CORAL COVER AND ABUNDANCE OF GROUPERS (FAMILY SERRANIDAE) IN THE SHALLOW WATERS OF LANKAYAN ISLAND, SABAH

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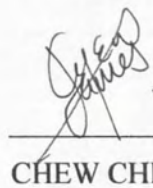

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ABSTRACT

Few studies document the many benefits of establishing marine protected areas in Malaysia from empirical studies. In this study, I document the ecological benefits of protecting Lankayan Island and the surrounding fringing and path reefs in Sabah, Malaysia. Since 1989 a resort was built to cater to tourists in Lankayan Island, the island was only officially gazette as a marine protected area in the year 2001 as an effort to preserve its ecology. The fish line transect and the point sampling transect from the Reef Check Method was utilized and modified to obtain an assessment of the condition of the reef ecosystem. Three major aspects were taken into account: an estimate of the diversity of Serranidae (groupers or kerapu), an estimate of biomass of the serranids, and the correlation between coral cover and serranids. A total of 32 sites were surveyed and conducted during the month of April to May 2004. The average estimation of diversity was about 0.462, whilst the average estimation of total biomass obtained was more than nine kilogram, and there is a weak correlation between the density of coral cover and number of serranids most probably was due to underestimation during sampling. These findings have documented the status of the coral reefs and grouper populations in Lankayan and established a benchmark that will serve as a reference for future monitoring programs in further assessment of the success of conservation management of this island and its marine resources. The estimates of grouper populations on the reefs can also serve as baseline data to be achieved by other marine protected areas due to the absence of the estimate from a pristine reef. Protection of the coral reefs around Lankayan from destructive fishing has allowed the reefs and its fish population, particularly the commercially important groupers (Serranidae) to thrive. The benefit of protection can be further demonstrated in the increase of biomass of groupers.

BATU KARANG DAN KELIMPAHAN KERUPA (FAMILI SERRANIDAE) DI PERAIRAN PULAU LANKAYAN, SABAH

ABSTRAK

Pelbagai kebaikan penubuhan kawasan perlindungan marin kurang didukumentasikan secara empirik di Malaysia. Dalam kajian ini saya telah mendukumemtasikan faedah ekologikal yang dibawa oleh kerja perlindungan di Pulau Lankayan dan terumbu pada perairannya. Sejak tahun 1989, Pulau Lankayan telah menjadi destinasi pelancongan yang terkemuka dan pada tahun 2001 ia diisytiharkan sebagai kawasan perlindungan marin supaya ekologinya dapat dikekalkan. Metod "fish line transect" dan "point sampling transect" dari "Reef Check Method" telah digunakan serta diubahsuai supaya mencapai objektif menurut kewujudan ekosistem terumbu. Tiga aspek utama telah diambil kira: jangkaan diversiti spesies Serranidae (kerupa atau groupers), jangkaan biomass serranids, dan correlasi diantara batu karang dan serranids. Sejumlah 32 kawasan terumbu diservey sepanjang bulan April dan Mei 2004. Secara purata, jangkaan diversiti adalah lebih kurang 0.462, manakala jangkaan jumlah biomass adalah lebih daripada sembilan kilogram, dan correlasi diantara batu karang dan kerupa adalah lemah, mungkin disebabkan oleh jangkaan yang kurang semasa pengumpulan data. Penemuan diatas telah mendukumenkan status kawasan terumbu dan populasi kerupa serta menubuhkan tanda aras kepada kerja pemonitoran masa hadapan di Lankayan supaya kejayaan pengurusan pemuliharaan dan sumber dapat dinilai. Selain itu, disebabkan kekurangan kawasan perlindungan yang unggul, jangkaan populasi kerupa juga boleh digunakan sebagai rujukan dan kawalan yang harus dicapai bagi kawasan marin yang sewilayah dengannya. Kerja perlindungan terumbu di Lankayan telah menghalang aktiviti penangkapan ikan, justeru membenarkan kerapu (Serranidae) yang bernilai komersil bertumbuh bebas serta meningkat dari segi biomass.

