NUTRIENTS CONCENTRATIONS AND SEAGRASS COVER
IN THE AMBONG BAY AND USUKAN BAY OF KOTA BELUD, SABAH

NURULAFIZAH BINTI MOHD ALI

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FOR THE DEGREE OF BACHELOR OF SCIENCE

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[Signature]

NURULAFIZAH BINTI MOHD ALI

BS1110523

20th JUNE 2014
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ABSTRACT

This study was conducted in 10 stations of two bays, namely Ambong Bay and Usukan Bay of Kota Belud, Sabah from November 2013 until March 2014. The stations were selected randomly to represent both bays. Objectives of this study were 1) to determine the nutrients (ammonia-N, nitrite-N, nitrate-N, phosphate-P) concentration in the Ambong Bay, Usukan Bay and to compare with the Marine Water Quality Criteria and Interim Standard for Malaysia (IMWQS), 2) to measure and to compare seagrass cover in the six stations of two bays and 3) to evaluate the relationships of nutrients concentration and seagrass cover in the six stations at the two bays. The nutrient analysis (NO₃-N, NO₂-N, PO₄-P, and NH₃-N) were done by using colorimetric and Spectrophotometric method. Quadrat of 0.25m² was used and dropped three times randomly for evaluating the percentage cover of seagrass. All the seagrass in the quadrat was recorded by using class dominance. Based on the T-test analysis, the results showed that the means concentrations in both bays were significant different (p<0.05) for ammonia and phosphate concentrations. However, the means concentrations for nitrite and nitrate for both Ambong Bay and Usukan Bay did not show any significant different (p>0.05). The mean concentrations of ammonia and nitrite for both bays are lower than the standard value of IMWQS. In the other hand, the mean concentrations for phosphate and nitrate for both bays are higher than the standard value of IMWQS. The results also showed that the concentrations of ammonia had significant (R²= 0.9839, p<0.05) very strong relationship with the seagrass cover. The concentration of phosphate (R²=0.267), nitrite (R²=0.4382) and nitrate (R²=0.6135) of the six stations are also strong but not as strong as phosphate. Based on the observation, nutrients source in Usukan Bay was from Abai River, and the main source of nutrients for Ambong Bay was from the aquaculture activity. Therefore, the area should be given oversight for this issue. Sources of pollution should be identified so that the precaution steps can be made to ensure the protection to this area.
ABSTRAK

Kajian ini dijalankan di 10 stesen yang terletak di dua teluk, iaitu Teluk Ambong dan Teluk Usukan Kota Belud, Sabah bermula dari November 2013 sehingga Mac 2014. Stesen telah dipilih secara rawak untuk mewakili kedua-dua teluk tersebut. Objektif kajian ini adalah 1) untuk menentukan kepekatan nutrien (ammonia -N, nitrit -N, nitrat -N, fosfat -P) di Teluk Ambong dan Teluk Usukan serta untuk membandingkan kepekatan yang diperolehi dengan Kriteria Kualiti Air Marin dan Standard Interim bagi Malaysia (IMWQS), 2) untuk mengukur dan membandingkan peratusan taburan rumput laut di enam stesen terpilih di dua teluk dan 3) untuk menilai hubungan kepekatan nutrien dan peratusan taburan rumput laut di enam stesen terpilih. Analisis nutrien (NO₃-N, NO₂-N, PO₄-P, dan NH₃-N) telah dilakukan dengan menggunakan kaedah kolorimetrik dengan menggunakan spektrofotometer. Kuadrat 0.25m² telah dijatuhkan 3 kali secara rawak untuk mendapatkan anggaran peratusan rumput laut. Semua rumput laut di dalam kuadrat telah direkodkan dengan menggunakan pengelasan dominasi. Berdasarkan analisis Ujian-T, keputusan menunjukkan bahawa min kepekatan untuk ammonia dan fosfat dalam kedua-dua teluk adalah berbeza (p<0.05), dan min kepekatan untuk nitrit dan nitrat pula sebaliknya iaitu tidak menunjukkan perbezaan yang signifikan (p>0.05). Min kepekatan ammonia dan nitrit adalah rendah berbanding standard yang dicadangkan oleh IMWQS dan sebaliknya pula, min kepekatan fosfat dan nitrat didapati lebih tinggi daripada yang disyorkan oleh IMWQS. Hasil kajian juga menunjukkan bahawa kepekatan ammonia mempunyai hubungan positif yang sangat kuat dengan peratusan taburan rumput laut (R²= 0.9839, p<0.05) tetapi untuk hubungan kepekatan fosfat (R²=0.2367), nitrit (R²=0.4382) dan nitrat (R²=0.6135) dengan peratusan taburan rumput laut yang menunjukkan hubungan yang tidak sekuat ammonia. Berdasarkan pemerhatian, sumber utama nutrien dalam Teluk Usukan adalah dari Sungai Abai, dan untuk Teluk Ambong adalah dari aktiviti akuakultur. Oleh itu, kawasan ini harus diberi perhatian untuk isu-isu ini. Sumber-sumber pencemaran patut dikenal pasti bagi memastikan langkah berjaga-jaga boleh diambil supaya kawasan ini dapat dilindungi dari pencemaran.
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LIST OF SYMBOLS, UNITS ABBREVIATIONS AND TERMS

