



Seagrass Diversity and Distribution in Coastal Area of Kampot Province, Cambodia

OUK VIBOL

Fisheries Conservation Department, Cambodia
E-mail: ouk.vibol@online.com.kh

SO NAM

Inland Research and Development Institute, Cambodia

LIM PUY

Ministry of Water Resources and Meteorology, Cambodia

PICH SEREY WATH

Community Fisheries Development Department

Received 10 March 2010

Accepted 25 July 2010

Abstract The seagrass species diversity and distribution were evaluated in the coastal area of Kampot Province, Cambodia. Observations of general environmental conditions which support seagrass growth are included. The samples were taken from 960 points within the seagrass area with quadrat method. Twelve seagrass species were reported. They are: *Halodule uninervis*, *Cymodocea rotundata*, *Halophilla decipiens*, *Syringodium isoetifolium*, *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila ovalis*, *Cymodocea Serrulata*, *Halophila beccarii*, *Halophila minor*, *Ruppia maritima* and *Halodule pinifolia*. Of the twelve species, *Halodule uninervis* was the most dominant and was widely distributed along the coastline of Kampot. Based on survey and data analysis, less number of seagrass species occurred in the shallower water depth (0.1-1 meters) and deeper water depth (4-7 meters), whereas more species occurred in the water depth of 1-3 meters. Four species; *Halodule uninervis*, *Cymodocea rotundata*, *Halophilla decipiens*, *Syringodium isoetifolium* widely distribute everywhere. The seagrass coverage in the area is correlated with water depth. The higher seagrass coverage was found in the shallow water whereas the lower seagrass coverage was found in the deeper water.

Keywords seagrass diversity, coastal, Cambodia

INTRODUCTION

Seagrasses provide a vast array of services to Cambodia including fishing for critical food resources, coastal protection, tourism and biodiversity. They also provide important habitats essential in sustaining the marine fisheries of Cambodia. Seagrasses are submerged flowering plants (Nguyen, 2007) and they have leaves, stems, roots and rhizomes and can reproduce both asexually, through the production of new shoots along the rhizome, and sexually through seed producing flowers. Fortes (2006) mentioned that seagrasses grow and complete their life history submerged in either brackish or marine water. Seagrass meadow usually occurs in shallow water, sheltered soft-bottomed marine coastlines and estuaries of the world (Kirkman, 1990). These meadows may consist of multi-species communities of up to 12 species (Kirkman, 1985). Kuo and McComb (1989) stated that there are only 58 species of seagrass described worldwide, within 12 genera, 4 families and 2 orders. Furthermore, 18 species of seagrass in total are recorded from the coastal waters of the South China Sea (UNEP, 2004), 12 species of seagrass from seven genera and three families are found in Marine water of Thailand (Khanjanapaj et al., 1996).

Recent survey conducted by the Fisheries Administration (2004) provided the baseline information about the distribution of seagrass locality, species diversity in some coastal areas of Cambodia, but the species abundance, distribution over time are largely unknown as yet. DoF (2004)

reported that totally, six species of seagrass have been reported in Kampot: *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila decipiens*, *Syringodium isoetifolium*, *Cymodocea rotundata*, *Halodule uninervis*. With this regards, the information on seagrass diversity and distribution is a necessary prerequisite to manage seagrass resources effectively and successfully.

Main objectives of the study are to determine species composition and distribution of seagrass in Kompot's costal area, to observe the percentage of coverage species by using quadrat as a key tool and to observe the species composition in different water depth.

METHODOLOGY

The study was carried out in coastal area of Kampot Province, where seagrass lays out from Trapiang Ropove to Kep Municipality which covers 20,000 ha. The survey on seagrass distribution and species composition index (SCI) was carried out along the stretch of coastal area in Kampot province in order to better understanding of the current status of seagrass distribution and species index. Three main parameters were collected: percentage cover of seagrass, species composition and depth.

