



UNIVERSITI PUTRA MALAYSIA

**POPULATION OF WATERBIRDS IN TWO MANGROVE TYPES,
AVICENNIA AND *RHIZOPHORA* IN IRAN**

SABER GHASEMI

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By

SABER GHASEMI

**Thesis submitted to the School of Graduates Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

June 2011

I would like to dedicate this thesis to my late mother, Soraya Shams, and my wife Neda Mola, for all of their love.



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy.

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Chairman: Associate Professor Mohamed Zakaria Hussin, PhD

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Relationship between mangroves and their associated marine life cannot be overemphasized. Mangrove habitats play host to a moderate number of waterbirds around the globe, but their relative roles of mangrove habitat structure in association with variation in both individual waterbirds distributions and their communities have yet explicitly examined. The objectives of this study were: (1) To determine the abundance, diversity and evenness of waterbirds in two different type of mangroves habitat (*Avicennia* and *Rhizophora*), (2) To compare environmental variables, soil as well as surrounding water sources, and vegetation structure as effective components in determining the safe habitat for waterbirds, and (3) To examine the diversity and density of gastropod and mudskipper in two habitats as effective components in determining food resources.

The study was conducted from 22 September 2008- 21 September 2009 in the *Avicennia marina* habitat that stands in Hara Protected Area (HPA) and *Rhizophora mucronata* habitat that stands in International Wetland of Gaz and Hara Rivers Delta

(GHRD). Bird observations were conducted using a point count method and results were categorized into the types of birds including wading birds, seabirds and waterfowls.

A total of 76074 waterbird observations, representing 62 species from 15 families and 5 orders, were recorded in two sites. Based on the type of bird category, a total of 57373 (43 spp.), 18681 (17 spp.), 20 (2 spp.) observations were recorded in the categories of waders, seabirds and waterfowls respectively. From these observations, a total of 59387 waterbird observations, representing 56 species were recorded at HPA, while 16687 observations, belonging to 54 species were recorded at GHRD. Moreover, based on category of bird a total of 44078 waders, 15297 seabirds and 12 waterfowls were recorded at HPA and 13295 waders, 3384 seabirds and 8 sightings of waterfowls at GHRD. Forty eight species of waterbird (15 families) were common in both habitats. Eight species exclusively used HPA while six species occurred only at GHRD. The Crab Plover (*Pluvialis squatarola*) and Eurasian Curlew (*Numenius arquata*) were the dominant species at HPA and GHRD, respectively.

The abundance of all waterbirds for two habitats was highly significant ($P < 0.001$).

The mean values abundance of the waterbirds by seasons was higher at HPA than GHRD mangrove forest (3711 ± 427 observations vs. 1283 ± 209 observations).

This study indicated that there were highly significant differences among the all surface water variables including temperature, pH, EC, TSS and salinity ($p < 0.01$), excluding DO ($p > 0.05$) with habitat. The soil parameters also showed significant difference between two habitats for available potassium, organic carbon, percentage of clay and silt at depth of 0-20 cm, and organic carbon, pH, EC and percentage of

sand and silt at depth of 20-40 cm ($p < 0.05$). In general, *R. mucronata* occurs with higher density, tree height and canopy than *A. marina* in the coast of Hormozgan province ($p > 0.05$). While diameter at breast height and crown spread for *A. marina* were higher than *R. mucronata*. Furthermore, there was a significant difference in number of gastropods between the two types of mangroves ($t = 1.34$, $p < 0.05$), but there was no significant difference in number of mudskipper between the mangroves ($t = 2.041$, $p < 0.05$).

A strong positive response was found between the environmental variables and abundance of waterbirds, using redundancy analysis. However, soil parameters did not highly affect the abundance of waterbird species, but they were important in growth of mangroves and habitat of gastropods.

As a conclusion, results of this study supported the hypothesis that micro-environment and micro-habitat factors could affect the composition, abundance, density and diversity of the waterbirds especially waders across the two types of mangrove vegetation. Therefore, changes in the environmental variables are the key factors that influence the waterbird response. Thus the waterbird populations can be used as a key tool for monitoring the status of mangrove habitats and environmental changes.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**POPULASI BURUNG AIR DI DUA JENIS HUTAN BAKAU,
AVICENNIA DAN *RHIZOPHORA* DI IRAN**

