

**THE DEVELOPMENT AND USE OF GIS DATABASE FOR THE STUDY OF
MIGRATORY BIRDS IN KUALA GULA NATIONAL PARK**

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THE DEVELOPMENT AND USE OF GIS DATABASE FOR THE STUDY OF
MIGRATORY BIRDS IN KUALA GULA NATIONAL PARK

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To my beloved parents,

Lum Chee Cheong & Foong Siew Yin

Thanks for the dim of light when all I see were darkness...

Thanks for giving me the best things in my life...and finally

Thanks for your sacrifices to make me a better person each day....

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ABSTRACT

Migratory birds are one of the living organisms that should be protected. These birds from northern hemisphere fly as far as 26 000 km a year across the continent for survival during the winter season. In addition, the migratory birds have consistently stopped by at Malaysia during the roosting season from November to March every year because they are attracted to the richness of Matang Mangrove Forest. The Department of Wildlife and National Parks (Kuala Gula) has carried out observation on the arrival of these migratory birds. The process of data collection had started since 1993, however, there is still no analysis had been carried out on the trend of bird migration for the past decade. The aim of this study is to develop a GIS database for the Department of Wildlife and National Parks (Kuala Gula) in order to facilitate the study of biodiversity and sustainability of migratory birds. Meanwhile, the objectives of this study is to find out the requirement of Department of Wildlife and National Park (Kuala Gula) ; build a GIS database for the migratory birds and performed analysis on the observed data. The methodology flows from need assessment to data collection, database development and system integration, and finally results and analysis on trend of bird migration, ecosystem properties, environment sensitivity analysis, morphometrics analysis and spatial statistic analysis on the distribution of the migratory birds. Database for managing biodiversity and sustainability of migratory birds has been developed using ArcView 3.2, MapObject 2.0, Microsoft Visual Basic 6.0, AutoCadMap 2.0 and S-Plus 2000. The result is a migratory bird's database with statistical results on the trend of bird migration. From the results of trend of bird migration, the endangered species of migratory birds can be identified. Subsequently, from the endangered species being classified, it can provide guidelines and procedures in maintenance of the mangrove areas.

ABSTRAK

Perkembangan dalam bidang bioteknologi telah banyak membantu kerajaan dalam usaha mengurangkan peratusan kepupusan hidupan terancam seperti burung migrasi. Burung migrasi dari hemisfera utara terbang sejauh 26 000 km setiap tahun merentasi kontinen semasa musim sejuk dari bulan November sehingga Mac. Burung migrasi ini akan berhenti di Hutan Simpan Matang semasa musim berehat kerana tertarik dengan kawasan paya bakau yang kaya dengan pelbagai jenis hidupan. Jabatan Perhilitan Kuala Gula telah menjalankan operasi pemerhatian dan pengumpulan data semasa ketibaan burung migrasi ini, bermula sejak tahun 1993, namun masih tiada analisis pernah dijalankan untuk mengetahui haluan proses penghijrahan burung migrasi di Malaysia. Tujuan kajian ini dijalankan adalah untuk membangunkan satu pangkalan data burung migrasi untuk Jabatan Perhilitan Kuala Gula supaya kajian terhadap kepelbagaian hidupan dan langkah pemuliharaan dapat dijalankan. Sementara itu, objektif kajian ini adalah untuk menjalankan kajian keperluan pengguna, membangunkan satu pangkalan data GIS untuk burung migrasi dan menjalankan analisis terhadap data burung migrasi. Metodologi kajian ini bermula dari kajian keperluan pengguna iaitu Jabatan Perhilitan Kuala Gula, seterusnya pembangunan pangkalan data dan pengintegrasian sistem dan akhirnya analisis terhadap haluan penghijrahan burung migrasi, kepekanaan persekitaran, data *morphometrics* dan akhir sekali analisis statistik spatial terhadap penyebaran burung migrasi ini. Satu pangkalan data untuk pengurusan dan pemulihan burung migrasi telah dibangunkan dengan menggunakan ArcView 3.2, MapObject 2.0, Microsoft Visual Basic 6.0, Autocad Map 2.0 dan S-PLUS 2000. Hasil daripada tren penghijrahan burung migrasi ini, burung yang diancam kepupusan, spesis baru, penghijrah tetap dan kitar hayat burung migrasi ini dapat diketahui. Hasil analisis menunjukkan burung yang diancaman kepupusan dapat dilindungi serta kawasan yang peka bagi burung migrasi ini perlu diberi perhatian sekiranya ada pertembungan dengan projek pembangunan di sekitar kawasan tersebut.