The survey used the existing seagrass map to produce a series of grid maps with 900 survey points indicated (Fig. 1). The deviation from each grid in each series of survey map was 500 meters in rectangular shape. By using this map, in each survey point the survey checked to find out species of seagrass, percentage cover of seagrass, height of each seagrass species, and water depth. The survey also used:

- GPS to find out the survey points
- Seagrass percentage cover sheets to identify percentage cover of seagrass at each point
- Species identification sheet to identify species composition at each point
- A ruler to measure the height of seagrass
- Measurement line to measure the depth of water at the points

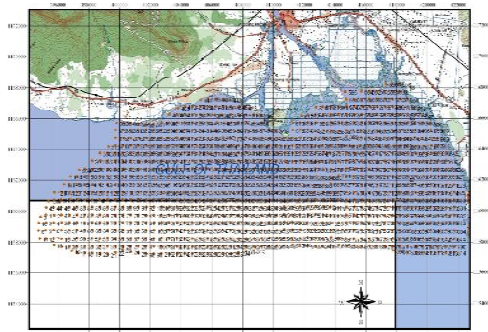


Fig 1 Map with survey point

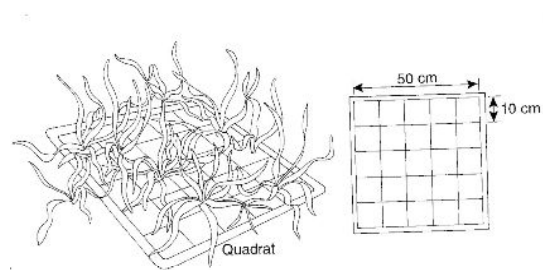


Fig 2 Quadrat Method used at survey point

For sampling of seagrass species, density and coverage, the appropriate method is Quadrat Method. It can be used in areas with a more or less homogeneous seagrass distribution, in which the environmental gradient is more or less uniform. In this type, random sampling can be done. The quadrat size so far determined is 1/4 of a square meter or 0.25 m² or 50 cm x 50 cm. For the method developed by Saito and Atohe (1970), and is subdivided into twenty five (25) 10 cm x 10 cm areas.

RESULTS

Seagrass Diversity

Based on the research, 12 species of seagrass belonging to seven genera and two families were found within the Kampot coastal area. They are as follows.

Family: Cymodoceaceae

Halodule uninervis: It had two forms, normal leaf 3-4 mm wide and narrow leaf 1-2 mm wide. The plant was growing as a nonspecific stand and in mixed vegetation with other species. This species occurred in shallow water down to a depth of 4 m on muddy-sand. This species is used as food by Dugong and good habitat for spawning and feeding ground for fish and invertebrates. This species was widely distributed everywhere in Kampot coastal area, from Trapiang Ropov to Kep province.

Halodule pinifolia: This species has very tiny and long leaf with the width varied from 0.25 to 1 mm and with length varied from 20 to 25 cm. Generally the leaf blade grows from the main root and then divides to two leaves at the other side. Normally this species has flower and fruit, but they were not found during the species identification. Among the 12 species found in this area *Halodule pinifolia* is very less dominant but good for feeding ground for Green turtle. It is found within 1.5-2 m water deep.

Cymodocea rotundata: The leaf is long and flat. The leaf is 2-4 mm wide and 7-15 cm long and the ended leaf is shiny and hard shape. The root is long and shiny. There are skins at the base of the trunk. The species is the second dominant and found every water depth at sandy bottom with dead coral fragment.

Cymodocea serrulata: This species is of moderate size, larger than *Cymodocea rotundata*. The leaf is flat and straight with 5-9 mm wide and 6-15 cm long and the leaf ended in a saw shape. The leaf blades are more curved than those of *C. rotundata*. There are skins at the base of the trunk. This species grows in muddy sand and sand with dead coral fragment.

Syringodium isoetifolium: The leaf looks like the leaf of onion with diameter of 1-2 mm. The leaf is long from 7-30 cm and leaf end is sharp-pointed. There are two to three leaves on each branch. This species grows in muddy-sand substrate and either as unspecific or mixed with *H. uninervis*.

Family: Hydrocharitaceae

Thalassia hemprichii: The flowers and seeds were not found and the seed sometimes is used as food for human consumption. The leaf is curved and flat. Each leaf had 10-17 leaf blades. The skin at base of trunk is 3-7 cm long and the bulb is big, up to 5 mm. This species grows in muddy-sand and dead coral fragment.

Enhalus acoroides: This is the largest species among 12 species found in Kampot Province. The flower and fruit were found during the survey. The leaf is thick, flat and long with the width of 1.25-1.75 cm and the length is 30-150 cm. The base of the trunk is big and covered by black long tiny roots. The species grows in muddy-sand substrate.

