MARINE HABITAT MAPPING ON LABUAN MARINE PARK, FEDERAL TERRITORY OF LABUAN, MALAYSIA

THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF MARINE SCIENCE

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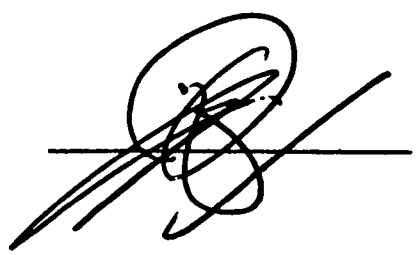

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ABSTRACT

Marine environment consists of many habitats that support marine life. High diversity of marine life forms a complex ecosystem in coastal environments. Therefore, habitat mapping is useful for development and better management planning on marine habitat. Therefore, marine habitat mapping study was conducted in Labuan Marine Park (LMP) area. The objectives of this study were to identify the actual marine habitat (coral reef, macroalgae, sea grass) distribution, to characterize the seabed type, and to create a map of marine habitat and seabed characteristics within the park. LMP is declared as Marine Park since 1994 and only the Marine Park in East Malaysia that managed by Department of Marine Park Malaysia. This park is consists of three islands (Kuraman, Rusukan Besar, Rusukan Kecil) and estimated area of 37.9km^2. The assessments of marine habitat distribution and seabed characteristics were conducted using the side scan sonar (SSS) and supporting images (topography map, satellite, and Google Earth images). The SSS and supporting images were verified by SCUBA diving and sediment assessment on the seabed. The data from previous studies were also used to enhance the results. The classification of seabed was divided into three basic attributes, which are major structure (hard bottom and unconsolidated structures), minor structure (coral, rock, silt, sand), and marine habitat (coral reef, macroalgae, and seagrass) cover. The hard bottom structure is mostly dominant around the islands and at the northern part of the marine park area. Meanwhile, the unconsolidated structure is mostly found in the middle and east part of the park. Coral reef areas are well distributed around the islands in the shallow water area. It is formed from hard and soft corals. The distribution of coral has been recorded at the area between Rusukan Besar Island and Rusukan Kecil Island, and at the southeast part of the park. Meanwhile macro algae mainly found attached to mixed live coral reefs or submerged rocks around islands. Small patches of seagrass habitat located at the middle part of the park. These results are important as detail baseline information on marine habitat for conservation, protection and better management of LMP.

ABSTRAK

PEMETAAN HABITAT MARIN DI TAMAN LAUT LABUAN, WILAYAH PERSEKUTUAN LABUAN, MALAYSIA

Persekitaran marin terdiri daripada pelbagai jenis habitat yang menyokong hidupan laut. Kepelbagaian hidupan laut yang banyak membentuk satu ekosistem yang kompleks dalam persekitaran pantai. Oleh itu, pemetaan habitat amat berguna untuk pengurusan pembangunan dan perancangan yang lebih baik untuk habitat marin. Oleh sebab itu, pemetaan habitat marin telah dijalankan di kawasan Taman Laut Labuan (LMP). Objektif kajian ini adalah untuk mengenal pasti liputan dan taburan habitat marin (terumbu karang, mackroalga, rumput laut), mengklasifikasikan jenis dasar laut, , dan menghasilkan peta habitat marin dan jenis dasar laut dalam taman laut. LMP diisytiharkan sebagai Taman Laut sejak tahun 1994 dan satu-satunya Taman Laut di Timur Malaysia yang diuruskan oleh Jabatan Taman Laut Malaysia. Taman ini terdiri daripada tiga pulau (Kuraman, Rusukan Besar, Rusukan Kecil) dan anggaran kawasan adalah seluas 37.9km^2. Penilaian ciri-ciri taburan habitat dan dasar laut telah dijalankan dengan menggunakan sonar imbasan sisi (side scan sonar, SSS) dan beberapa imej sokongan (peta topogafi, imej satellite dan Google Earth). Imej-imej daripada SSS dan imej sokongan telah disahkan oleh menyelam SCUBA dan penilaian sedimen dasar laut. Data daripada kajian terdahulu juga digunakan untuk meningkatkan hasil kajian. Pengelasan dasar laut dibahagikan kepada tiga sifat asas, iaitu struktur utama (bahagian bawah keras dan struktur yang tidak disatukan), struktur kecil (terumbu karang, batu-batuan, kelodak dan pasir) dan kawasan habitat marin. Struktur bahagian bawah keras kebanyakannya mendominasi kawasan sekitar pulau-pulau dan di bahagian utara kawasan taman. Sementara itu, struktur yang tidak disatukan kebanyakkannya ditemui di bahagian tengah dan timur taman. Kawasan terumbu karang dapat dijumpai di sekitar pulau-pulau di kawasan air cetek. Ia terbentuk daripada batu karang keras dan lembut. Kawasan karang telah direkodkan di kawasan antara Pulau Rusukan Besar dan Rusukan Kecil, dan pada bahagian tenggara taman. Sementara itu, makro alga didapati melekat secara langsung pada terumbu karang atau campuran batu di sekitar pulau. Tompokan kecil habitat rumpai laut terletak di bahagian tengah taman itu. Keputusan ini adalah penting sebagai maklumat asas seperti habitat marin untuk pemuliharaan, perlindungan dan pengurusan yang lebih baik untuk LMP.