CONTENTS

CHAPTER	TITLE	PAGE
	FRONTPAGE	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	CONTENTS	vii
	LIST OF TABLES	xiii
	LIST OF FIGURES	xiv
	LIST OF APPENDICES	xvii
	LIST OF ABBREVIATIONS	xviii

1	INTRODUCTION	
1.1	Background of study	1
1.1.1	Issues on biodiversity and sustainability	3
1.1.2	Genetic, species and ecosystem diversity	5
1.1.3	Endangered species of birds	6
1.1.4	The concept of ecosystem and environment protection	7
	1.1.4.1 Ecosystem properties	7
1.1.5	Environment protection	8
1.1.6	Kuala Gula the bird sanctuary	

1.2	Problem Statement	11
1.3	Aim and Objectives	12
1.4	Area of study	13
1.5	Scope of study	14
1.6	Importance of study	15
1.7	Related research	16
1.8	Summary	18

2

LITERATURE REVIEW

2.1	Introduction	20
2.2	Mangrove forest in the world and wetlands in Malaysia	21
2.2.1	Classification of wetlands and mangrove forests	21
2.2.2	Geo-historical change of wetlands in the glacier age	24
2.2.3	General description of Matang mangrove Forest	25
2.3	The wetlands international	28
2.4	Birds in Matang Mangrove Forest	29
2.5	Early ideas about migration	30
2.5.1	The concept of bird migration	33
2.5.2	Techniques for studying bird migration	34
2.5.2.1	Direct Observation	35
2.5.2.2	Aural	35
2.5.2.3	Preserved Specimen	36
2.5.2.4	Marking	36
2.5.2.5	Radio Tracking	38
2.5.2.6	Radar Observation	39
2.6	Life cycle of the migratory birds	47

2.7	Ecosystem in Kuala Gula wetlands	50
2.7.1	Preferences of food for the migratory birds	54
2.7.2	The interdependent of component in an Ecosystem	55
2.7.3	The changing ecosystem in Kuala Gula wetlands	55
2.8	Environment threats to migratory birds	56
2.9	Issues on sustainability in Malaysia	57
2.10	Definition of GIS and its implementation in managing biodiversity and sustainability issues	58
2.10.1	GIS application	58
2.9.2	Components of GIS	59
2.9.3	Geographical referenced data	60
2.9.3.1	Spatial data	61
2.9.3.2	Attributes data	61
2.9.3.3	GIS operation	61
2.9.3.4	Benefits of GIS	63
2.11	GIS application in managing biodiversity and sustainability issues	63
2.12	Research on bird migration around the world	66
2.13	Research on migratory birds in Malaysia	69
2.14	Trend of bird migration	71
2.15	Research on Environment Sensitivity Index	72
2.16	Summary	73

3

RESEARCH METHODOLOGY

3.1	Introduction	74
3.2	Need assessment	76
3.2.1	User requirement for data	76
3.2.2	User requirement for database	76
3.2.3	User requirement for user-interface	77

3.3	Data collection	77
3.3.1	Spatial data collection	77
3.3.2	Attribute data collection	78
3.4	Database designation	78
3.4.1	Conceptual Design	79
3.4.2	Logical Design	81
3.4.3	Physical Design	83
	3.4.3.3 Software for this study	84
3.5	Database development	87
3.5.1	Spatial data entry	87
	3.5.1.1 Scanning	88
	3.5.3.2 Digitizing	88
	3.5.1.3 Editing	89
	3.5.1.4 Topology creation	89
	3.5.1.5 Viewing	90
3.5.2	Attribute data entry	91
3.6	User interface creation	92
3.6.1	Menu	95
	3.6.1.1 Menubar	96
	3.6.1.2 Toolbar	98
3.6.2	The database	99
	3.6.2.1 Distribution of migratory birds	100
	3.6.2.2 Food preferred by the migratory birds	102
3.6.3	Picture of the migratory birds	105
3.7	Application testing	106
3.8	Summary	106

4

RESULTS AND ANALYSIS

4.1	Introduction	108
4.2	Trend of bird migration	109

4.2.1	Distribution of migratory birds	109
4.2.2	Total species of migratory birds found in Kuala Gula wetlands according to year basis	112
4.2.3	An overview on the trend of bird migration in Kuala Gula wetlands	114
4.2.4	The new species found in Kuala Gula wetlands	116
4.2.5	The species that has stop visiting Kuala Gula wetlands	118
4.2.6	The endangered species of migratory birds in Kuala Gula wetlands	119
4.2.7	The constant visitor to Kuala Gula wetlands	123
4.2.8	Situation in Kuala Gula wetlands after the roosting season	126
4.3	Environment Sensitivity Analysis	127
4.3.1	Distribution of migratory birds	127
4.3.2	Conservation of the mangroves area for the migratory birds	130
	4.3.2.1 Spatial analysis to determine the sensitive area for the migratory birds	131
	4.3.2.2 Simple query to find out the sensitive lot for the migratory birds	136
4.4	An overview of shorebird banding in Asia	138
4.4.1	Series of codes use in ageing birds by CISRO Australia	139
4.4.2	Analysis on morphometrics data	141
4.5	Spatial statistic on the distribution of migratory birds	148

	4.7	Summary	155
6		CONCLUSION AND RECOMMENDATIONS	
	6.1	Introduction	157
	6.2	Results and analysis	157
	6.3	Recommendations	158
	6.4	Conclusion	159
		REFERENCES AND BIBLIOGRAPHY	166-165
		APPENDICES	166-233