Halophila ovalis: The leaf is elliptical shape and 5-20 mm long. The leaf had more than 12 leaf blades. This species was small and with delicate root. The species grows in different substrate, varied from sand, muddy-sand to dead coral substrate. It was very hard to see as it can not stabilize the substrate and sometimes was covered by sand or mud. The species is very good food for dugong.

Halophila decipiens: The leaf is transparent and elliptical in shape with a length of 1-2.5 cm. The leaf is covered by tiny hair. Each leaf has 6-8 leaf blades. The species grows on the coral dead fragment, normally found in deeper water.

Halophila minor: This is the smallest species in the coastal area of Kampot. The leaf is elliptical in shape and less than 3 mm long. Each leaf has 10-12 leaf blades. The root is long and covered by tiny hair and it grows on muddy-sand mixed with *H. ovalis*.

Other species: Two more species are under investigation; these may become identified as *Halophila beccarii* and *Ruppia maritima*.

Species Distribution

Species Coverage

Results from the survey showed that 12 species of seagrass were found in the Kampot coastal area from 0.1 to 7 meter deep (Table 1). The dominant species significantly was *Halodule uninervis* 34.28 percent, followed by *Cymodocea rotundata* 18.91 percent, *Halophila decipiens* 17.20 percent while the lowest distribution was *Halodule pinifolia*, *Ruppia maritima* and *Halophila minor* with

percentages of 0.11, 0.23 and 0.34, respectively. ANOVA statistical test showed that there was a significant difference ($P < 0.05$) of species composition between water depth and species cover.

Table 1: Average Species diversity and composition in the Coastal Area of Kampot

Species	Composition	Rank	Species	Composition	Rank
- <i>Halodule uninervis</i>	34.28	1	- <i>Halophila ovalis</i>	4	7
- <i>Cymodocea rotundata</i>	13.91	2	- <i>Cymodocea Serrulata</i>	3	8
- <i>Halophilla decipiens</i>	13.20	3	- <i>Halophila beccarii</i>	2.5	9
- <i>Syringodium isoetifolium</i>	13	4	- <i>Halophila minor</i>	0.34	10
- <i>Enhalus acoroides</i>	9	5	- <i>Ruppia maritima</i>	0.24	11
- <i>Thalassia hemprichii</i>	6	6	- <i>Halodule pinifolia</i>	0.11	12

Distribution of species composition by water depth

Following are the results of the average species composition and coverage at different water depths.

Species composition and coverage at water depth of 0.1-0.5 meter: Within this water depth, 3 species were found and the dominant species was *Halodule uninervis* with the average species composition of 67.17%. The least dominant species were *Halophila ovalis* and *Enhalus acoroides* which contributed 28% and 19.56% respectively.

Based on data analysis, the average percentage cover of the seagrass in the area was 36%, in which *Halodule uninervis* contributed up to 28%.

Percentage of species distribution and coverage (0.5-1 meter deep): At 0.5 to 1 meter water deep, 4 species occurred. *Halodule uninervis* was still the dominant species with 62.11%. *Cymodocea rotundata*, *Syringodium isoetifolium* and *Enhalus acoroides* were also found but with lower species composition. The survey showed that the percentage cover in this area was significantly higher. Based on data analysis the coverage of seagrass in this area was 76%, in which *Cymodocea rotundata* covered more area compared to other species. The higher seagrass coverage would lead to higher marine species diversity.

Percentage of species distribution and coverage (1-1.5 meter deep): Based on the data analysis, from 1 to 1.5 meter water deep, 6 species were found; they are *Halodule uninervis*, *Halophila decipiens*, *Enhalus acoroides*, *Cymodocea rotundata*, *Syringodium isoetifolium* and *Halophila ovalis*. Based on data analysis, *Halodule uninervis* was still the dominant species which contributed up to 33.33% and this was followed by the new species, *Halophila decipiens*, which contributed at 30.56%. The compositions of the other species were significantly lower. The analysis also showed that the coverage of seagrass in this area was significantly lower than in the water depth of 0.5-1 meter, but still at a good level (44.11%). The highest contributions of species coverage were *Halodule uninervis* (15%) and *Halophila decipiens* (10%). The least species coverage was *Syringodium isoetifolium*.

