Wetland and Ecotourism Weston in Sabah (Borneo), East Malaysia

All Saints' Secondary School,
Likas, Sabah, Malaysia.

P.O.Box 10520,
88805 Kota Kinabalu,
Sabah,
Malaysia
Tel : (+60) 088 428610
Fax : (+60) 088 425662

Name List

a. Andrina Tay Chu Huey
b. Carlwin Yee Tet Choi
c. Chan Qing Shen
d. Christable Ignatius Susau
e. anet Jasintha Lopez
f. Mariel Ronald Rokam
g. Muhammad`Faiz Maming
h. Patricia Sadom
i. Tan Sim Yee
j. Yeoh Yeik Shua

Supervisors

a. Mrs. Susan Chin Syuk Man
b. Mrs. Loh Su Ling

This educational study focus on the ecotourism value of wetlands in Sabah, East Malaysia; particularly in Weston. Weston is the major wetland that benefit the local from their daily income besides promoting the ecotourism in Malaysia. Wetland is the best educational base for the students locally and as a research field for the scientists from all over the world. Moreover, wetland is also the heaven for a family gathering during the leisure time.

Introduction

Definition of a Wetland in General

According to Mitsch & Gosselink 1986, wetland is an environment at the interface between truly terrestrial ecosystem and aquatic system making them inheritably different from each other yet highly dependent on both.

Another definition of wetland taken from The United States Army Corps of Engineers and The United States Environmental Protection Agency is those Areas that are inundated or saturated by surface or ground water at frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil condition.[1]

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin, December 1979). [2]

In general, wetland are areas where water covers the soil , or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.[3]

Classification of Wetland Generally

Below are terms used for various types of wetlands: [4]

- A bog or muskeg is acidic peat land (peat bog).
- A moor was originally the same as a bog but has come to be associated with this soil type on hill-tops.
- A moss is a raised bog in Scotland
- A fen is a freshwater peat land with chemically basic (which roughly means alkaline) ground water. This means that it contains a moderate or high proportion of hydroxyl ions (pH value greater than 7).
- A carr is a fen which has developed to the point where it supports trees. It is a European term, mainly applied in the north of the UK.
- A fresh-water marsh's main feature is its openness, with only low-growing or "emergent" plants. It may feature grasses, rushes, reeds, typhas, sedges, and other herbaceous plants (possibly with low-growing woody plants) in a context of shallow water. It is an open form of fen.
- A coastal salt marsh may be associated with estuaries and along waterways between coastal barrier islands and the inner coast. The plants may extend from reed in mildly brackish water to salicornia on otherwise bare marine mud. It may be converted to human use as pasture (salting) or for salt production (saltern).
- A swamp is wetland with more open water surface and deeper water than a marsh. In North America, it is used for wetlands dominated by trees and woody bushes rather than grasses and low herbs, but this distinction does not necessarily apply in other areas, for instance in Africa where swamps may be dominated by papyrus.
- A dambo is a shallow, grass-covered depression of the central and southern African plateau which is waterlogged in the rainy season, and usually forms the headwaters of a stream or river. It is marshy at the edges and at the headwater, but maybe swampy in the centre and downstream.

- A mangrove swamp or mangal is a salt or brackish water environment dominated by the mangrove species of tree, such as *Sonneratia*. Species.
- A paperbark wetland is a fresh or brackish water environment dominated by the Melaleuca tree.
- A bayou or slough are southern United States terms for a creek amongst swamp. In an Indian mangrove swamp, it would be called a creek.
- A constructed wetland is artificially contrived wetland, intended to absorb flash floods, clean sewage, enhance wildlife or for some other human reason.
- A pocosin is a bog-like wetland dominated by fire-adapted shrubs and trees, found mainly in the southeastern United States on the Atlantic Coastal Plain.
- Seasonally flooded basins or flats.
- Inland fresh meadows.
- Inland shallow fresh water.

Characteristics of Wetland in General
[5]

Soils

Wetlands are found under a wide range of hydrological conditions, but at least some of the time water saturates the soil. The result is a hydric soil, one characterized by an absence of free oxygen some or all of the time, and therefore called a "reducing environment."

Vegetation

Plants (called hydrophytes or just wetland plants) specifically adapted to the reducing conditions presented by such soils can survive in wetlands, whereas species intolerant of the absence of soil oxygen (called "upland" plants) cannot survive. Adaptations to low soil oxygen characterize many wetland species.

There are many types of vegetation in wetlands. There are plants such as Cattails, bulrushes, Sedges, Arrowhead, Water Lilies, Blue Flag, and Floaters like common duckweed. Pondweed is also another type of plant that grows in wetlands, but it is not easily seen. Peatland can be dominated by red maple, silver maple, and Elm trees. Some types of trees in peatland can exhibit lower trunks and roots that have adapted to the wet surroundings by forming buttresses,like the cypress, enlarged root bases to better support the trees in the mucky soil. Trees can also form knees, raised roots that allow for gas exchange. Swamps can also have white Cedar, Tamarack, and White Pine. Below the canopy, there are often limited amounts of shrubs such as speckled Alder, Winterberry, and Sweet Gale.

Mangroves are a species of plant which typically thrive in coastal wetlands (called marine or estuarine environments). They are a special tree taxon that can survive in salty wetland water. Mangroves also provide the base for the wetland food chain. They are the producers in the wetland environment. Because mangroves add sulfur to the wetlands, it makes the water more acidic, therefore allowing decomposed matter in the water to biodegrade faster than it normally would, which in turn, provides more food for the organisms in the wetland ecosystem.

Hydrology

Generally, the hydrology of a wetland is such that the area is permanently or periodically inundated or saturated at the soil surface for a period of time during the growing season. The presence (or absence) of water is not necessarily a good method for identifying wetlands because the amount of water generally fluctuates depending on such things as rainfall patterns, snow melt, dry seasons, longer droughts, and tidal patterns. Often the same wetland can appear to be an open body of water some times and a dry field at other times due to significant fluctuations in water levels. The three water sources that contribute to wetlands are:

- precipitation falling within the wetland
- groundwater moving up or out from the subsurface of the wetland
- surface flow from the surrounding watershed or nearby water bodies (lakes, streams, oceans, etc.)

