ECOSYSTEM MANAGEMENT OF THE LEOPARD CORALGROUPER (*PLECTROPOMUS* SPP.) POPULATION WITHIN THE SUGUD ISLANDS MARINE CONSERVATION AREA (SIMCA)

CHUNG FUNG CHEN

BORNEO MARINE RESEARCH INSTITUTE
UNIVERSITI MALAYSIA SABAH
2015

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CHUNG FUNG CHEN

THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

BORNEO MARINE RESEARCH INSTITUTE
UNIVERSITI MALAYSIA SABAH
2015

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DECLARATION

I declare that this thesis is my own works and has not been submitted in any form of another degree at any university or other institution of tertiary education. Information derived from the published or unpublished works of others has been acknowledged in the text and a list of references is giver.

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....
Chung Fung Chen
(PC20119778)

CERTIFICATION

NAME	:	**CHUNG FUNG CHEN**
MATRIC NO	:	**PC20119778**
TITLE	:	**ECOSYSTEM MANAGEMENT OF THE LEOPARD CORALGROUPER (*PLECTROPOMUS* SPP.) POPULATION WITHIN THE SUGUD ISLANDS MARINE CONSERVATION AREA (SIMCA)**
DEGREE	:	**DOCTOR OF PHILOSOPHY (MARINE SCIENCE)**
VIVA DATE	:	**11 May 2015**

CERTIFIED BY

1. **COMMITTEE CHAIR**
   Prof. Dr. Saleem Mustafa — Signature ______________________

2. **COMMITTEE MEMBER 1**
   Dr. Mabel Manjaji Matsumoto ______________________

3. **COMMITTEE MEMBER 2**
   Assoc. Prof. Dr. Gunzo Kawamura ______________________

4. **COMMITTEE MEMBER 3**
   Assoc. Prof. Dr. Connie Komilus ______________________

ACKNOWLEDGMENTS

This thesis is dedicated to my mother (Madam Chai Choon Fah), my belated sister (Jeniffer Chung), family members and friends that I love and care.

I am very grateful to my supervisory committee that consisted of Prof. Dr. Saleem Mustafa, Dr. Mabel Manjaji Matsumoto, Assoc. Prof. Gunzo Kawamura and Assoc. Prof. Dr. Connie Komilus. Special thanks to my head of supervisor, Prof. Dr. Saleem Mustafa for his continuous support, guidance and advice throughout this study. Prof Saleem read my research chapters word by word and he make sure i completed this study on time. I was fortunate to have Dr. Mabel to read and improved my general chapters. Dr. Mabel gave lots of encouragement to read and to write more. Assoc. Prof. Dr. Kawamura supported me in the understanding of the term 'cues' in fish behaviours and fish visual. Assoc. Prof. Dr. Connie Komilus supported me in the early stages of this study and provided some funding to attend conference.

A special thanks to Dr. Louise Teh and Dr. Lydia Teh who helped me to proof read several thesis chapters. Their continuous supports by sending me relevant journal papers, and encouragements to keep me up in progress. Their true friendships have been keeping me on the track.

Special thanks also to Dr. Nora Ibrahim, a friend that i never met in person. I get to know Nora since 2010 through a project with WWF-Malaysia. Since then, Nora never stop to give guidance, advices, and encouragement. She always say 'cheek up' whenever i was feeling down.

I am also grateful for Mr. Kenneth Chung for his continuous supports. Mr. Chung is not just paying my wages, but he has been giving a lot of leeway during my study. His trust in my services to Reef Guardian Sdn Bhd have been keeping me staying on marine conservation for the past 10 years.

Special thanks to Jessica Mikiu and her family members that kept me company during difficult times.

I grateful for my co-workers in Reef Guardian Sdn Bdn. They are Leony Sikim, Abdul Rashid (Hitam), Edwin Alberto, Davies Austin Spiji, and Rayner Anthony. They are like a family to me. They spent countless time assisting me in the field.

Many thanks to my friends and colleague included Dr. Norasma Dacho, Anton Ngui, Jasmine, Michiyo, Oi Jin, Muijin, Hona, Danny Chin, Christine, Anna Lai, Robert Cheung, Hazali, Karol, Ms. Chak, Stella, Faizan, and Dunstan.