LIST OF TABLES

NO	TITLES	PAGE
2.1	Classification of wetlands	22
2.2	Mangrove forests in the world	23
2.3	Mangrove forests in South East Asia	23
2.4	Productive and unproductive forest area in each division in Matang Mangrove Forest.	26
2.5	Comparative statement of area for each forest reserve	26
2.6	Life Cycle of the migratory birds	49
2.7	The level of consumerism and its species composition	53
2.8	Preferences of food for the migratory birds according to family	54
2.9	A classification of GIS activities	62
3.1	Source of spatial data	78
3.2	The menu and its description	97
4.1	Total species of migratory birds recorded from field observation from 1993-2004	113
4.2	Trend of bird migration for the migratory birds in Kuala Gula wetlands	115
4.3	The new species to Kuala Gula wetlands	117
4.4	The trend of extinct species in Kuala Gula wetlands	118
4.5	The endangered species of Black-capped Kingfisher in Kuala Gula wetlands	120
4.6	The endangered species of Blue-tailed bee-eater in Kuala Gula wetlands	121
4.7	The Common tern, a constant visitor to Kuala Gula wetlands	123
4.8	Marsh Sandpiper, a constant visitor to Kuala Gula wetlands	124

4.9	Location of interest for the migratory birds	130
4.10	GIS operation provided by geoprocessing wizard in ArcView	
	132	
4.11	Code, age and description of the migratory birds	140
4.12	Morphometrics data for year 1993 in Tanjung Piandang	142
4.13	Morphometrics data for year 2004 in Tanjung Piandang	143
4.14	Moult score for the migratory birds in 1993 and 2004	147

LIST OF FIGURES

NO	TITLES	PAGE
1.1	Kuala Gula and the surrounding mangrove areas	13
2.1	Summer and winter homes of the Black-and-white Warbler.	41
2.2	Isochronal migration lines of the Black-and-white warbler.	42
2.3	Migration of the Blackpoll Warbler.	43
2.4	Migration of the Cliff Swallow.	44
2.5	Migration of Pacific coast forms of the fox Sparrow.	45
2.6	Distribution and migration of Arctic Terns.	46
2.7	Distribution and migration of Harris' Sparrow.	47
2.8	Life cycle of the migratory birds	48
2.9	Food pyramid in Kuala Gula wetlands	52
2.10	The physical component of GIS	60
3.1	Methodology flow chart	75
3.2	The symbol for Conceptual Design	79
3.3	Entity Relationship Diagram for Migratory bird's database	80
3.4	The Logical Design of Migratory Bird's database	81
3.5	The steps of conversion from hardcopy to digital copy	88
3.6	Spatial data entry into ArcView 3.2	90
3.7	Attribute data in ArcView 3.2	92
3.8	The login form for the system	93
3.9	The front page of the system	94
3.10	The main form for handling map layers	95
3.11	The menu editor to create the menubar	96
3.12	The toolbar dialogue box	98
3.13	The image list dialogue box	99

3.14	The sub menu of the database	100
3.15	The list of the migratory birds	
101		
3.16	Distribution of migratory birds according to year basis	102
3.17	Food preferred by the migratory birds	103
3.18	Prey of the migratory birds	104
3.19	The interface for the picture of the migratory birds	105
4.1	The distribution of migratory birds from 1993-2004	109
4.2	The landuse in Larut Matang, Selama dan Kerian in 1993	111
4.3	The landuse in Larut Matang, Selama dan Kerian in 2000	112
4.4	Total species of migratory birds according to year basis	114
4.5	New species of migratory birds found in Kuala Gula wetlands	
117		
4.6	The trend of extinct species in Kuala Gula wetlands	119
4.7	A small group of migrant in Kuala Gula wetlands	122
4.8	Total number of migratory birds according to month basis for year 1993 in Kuala Gula wetlands	126
4.9	Distribution of migratory birds in the 90's	128
4.10	The distribution of migratory birds from 2000-2004	129
4.11	The attributes of migratory birds from 1993-2004	133
4.12	The results of merge operation	133
4.13	Attributes of migratory birds located inside the forest reserved in Matang Mangrove Forest	134
4.14	The results from clip operation	135
4.15	The attributes of migratory birds and cadastral lot in a new theme	136
4.16	Simple query to find out the sensitive lot for the blue-tailed bee-eater	137
4.17	The results of selected cadastral lot for the endangered species of migratory birds	137
4.18	Primary, secondary and tertials moult for the migratory birds	144
4.19	Standard system for scoring moult	145
4.20	Shorebird wing in moult	146

4.21	Moult score for five selected species of migratory birds in 1993 and 2004	147
4.22	First step to count the first order of spatial neighbours for the distribution of migratory birds	149
4.23	Step to count the spatial autocorrelation for the distribution of migratory birds	149
4.24	Results of spatial autocorrelation for the distribution of migratory birds in Kuala Gula wetlands and surroundings mangroves area	150
4.25	The two-tailed test for Moran, I analysis	152
4.26	Number of migratory birds in Kuala Gula wetlands and surrounding mangroves area	153
4.2.7	Colour classification of the distribution of migratory birds in Kuala Gula wetlands and surrounding mangroves area.	154

APPENDICES

NO	TITLES	PAGE
A	Application testing	166-170
B	Picture of the migratory birds	171-179
B	List of migratory birds in Kuala Gula wetlands	180-181
C	Source codes for the system of migratory birds	183-233

LIST OF ABBREVIATIONS

GIS	Geographical Information System
DNA	Deoxyribonucleic acid
CBD	Biological diversity
IGO	Intergovernmental organization
IAS	Invasive alien species
PA	Protected areas
ABS	Access and benefit sharing
CEPA	Education and public awareness
CHM	Clearing-house mechanism
DANIDA	Danish International Development Assistance
PERHILITAN	Department of Wildlife and National Park
JWRC	Japan Wildlife Research Center
TCBO	Thunder Cape Bird Observatory
IWRB	International Waterfowl and Wetlands Research Bureau,

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The Department of Wildlife Peninsular Malaysia has been established to give Malaysians an effective and capable service in conserving and managing sustainable use of habitat and species diversity in Peninsular Malaysia. On the other hand, the Department of Environment Malaysia plays an important role in ensuring the uniqueness; diversity and quality of the environment are preserved towards maintaining health, prosperity, security and well-being for the present and the future. The Department of Environment has declared 5 June as World Environment Day as a reminder for us to protect the environment.