Location determines which of these sources will be contributing water to a wetland.

Topography

Generally, wetlands are located within topographic features that are lower in elevation that the surrounding landscape such as depressions, valleys, and flat areas. Topography plays an important role in determining the size and shape of a wetland by controlling where the water goes and how long it stays there.

Biodiversity in a Wetland in General

Plants [6]

Native trees tolerant of wet soils:

- Red and silver maple *(Acer rubrum, A. saccharinum*m)
- River Birch Trees a tree for wet areas *(Betula Nigra*a)
- Catalpa spp.
- Ash *(Fraxinus sp*p.)
- Hornbeams *American Hornbeam Great for Habitat Improvement*
- *Cottonwood (Populus deltoides)*
- *Swamp white oak (Quercus bicolorr)*
- *Sycamores (Platanus spp.)*
- *Native shrubs tolerant of wet soils:*
- *Red osier dogwood (Cornus sericea)a)*
- *Leatherwood (Dirca palustris)*
- *Winterberry (Ilex verticulataa) Sparkleberry holly A great berry producer*
- *Inkberry (Ilex glabraa)*
- *Pussy willow (Salix discolorr)*
- *Willow Trees Trees for wet areas*
- *Shrubby cinquefoil (Potentilla fruticosa)*
- *Spicebush my long time favorite*
- *Chokeberries Read why these bushes may survive as the oceans rise*
- *Black Chokeberry produces great berry crops for the birds!!*
- *Cattails (Typhus spp.)*
- *Joe-Pye weed (Eupatorium maculatum)*
- *Great blue lobelia (Lobelia siphilitica)*
- *Ironweed (Vernonia noveboracensis)*
- *Blue flag iris (Iris versicolor)*
- *Boneset (Eupatorium perfoliatum)*
- *Cardinal flower (Lobelia cardinalis)*
- *Goldenrods (Solidago spp.)*
- *Marsh marigold (Caltha palustris)*
- *Swamp milkweed (Asclepias incarnata)*
- *Gentian spp.*
- *Bee balm (Monarda didyma)*
- *Arrowhead (Sagittaris latifolia)*
- *False hellebore (Veratrum viride)*

- *Turtlehead (Chelone spp.)*
- *Skunk cabbage (Symplocarpus foetidus)*
- *Royal fern (Osmunda regalis)*
- *Netted chain fern (Woodwardia areolata)*
- *Jack-in-the-Pulpit (Arisaema triphyllum)*
- *Cinnamon fern (Osmunda cinnamonmea)*
- *Shield ferns (Dropteris spp.)*
- *Lady ferns (Athyrium spp.)*
- *True bog plants requiring low pH and sun:*
- *Sundews (Drosera spp.)*
- *Butterworts (Pinguicula spp.)*
- Pitcher plants (Sarracenia spp.)

Animals [7]

American Toad	Monarch Butterfly
Beaver	Muskrat
Box Turtle	North American Wood Turtle
BullFrog	Northern Bobwhite
Crayfish	Northern Raccoon
Copperhead	Northern Water Snake
Dekay's Brown Snake	Painted Turtle
Dragonfly	Rat Snake
Eastern Cottontail Rabbit	Red Salamander
Eastern Fox Squirrel	Snapping Turtle
Eastern Grey Squirrel	Spotted Turtle
Eastern Hog-Nosed Snake	Striped Skunk
Five-Lined Skink	Southern Cricket Frog
Green Frog	Tadpole
Little Brown Bat	Virginia Opossum
Minnows	White-tailed deer

Human Activities in a Wetland Generally [8]

Below are four points to consider when assessing the general "on-site" impacts of land-uses on wetlands (for more information see references).
Changes to the flow pattern within the wetland through drainage channels which cause flow to become more channelled and less diffuse, thereby reducing the wetness of the area.

Disturbances of the soil, making it more susceptible to erosion.

Changes in the surface roughness and vegetation cover (when these are reduced the ability of the wetland to slow down water flow, reduce erosion and purify water is reduced).

Replacement of the natural vegetation by introduced plants, which generally reduces the value of the wetland for wetland dependent species.

Drainage and the production of crops and planted pastures

When wetlands are converted to cropland most of the indirect benefits of the wetland are lost, especially if the wetland is drained. Drained wetlands are less effective at regulating streamflow and purifying water because the drainage channels speed up the movement of water through the wetland. Drainage increases the danger of erosion by concentrating water flow and thus increasing the erosive power of the water. Also, the hydrological changes resulting from drainage have negative effects on the soil (e.g. reduced soil organic matter and moisture levels and, sometimes, increased risk of underground fires and increased acidity due to the oxidation of sulphides to produce sulphuric acid).

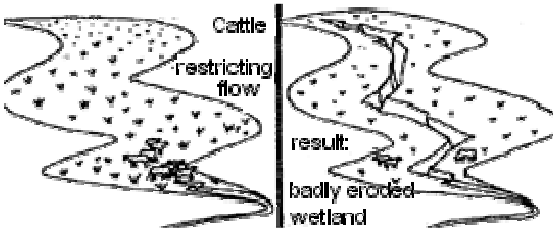
The soil is disturbed when crops are planted, and crops do not bind or cover the soils as well as the natural wetland vegetation (see Section 1). Thus, erosion is controlled less effectively, which may be a very serious problem in areas with high erosion hazards. Adding fertilizer and pesticides (which may leach into the river system) further reduces the effectiveness of the wetland in purifying water.

Timber production

Timber plantations have a high impact on the water storage function of wetlands because a lot of water is lost by the trees through transpiration. Some trees (e.g. gum trees) use more water than other trees (e.g. poplars, which lose their leaves in winter). Trees also have a strong negative effect on the habitat value of wetlands. Under increased shading beneath the trees, the vigour of indigenous plants which are not adapted to these conditions is reduced and they are often out-competed by alien invasive plants.