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LIST OF ABBREVIATIONS

SIMCA	Sugud Island Conservation Area
TNT	Trinitrotoluene
SPM	Suspended particulate matter
NGO	Non-government organization
MPA	Marine Protected Area
GPS	Global Positioning System
ID	Identity
BCD	Buoyancy Control Device
SPSS	Social science – Statistical methods – Computer programs
ICZM	Integrated Coastal Zone Management Policy
W	Weight
L	Length
a	Constant
b	Exponent
log	Logarithm
ln	Exponential logarithm
H'	Estimate diversity
H'_{max}	Maximum possible diversity
k	Number of categories
fi	Number of observation in sample i
$\sum$	Sum
J'	Evenness
n	Population size of sample
R^2	Linear Regression
m	Meter
m^2	Meter square
m^3	Meter cube
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Fisheries activities play a very important role in the state of Sabah, Malaysia. With a long coastal area and the richness of its natural resources, most of Sabah's populations tend to inhabit these areas. Due to lack of manpower to enforce the laws and regulations, the low awareness of the locals about conservation and sustainability and the intrusion of neighboring countries in the waters, the coral reef resources of Sabah are facing over exploitation and destruction. Lankayan reefs were once fish-bombed but have been protected for about 15 years that this has allow them to recover to become a good diving destination. This study documents the recovery of the coral cover and groupers (Serranidae), a predatory group of fishes that are important in the live reef food fish trade.

In order to maintain sustainability, one must raise the awareness of the public "*...that conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population, for which purpose access to and sharing of both genetic resources and technologies are essential...*" (*Anon.* Convention of biological diversity, 1992).

Implementing laws, regulations and management plan, such as the project of Sugud Islands Marine Conservation Area (SIMCA) is vital to maintain sustainability and provide a base for monitory work.

Figure 1.1 Map of Sugud Island Marine Conservation Area (adapted from SIMCA regulation manual).

SIMCA was established within the legal confines of the wildlife Conservation Enactment of 1997, Under Section 21(1) of the Wildlife Conservation Enactment 1997 - SIMCA must be assured of strict adherence to the adopted Management Plan

Supplement B. Prior to 1997. Lankayan Island which is within the protected area was already well known as one of the hotspot for scuba diving and angling. The surrounding areas were subjected under heavy human activities, such as exploitation of fishes with illegal method of fisheries (Chandra, 2004) by the locals and neighboring countries (fish bombing and cyanide fishing) and uncontrolled tourism activities.

The Management Plan was induced to protect the region with regards to directly regulating human involvement and activities. The regulations within the SIMCA prohibit fishing, taking, anchoring on reefs, waste discarding, and destruction on the coral reefs. The approximate area of SIMCA is 46,300 hectares; consisting three islands, Lankayan Island, Tegaipil Island and Billean Island. The surrounding reefs of Lankayan Island were chosen as the studied area because it already had identified the exact location of the reefs. Before SIMCA was established some reefs experience great fisheries exploitation and destruction of coral reefs through illegal fishing activities, such as fish bombing and cyanide fishing; so with this study the effort and impact of the management plan will be documented.

1.2 OBJECTIVES AND HYPOTHESES

The purpose of this study is to document recovery of the coral reefs and fishes, particularly groupers, in the Lankayan conservation area. Furthermore, it will illustrate the importance of healthy coral reefs for coral reef fisheries (e.g., groupers) and closures, such as Lankayan Island, which function as fish sanctuary.

The specific objectives of the study are:

- To find out the diversity of groupers (Serranidae) in the surrounding waters of Lankayan Island.

- To estimate the biomass of groupers in all targeted reefs.

- To determine relationship between abundance of groupers and coral cover.

The information gathered from the above objectives can illustrate the importance of healthy coral reefs for coral reef fisheries.

1.2.1 The Corresponding Hypotheses for each Objective are:

- H_0: Groupers are diverse.

  H_1: Groupers are not diverse.

- H_0: Biomass of groupers is high in Lankayan.

  H_1: Biomass of groupers is not high in Lankayan.

- H_0: There is significant relationship between coral cover and groupers.

  H_1: There is no significant relationship between coral cover and groupers.