Environment interacts with all kinds of living objects. The issues on environment are a growing interest nowadays because it plays a vital role in the continuity of human-being existence. There are a lot of environmental issues nowadays such as pollution, deforestation, global warming, biodiversity and sustainability and so forth.

Pollution is not a new issue to our society nowadays. The air, water and sound pollution can create negative effects on human health such as food poisoning,

asthma and respiratory infections such as bronchitis and pneumonia, headaches, nausea and allergic reactions. Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys.

Development is the key to civilization and the only way for development is deforestation. However, deforestation without careful planning will create a great disaster to human being such as landslide, flood and global warming. The negative effect of deforestation is getting more attention from our society and many precautions had been taken to minimize the possibility of this occurrence such as the enforcement of laws and forest reservation plannings.

The issue on biodiversity and sustainability is another issue being discussed by our society. The risen in awareness is due to people realizing on the importance of species dependency in this world. Every species living on the earth interacts with one another in which the air, water and sunlight plays an important role as external resources to make the cycle complete. Nobody can guarantee the continuity of existence for every species including human beings. However, there are numerous precautions that can be taken to prolong the extinction period of every species. For example, careful management on the conservation and protection of the endangered species will definitely help to decrease the percentage of extinction.

The goals of sustainable development in Malaysia are not being met, partly because of the lack of access to advanced technology for environmental monitoring as well as for biodiversity and sustainability management practices. Geographic Information Systems (GIS) is a unique and important tool for monitoring the degradation of tropical ecosystems.

1.1.1 Issues on Biodiversity and Sustainability

Biological diversity means the full range of variety and variability within and among living organisms and the ecological complexes in which they occur. In addition, biological diversity encompasses community diversity, species diversity, genetic diversity, and ecosystem diversity. Life comes in an almost infinite variety of fascinating and enchanting forms, from microscopically small unicellular species to giant whales and elephants. In turn, species are formed by different kinds of populations, these by different kind of individuals and these by different types of organs, tissues, cell, and genes.

Biodiversity is therefore not an entity, a resource, but a property, a characteristic of nature. Species, populations, certain kinds of tissues are resources, but not their diversity as such. But diversity is a defining characteristic of life. Without diversity life is not conceivable, just like a ball without roundness is not conceivable, or a diamond without hardness is not a diamond. There is so much diversity, and it takes so many forms we ask in disbelief, where does this diversity come from? Fundamentally it derives from the properties of a variety of macromolecules, most notably DNA and proteins. Their characteristics make biodiversity possible. Biodiversity underpins the processes that make life possible. Healthy ecosystems are necessary for maintaining and regulating: atmospheric quality, climate, fresh water, marine productivity, soil formation, cycling of nutrients and waste disposal (Reid and Laird, 1993).

Malaysia is the world's 14th ranking mega-diversity country as stated in a report by Association of Southeast Asian Nation. To give one an idea how valuable biodiversity is, experts have estimated that more than 40% of the world's economy and 80% of the needs of the world's poor are taken from biodiversity (Illuminado, 2003).

In addition, Malaysia has 2.12 million hectares of national and state parks, wildlife sanctuaries, turtle sanctuaries and wildlife reserves. Some 3.43 million hectares are also protected as water catchments area (Sorensen, 2002).

Recently there is a regional conference on Biological Diversity (CBD) that took place from 9-20 February 2004, at the Putra World Trade Centre in Kuala Lumpur, Malaysia. Over 2,300 participants attended, representing 161 governments, as well as UN agencies, non-governmental organizations (NGOs), intergovernmental organizations (IGOs), indigenous and local communities, academia and industry. The meeting had come out with a decision which had adopted 33 decisions on biodiversity and tourism; monitoring and indicators; the ecosystem approach; biodiversity and climate change; sustainable use; invasive alien species (IAS); the Strategic Plan; mountain biodiversity; inland water ecosystems; marine and coastal biodiversity; protected areas (PAs); access and benefit-sharing (ABS); technology transfer and cooperation; Article 8(j) (traditional knowledge); incentive measures; communication, education and public awareness (CEPA); scientific and technical cooperation and the clearing-house mechanism (CHM); financial resources and mechanism; and national reporting. (Damodaran, 2004)

In April 2003, Wetlands International commenced on a two-year conservation project at Kuala Gula wetlands, with funding from Danish International Development Assistance (DANIDA) (Asian Waterbird Census 1997-2001).

