FINAL REPORT

SEAGRASS TRANSPLANTING ACTIVITIES AT COASTAL AREA OF UNIVERSITI MALAYSIA SABAH, KOTA KINABLU, SABAH

BORNEO MARINE RESEARCH INSTITUTE

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Prepared by
Associate Prof. Dr. Ejria Saleh
Mr Yap Tzuen Kiat
Borneo Marine Research Institute
Universiti Malaysia Sabah

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1.0 INTRODUCTION

1.1 Seagrass

Seagrasses are flowering plants that grow in shallow sheltered coastal areas. Most of the seagrass species have long green, grass-like leaves and a buried root-like structure (rhizome) in the sediment. According to Bujang, et al (2018), there are 16 species of seagrasses in Malaysia which are *Enhalus acoroides, Halophila beccarii, Halophila decipiens, Halophila ovalis, Halophila major, Halophila minor, Halophila spinulosa, Halophila sp., Halodule pinifolia, Halodule uninervis, Cymodocea rotundata,Cymodocea serrulata,Thalassia hemprichii, Syringodium isoetifolium, Thalassodendron ciliatum, and Ruppia maritima.* Most of these seagrass species are found at coastal environment between mangrove and coral areas.

Seagrass plays an important role in a marine ecosystem. It provides food, habitat and nursery areas for countless invertebrates and fish species living within the seagrass. The overall health of coastal marine ecosystems can be determined by the condition of the seagrass communities (Ramili, et al, 2018). Seagrasses are also known for it's highly valuable ecosystem services such as stabilizing the sea bed, maintaining water quality and part of coastal protection. Not only that, seagrasses also help to stabilize the sea bottom by reducing water currents and wave force at coastal areas. The root systems of seagrass can extend both vertically and horizontally which has a similar function as the land grass that prevent soil erosion. The seagrass can filter nutrients that come from land-based industrial discharge and stormwater runoff before they are washed out to the sea and to other sensitive habitats. Seagrass habitat are mostly found at intertidal area of Kota Kinabalu coastal waters and surrounding islands.

In Sepanggar Bay, seagrass habitat can be found at UMS coastal area, Kg. Kibagu, Sabah Ports Sdn Bhd (SPSB) and naval based coastal areas. However coastal development around Sepanggar Bay contribute to the displacement of seagrass habitat. Relocation and rehabilitation of the seagrass is needed as a part of the coastal management in this area.

1.2 Threats of Seagrass

The seagrass habitat that are located near the coastal area are generally affected by natural threats and anthropogenic threats. The natural threats by physical disturbance due to wind-driven waves and/or storms cause shifting of sand and erosion (Bujang, et al., 2006). Climate change will increase global temperature and may also cause several effects on the seagrass habitat and contribute to its loss (Duarte, et. al., 2004). Climate change may intensify the natural local threats on seagrass.

Anthropogenic threats are human activities such as dumping of high nutrients into the sea causing eutrophication and high suspended sediment (Duarte, et al., 2004). As result, photosynthesis of the seagrass is affected by sunlight to penetrate less into the water column. Coastal development such as land reclamation activities at coastal areas will lead to the loss of seagrass habitats. Activities related to boating, tourism, aquaculture, ports, energy projects and housing development are also placing pressure on costal area (Unsworth & Cullen-Unsworth, 2017). The remaining seagrass areas in Sepanggar Bay is a traditional place to catch fish, gleaning bivalves and sea cucumbers by the coastal communities. Therefore, awareness programs on the importance and threats of seagrass are needed so that the ecosystem can be preserved for the coming generations.

1.3 Restoration of Seagrass

In Malaysia, the major transformation of the coastal area is required more space for the coastal development that lead to coastal reclamation. The rapid coastal development is driven by the increasing population and supporting coastal tourism activities. Among the most affected areas is the marine ecosystems including seagrass.

One of the integral parts of coastal conservation and the management strategies is marine ecosystem restoration. Seagrass restoration activities via the introduction of seagrass planting in the new areas are part of coastal management priorities (Bell, et al, 2008). Restoration of the seagrass habitats has not been widely explored as it has a lack of understating on the importance of their habitat to support the coastal ecosystem. However, the interest in seagrass restoration activates has increased in recent decades as high reclamation and development activities at coastal areas (Bourque & Fourqurean, 2014).