- Grazing of undeveloped wetlands by domestic stock

Grazing may have both positive and negative effects on the indirect benefits of wetlands. In wetlands which have some areas grazed short and other areas left tall, the diversity of habitats is increased. In wetlands which are grazed short completely, the diversity of habitats is decreased.
Heavy grazing may cause valuable grazing species to be replaced by less productive and/or palatable species. Some wetlands erode easily when disturbed by trampling and grazing. The most easily eroded are those wetlands with unstable soil and where water flowing diffusely across the wetland concentrates into a channel. In these situations erosion can cause the channel to cut up into the wetland and dry it out, destroying most of its value. Thus, grazing pressure should not be too high and cattle need to be kept away from these flow concentration areas.



Mowing and harvesting of plants

Mowing and harvesting of plants by hand tends to have much less of a negative impact on the indirect benefits of wetlands than cultivation. Cutting plants has similar effects to grazing and generally increases habitat diversity, provided that extensive areas are not mown or cut at one time. Mowing and harvesting may also be harmful if done while animals are still breeding. In the case of mowing, the machinery used for cutting may also disturb the wetland soil and increase the danger of erosion. This would not occur when plants are harvested by hand.

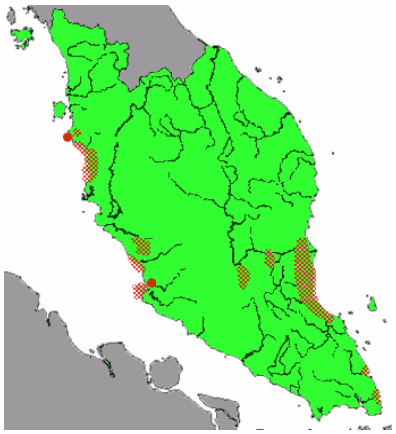
- Fishing and hunting

If too many animals are caught or hunted there will not be enough left to reproduce and to replace the ones that are removed

Type of Wetland found in Malaysia

The type of wetland found in Malaysia are swamps which can be divided into two categories that are the forested and shrub swamps.

Map of the Wetlands in Malaysia



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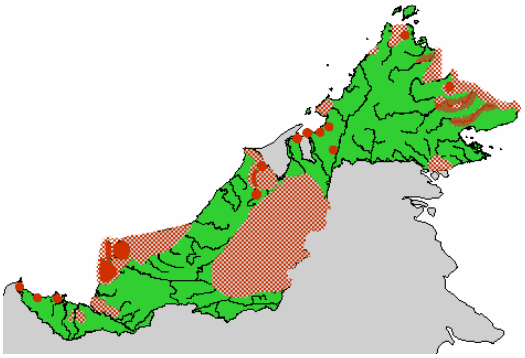


[10]

Classification of Swamps

There are two types of swamps :

- Forested swamps

Trees in forested wetland are more than twenty feet tall. Both evergreen and deciduous trees grow here. Bogs are found in wooded areas where glaciers have carved holes. In this area few plants grow because of the acid in the soil and lack of oxygen. Dead plants that do not decay become a mat of rotting plants called peat. [11]

- Shrubs

Small trees and bushes that are less than 20 feet in height grow in the scrub/shrub wetlands. The water is close to the surface and next to rivers, lakes and streams. Willows, spirea and common rush grow well here. The plants have more than one stem and the stems may be bendable. [12]

Biodiversity in the wetlands of Malaysia

Plants [13]

By form

▪ Mangrove trees (growing in seawater)	▪ Nipah Palm (*Nypa fruticans*)
▪ Api Api Putih (*Avicennia alba*)	▪ Seven Golden Candlesticks (*Cassia/Senna alata*)
▪ Api Api Ludat (*Avicennia officinalis*)	▪ Straits Rhododendron (*Melastoma malabathricum*)
▪ Api Api Bulu (*Avicennia rumphiana*)	▪ Cattail (*Typha augustifolia*)
▪ Bakau Putih (*Bruguiera cylindrica*)	▪ Lotus (*Nelumbo nucifera*)
▪ Tumu (*Bruguiera gymnorrhizha*)	▪ Water Lily (*Nympaea spp.*)
▪ Bakau Minyak (*Rhizophora apiculata*)	▪ Duckweed(Lemnacea)
▪ Rhizophora mucronata	▪ Water Hyacinth (*Eichhornia crassipes*)
▪ Bakau Kurap (*Rhizophora mucronata*)	▪ Acacia (*Acacia auriculiformis*)
▪ Mangrove Apple (Sonneratia spp.)	▪ Seven Golden Candlesticks (*Cassia/Senna alata*)
▪ Great Morinda (*Morinda citrifolia*)	▪ Common Derris (*Derris trifoliata*)
▪ Sea Almond Tree (*Terminalia catappa*)	▪ Alexandrine Laurel (*Callophyllum inophyllum*)