An article taken from the Star Newspaper (5 March 2005) has stated that nine companies would be charged in the court in connection with the degradation around the Bukit Cahaya Seri Alam Agriculture Park. Besides, the Selangor Government has also announced that local councils would no longer have the

power to approve any development projects near by environment sensitive places. Menteri Besar Datuk Seri Dr Mohamad Khir Toyo was ordered to take immediate action by Prime Minister Datuk Seri Abdullah Ahmad Badawi, who expressed outrage over the degradation of Bukit Cahaya after seeing the destruction from the air in a 45-minute helicopter ride.

The main causes for loss of biodiversity in Malaysia are habitat destruction, over harvesting and pollution. As of early 1995, the National Policy on Biological Diversity was in the final phase of formulation before being endorsed by the Cabinet. The aim of this national strategy is to maintain plants and animals in their original habitats as well as outside of their original habitats in facilities such as botanical gardens. The purpose is to ensure long-term food security and preservation of the unique biological heritage of Malaysia (Natural Resources Aspect of Sustainable Development in Malaysia).

1.1.2 Genetic, Species and Ecosystem Diversity

- ***Genetic diversity*** is the combination of different genes found within a population of a single species, and the pattern of variation found within different populations of the same species.
- ***Species diversity*** is the variety and abundance of different types of organisms, which inhabit an area.
- ***Ecosystem diversity*** encompasses the variety of habitats that occur within a region, or the mosaic of patches found within a landscape (Solbrig, et. al, 1994).

1.1.3 Endangered Species of Birds

Danish Co-operation for Environment and Development chief technical adviser Kim Worm Sorensen said the rate of extinction today is six species per hour. In rainforests, the extinction rate is 50,000 species a year (Sorensen, 2002). Meanwhile, an article in the Star newspaper stated that forty species are globally threatened in Malaysia. This places Malaysia on the 10th spot on the list of Asian countries with the most number of bird species at risk of extinction. Of the 40 species, three are considered critically endangered, four are endangered and 33 are vulnerable. During the last century, some species of birds have gone extinct, such as the green peafowl in Peninsular Malaysia and the white-shouldered ibis in Sarawak (Malaysia's Avifauna - The endangered ones).

Although biodiversity loss primarily centers upon the destruction of entire ecosystems, some species are more at risk, and more critically endangered than others. The biological value of some is not immediately obvious, but each has its own unique place in the ecosystem, and the depletion or loss of one species can have unexpected and devastating knock-on effects on others.

There are a few local birds, which are under the category of endangered species such as the Milky Stork and Lesser Adjutant. It is recorded that about 5500 Milky Stork left in the world and 100 left in Malaysia. The three critically endangered species are the Christmas Island frigatebird, White-rumped vulture; Chinese crested tern and Silvery wood pigeon. The four endangered ones are Storm's stork, Nordmann's greenshank, Bornean peacock-pheasant and white-winged duck.

Malaysia has important populations of many threatened rainforest birds. These include three species endemic to the peninsula: the mountain peacock-

pheasant, Malayan whistling-thrush and the Malaysian Peacock-pheasant. The coastal and inland wetlands host globally threatened resident and migratory water birds such as the milky stork, lesser adjutant, and storm's stork, spotted greenshank, spoon-billed sandpiper and Chinese egret (Sim, 2003).

1.1.4 The concept of Ecosystem and Environmental Protection

A simple definition by Transley (1935), ecosystem is an assemblage of biotic and abiotic components making up an interdependent system. Abstraction of nature such as the ecosystem concept can be used in both a general way and a local, specific way. For example, one can discuss the tall grass prairie ecosystem as an abstract representation of an ecosystem type that once covered much of the former Prairie Peninsula. But one can also use the ecosystem concept to describe, analyze, and predict behavior of a specific representation of a general ecosystem type, such as prairie relict consisting of only a few acres along a railroad in Rowa (Reiners, 1995).

1.1.4.1 Ecosystem Properties

When analyzing and modeling environmental systems at the ecosystem level, it is useful to focus on certain structural and functional properties. A list of very general ecosystem properties, each of which can be subdivided for more detail and definition of particular ecosystem is as follows:

- Climate at appropriate space and time scales
- Soils

- Water regime (hydrology, chemistry)
- Species composition
- Physical structures (dimensions, distribution of live and dead biomass, photosynthetic area)
- System energetic (physical energy budgets, biological energy flows)
- Nutrient budgets and cycles
- Regulatory processes
- Topological relationships (influences from neighboring ecosystem)

(Reiners ,1995)

The ecosystem in Kuala Gula is the main attraction for tourism. The richness of mangrove has attracted the migratory birds to stop by and find their food there. The mangrove contains of many living organism such as birds, fish, mollusks, crustaceans, frog, worms, prawn, insects, grass and so forth interacts with one another. Air, water and sunlight play an essential role in completing the circles of ecosystem.

1.1.5 Environment Protection

Efforts to draft legislation on the protection of wildlife in Peninsular Malaysia dated as far back as 1869. The first legislation was the Straits Settlement Ordinance No. 3 of 1894, which covers only a few species. 1955 was a historical year for the Wildlife Department as the Wild Animals and Birds Protection Ordinance No.2 of 1955 was passed. In 1972, the Wildlife Protection Act No. 76 of 1972 was drafted and was subsequently passed by the Parliament and obtained Royal Approval on 28 April 1972. The Act was published and gazetted on 4 May

1972.