Seagrass restoration is geographically widespread with much efforts to replant seagrass as small planting units (Bell et al., 2008). Restoration of the seagrass can be successful if there is re-establishment of ecological attribute system such as structure, composition, and function (Bourque & Fourqurean, 2014).

The aim of the project is to safeguard Sepanggar Bay's seagrass inheritance from further degradation and impact by future development that is expected to take place within the Sepanggar vicinity including the Sabah Ports Sdn Bhd (SPSB) coastal area. The specific objectives of this project are:

i. To relocate seagrass shoots from SPSB to Kg Kibagu and coastal area of UMS.

ii. To identify the biological and physical factors that affecting the seagrass restoration

iii. To organise awareness program on seagrasses and their habitat

The seagrass restoration effort is expected to increase seagrass coverage in Kota Kinabalu's coastal area as well as lend support to marine life habitat. It involves transplanting seagrass population from donor site at Sabah Ports Sdn Bhd to a new location within the Universiti Malaysia Sabah coastal area (near the Outdoor Development Centre) and Kg. Kibagu. Failures in seagrass transplantation arise from any number of causes such as storms, animal disturbance, lack of experience by

those performing the work, insufficient light, emersion and exposure to air (Calumpong & Fonseca, 2007).

2.0 LITERATURE REVIEW

2.1 Seagrass in Sabah

In Malaysia, coastal ecosystems between mangroves and corals form the habitat for the seagrasses (Bujang et al., 2006). The structural complexity of the marine ecosystems can determine the productivity and biodiversity of areas. Various type of seagrass has a different type of characteristics and interactive community within and from the outside account for the high diversity and enable the survival of diverse marine life (Bujang, et al., 2018).

In Sabah, there are 12 species of seagrass occupying substrates ranging from sandy, muddy-sandy to coral rubble of the intertidal zone down to a water depth of 2.5 m (Bujang, et al., 2006). Sepanggar Bay consists of inter-tidal area mixed associations of seagrass species; *Enhalus acoroides, Cymodocea rotundata, Halodule uninervis, Halophila ovalis and Thalassia hemprichi.* (Murshidi, et.al 2018). However, the dominant seagrass species in SPSB is *Enhalus Acoroides* (Figure 1).

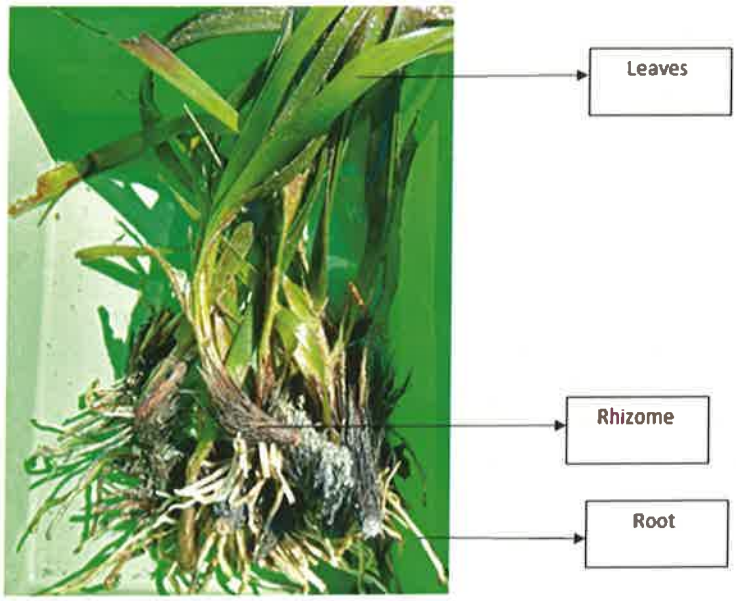

Figure 1: Dominant seagrass species, *Enhalus Acoroides* in SPSB

Enhalus acoroides is belongs to hydrocharitaceae family which is also known as tape seagrass. It is a perennial plant with underground thick rhizome with long black bristles and cord-like roots and long strap-like leaves that are 12 cm wide and 30-150 cm long (Lanyon, 1986). Usually, this species found on shallow sandbanks that are also often adjacent to mangrove forests and widespread in the tropical part of the Indian Ocean, Western Pacific Ocean, Malay Archipelago and the Philippines (Boisset & Ferrer-gallego, 2016).