DO = Dissolve oxygen
NO₂⁻N = Nitrite-N
NO₃⁻N = Nitrate-N
mg = Miligram
g = Gram
µg/L = Micro gram per litre
mm = Millimetres
cm = Centimetres
kg = Kilogram
ml = Millilitres
km = Kilometres
psu = Practical salinity unit
°C = Degree Celsius
% = Percent
PO₄⁻P = Phosphate-P
NH₃⁻N = Ammonia- N
SiO₂-Si = Silicate-Si
mg/L = milligram per litre
tds = Total dissolved solid
NTU = Nephelometric Turbidity Unit
CHAPTER 1

INTRODUCTION

1.1 Nutrients

Nutrients consist of dissolve inorganic elements such as nitrogen and phosphorus that important for seagrass and phytoplankton growth. Nutrients supply sets the productivity potential of primary producers in aquatic ecosystems. When light and temperature are adequate and loss rates do not exceed gains, the availability of macronutrients such as nitrogen and phosphorus controls algal and seagrass productivity (Worm et al., 2000).

Nitrate is the final product of aerobic decomposition. It can be reduce to nitrite by denitrification process and undergoes oxidation process to form nitrogen. Nitrogen enter water column in form of nitrate either from fertilizers, industrial sewage, or domestic sewage. Nitrite is a nutrient that produced after the oxidation of ammonia in nitrification process in seawater. The concentration of nitrate and nitrite in water column can give a rough view of nutrients status and organic pollution. Nitrate is generally known as limiting factor in primary production (Krom et al, 1991)

Phosphorus is an important nutrient for phytoplankton growth. In seawater surface, phosphorus exists in form of dissolve organic phosphate. This is due to decomposition process by plants. The main source of phosphorus is detergent, chemical from water treatment, and fertilizers (Wade (a), 1974).
Ammonia is also an important nutrient for phytoplankton growth. The excess of ammonia can be toxic and poisonous. The main source of ammonia is from ammonification process which is the decomposition process of dead organisms by microbes (Chongprasith et al., 1999).

1.2 Seagrass

Seagrasses are angiosperms plants that have adaptation in marine environment. Just like the grasses on land, seagrass also has roots, leaves, rhizomes, branches, flower and fruits to produce seeds. They can be found in shallow coastal water and often in sandy area. There are 60 species of seagrass in the world that have been recorded (Phang, 2000). This plant is reproducing by seed pollination. The strong true roots that attach to the substrate prevent seagrass from being carried by the wave and hold it firm to the ground. Seagrass is a green plant that need sunlight for it growth and photosynthesis.

The nutrients concentration is important for seagrass distribution (Patey et al., 2008). The excess of nutrients can give an advantage for phytoplankton growth but it is a disadvantage to seagrass. This is because the bloom of phytoplankton due to nutrients can cause the light intensity in seawater decreases. Phytoplankton will cover the surface area and block the sunlight thus seagrass cannot undergo photosynthesis process (Lelian, 2008).

1.3 Significant of study

The significant of this study is to know the current concentration of nutrients in both bays and to have a brief review of the Ambong Bay and Usukan Bay. Increase in nutrients concentrations can lead to increasing of primary production. If this condition occurs continuously, it may increase the population of phytoplankton especially harmful alga. Thus, destruction of seagrass meadows is commonly due to the eutrophication.
Seagrasses provide food for sea turtles, nearly 100 fish species waterfowl and for the marine mammals the manatee and the dugong; the latter is on the IUCN red list as vulnerable to extinction. Seagrasses also support complex food webs by virtue of their physical structure and primary production and are well known for their role as breeding grounds and nurseries for important crustacean, finfish and shellfish population. Seagrasses are the basis of important detrital food chain. The plants filter nutrients and contaminants from the water, stabilize the sediments and act as dampeners to wave action. Therefore, it is important to make sure the seagrass beds are in great condition to ensure the sustainability of marine organisms and fishes.