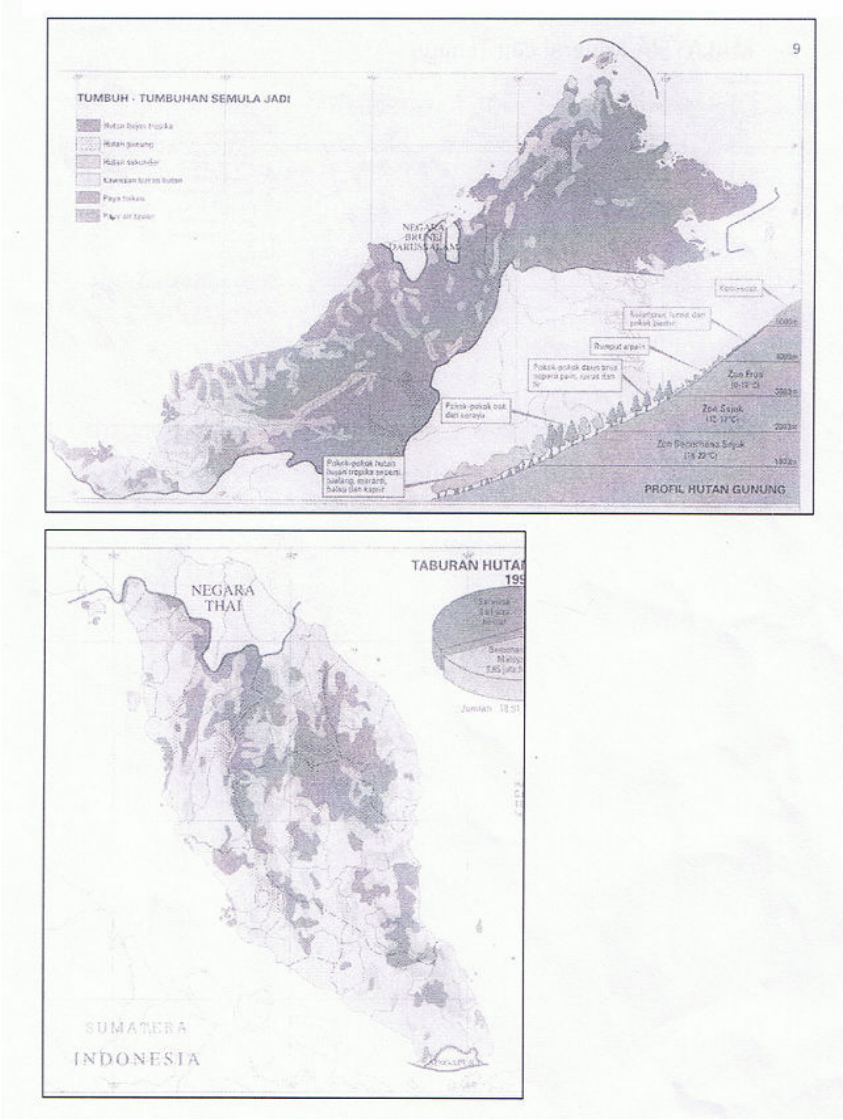
▪ Portia Tree (*Thespesia populnea*)	▪ Api Api Putih (*Avicennia alba*)
▪ Sea Hibiscus (*Hibiscus tiliaceus*)	▪ Api Api Ludat (*Avicennia officinalis*)
▪ Sea Poison Tree (*Barringtonia asiatica*)	▪ Api Api Bulu (*Avicennia rumphiana*)
▪ Crinum Lily (*Crinum asiaticum*)	▪ Bakau Putih (*Bruguiera cylindrica*)
▪ Sea Holly (*Acanthus ilicifolius* and *A. ebracteatus*)	▪ Tumu (*Bruguiera gymnorrhizha*)
▪ Mangrove Fern (*Acrostichum aureum*)	▪ Bakau Minyak (*Rhizophora apiculata*)
▪ Cherry Tree (*Muntingia calabura*)	▪ Bakau (*Rhizophora stylosa*)
▪ Acacia (*Acacia auriculiformis*)	▪ Cattail (*Typha augustifolia*)
▪ Saga Seed Tree (*Adenanthera pavonina*)	▪ Cherry Tree (*Muntingia calabura*)
▪ Simpoh Air (Dillenia suffruticosa)	▪ Duckweed
▪ African Tulip Tree (*Spathodea campanulata*)	▪ Guinea Grass (*Panicum maximum*)
▪ Fishtail Palm (*Caryota mitis*)	▪ Lotus (*Nelumbo nucifera*)
▪ Mangrove trees (growing in seawater)	▪ Water Lily (*Nympaea spp.*)
▪ Api Api Putih (*Avicennia alba*)	▪ Straits Rhododendron (*Melastoma malabathricum*)
▪ Api Api Ludat (*Avicennia officinalis*)	▪ Great Morinda (*Morinda citrifolia*)

▪ Api Api Bulu (*Avicennia rumphiana*)	▪ Sea Almond Tree (*Terminalia catappa*)
▪ Bakau Putih (*Bruguiera cylindrica*)	▪ Fishtail Palm (*Caryota mitis*)
▪ Tumu (*Bruguiera gymnorrhizha*)	▪ Macarthur Palm (*Ptyschosperma macarthuri*)

Types of Mangrove Plants Found in Malaysia [14]

1. *Rhizophora sp.*
2. *Avicennia sp.*
3. *Bruguiera sp.*
4. *Sonneratia sp.*
5. *Xylocarpus sp.*
6. *Nypa sp.*
7. *Casuarina equisetifolia sp.*

Mangroves are found in the areas of Malaysia where it is marked grey.



Animals [15]

SPIDERS

Family Araneidae

1. St. Andrew's Cross Spider (*Argiope spp.*)
2. Golden Orb Web Spider (*Nephila spp.*)
   Whip Spider (*Argyrodes flagellum*)
3. Tent spiders:
   a) Red Tent Spider (*Crytophora unicolor*)
   b) Beccari's Tent Spider (*Crytophora beccarii*)
   c) *Cyrtophora cicatrosa*

INSECTS

Family Saturniidae

1. Atlas Moth (*Attacus atlas*)
2. Family Phrrhocoridae
3. Cotton Stainer Bug (*Dysdercus decussatus*)

Family Formicidae

1. Weaver Ants (*Oecophylla smaragdina*)

CRUSTACEA

Family Thalassinidae

1. Mud Lobster (*Thalassina anomala*)

FISHES

Family Toxotidae

1. Archer Fish (*Toxotes spp.*)
2. Family Gobiidae
3. Giant Mudskipper (*Periophthalmodon schlosseri*)

REPTILES

Lizards

Family Varanidae

1. Malayan Water Monitor Lizard (*Varanus salvator*)
2. Family Scincidae
3. Mangrove Skink (*Emoia atrocostata*)

Family Agamidae

1. Changeable Lizard (*Calotes versicolor*)

Snakes

Family Colubridae

1. Subfamily Colubrinae
2. Flying Tree Snakes (*Chrysopelea spp.*)
3. Subfamily Homalopsinae (Rear-fanged Water Snakes)
4. Dog-faced Water Snake (*Cerberus rynchops*)

MAMMALS

Family Mustalidae

1. Smooth Otter (*Lutrogale perspicillata*)
2. Family Sciuridae
3. Plantain Squirrel (*Callosciurus notatus*)

SHORBIRDS AND WADERS IN GENERAL [16]

