0529) and Kuringipitiya (0.605) were greater than the

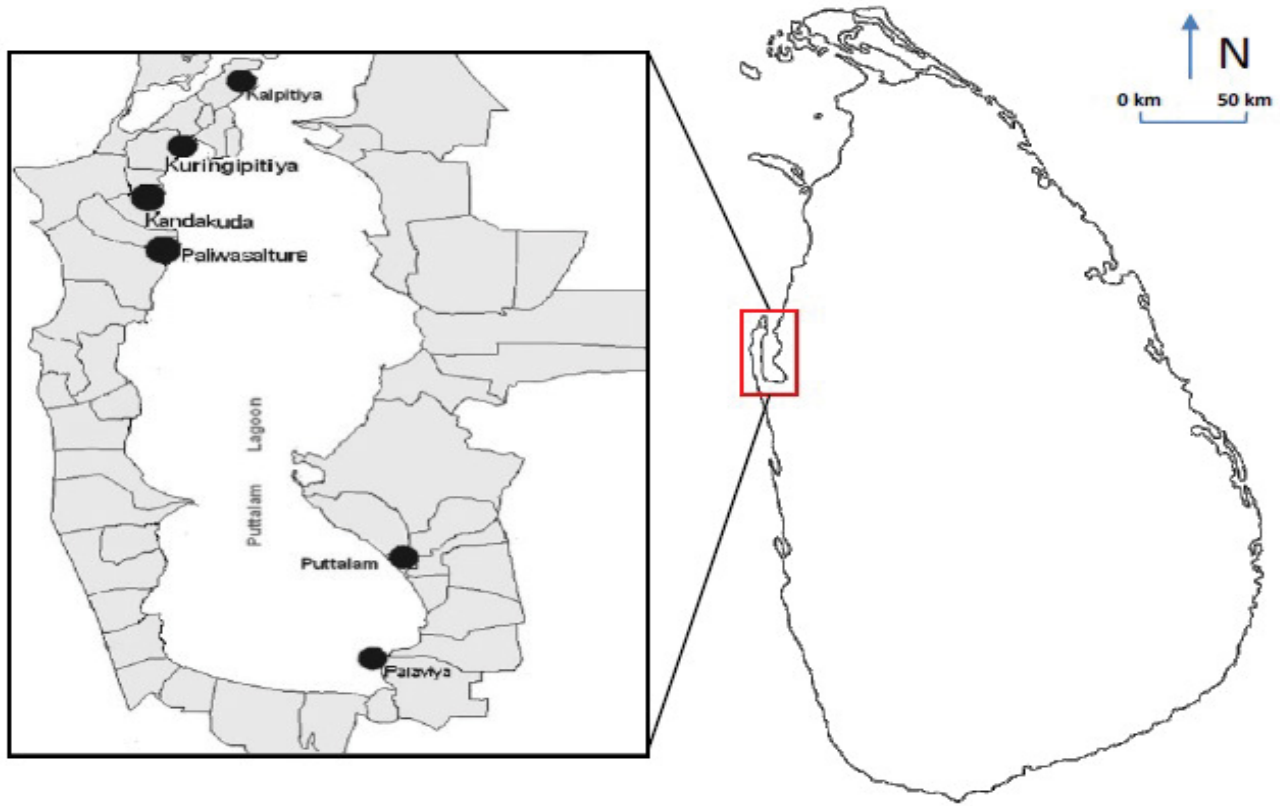

Figure 1: Locations of the study sites include Kalpitiya, Kuringipitiya, Palliwasalthurai, Kandakuda, Palavi and Puttalam.