With the Wildlife Protection Act No. 76 of 1972, the Wild Animals and Birds Protection Ordinance No.2 of 1955 were abolished. Wildlife conservation activities in Peninsular Malaysia come under the administration of the Federal Government. The Wildlife Department was later known as the Department of Wildlife and National Park or PERHILITAN in short (Department of Wildlife and National Parks).

1.1.6 Kuala Gula The Bird Sanctuary

Kuala Gula wetlands are located in the district of Kerian, about 45 km from Taiping, in the state of Perak. Kuala Gula is located towards the north of the Matang Mangrove Forest Reserve. Matang is the single largest tract of mangrove forest in Peninsular Malaysia. It covers an area of 40,000 ha. Matang was first protected in 1906 and is rated as the best managed mangrove forests in the world.

Kuala Gula and its associated wetlands (mudflats, mangroves, rivers and estuaries) extend to approximately 12,000 ha. It is an important area for fisheries as a majority of the local community at Kuala Gula is involved in this thriving business. There are about 600 families involved in the harvesting of fish, shrimp and shellfish, cockle farming, aquaculture as well as in the processing of shrimp and fish products. The mangrove is a rich breeding ground for various aquatic lives, including shrimps, cockles and mud crabs.

Kuala Gula mangroves are known best as a roosting and feeding site for migratory water birds. 48 migratory water birds including the Little Egret *Egretta*

garzetta and Great Egret *Casmerodius albus*, and many waders such as the Common Redshank *Tringa totanus*, Common Greenshank *Tringa nebularia*, Eurasian Curlew *Neminius arquata*, Common Sandpiper *Actitis hypoleucos* and Mongolian Plover *Charadrius mongolus*, as well as threatened resident water birds such as the Lesser Adjutant *Leptoptilos javanicus* and the endangered Milky Stork *Mycteria cinerea* has been recorded in Kuala Gula. These resident birds are nesting in this wetland. Birds of prey are also very common here, especially the Brahminy Kite, *Haliastur indus* and Crested-serpent Eagle *Spilornis cheela*.

The Department of Wildlife and National Parks (PERHILITAN) have established Kuala Gula as a bird sanctuary since 1970. These water birds migrate from the Northern to Southern Hemisphere especially from Siberia and Mongolia and stopover at Kuala Gula for feeding at the mudflats and mangrove forests in the wintering months. Every year approximately 5,000 visitors came to Kuala Gula for bird watching. Thousands of birds can be seen in Kuala Gula wetlands especially during the migratory and wintering season from September to April of the following year. During non-migratory season, you can see the resident water birds such as the Lesser Adjutant and Milky Stork.

Besides that, Kuala Gula lies close to two sites (Pulau Kelumpang and Pulau Trong Bird Sanctuary) that have been reserved as Bird Sanctuaries within the Matang Mangrove Forest Reserve. Both are island reserves that harbour probably the only viable population of the globally endangered Milky Storks in Malaysia. It is recorded about 5,550 left in the world and 100 left in Malaysia, and in a recent survey the wildlife officer of Kuala Gula Office observed 10 Milky Storks in Pulau Kelumpang. Kuala Gula is also a wildlife sanctuary. Mammals are also found in the mudflats and forest area. They are the Smooth Otter *Lutra perspicillata*, Silvered-leaf Monkey *Trachypithecus cristatus*, Long-tailed Macaque *Macaca fascicularis* and Ridgeback Dolphin (Sim, 2003).

1.2 Problem Statement

The migratory birds from northern hemisphere stop by in Malaysia before continuing their journey to other countries such as Australia during roosting season from November to March every year. For instance, from a group of migratory birds, there will be a few species which are categorized under endangered species due to the low rate of number found compared to other species. These endangered species need to be protected from any further harm to minimize the possibility of extinction.

Department of Wildlife and National Parks Malaysia (DWNPM) has conducted an early study on migratory birds in Matang Mangrove Forest in a joint venture research program with the Japan Wildlife Research Center (JWRC). The avifauna population was studied using three methods namely; direct observation, mist netting, and line transect surveys by scientists from both organizations in 1993-1995.

Although authority in Department of Wildlife and National Park, Kuala Gula still carry out field observation to collect the data of migratory birds till now, no analysis has been carried out on the data. In addition, there is still no GIS implementation in managing the data of migratory birds. As a matter of fact, the trend of bird migration in Malaysia has not been discovered. The statistical analysis on the endangered species of migratory birds for the last decade can give us an idea on how the trend of bird migration has been changed.

Geographical Information System is a computer system to manage the process and to analyze the geographical referenced data. There are some popular analysis provided by the GIS softwares namely, spatial analysis, 3D analysis and network analysis. Spatial analysis such overlay can be used to obtain an output that

fulfills the criteria of two layers. This analysis can be used to find out the sensitive area for the migratory birds.

In addition, GIS provides the function of spatial and attribute linking. By using GIS, the data from field observation can be linked to the map of the study area. GIS plays important roles in managing the sustainability of the mangroves area, which indirectly brightens up the future of the migratory birds to Malaysia.

Besides the sustainability purpose, Kuala Gula the bird sanctuary has attracted thousands of tourists every year just to have a glance of the spectacular view of those colourful migratory birds. For this reason alone, the need to protect the sensitive area for the migratory birds is undeniably significant to promote the tourism in Malaysia.