ABSTRACT

Surveys have indicated that reef fish populations have declined in Sabah Malaysia. Several species of large-size groupers (Serranidae) have been heavily targeted to support the live reef fish food trade (LRFFT). Reef fishes that form aggregations for spawning or other purposes are vulnerable to fishery. The coral trout (*Plectropomus leopardus*) is one of those species that aggregates at the time of spawning. Despite the importance of large-sized groupers to fishery, very little is known about how the species respond ecologically to the marine reserve protection. This study consisted of four main research objectives: 1) To determine if coral trouts (*Plectropomus leopardus, P. oligacanthus,* and *P. maculatus*, referred as *Plectropomus* spp.) respond positively to reserve protection; 2) To determine spatial and temporal aggregation pattern of *Plectropomus leopardus; 3)* To determine if substrate quality and prey density are associated with the aggregation and distribution of *Plectropomus leopardus,* and 4) To determine hydrodynamic conditions during reproductive season of *Plectropomus leopardus*. Study was conducted at Lankayan Island which is located within the Sugud Islands Marine Conservation Area (SIMCA).

Plectropomus spp. responds positively to marine reserve protection with mean abundance count inside the reserves three-times greater than outside. A total of 56 *Plectropomus* spp. Were recorded in 12,000 m^2 survey areas, with mean 1.17 fish per every 250 m^2. *Plectropomus leopardus* represents 80% of total count. *Plectropomus oligacanthus* and *P. maculatus* mean abundance were relatively low. Larger *Plectropomus* spp. was recorded at patch reefs within 3 to 5 Kilometres from Lankayan Island. This indicated that low to no fishing activities inside marine reserve allowed to maintain more and larger *Plectropomus* spp. up to 5 Kilometres from Lankayan Island. The hard coral cover was recorded high inside the reserve, and regression analysis indicated decreased percentage of hard coral cover with increased distance from Lankayan Island. However, no relationship was detected between the hard coral cover and the *Plectropomus* spp. abundance.

Plectropomus leopardus aggregated to spawn and to feed. Aggregation of *P. leopardus* was correlated with moon phases and underwater current strength. About 80% of the recorded aggregation was for feeding purposes. Peak feeding aggregation reached 61 individual fish in 1000 m^2. While aggregation for spawning was noticed during new moon from April to August. *Plectropomus leopardus* displayed four different body colorations during aggregation: 1) dark, 2) pale, 3) olive-green and 4) patterned. Correlation analysis indicated that the larger fish tended to be in darker phase. However, behaviour observations during aggregation indicated that coloration changes might not indicate individual sex but rather tendency and readiness to spawn. Large males with darkening fins edges described earlier were rare during the spawning aggregation. I speculated that the large male with darkening fins edge is a dominant individual that leads the spawning population and this role could be a signal for reproductively active fishes in get into readiness mode for spawning.

This study also recorded intra- and inter-specific cooperative hunting between *Plectropomus leopardus* with the other piscivorous species such as *Caranx*

melampygus, Carangoides bajad, P. oligacanthus, P. maculatus, Lutjanus russelli, Fistularia commersonii on juvenile transient prey fishes (*Pterocaesio tessellate, Pterocaesio diagramma, Dipterygonatus balteatus* and *Atherinomorus lacunosus*).

The distribution of *Plectropomus leopradus* was associated with the density of transient prey species population abundance. The prey density predicted *P. leopardus* density. However, the current direction was not a significant indicator that could be used for prediction. Meanwhile, transient prey fish's density was associated with the direction of the underwater currents. Transient prey fishes aggregated at reef sides that received current from sides running parallel off the reef. However, the aggregation and distribution of *P. leopardus* was not associated with the underwater current direction. There was no relation with the substrate quality, surface roughness, crevice number and volume between aggregation and non-aggregation sites. Thus, substrate quality and habitat complexity do not seem to affect *P. leopardus* distribution. However, aggregation site contained higher percentage of encrusting coral life form. Presumably encrusting coral life form provides more hole and large crevices compared to other coral life forms.