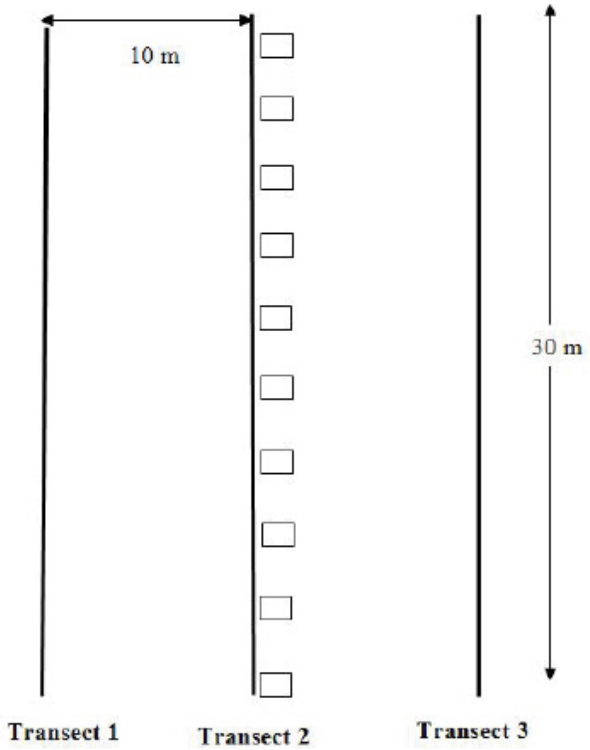

Figure 2: Layout of line transects and quadrant.

Species	Sites					
	A	B	C	D	E	F
Enhalus acroides	+	+	+	+	-	-
Thalassia hemprichii	+	+	-	+	-	-
Cymodocea rotundata	-	-	+	-	-	-
Cymodocea serrulata	+	+	-	+	-	-
Halodule uninervis	+	+	+	-	-	+
Syringodium isoetifolium	+	+	-	+	-	-
Halophila ovalis	-	-	+	+	+	+
Halophila decipiens	+	-	-	-	-	-

(+) = recorded species and (-) = not recorded species

Table 1: Seagrass species recorded with respect to the sites. A-Kalpitiya, B-Kuringipitiya, C-Paliwasalthurai, D-Kandakuda, E-Palavi, F-Puttalam.

evenness for Paliwasalthurai (0.463), Kandakuda (0.502) and Puttalam (0.314). Shannon-Wiener diversity index values indicated that the diversity of Kalpitiya was close to the diversity of Kuringipitiya whereas the diversity of Paliwasalthurai was close to the diversity of Kandakuda (Figures 4 and 5).

Statistically significant relationship ($p<0.05$) was found to exist between relative abundance of *E. acroides* and water temperature, between relative abundance of *C. serrulata, S. isoetifolium* and *H. uninervis* (wide variety) and pH of water and between relative abundance of *H. decipiens* and dissolved oxygen content of water. Other water quality parameters such as salinity and conductivity did not show relationship with abundance of seagrass species. Statistically significant relationship was found between water temperature and Shannon- Wiener diversity index values (Figures 6 and 7).

species	Sites											
	1		2		3		4		5		6	
	A	B	A	B	A	B	A	B	A	B	A	B
Enhalus acroides	+	+	+	+	+	+	+	+	-	-	-	-
Thalassia hemprichii	+	+	+	+	+	-	+	+	+	-	-	-
Cymodocea rotundata	+	-	-	-	+	+	-	-	-	-	-	-
Cymodocea serrulata	+	+	+	+	-	-	+	+	-	-	-	-
Halodule uninervis	+	+	+	+	+	+	+	-	+	-	+	+
Syringodium isoetifolium	+	+	+	+	-	-	-	+	-	-	-	-
Halophila ovalis	+	-	+	-	+	+	+	+	+	+	+	+
Halophila decipiens	+	+	-	-	-	-	-	-	-	-	-	-

(+) = recorded species and (-) = not recorded species

Table 2: Seagrass species recorded in 1991 and 2013. (1). Kalpitiya, (2). Kuringipitiya, (3). Paliwasalthurai, (4). Kandakuda, (5). Palavi, (6). Puttalam. (A-1991, B-2013).