2.2 Seagrass Transplanting

There are several ways to restore or rehabilitate the seagrass ecosystem. This includes the harvesting and transplanting seagrass plant with monitoring of restored sites or new planting area. Seagrass transplanting is the transfer of seagrass plants from one location to another location (Calumpong & Fonseca, 2007). This activity is labour intensive and requires divers during the planting and monitoring activities.

Seagrass transplanting methods can be grouped into three categories which is shoots with sediment intact that known as cores or plugs method, seeds and shoots with bare roots (Davis & Short, 1997). The cores or plugs method is the seagrass plugs with attached sediment and planted using core tubes of various sizes (Christensen, et. al, 2005). This method allow well developed seagrass root and rhizome system remain intact (Davis & Short, 1997).

The seeds methods is seagrass seeds are collected by taking reproductive shoots from natural beds and the shoots stored in seawater until the seeds mature and released (Davis & Short, 1997). This method may reduce human impacts on the seagrass at donor site and less laborious (Christensen et al., 2005). Sprig method is the seagrass rhizome with roots, shoots and leaves transplant into another area (BMT Oceanica Pty. Ltd., 2013). The shoots are planted singly or in group, with or without the anchor such as nail or a piece of steel (Davis & Short, 1997).

Transplantation of seagrass in this project involves the mature plants taken from healthy donor beds to the restoration site. The suitable conditions that have been established for seagrass survival are set at the restoration site. Seagrass transplantation should be used only to restore or rehabilitate seagrass beds lost due to human activities, including a reduction in water clarity, mining, dredging, fishing gear and vessel-related injuries, or for experiment manipulation (Calumpong & Fonseca, 2007).

2.3 Factors Affecting Seagrass Growth

The growth and survival of seagrass after transplanting might vary in different places and it also depends on the selection of the site. The major limitation on survival of transplanted seagrass that has been identified is poor site selection of transplanting area (Short, et al., 2002). Physical, chemical and biological properties of the environment effects the growth and distribution of the seagrass (Greve & Binzer, 2004). Physical and biological factors include excess water movement and bioturbation by burrowing organisms (Fonseca, et al., 1996). The biological factors is also contributed by the grazing of turtle and dugong that affects the seagrass growth. The combination of these factors can greatly reduce the survival and reproduction of both naturally occurring and transplanted seagrass (Philippart, 1994).

3. 0 METHODOLOGY

3.1 Study Area

Seagrass restoration project was carried out at Sepanggar Bay, Kota Kinabalu, Sabah, Malaysia (Figure 3.1). The seagrass species that are identified in that area are *Enhalus acoroides* and *Cymodocea rotundata*. Future development of the surrounding area of this seagrass may contribute to the seagrass degradation in this area. Seagrass restoration activities in this project are using bare roots method (sprig method).

Seagrass donor site is located at Sabah Ports Sdn Bhd (next to Sepanggar Bay Oil Terminal) while the planting site is in Kg. Kibagu and Universiti Malaysia Sabah (UMS) coastal area. Seagrass species identified in this coastal area are *Enhalus acoroides, Cymodocea rotundata, Halodule uninervis, Halophila ovalis* and *Thalassia hemprichii* (Murshidi, et al., 2018). Therefore, seagrass transplanting activities were implemented in this area as the current seagrass can adapt well with their surrounding environment. The new seagrass restoration activity may enhance the seagrass area in the donner site.