The moon phases that appeared to affect fish aggregation to spawn probably operated through tidal fluctuations. The hydrodynamic conditions in spring tide during full and new moon indicated higher surface current speed compared to neap tide. Increased surface currents were recorded during full moon and new moon from April to June. Typically after dusk, surface current increased during lowest ebb tide when the tide started to rise. High surface current during spring tides from April to June could be an important environmental drive to transport eggs and larvae to distant reefs. The ocean hydrodynamics is typically complex and is linked with other environmental factors such as wave, wind and topographical factors. Modelling on current speed and direction allow predictions on the possible dispersal of eggs and larvae. Understanding of the hydrodynamic pattern provided a basis to establish connectivity, recruitment and the source-sink habitats within and surrounding the marine reserve.

ABSTRAK

PENGURUSAN EKOSISTEM KERAPU LEOPARD (PLECTROPOMUS SPP.) DI KAWASAN PERLINDUNGAN MARIN KEPULAUAN SUGUD (SIMCA)

Kajian-kajian telah menunjukkan penurunan populasi ikan-ikan terumbu karang di Sabah Malaysia. Beberapa spesies ikan kerapu yang bersaiz besar menjadi sasaran perikanan bagi menampung permintaan perdagangan makanan ikan terumbu karang hidup (LRFFT). Plectropomus leopardus adalah spesies yang dilaporkan beragregasi semasa musim pembiakan. Ikan terumbu karang yang beragregasi untuk pembiakan dan untuk tujuan lain mudah diancam oleh aktiviti perikanan. Walaupun kepentingan ikan kerapu bersaiz besar ini penting terhadap perikanan, tetapi pengetahuan mengenai bagaimana spesies ikan ini bertindak secara ekologi ke atas pemuliharaan di kawasan perlindungan marin adalah terhad dan tidak diketahui. Kajian ini merangkumi 4 objektif utama, iaitu: 1) untuk menentukan sekiranya Plectropomus spp. (Plectropomus leopardus, P. oligacanthus dan P. maculatus) bertindak secara positif daripada pemuliharaan marin di Pulau Lankayan; 2) untuk menentukan kepelbagaian lokasi dan masa Plectropomus leopardus beragregasi; 3) untuk menentukan sekiranya kualiti substrat dan kehadiran ikan-ikan mangsa mempengaruhi taburan dan pengagregatan kepada Plectropomus leopardus; 4) untuk menentukan keadaan hidrodinamik semasa musim pembiakan Plectropomus leopardus. Kajian ini telah dilaksanakan di Pulau Lankayan yang terletak di dalam lingkungan Kawasan Perlindungan Marin Kepulauan Sugud (SIMCA).

Plectropomus spp. bertindak positif kepada pemuliharaan marin di dalam kawasan SIMCA. Kepadatan Plectropomus spp. adalah tiga kali ganda di dalam kawasan pemuliharaan berbanding dengan kawasan yang tidak dilindungi. Sejumlah 56 Plectropomus spp. telah direkodkan di keluasan 12,000 m^2 kawasan yang dikaji. Purata menunjukkan 1.17 ikan pada setiap keluasan 250m^2. Hampir 80% yang direkodkan adalah terdiri daripada Plectropomus leopardus. Jumlah kepadatan Plectropomus oligacanthus dan P. maculatus adalah agak rendah. Kajian juga menunjukkan Plectropomus spp. lebih banyak dan besar di perantaraan kawasan terumbu karang yang terletak 3 hingga 5 kilometer dari Pulau Lankayan. Ini membuktikan bahawa larangan aktiviti memancing di dalam kawasan pemuliharaan mampu mengekalkan populasi ikan yang lebih banyak dan besar. Walau bagaimanapun, kesan positif pemuliharaan terhadap Plectropomus spp. terhad sehingga 5 kilometer dari Pulau Lankayan sahaja. Pemuliharaan juga mengekalkan peratusan terumbu karang hidup di kawasan perlindungan. Analisis regresi menunjukkan penurunan peratusan terumbu karang hidup dengan peningkatan jarak dari Pulau Lankayan. Walau bagaimanapun tidak terdapat hubungan antara kepadatan Plectropomus spp. dengan peratusan terumbu karang hidup.