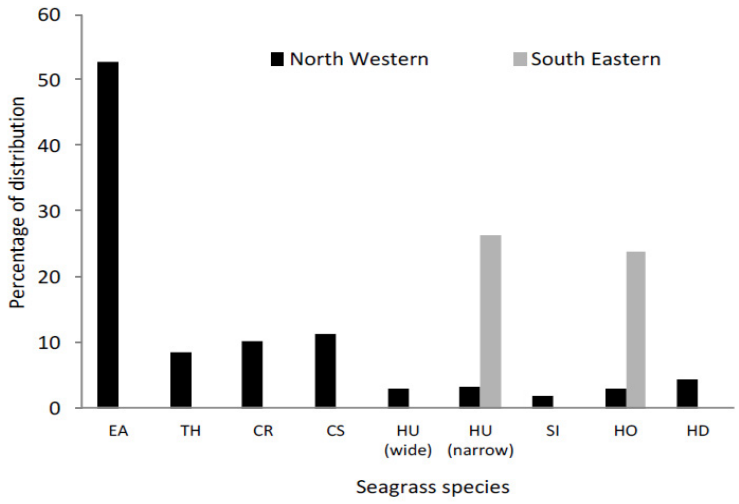

Figure 3: Distribution of seagrass species at North Western region and South Eastern region. *Enholus acroides* (EA), *Thalassia hemprichii* (TH), *Halodule uninervis* (HU), *Syringodium isoetifolium* (SI), *Cymodocea rotundata* (CR), *Cymodocea serrulata* (CS), *Halophila ovalis* (HO) and *Halophila decipiens* (HD).

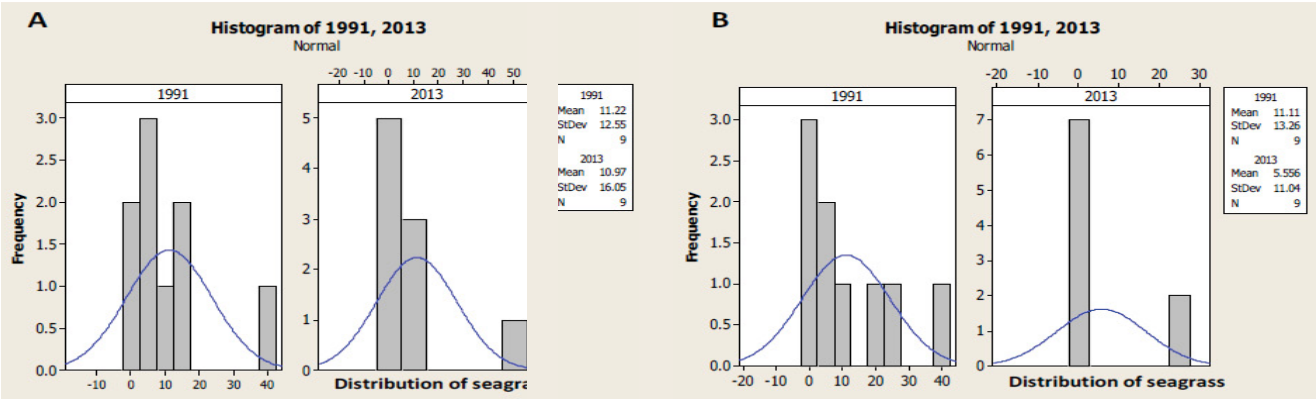

Figure 4: A). Histogram for the distribution of seagrass in 1991 and 2013, A). North Western region, B). South Eastern region.