1. Curlew Sandpiper *(Calidris ferruginea)*
2. Whimbrel (*Numenius phaeopus*)
3. Common Sandpiper (*Actitis hypoleucos*)
4. Greenshank (*Tringa nebularia*)
5. Marsh Sandpiper (*Tringa stagnatilis*)
6. Common Redshank (*Tringa totanus*)
7. Pacific Golden Plover (*Pluvialis fulva*)
8. Little Ringed Plover (*Charadrius dubius*)
9. Mongolian Plover (*Charadrius mongolus*)
10. Grey Heron (*Ardea cinera*)
11. Purple Heron *(Ardea purpurea)*
12. Little Heron *(Butorides striatus*)
13. Black-crowned Night Heron *(Nycticorax nycticorax)*
14. Great Egret (*Egretta alba*)
15. Little Egret (*Egretta garzetta*)
16. Intermediate Egret (*Egretta/Mesophoyx intermedia*)
17. Common Kingfisher (*Alcedo atthis*)
18. Stork-billed Kingfisher (*Pelargopsis capensis*)
19. Collared Kingfisher (*Halcyon chloris*)

Characteristics of a Shrub in Sabah [17]

The soil is often water logged for much of the year, and covered at times by as much as a few feet of water because this type of swamp is found along slow moving streams and in floodplains.

Classification of a shrub in Sabah

Shrubs in Sabah can be classified into :

- Mangrove swamps [18]

  Mangrove swamps are found along tropical seacoasts on both sides of the equator. They are named for the Mangrove trees that grow there. Mangrove swamps, to most people, look like muddy, swampy places filled with mosquitoes, snakes and spiders. Actually, they are a forest community that bridges the gap between land and sea. Mangroves are found along muddy estuaries of large rivers, and in sheltered intertidal coastal settings that include lagoons, bays, tidal creeks and inlets.

- Peat swamps [19]

  Although peat swamp forests are not as biodiverse as neighboring lowland rain forests, the Borneo Peat Swamp Forests are some of the most speciose peat swamp forests in the region. Peat swamp forests are a key habitat for the endangered Borneo endemic and unique proboscis monkey (*Nasalis larvatus*). They are also home to the world's most desirable aquarium fish, the arowana (*Scleropages formosus*).

Introduction to Mangrove Swamps

What is a mangrove? [20]

Mangroves are trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. Mangals are found in depositional coastal environments where fine sediments, often with high organic content, collect in areas protected from high energy wave action. A mangal is a plant community and habitat where mangroves thrive.They are found in tropical and sub-tropical tidal areas, and as such have a high degree of salinity. Areas where mangals occur include estuaries and marine shorelines.

Mangroves are a species of plant which typically thrive in coastal wetlands (called marine or estuarine environments). They are special tree taxon that can survive in salty wetland water. Mangroves also provide the base for the wetland food chain. They are the producers in the wetland environment. Because mangroves add sulphur to the wetlands, it makes the water more acidic, therefore allowing decomposed matter in the water to biodegrade faster than it normally would, which in turn, provides more food for the organisms in the wetland ecosystem.

Characteristics of a Mangrove Swamp
[21]

A red mangrove, *Rhizophora* sp.

Adaptations to low oxygen

Red mangroves, which can live in the most inundated areas, prop themselves up above the water level with stilt roots, and can then take in air through pores in their bark (lenticels). Black mangroves live on higher ground, and make many pneumatophores (specialized root-like structures which stick up out of the soil like straws for breathing) which are covered in lenticels. These "breathing tubes" typically reach heights of up to 30 centimeters, and in some species over 3 meters.

Limiting salt intake

Red Mangroves exclude salt by having rather impermeable roots which are highly suberised, acting as an ultra-filtration mechanism to exclude sodium salts from the rest of the plant. Water inside the plant shows that 90%, and in some cases of high salinity, up to 97%, of the salt has been excluded at the roots. Any salt which does accumulate in the shoot is concentrated in old leaves which are then shed, as well as stored away safely in cell vacuoles. White (or Grey) Mangroves can secrete salts directly, they have two salt glands at each leaf base (hence their name - they are covered in white salt crystals).

Limiting water loss

Because of the limited availability of freshwater in the salty soils of the intertidal zone, mangrove plants have developed ways of limiting the amount of water that they lose through their leaves. They can restrict the opening of their stomata (pores on the leaf surfaces, which exchange carbon dioxide gas and water vapour during photosynthesis). They also vary the orientation of their leaves to avoid the harsh midday sun, and so reduce evaporation from the leaves.

Nutrient uptake

The biggest problem that mangroves face is nutrient uptake. Because the soil is perpetually waterlogged, there is little free oxygen. Thus anaerobic bacteria liberate nitrogen gas, soluble iron, inorganic phosphates, sulfides, and methane, which makes the soil much less nutritious and contributes to a mangrove's pungent odor. Prop root systems allow mangroves to take up gasses directly from the atmosphere and various other nutrients, like iron, from the inhospitable soil. Gases are quite often stored directly inside the roots, and processed even when the roots are submerged during high tide.

Increasing survival of offspring

In this harsh environment mangroves have evolved a special mechnanism to help their offspring survive. All mangroves have buoyant seeds suited to dispersal in water. Unlike most plants, whose seeds germinate in soil, many mangrove plants (e.g. Red Mangrove) are viviparous, i.e., their seeds germinate while still attached to the parent tree. Once germinated, the seedling grows either within the fruit (e.g. *Aegialitis, Acanthus, Avicennia* and *Aegiceras*), or out through the fruit (e.g. *Rhizophora, Ceriops, Bruguiera* and *Nypa*) to form a propagule (a seedling ready to go), which can produce its own food via photosynthesis. When the propagule is mature it drops into the water where it can then be transported great distances.

Propagules can survive desiccation and remain dormant for weeks, months, or even over a year until they arrive in a suitable environment. Once a propagule is ready to root, it will change its density so that the elongated shape now floats vertically rather than horizontally. In this position, it is more likely to become lodged in the mud and root. If it does not root, it can alter its density so that it floats off again in search of more favorable conditions.