Plectropomus leopardus beragregasi untuk bertelur dan mencari sumber makanan. Pengagregatan Plectropomus leopardus adalah berkorelasi dengan fasa bulan dan kekuatan arus. Kira-kira 80% pengagregatan yang direkodkan adalah untuk tujuan mencari sumber makanan. Puncak kepadatan pengagregatan

mencapai 61 individu ikan dalam keluasan 1000 m^2. Plectropomus leopardus beragregat untuk tujuan pembiakan semasa fasa anak bulan dari April sehingga Ogos. Plectropomus leopardus memaparkan empat warna badan yang berbeza semasa pengagregatan, iaitu: 1) hitam, 2) keputihan, 3) hijau-zaitun dan 4) bercorak. Analisis korelasi menunjukkan bahawa ikan-ikan yang lebih besar memaparkan warna badan yang hitam atau gelap. Walau bagaimanapun, pemerhatian tingkah laku semasa pengagregatan menunjukkan perubahan warna tidak menandakan pembezaan jantina tetapi kemungkinan adalah untuk menunjukkan mood dan kesediaan untuk mengawan dan bertelur. Plectropomus leopardus jantan yang memaparkan kehitaman di bahagian sirip kurang direkodkan dalam kajian ini. Spekulasi dibuat bagi ikan yang memaparkan kehitaman di sirip adalah jantan dominan yang berfungsi untuk berkomunikasi dan memastikan ikan yang lain bersedia untuk mengawan dan bertelur.

Kajian ini juga merekodkan kerjasama memburu intra- dan inter-specific di antara Plectropomus leopardus dan Caranx melampygus, Carangoides bajad, P. oligacanthus, P. maculatus, Lutjanus russelli, Fistularia commersonii terhadap ikan-ikan juvenil dari spesies Pterocaesio tessellate, Pterocaesio diagramma, Dipterygonatus balteatus dan Atherinomorus lacunosu.

Taburan Plectropomus leopradus adalah berkaitan dengan kelimpahan ikan-ikan mangsa. Pengagregatan Plectropomus leopardus dapat diramalkan dengan kelimpahan dan kepadatan ikan-ikan mangsa. Sementara itu, kepadatan ikan mangsa juga berkait dengan hala tuju arus air. Kepadatan ikan mangsa beragregat di kawasan yang menerima arus air selari dengan posisi terumbu karang. Tetapi, taburan dan pengagregatan Plectropomus leopardus tidak dikaitkan dengan hala tuju arus air. Tidak terdapat perbezaan pada kualiti substrat, permukaan kasar rekabentuk, bilangan lubang dan keluasan lubang antara tempat pengagregatan dan tempat bukan pengagregatan Plectropomus leopardus. Oleh itu, substrat kualiti dan kekompleksan habitat tidak mempengaruhi taburan Plectropomus leopardus. Walau bagaimanapun, tapak pengagregatan mencatatkan peratusan terumbu karang yang berbentuk encrusting yang lebih tinggi. Kemungkinan terumbu karang encrusting ini menyediakan lebih banyak lubang dan ruang yang lebih besar berbanding dengan terumbu karang bentuk lain.

Fasa bulan mempengaruhi pengagregatan ikan-ikan dan perubahan air pasang surut. Semasa pasang surut tinggi ketika fasa anak bulan dan bulan penuh, keadaan hidrodinamik menunjukkan kelajuan arus di permukaan yang lebih tinggi berbanding dengan pasang surut yang biasa. Kelajuan arus permukaan yang lebih tinggi direkodkan semasa fasa anak bulan dan bulan penuh daripada bulan April hingga Jun. Kelajuan arus permukaan meningkat semasa air mula pasang, ketika selepas waktu senja. Kelajuan arus permukaan yang tinggi memainkan peranan penting bagi penyebaran telur dan larva ke kawasan terumbu karang yang jauh. Keadaan Hidrodinamik laut adalah komplex yang melibatkan interaksi pelbagai faktor persekitaran yang lain seperti ombak, angin dan topografi laut. Kaedah modelling yang digunakan dalam kajian ini boleh meramalkan kelajuan dan arah tuju arus permukaann dan ini membolehkan ramalan kepada penyebaran telur dan larva semasa musim pembiakan ikan dan terumbu karang. Pemahaman mengenai hidrodinamik memberikan asas penentuan kepada keterkaitan (connectivity), rekrutmen (recruitment) dan habitat antara sumber-sink (source-sink habitats) di dalam dan sekeliling kawasan pemuliharaan marin.

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