By

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Jun 2011

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Hubungan di antara hutan bakau dan perkaitannya dengan hidupan laut tidak boleh dipandang remeh dan perlu diberi penekanan. Habitat hutan bakau menjadi tuan rumah kepada sebilangan burung air di seluruh dunia, tetapi tidak ada penelitian yang jelas tentang peranan relatif struktur habitat hutan bakau mengikut kepelbagaian dari segi agihan burung air dan komuniti mereka. Tujuan utama kajian ini adalah untuk (1) menentukan kebanjiran populasi, kepelbagaian dan kepadatan burung air di dua jenis habitat hutan bakau yang berbeza (*Avicennia* dan *Rhizophora*), (2) untuk membezakan pembolehubah persekitaran, tanah dan juga punca air serta struktur vegetasi sebagai komponen-komponen efektif dalam mengenalpasti habitat yang selamat didiami bagi burung air dan (3) untuk mengenalpasti diversiti dan kepadatan kumpulan gastropoda dan mudskipper di dua habitat tersebut yang turut mempengaruhi kepadatan sumber makanan.

Kajian telah dilaksanakan dari 22 September 2008 hingga 21 September 2009 di kawasan *Avicennia marina* yang terdapat di kawasan Hara Protected Area (HPA) manakala *Rhizophora mucronata* yang terdapat di International Wetland of Gaz dan juga di Hara Rivers Delta (GHRD). Kajian terhadap kumpulan burung ini dilakukan menggunakan “using point count method”.

Keputusan bancian burung menunjukkan sebanyak 76,074 pengamatan burung air telah dijalankan iaitu mewakili 62 spesies dari 15 keluarga dan 5 peringkat di dua lokasi. Berdasarkan kategori burung, terdapat sebanyak 57,373 (43 spp.), 18,681, (17 spp.) dan 20 (2 spp.), pemerhatian telah direkodkan masing-masing untuk kategori *waders*, *seabirds* dan *waterfowls*. Dari pemerhatian ini, sejumlah 59,387 burung air adalah terdiri daripada 56 spesies telah dicatatkan di HPA, sementara 16,687 pemerhatian melibatkan 54 spesies telah dicatatkan di GHRD. Selain itu, kategori burung menunjukkan bahawa sejumlah 44,078 adalah jenis *waders*, 15,297 adalah jenis *seabirds* dan 12 adalah jenis *waterfowls* telah dicatatkan di dalam pemerhatian HPA. Manakala 13,295 adalah jenis *waders*, 3,384 adalah jenis *seabirds* dan 8 adalah jenis *waterfowls* di GHRD. Manakala 48 spesies burung air (15 famili) yang boleh didapati di kedua-dua habitat. Lapan spesies didapati secara eksklusif di HPA sementara 6 spesies hanya boleh didapati di GHRD. Crab Plover (*pluvialis squatarola*) dan Eurasian Curlew (*Numenius arquata*) adalah spesies dominan ditemui masing-masing di HPA dan GHRD.

Terdapat perbezaan yang amat signifikan dari segi populasi semua burung air disebabkan kepelbagaian habitat dengan nilai P kurang dari 0.001. Ini juga menunjukkan bahawa nilai purata populasi burung air mengikut musim adalah lebih

tinggi di HPA berbanding hutan bakau di GHRD ($3,711 \pm 427$ vs. $1,283 \pm 209$ pemerhatian).

Keputusan parameter persekitaran menunjukkan bahawa terdapat perbezaan yang signifikan di antara semua pembolehubah di permukaan air termasuk suhu, pH, EC, TSS dan *salinity* ($p < 0.01$), kecuali DO ($p > 0.05$) di antara kedua-dua habitat (HPA dan GHRD). Ujian tanah juga menunjukkan terdapat perbezaan yang signifikan di antara dua habitat dari segi kewujudan kalium, karbon organik, peratusan dari tanah liat dan lumpur pada kedalaman 0-20 cm, dan karbon organik, pH, EC dan peratusan pasir dan lumpur pada kedalaman 20-40 cm ($p < 0.05$). Secara umumnya, *R. mucronata* mempunyai kepadatan tinggi, pohon yang tinggi dan berkanopi berbanding *A. marina* di pantai wilayah Hormozgān. Sementara itu, diameter pada ketinggian paras dada dan lebar silara untuk *A. marina* lebih tinggi berbanding *R. mucronata*. Selain itu, ada perbezaan ketara antara jumlah gastropoda bagi kedua-dua jenis hutan bakau ($t = 1.34$, $p < 0.05$), tetapi tiada perbezaan yang signifikan antara jumlah mudskipper pada 2 lekasi tersebut (*Avicennia*, *Rhizophora*) ($t = 2.041$, $p < 0.05$). Keputusan analisis redundansi menunjukkan respons positif yang kuat antara pembolehubah persekitaran dan populasi burung air. Keputusan ujian regresi menunjukkan parameter tanah tidak member kesan ke atas kebanjiran dan kurang mempengaruhi kehadiran spesies burung air, namun ia adalah penting untuk pertumbuhan hutan bakau dan habitat gastropoda.