1.3 SURVEY PROTOCOL

A method known as Reef Check was used; and in order to carry out the survey two protocols within the method were implemented, that was the fish belt transect and substrate line transect. The development of this method began in the 1993 Colloquium on Global Aspects of Coral Reefs that was organized by Professor Robert Ginsburg of University of Miami. He found out that the available information to form a clear picture dealing with the status of the world's reef was absolutely not enough, due to the lack of scientists and the limited time they spent in the field. In 1996, Dr. Gregor Hodgson drafted the method "Reef Check" and posted it in the internet, allowing volunteers in the monitoring and assessment of the coral reefs.

Reef Check (see www.ust.hk/~webrc/ReefCheck/reef.htlm for more details), was used in 1997 for the first global survey of coral reefs. Reef Check provided scientific information that the world's reefs are in crisis due to over exploitation and pollution. Since then, 60 countries had adopted Reef Check to monitor the reefs in effort to preserve and maintain sustainability of bioresources. In 2002, "The Global Coral Reef Crisis: Trends and Solution", was published by Reef Check. This survey was conducted in 1500 reefs in the Atlantic, Indo-Pacific, and Rea Sea for five years.

1.4 SIGNIFICANT OF THE STUDY

The purpose of this study is to know the ecological importance of the Lankayan conservation as fish sanctuary. The study will document the diversity of groupers in Lankayan. Furthermore, it will possibly illustrate the importance of healthy coral

reefs for coral reef fisheries (e.g., groupers) and the closures, such as Lankayan Island which act as fishery sanctuary.

1.4.1 Coral Cover

Coral reefs are complex ecosystem with a very high biological diversity which is found in the shallow waters throughout the tropics. Coral reefs support the productivity of fisheries which in the other hand provide the essential source of protein in the food chain. Young fishes use the reef as their defense against being preyed beside from obtaining resources from it and the adult need the reef as the feeding and breeding ground. Despite the reefs complexity and biodiversity, they are also very sensitive to disturbance and highly variable. Natural disturbances such as cyclones or typhoons and human induced stress such as pollution (industrial, chemical and sewage) and sedimentation (land clearing, reclamation and mining) are greatly promoting the degradation of the world's coral reefs.

1.4.2 Grouper

Groupers belong to Family Serranidae (Order Perciformes). They are a dominant element (tertiary user) of the fish community on all coral reefs. The genera under this family are *Aethaloperca*, *Anyperodon*, *Centrogenys*, *Cephalopholis*, *Cromileptes*, *Epinephelus*, *Gracila*, *Plectranthias*, *Plectropomus*, *Pseudanthias*, *Selenanthias*, and *Variola*. The larger species of Serranidae play a very important role as table fish and commercial commodity at many localities. The smaller species also play an important part in the reefs food chain. The natural appearance and design of these fishes are so

attractive, thus making them very suitable for aquarium display. Most of the groupers are carnivorous, they mainly feed on small fishes and supplemented by crustaceans. Feeding mainly occurs during the early morning and mid-afternoon, and small schooling fishes are their commonly targeted prey (Allen, 2000).

CHAPTER 2

LITERATURE REVIEW

2.1 RECOVERY OF CORAL REEFS FROM HUMAN STRESS

2.1.1 Destructive Fishing

Coral reef fishes live close to the reef surface, and the spatial structure of the substratum or the composition of the coral community can affect the associated fish community (Luckhurst and Luckhurst, 1978). If coral cover decreased, the amount of bare substratum and rubble will eventually increased, fish communities in dynamited areas suffered a decrease in species richness and abundance (Riegl and Loke, 1999). In a non-manipulative studies of fish community responses to coral disturbance have provided equivocal estimates of the importance of coral cover in structuring fish assemblages reported varying responses of a range of fishes from different trophic categories to natural catastrophic habitat disturbance (Sano *et al.*, 1987).