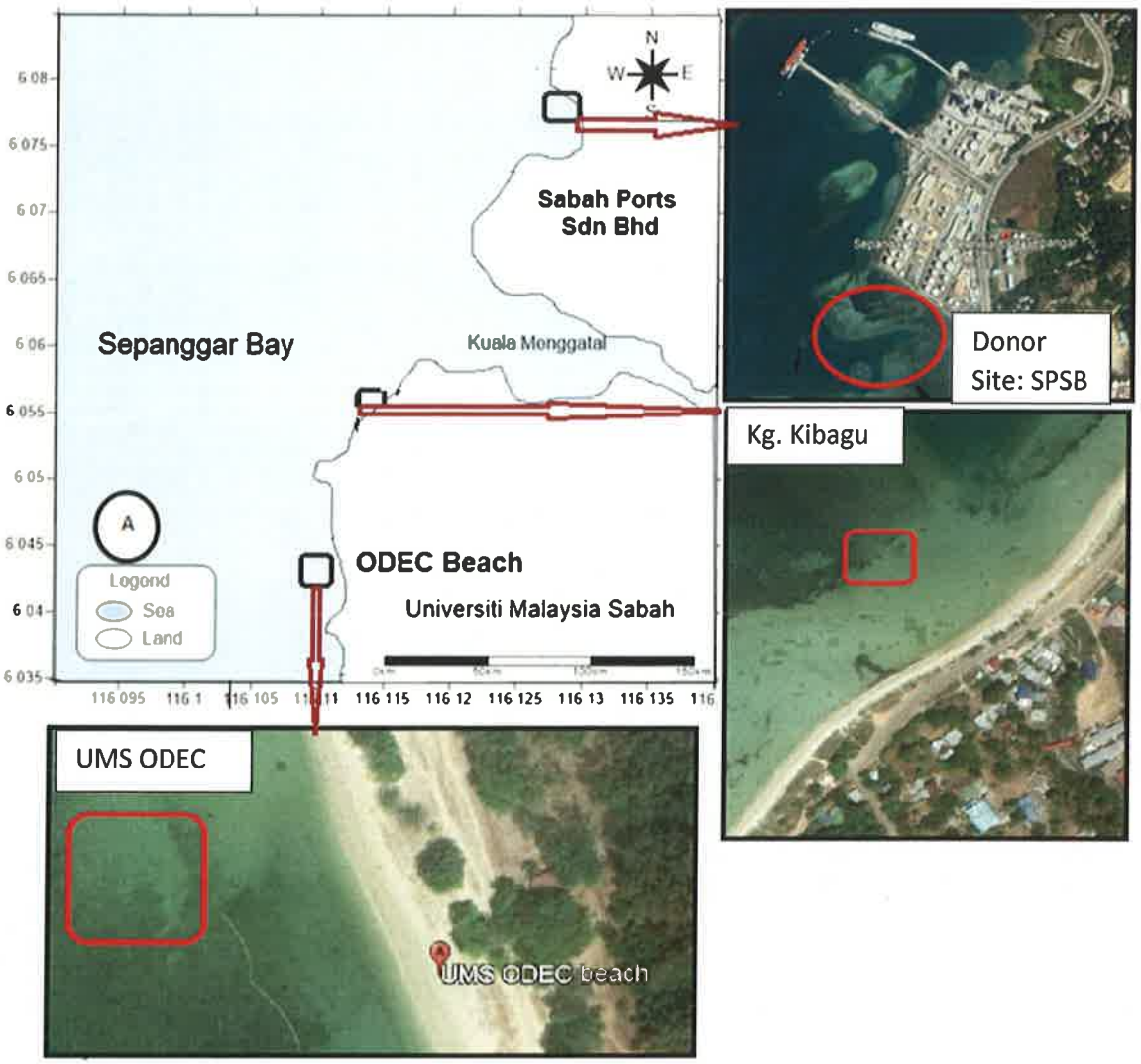

Figure 3.1 Location of the projet area, showing the donor site at Sabah Ports Sdn.Bhd and transplanting sites at UMS ODEC Coastal area and Kg Kibagu (Source: Google Map)

3.2 Transplanting Method

The shoot blades of the seagrass was uprooted by digging the rhizome by hand. The seagrass rhizome from the donor site were counted and placed in a container to minimize the disruption of root-rhizome, prevent exposure and desiccation of the seagrass that have been collected stored with a small amount of seawater (Vichkovitten, et al., 2016).