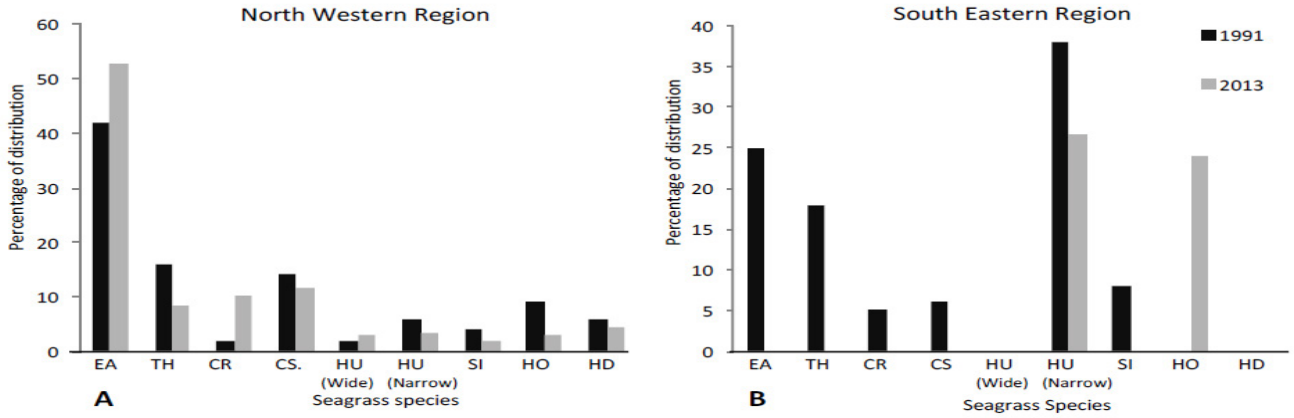

Figure 5: Bar chart for seagrass species distribution in 1991 and 2013, A). North Western region, B). South Eastern region. *Enholus acroides* (EA), *Thalassia hemprichii* (TH), *Halodule uninervis* (HU), *Syringodium isoetifolium* (SI), *Cymodocea rotundata* (CR), *Cymodocea serrulata* (CS), *Halophila ovalis* (HO) and *Halophila decipiens* (HD).

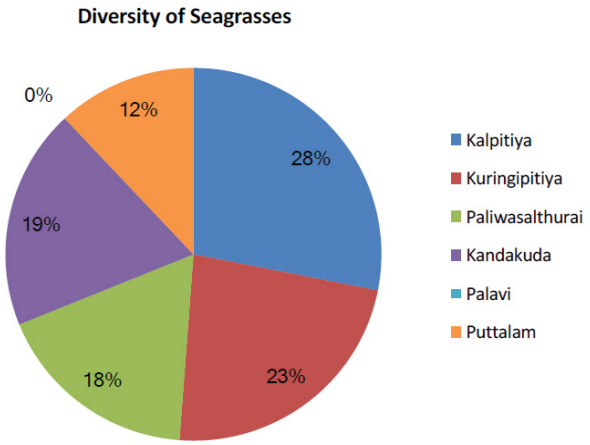

Figure 6: Pie chart for diversity of Seagrasses at six sites.

Figure

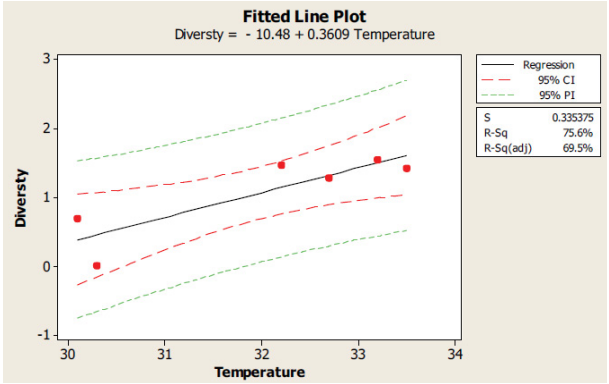

Figure 7: Relationship between diversity and water temperature of six sites in Puttalam lagoon.

Discussion

There have been recorded decline of seagrass species distribution from 2013 in both regions but degradation of seagrass distribution in South Eastern region is greater than North Western region because some species have been totally vanished from that region. Anthropogenic activities such as nutrient loading and sediment loading are confined the access to available plant resources [8,9]. High loading of sediments and dipping holes for fishing activities were observed during the study. Also stated that, although a high biodiversity in Puttalam lagoon, due to several anthropogenic activities [8] such as expansion of salt pans, unsustainable fishing practices, expansion of settlement and other infrastructures, establishment of prawn farms and excessive use of agrochemicals these ecosystems including tidal flats, sea grass beds, sand dunes and coral reefs have been degraded during past few decades. Six sites were homogeneous with respect to salinity, dissolved oxygen whereas six sites were heterogeneous with respect to temperature, pH and conductivity. The salinity level of water in both parts of the lagoon was around 30-34 ppt. According to salinity level of water in Eastern part of the lagoon is fairly low and salinity level in the South Western part is considerably high in 1991 [12], but during the present study that much of a salinity difference was not recorded. It would be affected by the climatic conditions (high wind and water current) and area which was covered for the sampling during study period. Therefore, a relationship between seagrass distribution and salinity of water was not found during the present study. Seagrass species which had been recorded [12] such as *E. acroides, T. hemprichii*, *S. isoetifolium*, *C. rotundata* and *C. serrulata* were not encountered in South Western region during the present study. This could be due to the seasonal changes in the physicochemical environment which confined occurrence of *marine angiosperms* [11]. Zero diversity was recorded in Palavi which is composed of only *H. ovalis* within study site. It can be due to the climatic conditions and area which was covered for the sampling during study period. There was high wind and water current during study period and those might have been affected on the final results [11]. Extensive areas of Puttalam lagoon shows soft muddy bottom. Seagrasses were not encountered at the first 10 m from shore to seaward in North Western region where as seagrasses have recorded with in first 5 m in South Eastern region. According to the present study the seagrass distribution has changed during 1991 to 2013 and there is an effect on water quality due to the distribution pattern of some seagrass species. *Enhalus acroides* and *Halophila ovalis* are widely distributed whereas *Thalassia hemprichii*, *Halodule uninervis*, *Syringodium isoetifolium*, *Cymodocea rotundata*, *Cymodocea serrulata* and *Halophila decipiens* were found in low quantities.