1.3 Aim and Objectives

The aim of this study is to develop a GIS database for Department of Wildlife and National Park, Kuala Gula in order to facilitate the study of the migratory birds.

Meanwhile the objectives of the study are listed as follows;

- To assess the need of the Department of Wildlife and National Park, Kuala Gula for database development
- To build a GIS database for the migratory birds
- To perform analysis using;
 - ✓ Trend of bird migration
 - ✓ Ecosystem in Kuala Gula wetlands

- ✓ Environmental Sensitivity
- ✓ Morphometrics data
- ✓ Spatial statistics on the distribution of migratory birds

1.4 Area of Study

Area of study is comprises of Kuala Gula and surrounding mangrove areas.

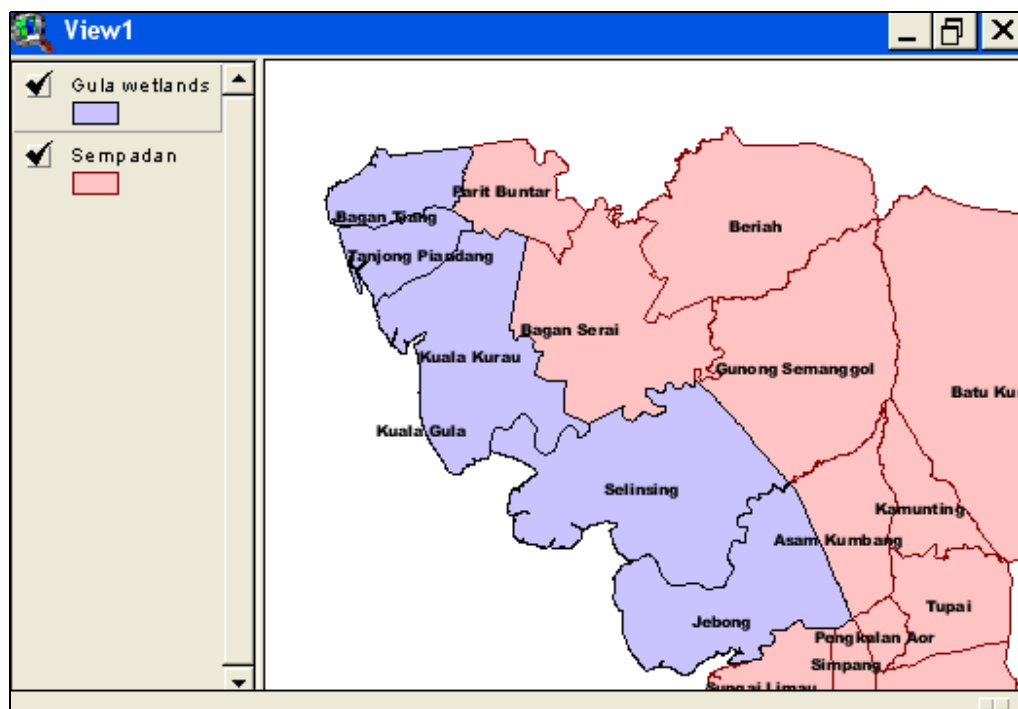


Figure 1.1: Kuala Gula and the surrounding mangrove areas

1.5 Scope of study

The scope of this study is basically related to software, data types, analysis to be performed and the designation of user interface. Several software being used which includes ArcView 3.2, MapObject 2.0, Microsoft Visual Basic 6.0, AutoCad Map 2.0 and S-Plus 2000.

The most important data for this study is the distribution of migratory birds within the study area from 1993 to 2004. The limitation for this data is the total number of migratory birds being recorded is just estimation because there is no consistency in date and time for observation. The data from 1998 and 2001 are not available; therefore they are excluded from the analysis because no fieldwork was carried out during these four years.

On top of that, morphometrics (measurement taken from a bird structure) data of the migratory birds is needed for this study to find out the age of the migratory birds to Kuala Gula wetlands. The availability of the data is from 1992 to 1995 and 2002 to 2004.

The cadastral lot for Kuala Gula wetlands is very important for the analysis on environment sensitivity in study area. Meanwhile, as an additional knowledge, the list of the migratory birds together with their picture is important for identification purposes.

Three main analyses for this study include: trend of bird migration, environment sensitivity analysis and spatial statistic on the distribution of migratory birds. All three analyses require the use of GIS functionalities in order to obtain the results. Meanwhile, an additional analysis on the morphometrics data for the migratory birds will be carried out as an additional knowledge on the shorebird

banding in Asia.

Finally, a friendly user-interface has been created for the authority in Department of Wildlife and National Park, Kuala Gula.

1.6 Importance of Study

This study is of paramount importance to find out the location of the migratory birds. In addition, this study can provide the information about the trend of bird migration in Malaysia. From the database being created for the distribution of migratory birds from 1993 to 2004, the new species, endangered species and the constant visitor of migratory birds to Kuala Gula wetlands can be identified. The total number of migratory birds being discovered every year would be summed up so that comparison can be made for a period of a decade. This analysis is very important to explain whether the ecosystem in Kuala Gula wetlands is still well-preserved.