The transplanting sites at ODEC-UMS and Kg. Kibagu were chosen randomly based on the suitability of the sediment and space. However, the spacing intervals between seagrass shoot is estimated about 12 cm. The transplanting activities were carried out during low tide and daytime regardless of planting convenience. The sediment was dug by using spade/shovel then one or two mature seagrass shoots is placed into the sediment by using bare hand. The seagrass transplants were carried out by phases and following the tidal cycle (Table 3.1).

3.3 Implementation of the project

The activities of this project were carried out based on it objectives. Most of the relocated seagrass shoots from SPSB to Kg Kibagu and coastal area of UMS activities were carried out between February and June 2019 (between the end of inter monsoon and early south west monsoon) during low tide. In the meantime monitoring on the planted seagrass for biological and physical factors that affects the seagrass survival were carried out between February and August 2019. Awareness program on seagrasses and their habitat were also organised within the project period September 2018 to September 2019.

Table 3.1: Tidal condition during transplanting and monitoring activities

Month	**Water level (M)**
22-23 January 19	0.1 – 0.3
21-22 February 19	0.3 – 0.4
20-21 March 2019	0.7 – 0.8
14 April 2019	0.7 – 0.8
4 May 2019	0.7 – 0.8

The planted seagrass was monthly monitored after the transplanting activities. The biological and physical impacts on seagrass were identified by snorkelling and taking picture. The biological impact was determined based on the present of marine organisms at that area while the physical impacts were identified based on the physical condition of the seagrass. The total number of remaining plants were monitored and counted to observe the survival rate of the seagrass.

3.3 Awareness program

This project has organised a number of awareness program. The main objectives of these programs are to spread information on important of seagrass as habitat and natural shoreline protection. The target group of the program are school children, youth and adults from different agencies.

4.0 RESULTS AND DISCUSSION

4.1 Seagrass Relocation activities

Relocation of seagrass from SPSB to other coastal area of Sepanggar Bay were carried out between January to June 2019 (four months) (Figure 4.1). Area selected for transplanting site are Kg Kibagu in January 2019 and the rest of the months were planted in coastal area of ODEC-UMS.