Homemade bombs such as TNT, potassium chlorate, or ammonium nitrate, ranging in size from 0.5kg to over 10kg, are detonated over the reefs, shattering all corals within a one to five meters radius and killing marine organisms up to a radius

of 77 meters (Jennings and Lock, 1996). Many fish killed from the shock waves are not even collected, so blast fishing is wasteful in addition to being indiscriminate and destructive (Alcala and Gomez, 1987). Nonetheless, blast fishing is relatively cheap and easy way to increase fish catches in the short term; the yield from a single, well-placed soda bottle bomb will earn an Indonesian fisherman over five times the average worker's daily salary (Fox and Erdmann, 2000). Surveys suggest that natural recovery from blasting is very slow, despite adequate source coral and good water quality (Fox *et al.* in press). Estimates of recovery from severe storm damage, which also fragments the reef framework, start at 40-70 years (Dollar and Tribble, 1993).

Many "artificial reefs" are primarily fish aggregation devices, but they do little in increasing coral biomass (Oren and Benayahu, 1997). Some workers have experimented with transplantation of living coral colonies or cultivation of coral "garden" to re-seed areas (Harriott and Fisk, 1995). Others have experimented using electrolysis to accelerate deposition of calcium carbonate and enhance growth of transplanted coral (Van Treeck and Schuhmacher, 1997). However, these rehabilitation techniques are expensive and inappropriate for the limited conservation resources of developing countries; a study comparing several coral restoration schemes found that costs could range from US$13,000 to over US$ 100,000,000 per hectare (Spurgeon and Lindahl, 2000).

By enhancing coral recruitment with stabilization of the loose rubble and re-creation of solid, structurally complex substrate; there was increased coral recruitment to the rock and cement treatments compared to untreated, bare rubble; the larger rock piles, designed to minimize the problems of burial or scattering

encountered in the pilot studies, showed considerable recruitment of hard corals after only six months, with 10-20 recruits per square meter at some sites, approximate cost of US$10/m^2 including materials, transportation, boat rental and labor (Fox *et al.*, 2000).

The first step in solving the problems include tighter control of fishing through traditional as well as newer methods e.g. international satellite monitoring of fishing boat movements; substantially increasing the number and size of marine protected areas and improving their management so that they can serve as `seedbeds' for surrounding areas; expanding research and testing of aquaculture of high-value reef species to meet the growing demand for seafood and other products that coral reefs will never be able to supply; using education and legislation to reduce demand for cyanide-caught live fish, particularly large animals that have a high value for dive tourism and that contribute greatly to reproduction (Johannes, 1998). Secondly, participation in the Reef Check program is one solution as it increases public awareness about the value of coral reefs and threats to their health. Funding agencies, political leaders and natural resource managers need to focus on implementing these achievable solutions now (Hodgson, 1999).

The relationship between the dispersal ability of organisms and genetic differentiation of population also provides a fundamental link between ecology and evolution (Ayre and Hughes, 2000). Growth rate of corals are temperature dependent and are greatest near the equator; as growth (whether as tissue or skeleton) is largely driven by metabolism, recovery rates of reefs (where recruitment is plentiful) are likely to vary with temperature in a similar way of metabolism (Eckert, 1988).

2.1.2 Overfishing

For thousands of years, humans have gathered and fished for coral reef organisms for use as curios, jewelry, and food (Hodgson, 1999). Habitat destructive fishing gears such as bottom trawls modify benthic habitats and reduce the biomass and diversity of invertebrate communities affecting secondary production at large spatial scales (Kaiser, 1998). In Jamaica, extreme fishing pressure has also led to near elimination of groupers, snappers and other predators, a decrease in the sizes of herbivorous fishes, and other changes in the structure of the fish assemblages; many branching corals are routinely broken apart into live fragments, mainly by physical disturbances (Hughes, 1994). Reefs that have been subjected to overfishing and hurricanes might show greater responses to urchin mortality (Hay, 1984). The relative contribution of *Diadema* and herbivorous fishes to grazing rates on coral reefs apparently varies with depth and fishing pressure, with the urchins playing a larger role in shallower, overfished habitats (Foster, 1987).

Coral reefs are complex communities, and interactions such as those between herbivorous and benthic algae (Hay, 1991) are important in maintaining biodiversity. Recovery of a coral reef depends on growth and regeneration of surviving coral colonies and recruitment of larvae (Endean, 1976). Careful monitoring of the fish populations and the fishery and the application of fishery management will be required in order to avoid over-exploitation (Miller and Gerstner, 2002).

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