Species composition and coverage at water depth of 1.5-2 meter

Based on the survey, between 1.5 and 2 meter water depth, more species occurred. Based on data analysis, the dominant species was *Enhalus acoroides* with the species composition of 35.43%, followed by *Halodule uninervis* (27.13%), *Cymodocea rotundata* (20.21%) and *Cymodocea rotundata* (12%). Other species such as *Halodule pinifolia*, *Syringodium isoetifolium* and *Halophila decipiens* were very low.

In this area, the coverage was lower (34%), it was significantly lower than at the water depth of 0.5-1 meter but similar to the coverage at the water depth of 1-1.5 meters. The dominant species in the area were *Enhalus acoroides*, *Halodule uninervis* and *Cymodocea rotundata*.

Species composition and coverage at 2-2.5 meter depth: From 2 to 2.5 meters water deep, based on data analysis, 9 species were found. The largest species contribution was significantly found with *Halodule uninervis* which amounted of 47.42% and followed by *Cymodocea rotundata* which amounted to 20% on average and *Enhalus acoroides* at 10%. The lower species occurring in the area were *Halophila decipiens*, *Halophila minor*, *Cymodocea serrilata*, *Halophila ovalis* and *Syringodium isoetifolium* which each contributed 0.5-6% only. In this area *Thalassia hemprichii* was found. Based

on the data analysis, the cover of the seagrass in this area was low, at 30.4% only. The highest species cover was *Halodule uninervis* which covered only 10% followed by *Cymodocea rotundata* of 8% and *Enhalus acroroides* of 6%.

Species composition and coverage at 2.5-3 meter deep: Based on the data analysis, 9 species occurred at the water depth of 2.5 to 3 meters and the status and condition of these species were similar to that which occurred at the water depth of 2 to 2.5 meters. The dominant species in terms of species composition was *Halodule uninervis* which contributed 40.5%. The second and third dominant species were *Cymodocea rotundata* and *Enhalus acroroides* which contributed 20% and 15%, respectively.

The analysis also showed that the coverage of the species in this area was low, covering 27.23% only. The highest species coverage was *Halodule uninervis* which contributed 9%, followed by *Cymodocea rotundata* and *Enhalus acroroides*. Another 5 species such as: *Halophilla decipiens*, *Halophila minor*, *Halophila ovalis* and *Cymodocea serrulata* were also found and their contribution was very low in species composition and coverage.

Species composition and coverage at 3-3.5 meter deep: At 3 to 3.5 meter deep, 8 species were found, such as *Halodule uninervis*, *Cymodocea rotundata*, *Enhalus acroroides*, *Halophila ovalis*, *Halophila beccarii*, *Cymodocea serrulata*, *Halophila decipiens* and *Syringodium isoetifolium*. Among these 8 species, *Halodule uninervis* (45.36%) was still the most dominant one, followed by *Cymodocea rotundata* (20%). A new species, called *Halophila beccarii*, occurred at this depth. Based on data analysis, the coverage of the species in this area was also low (25.7%) compared to shallower water.

Species composition and coverage at 3.5-4 meter deep: At 3.5 to 4 meter deep, the number of seagrass species declined from 8 to only 6. Among these *Cymodocea serrulata* and *Enhalus acroroides* disappeared. *Halodule uninervis* was still the dominant species which contributed up to 42% and followed by *Cymodocea rotundata* (31%). The other 4 species; *Halophila decipiens*, *Halophila beccarii*, *Halophila ovalis* and *Syringodium isoetifolium* contributed less. However, the coverage of these species in this area was still quite abundant, covering an area of about 40%. Among the coverage, *Halodule uninervis* covered a significantly larger area, followed by *Cymodocea rotundata* (4.7%), *Halophila decipiens* (5%), *Halophila beccarii* (3.2%), *Halophila ovalis* (3.1%) and *Syringodium isoetifolium* (0.03%).

Percentage of species composition and coverage at 4-4.5 meter deep: In the deeper water the species diversity was low. The results of the survey, based on the data analysis, showed the number of species in this area was 4. Two species, *Halophila beccarii* and *Halophila ovalis* disappeared. The composition of *Halophila decipiens* species was the highest one (47%), followed by *Syringodium isoetifolium* and *Halodule uninervis*. Compared to other areas, the coverage of the species in this area was significantly lower. The analysis shows that the coverage of all 4 species covered 17.76% only and the rest was seaweed and free area. However, the coverage by species in this area was not significantly different and ranged from 2 to 6% only.