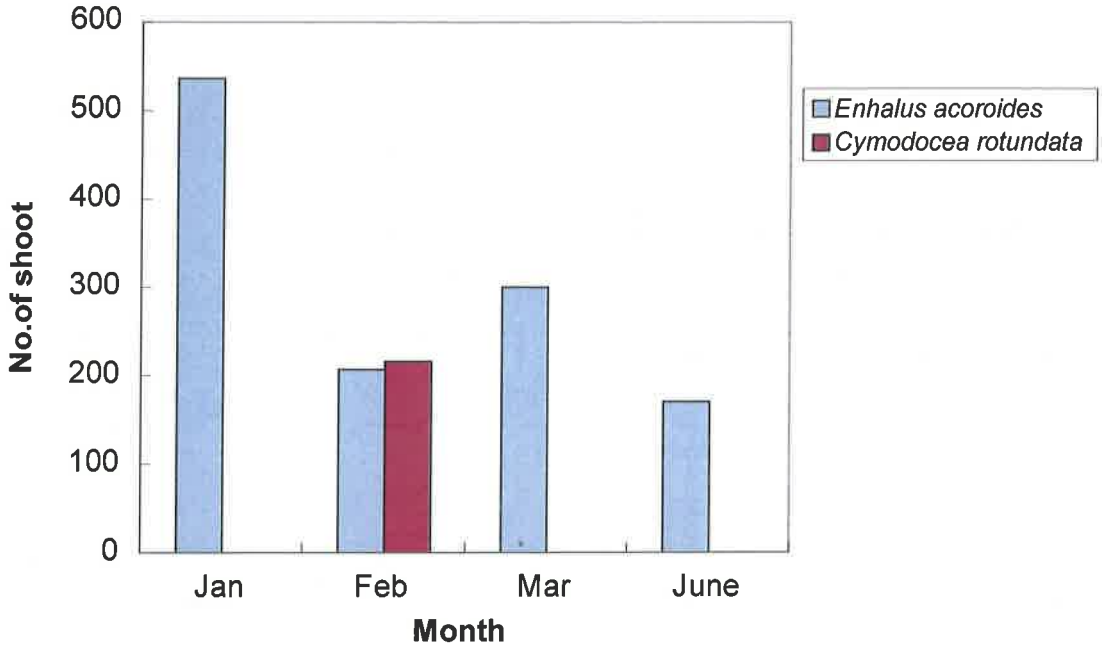

Figure 4.1: Number of transplanted seagrass shoots planted between January and June 2019

The highest seagrass shoots (536 *Enhalus Acoroides* shoots) was planted in January 2019. There were two species of seagrass that have transplanted in February which includes 206 shoots of *Enhalus acoroides* and 216 shoots of *Cymodocea rotundata.* Only seagrass from *Enhalus Acoroides* species was transplanted in March and June 2019 with number of shoots planted of 300 shoots and 170 shoots, respectively. There were no transplanting activities in April and May 2019 due to high water level and jelly fish bloom season.

Planting of seagrass were carried out by staffs from Sabah Ports Sdn. Bhd., Suria Holding Berhad., postgraduate and undergraduate students from Universiti Malaysia Sabah, Universiti Malaysia Sarawak as intent students, Universiti College Sabah Foundation (UCSF). Study on seagrass area in SPSB and monitoring of planting seagrass were also assessed as part of undergraduate final year projects. Some pictures taken at seagrass donor site and planting activities are in **Appendix 1-2.**

The planted seagrass was monitored between February to August 2019 show that the percentage of survival was reducing to almost 60% after 5 months of planting (Table 4.2).

Table 4.2: Monitoring of transplanted seagrass in between February to August 2019

Date	No of shoot	Species	Transplanting site	Feb (Status)	Mar (Status)	April (Status)	July (status)	August (status)
22.01.19	278	*Enhalus acoroides*	Kg Kibagu (Blue House)	uprooted	20%	*	*	*
23.01.19	258	*Enhalus acoroides*	Kg Kibagu (Mid)	uprooted	Unsure	*	*	*
21-22.02.19	206	*Enhalus acoroides*	ODEC (Mid)		80%	80%	72%	66%
	216	*Cymodocea rotundata*	ODEC (Mid)	uprooted	0%	0%	0%	0%
20-21.03.19	300	*Enhalus acoroides*	ODEC (South)			90%	81	74%
TOTAL	**1042**	***Enhalus acoroides***						
	216	***Cymodocea rotundata***						

*** Turbidity high, unable to observe**

4.2 Physical and Biological factors affecting seagrass

Challenges identified during the transplanting of seagrass shoots at UMS Coastal areas are wave actions and tidal currents. Strong currents and wave actions could contribute to the re-suspension and transport of the sediment at planting site. This process causes uprooting of the seagrass shoots detached from the seabed. The monitoring periods (July and August 2019) were encountered rainy season and increase suspended sediment from land area end up at sea including Sepanggar Bay. Suspended sediment covered the seagrass leaves and prevent photosynthesis (Figure 4.2) especially the newly planted seagrass. According to Brodersen, *et al.* (2017), the small reductions in light availability can cause pronounced declines in distribution and growth of the seagrass meadows.

Figure 4.2 Suspended sediment cover the seagrass leaves

Bioturbation activities (Figure 4.3) are also one of the factors that influencing seagrass transplanting success and decreasing its survival at the new area. The presence of sediment burrowers such as worms, snail and clam around the study area cause uprooting of the transplanted seagrass. According to Lanuru, et al. (2018), bioturbation was noted as one of the factors affecting the natural seagrasses and transplanted seagrasses.