1.4 Objectives

1. To determine nutrients (ammonia-N, nitrite-N, nitrate-N, phosphate-P) concentrations in the Ambong Bay, Usukan Bay and to compare with the Marine Water Quality Criteria and Interim Standard for Malaysia (IMWQS)
2. To measure and to compare seagrass cover in the six stations of the two bays.
3. To evaluate the relationships of nutrients concentration and seagrass cover in the six stations of the two bays.

1.5 Hypothesis

1. The nutrients concentration in the two bays are in the range of IMWQS
2. The seagrass percentage cover in six stations of Ambong Bay and Usukan Bay are not significant different (p<0.05)
3. There are relationships of nutrients concentration and the seagrass cover in of the six stations of two bays.
CHAPTER 2

LITERATURE REVIEW

2.1 Nutrients

Nutrient is any materials that taken into a living organism, serves to sustain it in its existence, promoting growth, replacing losses, or providing energy (Romero et al., 2002). Nutrient can be divided into two types; macronutrient and micronutrient (Norfaizah, 2008). Macronutrient is nutrients that the body uses in relatively large amounts. In other hand, micronutrient is the nutrients that body uses in relatively small amounts. The nutrients in seawater consist of ammonia, nitrite, nitrate, phosphate and silicate. The excess of nutrient in water column is called eutrophication (Livingston, 2001).

All living organisms require the nutrients nitrogen and phosphorus for their growth, metabolism and reproduction. Nitrogen is a component of amino acids, nucleic acids and other cell components, while phosphorus is found primarily in nucleic acids, phospholipids and adenosine triphosphate (ATP) (Krom et al., 1991). Research has demonstrated that phytoplankton productivity in the surface ocean is often limited by the amount of available fixed inorganic nitrogen and, in some cases, available phosphorus (Patey et al., 2008).

Nitrogen is present in the marine environment in various forms. Nitrate is the principal form of fixed dissolved inorganic nitrogen assimilated by organisms, although certain organisms can utilize nitrite, ammonium or even dissolved molecular nitrogen (Livingston, 2001). Orthophosphate is considered the most important phosphorus species in seawater that is immediately biologically available. Dissolved...
inorganic nutrients are usually the preferred substrates for phytoplankton, since organic sources of nitrogen and phosphorus generally require enzymatic remineralisation.

In the form of phosphate, it is the one of the major nutrients required for plant nutrition and is an essential component of all living organisms. Phosphate is ubiquitous and thus, is found naturally on land, in water and in food. However, high concentrations of phosphate in aquatic environment can cause eutrophication (Tong, 1999). Increased abundance of microalgae on the shore and phytoplankton in the pelagic zone is considered to be confined to the vicinity of specific input (Wade (b), 1974).

However, with the increase use of agricultural fertilizers, the expansion of intensive stock rearing and additional sewage and industrial discharges, excessive algal blooms are being increasingly reported around the world (Chongprasith et al., 1999). Excessive algal blooms lead to deoxygenation of the water column, mortalities of fish and invertebrates, and reduction of coastal amenities due to sludge and scum from decaying algae.

Nitrogen is the second most abundant nutrient element and exists in a range of organic and inorganic forms (Connell and Miller, 1984). The present of nitrate and nitrite in soil and water are result from the natural decomposition by microorganisms of organic nitrogenous materials in plants, animal and animal excreta. The ammonium ion formed is oxidized to nitrite and nitrate. Natural occurrence of nitrite and nitrate in the environment is a consequence of the nitrogen cycle but normally nitrite is only found in very low concentrations (WHO, 1978). Human activities are increasing the amount of nitrite and nitrate in aquatic system including agricultural input, animal wastes, human waste, industries producing metals, dyes, and celluloid and some types of aquaculture (Lewis and Morris, 1986).

Large temporal and spatial variations in nutrient concentrations exist in the oceans because of physical and biological processes. In surface waters, biological uptake depletes nitrate and phosphate. In highly stratified oligotrophic surface waters, with low nutrient inputs, nitrate and phosphate are typically at nanomolar (nM)
concentrations (Patey et al., 2008). Approximately 40% of the world’s oceans fall into this category. Nitrate and phosphate concentrations increase to micromolar concentrations with depth, as remineralisation of sinking particulate matter returns dissolved nutrients to the water column.