Hasil kajian ini menyokong hipotesis bahawa faktor mikro-persekitaran dan mikro-habitat boleh mempengaruhi komposisi, kebanjiran, kepadatan dan kepelbagaian burung air terutama bagi *waders* di kedua-dua jenis vegetasi hutan bakau. Oleh kerana itu, perubahan pembolehubah persekitaran merupakan faktor utama

mempengaruhi respons terhadap agihan burung air dan jester itu, kajian terhadap populasi burung air boleh dijadikan alat memantau status habitat hutan bakau seta perubahan persekitarannya.



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I certify that an Examination Committee has met on 1th June 2011 to conduct the final examination of Saber Ghasemi on his PhD thesis entitled “POPULATION OF WATERBIRDS IN TWO MANGROVE TYPES, *AVICENNIA* AND *RHIZOPHORA* IN IRAN” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommended that the student be awarded the Doctor of Philosophy degree.

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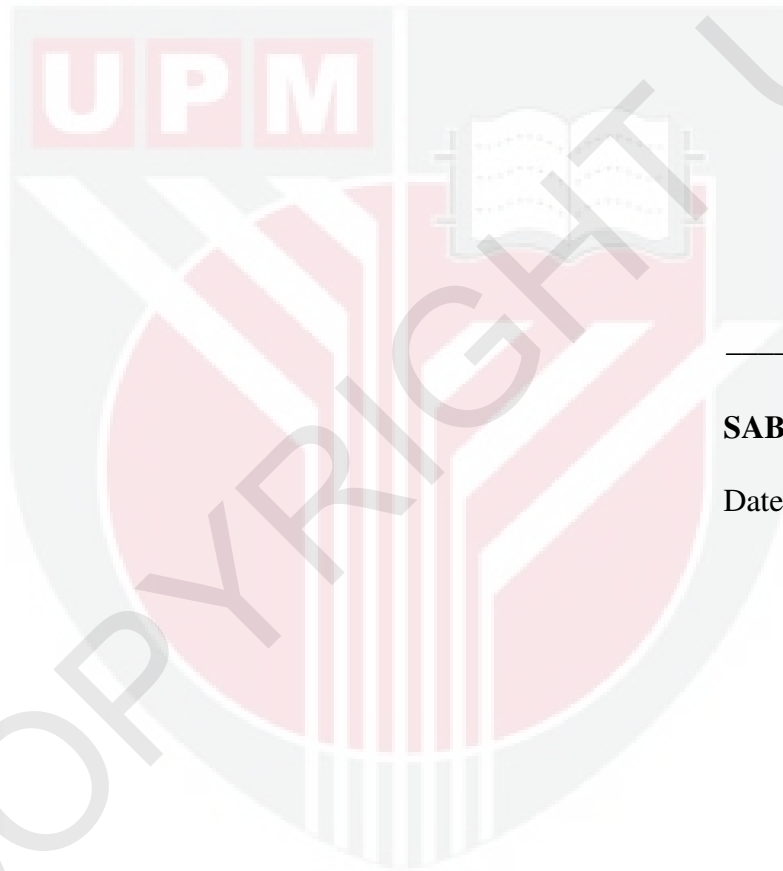
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DECLARATION

I declare that the thesis is my original work expect for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



SABER GHASEMI

Date: 1 June 2011

PREFACE

The main objective of this study is to determine the abundance, density and diversity of waterbirds in two different mangrove types (*Avicennia* and *Rhizophora*) in Iran. This study is constructed on the assumed relationship between various environmental variables and waterbirds especially waders and seabirds. The main research chapters (chapters four to six) have been written as scientific papers that four of them were accepted and published in the ISI journals till submission date, and thus can be viewed as independent studies. References and appendices are included at the end.

Chapter one introduces the general background, problem statement, null hypothesis and objectives of the research. Chapter two investigates the specific opinion about subjects of research. Chapter three introduces the study sites and general methods of research. The environmental and vegetation factors in the *Avicennia* and *Rhizophora* mangrove forests are the focus of Chapter four. Chapter five is a detailed examination of the available forages of waterbirds in two sites and considers the significance of the differences in foraging availability for waterbirds between the study sites. In chapter six, relative abundance and diversity of waterbirds in *Avicennia* and *Rhizophora* mangrove forests are presented at Hara protected area, and Gaz and Hara rivers delta. This chapter also examines the seasonal variation of waterbirds related to environmental conditions and food resources in study sites. Chapter seven concludes the thesis with a general discussion and conclusion of the significant outcomes of the study and recommendations.

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