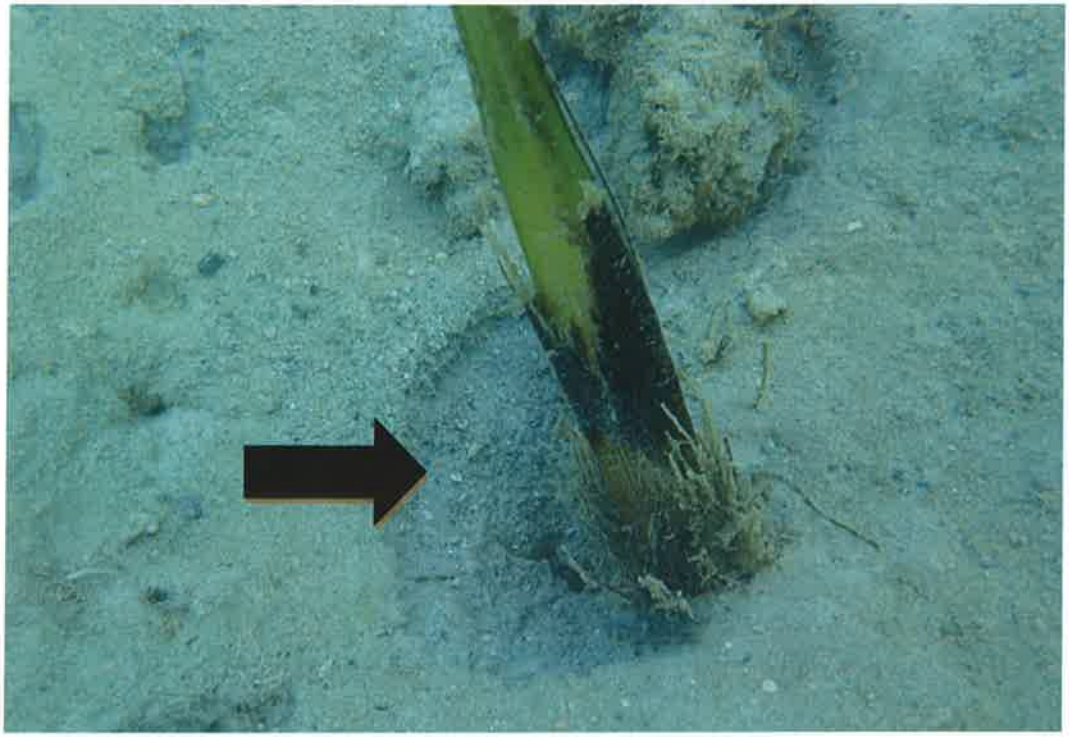

Figure 4.3 Bioturbation processes cause by some marine organisms at seagrass shoot. (Photo credit: Yap Tzuen Kiat, 2019)

ODEC, UMS and Kg Kibagu are open areas for coastal community to fish. Human activities (fishing or gleaning) (Figure 4.4) might be the factors for the decreasing seagrass survival at the new area. UMS coastal area is also known for its tourist attraction around Kota Kinabalu city. The recreational activities such as boating, walking at the intertidal area during low tide for leisure could contribute to the decrease of seagrass survival rate by accidently stepping on the seagrass.

Figure 4.4 Human activities around the seagrass planting area. (Photo credit: Ejria Saleh, 2019)

4.3 Awareness program

The project carried out a number of the awareness program related to seagrass as listed in the Table 4.1 and Appendix 3. Program on seagrass transplanting workshop part 1 and part 2 were done for the staff of Sabah Ports Sdn Bhd and Suria Holding Berhad. Awareness program on seagrasses were also carried out during the special events such as World Wildlife Day, National World Earth Day and World Oceans Day.

In conjunction with the World Oceans Day, Borneo Marine Research Institute has organised the Ocean Celebration Week. Among the program was awareness programs for seagrass on the 19th and 28th July 2019. *Empowering woman for the ocean and climate change* program was designed to enhance women's knowledge on the ocean particularly on water sampling, fish feeding, aquarium tour, field data analysis and monitoring marine ecosystem (seagrass). The target group are working women from various agencies around Kota Kinabalu.