### 2.2 Eutrophication

The eutrophication can cause the increase of phytoplankton biomass in the water column. The excess growth of phytoplankton can cause the water turbidity is high. When this is happen, the light penetration is low. The dissolve oxygen also decreases due to photosynthesis process by phytoplankton (Gumpil, 2002). This is really giving a negative impact especially towards the seagrass growth because seagrass frequently occur in oligotrophic waters (Romero et al., 2002).

### 2.3 Standard of nutrients in seawater

The standards mean concentration for nitrate (NO$_3$-N) is $<0.060$ mg/L. For nitrite (NO$_2$-N) is $<0.055$ mg/L, phosphate (PO$_4$-P) is $<0.015$ mg/L and for ammonia (NH$_3$-N) is $<0.070$ mg/L (IMWQS, 2008). According to ASEAN Marine Water Quality Criteria (1999) the standard concentrations for nitrite, phosphate, and ammonia is 0.055 mg/L, 0.015 mg/L, and 0.070 mg/L respectively. For the ammonia, nitrite and nitrate, this value was calculated using the most sensitive acute toxicity result and a universal application factor. However, for phosphate standard concentration, this value was calculated by reviewing the existing guidelines from other jurisdictions, phytoplankton growth studies, and ambient concentrations in the ASEAN region (AMWQC, 1999).

### 2.4 Seagrass

Seagrasses are monocotyledonous flowering plants that have adaptation and ability to growth submerged completely in seawater. They grow in shallow coastal area (den Hartog, 1970). Seagrasses play an important role as a substrate stabilizer, food producer, shelter, and nursery grounds for marine organisms. It is also have high productivity, ability to recycle nutrients, accumulate sediments, and organic material as well as stabilize the shorelines from strong currents (De Longh et al., 1995).
According to Birkeland, 1983, the tropical seagrass beds have the highest primary productivity rate compared to several other aquatic and terrestrial ecosystems; 4650 grams carbon per square meter per year. Seagrasses are able to sustain high primary productivity even under low-nutrient availability (Romero, 2002).

There are 12 genera and 60 species of seagrasses recorded in the world. In Malaysia, seven tropical genera and 14 species are found (Phang, 2000). Twelve of the species are found in Sabah (Table 2.2). In Malaysia, Sabah is the state with the most seagrass distribution. There are 2 families, 7 genera, and 12 species (Table 2.1). The two families are family *Cymodoceaceae* and family *Hydrocharitaceae* (Lelian, 2008).

### Table 2.1: Seagrass distribution in the world (Source: Lelian, 2008)

<table>
<thead>
<tr>
<th>Family</th>
<th>Genus</th>
<th>No of species</th>
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<tr>
<td>Posidoniaeae</td>
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<td><em>Amphibolis</em></td>
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<tr>
<td>Cymodoceaceae</td>
<td><em>Halodule</em></td>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td><em>Syringodium</em></td>
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<td><em>Thalassodendron</em></td>
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<td>Zosteraceae</td>
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<td></td>
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<td>Ruppiaceae</td>
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<td><em>Halophila</em></td>
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Table 2.2: Seagrass species in Sabah (Source: Lelian, 2008)

<table>
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<th>State</th>
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<td>Cymodocea serrulata</td>
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<tr>
<td></td>
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<td>Halodule pinifolia</td>
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<td></td>
<td>Halodule uninervis</td>
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<td></td>
<td>Syringodium isoetifolium</td>
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<td>Thalassodendron ciliatum</td>
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<td>Halophila spinulosa</td>
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<td>Thalassia hemprichii</td>
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CHAPTER 3

METHODOLOGY

3.1 Study area

The sites chosen for this study were in Ambong Bay and Usukan Bay of Kota Belud, Sabah. These bays were known previously to contain some of the best coral reefs and seagrass beds along Sabah’s west coast. Scattered and sparse seagrass beds were found in the bay close to the sheltered beaches. Ten stations were selected for this study (Figure 3.1). For nutrients water samples, each bay represent by five stations, while for the seagrass cover, two stations located in Usukan Bay while four stations were in the Ambong Bay. This is because in other stations there is no seagrass. Therefore, the comparison of seagrass cover percentage is only between these six stations.
Figure 3.1: Study area, Ambong Bay and Usukan Bay, Kota Belud Sabah

3.2 Sampling techniques

3.2.1 Water sampling

Water sample for nutrients analysis were taken by using Van Dorn water sampler. The samples were taken from depth 0.5 m from surface. The water samples then were kept in the polyethylene bottle and were brought back to laboratory to be filtered and kept in the refrigerator (Figure 3.2).
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