Types of Mangrove Species [22]

Species	Vernacular name	Life-form
True Mangrove species Family Rhizophoraceae Rhizophora apiculata	Bakau minyak	T
Rhizophora mucronata	Bakau kurap	T
Bruguiera gymnorrhiza	Tumu merah	T
Bruguiera parviflora	Lenggadai	T
Bruguiera cylindrica	Berus	T
Ceriops tagal	Tengar	T
Family Avicenniaceae Avicennia alba	Api-api	T
Avicennia marina	Api-api jambu	T
Family Sonneratiaceae Sonneratia alba	Perepat	T
Sonneratia ovata	Gedabu	T
Sonneratia caseolaris	Berembang	T
Family Meliaceae Xylocarpus granatum	Nyireh bunga	T

Xylocarpus moluccensis	*Nyireh batu*	*T*
Family Rubiaceae *Scyphiphora hydrophyllacea*	*Chigam*	*S*
Family Combretaceae *Lumnitzera littorea*	*Terumtum merah*	*T*
Family Euphoribiaceae *Excoecaria agallocha*	*Buta-buta*	*T*
Family Meliaceae *Nypa fruticans*	*Nipah*	*P*
Family Plypodiaceae *Acrostichum aureum*	*Piai raya*	*F*
Acrostichum speciosum	*Piai lasa*	*F*
Acanthus illicifolius	*Jeruju hitam*	*S*
TOTAL = 20 TRUE MANGROVE SPECIES		

Derris uliginosa	*Setui*	*C*
Hibiscus tiliaceus	*Bebaru*	*T*
Barringtonia asiatica	*Putat laut*	*S*
Pandanus odoratissimus	*Pandan*	*H*
Oncosperma tigillarium	*Nibong*	*P*
Calamus erinaceus	*Rotan bakau*	*R*
Morinda citrifolia	*Mengkudu*	*S*
Ipomoea pres-caprae	*Kangkung*	*H*
Passiflora foetida	*Gegambo*	
TOTAL = 9 MANGROVE ASSOCIATED SPECIES		

Notes: T - Tree; S - Shrub; C - Climber; P - Palm; H - Herb; R - Rattan and F – Fern

Uses of Mangrove Plants in Sabah [23]

Species	Product	Uses
Avicennia marina	Young leaves Roots Bark Wood	Human consumption, cattle feed Cure on minor fish stings Astringent Firewood
Avicennia alba	Seed powder/paste Sap from bark Fruit	Cure for small-pox Contraceptive Human consumption
Avicennia officinalis	Seed	Relieving ulcers
Bruguiera gymnorrhiza	Fruits Hypocotyle Wood Bark	Medicine on eye Ailment Eaten as vegetable, seasoning raw fish Firewood Preparation of adhesive
Bruguiera parviflora	Wood	Firewood
Rhizophora mucronata	Prop and stilt roots Wood Bark of prop roots Fruits Bark	Firewood Mosquito repellent Human consumption Cure for diabetes
Rhizophora apiculata	Wood	Firewood
Acanthus ilicifolius	Leaf extract	Relieve rheumatism

Ecological Importance of Mangroves [24]

Mangrove forests known as 'rainforests' by the sea' are one of the most important coastal ecosystems in the world in terms of primary production and coastal protection. Distributed in the tropical and sub-tropical regions, mangroves reach their maximum development and great luxuriance in Southeast Asia. The luxuriance of mangroves in Southeast Asia has let many to believe that it is the birth place for mangroves and from this region, the seeds and seedling of mangroves might have moved on ocean currents to different coastal regions in the tropical latitudes. In effect, the mangroves got established in marine environments of the tropics.

Mangrove trees have special adaptation to live in saline habitats. The specialized seeds of mangroves are tough, float and travel great distances in salt water and take root far from its parent tree. The seeds germinate and grow into seeding right on the parent tree. During this time, they acquire the carbohydrates they need later to grow on their own. The mangrove tree eventually drops its seedlings, where they take root in the mud below or are swept out by the tide.

The mangrove trees have unique biological adaptation to survive this marine environment, including reproductive biology, salt tolerance, and growth form. They are well adapted to anoxic sediments. They produce aerial and tap roots which filter out the salt in the brackish water they grow in and support roots which grow directly into the mud to anchor them. Breathing roots allow them to survive in anoxic sediments. Buttresses and above ground roots enable them to grow in unstable mud flats. Their foliage removes excess salt from the sap and conserves water to cope with periods of high salinity.

Conservation of Mangrove Swamps in Sabah

Conservation of Mangroves in Klias [25]

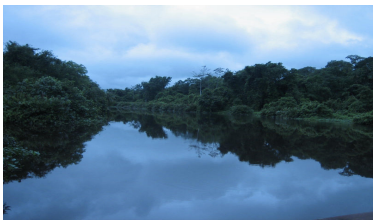
Conservation measures taken:

Five Forest Reserves have been established: Sungai Binsuluk Forest Reserve (12,106 ha, mainly peat swamp forest); Klias Forest Reserve (3,630 ha, mainly peat swamp forest); Padas Damit Forest Reserve (9,027 ha, mixed swamp forest and nipa); Kampung Hindian Forest Reserve (580 ha, mostly mangrove); and Menumbak Forest Reserve (5,710 ha, mangrove). In 1978, 30,900 ha of the coastal parts of Klias Peninsula were gazetted as a National Park, but the Park was de-gazetted in 1980. Although this de-gazettement resulted in some international Criticism, it is doubtful that National Park status was truly appropriate for Klias as twelve settlements existed within the Park boundary before it was gazetted.

Conservation measures proposed:

It has been recommended that Padas Damit, a large freshwater swamp at 5°21'N, 1 15°30'E, be protected both as a crocodile breeding area and for waterfowl. Padang Teratak has been proposed as a Wildlife Sanctuary under the proposed new amendments to the Fauna Conservation Ordinance. Sungei Padas Damit and at least some of the surrounding area should be surveyed from the air in order to assess breeding colonies of egrets (Lansdown, 1987a).