Table 4.1 Program/activities supported by this project

No	Program/ Activities	Date	Objectives	No of participants
1	Seagrass transplanting workshop part 1	22 November 2018	Increase participants knowledge on the importance of seagrass and highlight impact of coastal activity and climate change to seagrass ecosystem	69 person
2	Seagrass transplanting workshop part 2	22 & 23 January 2019	Introduce seagrass species and habitat, and method of transplanting	31 person
3	Seagrass exhibition and talk in conjunction to World Wildlife Day	03 March 2019	Educational and awareness program	Open to public
4	Seagrass exhibition: International Conference on Marine Science and Aquaculture	12-13 March 2019	Educational and awareness program	Open to public
5	Seagrass exhibition: in conjunction to National World Earth Day	21 April 2019	Educational and awareness program	Open to public
6	Seagrass exhibition: in conjunction to Sabah DNA Day	22-25 April 2019	Educational and awareness program	Open to public
7	Talk on Seagrass and climate change in conjunction to UMS Environment Day	25 April 2019	Educational and awareness program	Open to public
8	Empowering woman for the ocean and climate change in conjunction to World Oceans Day	19 July 2019	introduce the IPMB research methods including monitoring of planted seagrass at ODEC – UMS coastal area.	50 person 10 person (AJK)
9	*Kesedaran Ekosistem Rumput laut* in conjunction to World Oceans Day Peranan Dan Ancaman	28 July 2019	Introduce seagrass and threats to school children	34 person 6 person (AJK)
10	Pereka 2019	24-25 October 2019	Method for seagrass planting	Open to public 2 person (AJK)

The program entitled '*Ekosistem Rumput laut: Peranan Dan Ancaman*' was targeted for school children at ages between 9-12 years old. The special guest was from Sekolah Rendah Kebangsaan Mantob, Kiulu Tuaran. The main activities was a short talk on "What is Seagrass?", tour at the Aquarium and Museum of Universiti Malaysia Sabah to expose the conservation effort done by UMS on seagrass, followed by the seagrass's herbarium. This is a hands on activity that the participants can touch and observ the different type of seagrasses species and marine life associated seagrass. At the end of the session, each participant creates their own masterpiece on seagrasses batik canting. This program was jointly funded by MESTECC and Sabah Ports Sdn. Bhd.

Data collected from this project were presented in many occasions. Some of the findings were used in UMS PEREKA 2019 on 24-25 October 2019. The seagrass planting method presented in this event was won the silver awarded under the research category. We hope that there will be more output in the form of book and journal publish from this project.

5.0 CONCLUSION

Seagrass transplanting activities is one way to restore the seagrass habitat. The restoration of the seagrass habitat is important to the coastal development and land reclamation on seagrass beds. There have been a total of 1258 seagrass shoots has been relocated from meadow adjacent to Sabah Ports Sdn Bhd to Kg. Kibagu and ODEC beach, Universiti Malaysia Sabah. Survival of the transplanted seagrass shoots may be affected by local weather and biological factors. No seagrass collection or transplanting activities was carried out in April 2019, due to safety reasons as it is jellyfish bloom season and high water level conditions.

During the monitoring period in April and September 2019, some seagrass shoots was partially or fully uprooted or covered with sediment. The transplant has a low survival rate but transplantation of the seagrass would potentially enhance seagrass meadows to support the coastal ecosystem function. Challenges during the seagrass transplanting and monitoring activities were bad weather condition, rough sea and high suspended sediment.

There were ten awareness programs that fully or partially supported by this project. We hope that the programs have provided some understanding and appreciation to the seagrass habitat and its worth to protect for the upcoming generation.

Appendix 1. Collecting seagress shoots from donor sites

Collection seagress shoots at SPSB

Some of the seagress shoots collected at SPSB

Appendix 2. Seagress planting activities at ODEC-UMS

Planting activities at intertidal area of ODEC UMS

Condition of the seagras after one month of planting

Appendix 3: Educational and awareness program

Seagrass planting activities (Top and middle photos) and Program Kesedaran Ekosistem Marin Ekosistem Rumput laut: Peranan Dan Ancaman on 28 July 2019 (bottom photo). Photo Credit: Michale Yap Tzuen Kiat

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