Conclusion

Distribution pattern of seagrasses were influenced by the nature of the habitat and physicochemical parameters of the lagoon significant relationship have been recorded only for few species of seagrasses only with some water quality parameters. Physical parameters such as temperature, salinity, waves, currents, depth, substrate and day length influence on the physiological activities of seagrasses. In general, seagrasses of Puttalam lagoon are well distributed but increase in water temperature, anthropogenic activities due to wide ranging reasons and decrease in seagrasses species in certain lagoon have to be addressed in a manner that is suitable for maintaining the as a nature of this destroyed ecosystem for future generations and sustainability.

Author's Contributions

TH and SCJ conceived the study, concept, and design and conducted most of the field experiments; analyzed and interpreted experimental results. SCJ and AJM contributed to the proposal for study design and supervision of the study. AD and SCK contributed with a critical.

References

1. Den Hartog C, Kuo J (2000) Seagrasses, a profile of an ecological group. Biol Mar Medit 7: 3-17.
2. Tampa bay estuary program (tbep) (2006) charting the course, the comprehensive conservation and management plan for tampa bay. st. Petersburg, Tampa bay estuary program 151.
3. Hilconida CP, Menez EG, Ronald PC (1983) Seagrasses from the Philippines. Smithsonian institution press, city of Washington.
4. Johnson P, Jhonston R (1995) Productivity and nutrient dynamics of tropical seagrass communities in puttalam lagoon, Sri Lanka. Royal Swedish Academy of Sciences 24: 411-417.
5. Pathirana KPP, Kamal ARI, Riyas MC, Safeek ALM (2008) Management of coastal resources in Puttalam lagoon, Sri Lanka. COPEDEC VII, Dubai, UAE.
6. Dayaratne P, Linden O, De Silva R (1995) The Puttalam/Mundal estuaries system and associated coastal waters; a report on environments degradation resource management issues and options for their Solutions, NARA, Colombo.
7. Dayaratne P, De Silva RN, Linden O (1995) Puttalam lagoon and Mundal lake, Sri Lanka: a study of coastal resources, their utilization, environmental issues and management options. Swedish Academy of Sciences, Allen Press 24: 391-401.
8. IUCN (2008) Ecological and socio-economic assessments of selected sites of the Puttalam lagoon area.
9. Campbell SJ, McKenzie LJ (2002) Manual for community (citizen) monitoring of seagrass habitat.
10. De Silva MWRN, Ranathunga RAS (1987) Seagrass beds of the Negombo lagoon. Natural resources, Energy and science Authority of Sri Lanka, (NARESA/EN/85/1).
11. Amarasinghe MD, De Silva KHWL (2007) Substrate characteristics and species diversity of marine angiosperms in a micro-tidal basin estuary on the west coast of Sri Lanka. J Aquat Sci 12: 103-114.
12. Jayasuriya PMA (1991) The species composition, abundance and distribution of seagrass communities in Puttalam lagoon. Vidyodaya J Sci Colombo 3: 93-102.