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LIST OF ABBREVIATIONS

LMP	-	Labuan Marine Park
SSS	-	side scan sonar
MPA	-	Marine Protected Area
DMPM	-	Department of Marine Park
NRE	-	Ministry of Natural Resources and Environment
GPS	-	Global positioning system
GIS	-	Global Information System
WWF	-	World Wildlife Fund
UMS	-	Universiti Malaysia Sabah
SCUBA	-	Self-contained Underwater Breathing Apparatus
eq	-	Equation
St.	-	Station
Km	-	Kilometer
m	-	Meter
NE	-	Northeast
SW	-	Southwest
SE	-	Southeast
kHz	-	Kilohertz
kg	-	kilogram

LIST OF SYMBOLS

° - Degree

' - Minute

" - Second

% - Percent

& - And

Φ - Phi

² - Square

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CHAPTER 1

INTRODUCTION

1.1 Marine Habitat

In general, habitat could be defined as an area or natural environment in which a species normally lives, or the place where the dominant life forms (Bickers, 2003). However, according to McCutcheon and McCutcheon, (2003), habitat is the place in nature where the plants and animals live and grow together. This includes the landscape and climate that affects them. For marine life, habitat is categorized based on their abiotic features, physical and chemical characteristics of the environment (Kerleskint *et al.*, 2010). The diversity of marine habitat forms a dynamic ecosystem with productive marine ecology. It has a network of species on which all life depends on food, climate, even air to breathe (UKM News Portal, 2014). It is comparable to the tropical rainforest however, it is the least understood; even though the ocean is the most influential ecosystem in the world. Common marine habitats in Malaysia and tropical regions are coral reefs, seagrass beds, macro algae, rocky shore, and sandy shore. These habitats can be turned into an ecosystem that supports a high diversity of marine life.

The seabed characteristics play a main role in marine habitat distribution. Marine habitats are mostly formed on the specific seabed which best suit their nature. The characteristics of the seabed sediment are different depending on the size and territory. The seabed features may change through time with the influence of factors such as natural processes and anthropogenic activities. More, seabed features could disappear due to underwater hydrodynamic activities. The nature of the seabed such as hard bottom and unconsolidated structure could vary in term of the size, colour, place, and much more. According to Jauhariyuddin (2001), the larger particles size of sediment will be deposited while the smaller particles size will be taken to other places.

For centuries, marine habitats have influenced the pattern of settlements for humankind. The thriving settlements are normally with access to fishing grounds. Unfortunately, many studies recorded that marine habitat is facing degradation due to threats either by anthropogenic activities or by natural disturbance (Jackson, 2001; Guldberg and Bruno, 2010; Yasuhara *et al.*, 2012). Threats from the nature are in the form of storms, typhoons, big waves and unusually climate pattern. These natural threats combined with anthropogenic activities such as development at the coastal area, sedimentation, destructive fishing activities, agriculture, and pollution has caused major degradation towards the marine habitat. These impacts would need a long period of time for recovery. In some cases, there are marine habitats that do not manage to recover. According to Lee (2007), anthropogenic activities have affected the marine ecosystem in the sea over the past five decades or more. This is probably because most developing regions are concentrated in the coastal area and most of the marine habitat is found near to the coastline.

Habitat degradation has increased day by day and has become a huge problem to the marine environment; disrupting marine and human life. To combat this, many awareness and educational programs have been developed to overcome these problems. Marine Protected Area (MPA) or Marine Park, marine reserves area, zoning area, land use and development regulation, monitoring and reporting are the several efforts that are implemented by developed countries to overcome habitat degradation. Other than that, awareness and monitoring programs have also been organised for communities and policy makers to create awareness on the importance of marine habitat to the humankind. Many organizations such as NGOs, agencies, and universities have co-operated in setting up programs especially in MPA or Marine Park area.

The main problem in determining the percentage of marine habitat loaa id the lack of accurate data and information on marine resources. Therefore, there must be a solution to manage the information on marine ecosystem. Scientists need to know the exact location, extent, and status of the marine habitat in order to monitor and conserve the habitat.

1.2 Marine habitat mapping importance

The protection of marine habitat has become a global issue recently for conservation and monitoring efforts. Rapid development in the coastal areas are causing high rates of pollution that are mostly released to the sea and thus affecting the marine habitat; this combined with overfishing has negatively impacted the marine environment. Based on a report by WWF (2009b), about 60% of coral reefs are estimated to disappear by 2030 if the destruction continues.