From the migratory bird's database, the date of arrival for the species of migratory birds has been jotted down in the database. From there, a temporal analysis can be performed on the seasonal arrival of these migratory birds. The results on this analysis can provide a valuable information for bird lovers in Malaysia so that they can carry out bird watching activities at the peak season of the arrival of these migratory birds.

Environmental sensitivity analysis is utmost important to find out the sensitive areas for the migratory birds. These sensitive areas for the migratory birds need to be protected in order to prolong the extinction period. GIS operation such as

buffer and overlay is performed so that the government can carry out conservation activities affectively.

Apart from that, spatial statistic on the distribution of migratory birds can provide a result concerning the spatial patterns on the distribution of migratory birds. There are three types of spatial patterns namely, clustered, dispersed and random. The nature of spatial autocorrelated data that is the data that is not random in space. This result is important to provide an indication whether the places of the distribution of migratory birds share the similar characteristic.

Finally, this study is significant towards sustaining the migratory birds to Malaysia. This is to ensure the migratory birds from northern hemisphere will continue to visit Kuala Gula and the surrounding mangrove areas in the future so that the ecosystem in the study area can be preserved.

1.7 Related Research

There are numerous related studies on migratory birds and trend of bird migration. The pioneer study for migratory birds in Malaysia was conducted between September 1993 to January 1995 by the Department of Wildlife and National Parks (DWNP) and the Japan Wildlife Research Center (JWRC) in the joint venture research program on the biodiversity of Wetland in Malaysia. Scientists from both organizations also conducted studies on migratory bird's population during their annual migration. The studies on avifauna were conducted at various locations in the Matang mangrove forest reserve during the three years study period. Bird observation was conducted along the rivers especially Sungai Gula, Sungai Selinsing and Sungai Kelumpang. The avifauna population was studied using three methods namely; direct observation, mist netting, and the line

transect surveys. The study was conducted from 15 September to 7 October 1993 for the first phase, from 7 to 17 for the second phase and from 18 to 21 January 1995 for the third phase. A total of 78 species from 33 families were recorded during the first phase of study, 75 species from 36 families in the second phase, and only 37 species from the third phase respectively (Satoo, 1995).

A study by Oliver in 1999 was to design a GIS database to produce an ESI map to determine the environmental sensitivity areas when oil spill occurs. It is also a decision making tool for the management in prevention and clean up before or after the oil spill occurs.

An extension from the study by Oliver, a team from Universiti Teknologi Malaysia (Ibrahim Busu, Norkhair Ibrahim, Ghazali Desa and Surya Asnarius) with a cooperation of the Japanese Wildlife Research Center (JWRC) has produced an ESI map for oil spills. This study has been conducted to develop the ESI maps based on standard Sensitivity Index, which is produced by the NOAA and Coastal Resources for East Coast Peninsular Malaysia. The primary objectives of this study were to design and develop ESI database, to design and produced ESI maps for study area using GIS technology and to analyze the advantages of using GIS approach to produce ESI maps as compared to conventional method. The final results of this study include the ESI system and ESI maps. The maps produced are divided into three major types, which is Sensitivity Index for the Shoreline, Biological Resources and Human-Use Resources.

Besides that, North American Breeding Bird Survey had carried out a research on trend of bird migration in America. The aim of the research is to find out the change of population of local and migratory birds. Of the 245 species considered, 130 have negative trend estimates, 57 of which exhibit significant declines. Species with negative trend estimates are found in all families, but they

are especially prevalent among the mimids (mockingbirds and thrashers) and sparrows. A total of 115 species exhibit positive trends, 44 of which are significant increases. Flycatchers and warblers have the largest proportions of species with increasing populations (Peterjohn, et. al, 1992).

Futhermore, Debbie Badzinski (2003) has carried out a research on trend of bird migration for 63 species of migrant birds, and eight species of irruptive or partial migrants at Thunder Cape Bird Observatory (TCBO) from 1995-2002. These indices were calculated from daily estimated totals of birds passing through the designated area. This result had came out with three conclusions, which were summarized as follows;

- i) **Spring population trends** (1995-2002). Based on spring population trends, 81% (35/43) of species have declined and only 19% have increased at TCBO between 1995-2002.
- ii) **Fall population trends** (1995-2002). The majority of fall migrants at TCBO also had decreasing population trends from 1995-2002. Seventy-three percent (45/62) of fall migrants declined, and only 27% increased (17/62).
- iii) **Combined spring/fall population trends** (1995-2002). Combined spring/fall trends were calculated for 39 species at TCBO. Eighty-one percent (31/38) of species at TCBO declined and only 18% (7/38) of species had positive trends from 1995-2002.

1.8 Summary

This chapter presents introductory discussion of this study. The discussion covers the background of study, issues and problem statement, aims, objectives,

scope of study and importance of study. Some of the related researches to this study were also briefly discussed.

Chapter 2 is devoted to literature studies which includes among others; early ideas of bird migration, the concept of bird migration, techniques for studying migration, food for the migratory birds in Malaysia, environment treats to migratory birds, issues on sustainability in Malaysia, GIS in managing biodiversity and sustainability, research on bird migration around the world, research on migratory birds, trend of bird migration and Environmental Sensitivity Index in Malaysia.

Chapter 3 discussed about the methodology used in this study whereas the results and analysis of this study is discussed in chapter 4. At the end, conclusion and recommendations have been discussed in Chapter 5.

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