Percentage of species distribution and coverage at 4.5-5 meter water deep: At 4.5 to 5 meter deep, the data analysis showed that the species diversity and composition distribution was not significantly different than occurred at the water depth of 4-4.5 meter. However, the coverage of all species was significantly lower compared to shallower water.

Percentage of species composition and coverage at 5-6 meter deep: From 5 to 6 meter water deep, 3 species occurred, *Halodule uninervis*, *Syringodium isoetifolium* and *Halophila decipiens*. The species of *Cymodocea rotundata* was not found. The dominant species was still *Halophila decipiens*, followed by *Syringodium isoetifolium*. The analysis showed that the coverage of the species in this area was significantly lower; covering only 9% of the total area.

Percentage of species contribution and coverage at 6-7 meter deep: At 6-7 meter deep, 3 species occurred such as *Halodule uninervis*, *Halodule uninervis* and *Syringodium isoetifolium*. The dominant species was *Syringodium isoetifolium* and the least dominant was *Halodule uninervis*. However, based on data analysis the seagrass composition among the 3 was not significantly different. The coverage of the species in the area was also low but not significantly different from the water depth of 5-6 m.

Species composition and coverage at water depth of deeper than 7 meters: At water depths deeper than 7 meters no seagrass was found. Based on scuba diving the bottom substrate in that area was a mixture of dead coral fragment and sea shell fragment, that is not suitable for seagrass.

DISCUSSION AND CONCLUSION

There are twelve species of seagrasses in the coastal area of Kampot and most of these species provide very good habitats for spawning, feeding and nursing for fish, crustacean, snail, crab, and other vertebrates and invertebrates, especially for sea turtle, seahorse and dugong. Among ASEAN countries 16 species exist in the Philippines (Fortes, 1989), the greatest number of seagrass species amongst the ASEAN countries, 4 species in Brunei, 12 species in Indonesia, 9 species in Malaysia, 12 species in Thailand (Fortes, 1990), Cambodia is a country rich in seagrass diversity.

Among 12 species found in Kampot Province Cambodia, *Halodule uninervis* is the most dominant one and widely distributed, due to its ability to grow in a wide variety of substrates from mud, muddy-sand and sand. Moreover, the water conditions also support this species. The coverage of the species in the area correlates with water depth. The higher seagrass coverage was found in the shallow water whereas the lower seagrass coverage was found in the deeper water. This might be due to characteristics of species, supported substrate (muddy-sand or sandy-loam) and light synthesis in the water.

Species distribution ranges from 0.1 to 7 meter water deep. Three to four seagrass species occur in the shallow water from 0.1-1 meter and from 4 to 7 meters, while more species (6-8 species) occur in the water depth of 1-3 meters. Four species; *Halodule uninervis*, *Cymodocea rotundata*, *Helophilla decipiens*, *Syringodium isoetifolium* are widely distributed everywhere. This is a good for ecological system that supports many marine aquatic species.

REFERENCES

- DoF (2004) National report on seagrass in Cambodia. Cambodia.
- FiA (2004b) National report of status of seagrass in Cambodia. Fisheries Administration, No. 186, Phnom Penh, Cambodia.
- Fortes, M.D. (1989) Seagrass: a resources unknown in the ASEAN region. International Center for living Aquatic Resources Management, ICRAM Education Ser. 5, 46, Manila, Philippines.
- Fortes, M.D. (1990) Taxonomy and distribution of seagrass in the ASEAN region. Paper presented during the SEAGRAM 2: Advanced Training Course/Workshop on seagrass resources research and management, 38, Quezon City, Philippines.
- Fortes, M.D. (2006) Seagrass of the Asian sea. Poster presented the species of seagrass in Asian Sea.
- Kirkman, H. (1985) Community structure in seagrass in South Western Australia. Aquat. Bot.
- Kirkman, H. and Kuo, J. (1990) Pattern and process in Southern Western Australian seagrass. Aquat. Bot.
- Kuo, J. and McComb, A.J. (1989) Seagrass taxonomy, structure and development. In A.W.D. Larkum, A.J. McComb and S.A. Shepherd (Eds), Biology of Seagrass, 6-73, Elsevier, Amsterdam, Netherlands.
- Nguyen, X.H. (2007) Survey methods for seagrass community. Lecture introduced during Training Course on Assessment and Monitoring of Seagrass for Research Official of Fisheries Administration in Kampot, Cambodia.