Some examples of mangrove swamps that can be found in Sabah are:



Klias Peninsular [26]

A continuous flat area of peat swamp (60,700 ha), freshwater alluvium (14,500 ha) and coastal transitional swamp (28,500 ha) including 8,700 ha of largely undisturbed mangrove. The vegetation includes both undisturbed and exploited forest, scrub, herbaceous plants and mixed cultivation. The site includes Padas Damit, a freshwater swamp of great importance to waterbirds and crocodiles. Situated on the southern half of the Klias Peninsula, the Padas Damit River runs from areas of mixed cultivation through peat swamp forest and extensive nipa swamp before reaching coastal mangroves at its mouth. Padang Teratak is about 100 ha of open grassy marsh with scattered clumps of low bushes, bordered on one side by agricultural land and a small settlement and on the other by peat swamp forest. There is a large egret roost in nipa fringing the Padas Damit River. Peat and freshwater swamp areas are affected by variations in rainfall and run-off. Water levels are highest during the wet season (November-February); the mangrove areas are tidal. Salinities vary from saline at the coast to brackish in nipa swamps and fresh in peat swamps. The water in the peat swamps is acidic. Water is more or less permanent in the peat swamps, but as the swamps develop, the surface water level may fall.

Kinabatangan [27]

The Kinabatangan Wetlands is an important conservation area for a large number of animals. This wetlands sanctuary, centered on the Kinabatangan River, is home to clouded leopards, Asian elephants, civet cats, otters, hornbills, egrets, hawks and many more. This place is also the area with the highest concentration of primates in the whole of Borneo with ten species of monkeys and apes. Of particular note is the Proboscis monkey, a unique monkey with a stump for a nose and found nowhere else in the world but in Borneo. There are also many lakes in the area which are rich in fish and prawns; perfect for fishing.

Biodiversity in wetlands of Sabah

Plants [28]

Rhizophora mucronata

This species is found in gregarious stands at the outer parts of deltas, forming a seaward fringe. There is a mixture of *R. apiculata*.

Rhizophora apiculata

R. apiculata lines tidal river banks and estuarine delta areas. These are the main areas of mangrove forests and other species are *Ceriops tagal*, often in dense clumps; *Lumnitzera littorea* as large standards on drier sites; and *Xylocarpus granitum* lining river banks. Locally smaller stands are often dominated by *C. tagal* (this species reaches 45 cm in diameter, but has been much exploited for its bark) with the shrub *Scyphiphora hydrophyllaceae*, *X. granatum* and *R. apiculata* are occasionally present as larger trees.

Nipa fruticans

This palm is found in extensive pure stands in delta areas, and it also lines the banks of major rivers to the limit of tidal influence. It is important as a coloniser as its growth habit accentuates mound development.

Oncosperma vigillaria

This is another palm occurring in smaller stands, generally on sandy mud heaps associated with crabs at the back of woody mangroves, especially where the transition to dry land is relatively abrupt.

Bruguiera gymnorrhiza

Dense pure stands of *B. gymnorrhiza* are often found behind the main zone where the duration of tidal influence is not as great. Stemless palms and the fern *Acrostichum aureum*, which invades (b) when cut, occur in open spaces on mounds. *Heritiera littoralis* is an associate at the limits of inundation with *Lumnitzera littoralis* and local patches of other *Brugueira* species also occur behind the main zone. *Osbornia octodonta* is another species of the inner (or back) mangroves.

Avicennia alba

The outer fringes of large rivers, especially exposed bends, often have more or less pure stands of large pioneer species *Avicennia alba*. The habitat of *Sonneratia alba* is similar and both species may be found on sandy beaches where wave action is not severe.

Aglaia argentea	*Ilex cymosa*
Amoora rubiginosa	*Jackia ornata*
Aromadendron nutans	*Kokoona ovatolancsolata*
Baccaurea bracteata	*Koompassia malaccensis*
Blumeodendron tokbrai	*Knema kuntsleri*
Callophylum retusum	*Lithocarpus dasystchyus*
C. rhizophorum	*Litsea resinosa*
C. sclerophyllum	*L. crassifolia*
Campnosperma coriacea	*Lophopetalum multinervium*
Carallia brachiata	*L. rigidum*
Combretocarpus rotundatus	*Melanorrhoea beccarii*
Cratoxylon arborescens	*Nothaphoebe obovata*

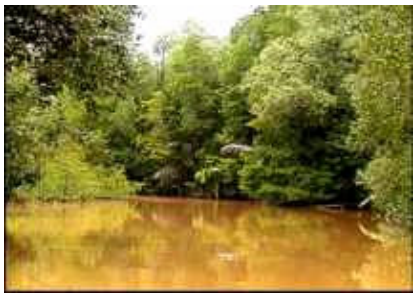
Ctenolophon parvifolius	*Palaquium pseudocuneatum*
Dillenia pulchella	*Parartocarpus venenosus*
Diospyros evena	*Parastemon urophyllum*
Disepalum coronatum	*Parishia sericea*
Dyera polyphylla	*P. polycarpa*
Elaeocarpus griffithii	*Pseudosindora palustris*
E. marginatus	*Prunus turfosa*
Eugenia (Syzygium?) christmannii	*Sandoricum emarginatum*
Ganua motleyana	*Stemonurus scorpioides*
Gardenia pterocarpus	*Tarenna bartlettii*
Gonystylus maingayi	*Tetramerista glabra*
Horsfieldia crassifolia	*Xylopia corifolia*
Ilex cymosa	*Eugenia sarawakensis*
Buchanania arborescens	*Baccaurea puberula*
Ficus sundaica	*Alstonia augustifolia*
Nothaphoebe kingiana	*Pouteria malaccensis*
Diospyros elliptifolia	*Calophyllum globuliferum*

Animals [29]

- Proboscis Monkey
- long tailed macaques
- Silvered leaf langurs
- White bellied eagles
- mud skippers
- horseshoe crabs
- Hornbills
- Little Egret
- Green Heron
- Cinnamon Bittern
- Crocodiles
- Fireflies
- Monitor lizards
- Flying foxes
- Stork-billed kingfisher
- Mangrove kink
- Mud lobster
- Smooth otter

Type of wetland in Weston

The type of wetland found here are mangrove swamps which are in the shrubs category.