Marine habitat map is essential with the growing population and increased coastal development, causing the degradation of the marine habitat. Recently, marine habitat mapping has become an integral part of coastal marine science especially in terms of habitat conservation (Copeland *et al.,* 2011). The habitat map will provide a better understanding of the marine habitats in order to protect and manage the natural resources that are exposed to the threat of global warming, destruction of habitat, fishing, and pollution. The map can cover both specific protected area and wider environment.

Numerous maps of marine habitats have been produced since the importance of the marine environment to the human has been acknowledged. The maps could hold thousands of great scientific interest that are related to the marine environment. Knowledge of the status, distribution, and extent of the habitat can establish a sensible approach for the scientist, policy maker, and resource manager to conserve and monitorthe marine habitats and to better manage the marine environment. Mapping is also the way to assess the potential marine area for future development.

1.3 Marine habitat mapping for marine parks

The map of the marine habitat in the marine park should be adequate to depict the information on habitat status and distribution. Conventional methods such as belt transect, line transect, manta tow survey and quadrat plot can be used as supporting method to present the habitat in the form of a map (Lee, 2007).

However, these methods are sometimes too costly, time consuming and could only map a small area. Much time in the field and only cover a small-scale basis. These methods are not suitable to fulfil the need of mapping in large-scale areas promptly.

In line with the development of information technology and communication, the technology of remote sensing offers a practical and economical means to map the marine habitat, especially over large areas. Remote sensing technology extends possible data that achieved from present to over several decades back. It also offers the various scales from systematic observations (Langley *et al.*, 2001; Nordberg and Evertson, 2003). Remote sensing technology uses satellite imaginary data. It obtains information on an object or area by analysing the data without touching the object but by using a sensor that uses electromagnetic waves (Bowo *et al.*, 2014).

Besides remote sensing, another suitable mechanism for transmitting information through the water column is by using acoustic waves through sonar system. The tool using the system is named Underwater Acoustic Mapping Systems, which are divided into single-beam echo sounding, multi-beam echo sounding andside scan sonar (SSS) (Pawar and Rangole, 2013). In this study, SSS is used since it is a high-resolution tool that provides data in the wide area of seabed. This tool has been used since 1980s in order to map and visualize the seabed (Bickers, 2003). This data can be analysed and describe the characteristic of the seabed based on the frequency of backscatter intensity. The delineate changes of the seabed are based on the changes of intensity or intensity level. Many studies of marine habitat on the seabed had been done by using SSS combine with other methods such as aerial photo, satellite images, and ground truthing to get a more accurate view of the area. SSS not only detect the marine habitat but also identify the characteristic of the seabed.

1.4 Problem Statements

This study was carried out to develop a map for the marine habitat and seabed characteristic in Labuan Marine Park (LMP) by using GIS software. Scientific studies (Pilcher and Cabanban, 2000; Waheed *et al.*, 2007; Awang and Chan, 2013; Draisma, 2013; Azad and Sakari, 2013; Saleh *et al.*, 2013) have been done in this area and there are an abundant of existing baseline data. However, the studies are not carried out continuously and there are existing gaps in data. The quantity of information on marine habitat is limited in terms of the area and methodology. There is a great need for more information and data on the marine habitat. Thus, an enhancement from mapping is beneficial.

Moreover, previous scientific studies are focused on the status of the marine habitat such as corals, macroalgae, and seagrasses. There are limited publications on seabed characteristic has been published. The only publication on this was through the Marine Biodiversity Expedition 2012 Federal Territory of Labuan - Kuraman, Rusukan Kecil & Rusukan Besar Islands, by Universiti Malaysia Sabah (UMS). The information on marine habitat and seabed characteristics are limited to the certain areas in the park and only focusing on several station points.

1.5 Objectives

The objectives of this study are:

a. To identify the actual marine habitat (coral reef, macroalgae, seagrass) distribution in LMP;
b. To characterize the seabed type within the park area;
a. To create maps of marine habitat and seabed characteristics within the park.

1.6 Significance of study

Marine habitats that make up the seabed play an important role in maintaining a healthy and productive ecosystem. This study attempts to explore the marine habitat in LMP by using SSS and GIS software in generating habitat map.

The purposes of this study are to survey, examine and document information on the marine habitat and seabed characteristics in LMP. The field data were verified and presented in a map form. The maps act as baseline information for Marine Park Department to enhance conservation and protection for future planning and management of LMP. The management of LMP faces obstacles as the park do not have any say on the development of the Kuraman island and Rusukan besar island as these islands are private land (Mstar, 2014). Any development will lead to environmental changes and affect the marine habitat in the coastal marine water. Therefore, the map produced in this study would give integrated and comprehensive information, such as habitat classification, description and databases of the LMP marine ecosystems before any further action will be taken by the islands owner to develop the islands. In the same time, the rapid development along the coastline in Labuan main Island could also use this habitat map for future town development planning and environmental protection. Furthermore, the marine habitats map would be useful as references and guideline in the future to scientists, students, policy maker, coastal manager, who studies on the marine habitat and resources in LMP.

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