- Weston [30]

The Borneo Weston Wetland is found here. Weston has not only the largest and best-preserved river mouth wetland in North Borneo, it also boasts of having one of the most complete collection of mangrove plant species in South East Asia. The whole wetland (reaching into lower part of Kuala Penyu) is roughly the size of Singapore. Due to its sheer size, Weston wetland's landmass has the most varied water, soil and other environmental conditions, thus allowing diverse mangrove plant species to exist.

Biodiversity in Mangrove Swamps in Weston

Plants [31]

The massive stilt roots of *Rhizophora*

Bakau flowers

Bakau seedling

Bakau seedling managed to to touch the ground

1) Local name : Red Mangrove (Bakau Kurup)
Scientific name : *Rhizophora alba*

All *Rhizophora* species have arching stilt roots that emerge from the trunk, hence their scientific name *Rhizophora* which means "root bearer" in Greek.

These roots not only hold up the tree in soft mud, but also permeable to gases, while remaining impermeable to salts. In fact, the entire upper root system including the trunk and prop roots that emerge from the branches have this feature. Thus the roots also help the tree to breathe.

Rhizophora use ultrafiltration at the root level to exclude salt. It is believed that they store any salt that gets through in old leaves which they later shed. *Rhizophora* grow best in wet, muddy and silty sediments.

When the seedling finally falls, at first it floats horizontally, and drifts with the tide. It can survive for long periods at sea. After some weeks, the tip gradually absorbs water and the seedling floats vertically and starts to sprout its first leaf from the top, and roots from the bottom. When it hits land, it grows more roots to anchor itself upright, and then more leaves. Rhizophora seedlings grow rapidly to avoid being submerged at high tide. They can grow by 60cm in the first year. Mature plants reach the princely height of 40ft to 70ft.

Uses as food: Fruits may be eaten, after scraping off the skin and boiling with wood ashes, according to some sceptical accounts. The Wealth of India describes the fruit as sweet and edible, and indicates that the juice is made into a light wine. Young shoots are cooked and eaten as a vegetable. But honey collected from the flowers is said to be poisonous.

Other uses: The timber is heavy, difficult to saw and not durable unless it is dried for a long time. But it is used for construction, to make fish traps, house frames, pilings and poles.

Rhizophora is the preferred mangrove wood for firewood and to make charcoal. It produces an even heat and is easy to split for firewood. It is also chipped and used in commercial paper and rayon production in Indonesia and East Malaysia (Sabah and Sarawak). Tannins and dyes are extracted from the bark; a black to chestnut dye is obtained from the leaves. Unlike some other mangrove trees, new growths from *Rhizophora* trees only emerge from branch tips and not the trunk. So they can be killed by excessive collection of branches for firewood or other uses. They are planted along coastal fish ponds to stabilise the banks.

Pencil-like pneumatophores

Avicennia Alba's fruits

Avicennia Alba's flowers

2) Local name : Black Mangrove (Api-api Putih)

Scientific name : *Avicennia alba*

Avicennia have the highest salt tolerance of mangrove trees. They do not exclude salts at the root level. In fact, their sap is salty, at about one-tenth that of sea water. Instead, they secrete excess salt on their leaves through special pores, to be removed by rain or wind. Sometimes, the salt can be seen as a white crystalline layer on the upper surface of the leaf.

To avoid suffocation in the oxygen poor (anaerobic) mud, they have pencil-like pneumatophores. These stick out at regular intervals from long shallow underground cable roots that spread out from the trunk to stabilise the tree.

Uses as food: The seeds are boiled and eaten, in some places, they are sold in markets as vegetables.

Other uses: This fast growing mangrove tree is among the few used in replanting mangroves to protect coastlines (the others are Sonneratia and Rhizophora). Producing a low quality firewood, it is rarely used to make charcoal and is burnt only to smoke fish or rubber.

Traditional medicinal uses: The heartwood is used to make tonics. The bark and seeds are used as a fish poison and resin used in birth control.

Role in the habitat: Avicennia alba provides food for smaller creatures. Tiny moth larvae eat the fruits (Autoba alabastrata) and flower buds (Euopoicillia sp.). Beetles eat their leaves (Monolepta sp.)

Sonnerratia Bush with their pneumatophores.

Sonneratia's flowers

Fruits that gives the "sea apple" name to the plant.

3) Local name : Mangrove Apple (Pedada)
Scientific name : *Sonneratia alba*

Sonneratia have thick cone-shaped pneumatophores. They use ultrafiltration at the root level to exclude salt. *Sonneratia alba* can tolerate wide fluctuations in salinity and often grow on exposed, soft but stable mudbanks low on the tidal mudflats. It is believed that they store excess salt in old leaves which they later shed.

The bark of young *Sonneratia* is covered with a layer of wax, probably to protect it against water loss and attacks by creatures great and small.

Uses as food: Leaves may be eaten raw or cooked. The ripe fruit are eaten by people from Africa to the Malays and Javanese, and are said to taste like cheese. In Eastern Africa the leaves are used a camel fodder.

Other uses: *Sonneratia* is used for firewood, but is not the preferred mangrove tree for this purpose. Although it produces a lot of heat, it also produces a lot of ash and salt.

An impenetrable 70ft tall nipah wall

Nipah fruits

The beautiful flower of nipah

4) Local name : Nipah Palm (Attap/Nipah)
Scientific name : *Nypa fruticans*

The Nipah Palm is the among the few palms that grow well in mangroves. It grows in soft mud, usually where the water is calmer, but where there is regular inflow of freshwater and nutritious silt. They can be found inland, as far as the tide can deposit the Palm's floating seeds. It can tolerate infrequent inundation, so long as the soil does not dry out for too long.

It is the mangrove plant with the oldest known fossil, with pollen dated 70 million years old.

Compared to the Coconut Palm, the Nipah Palm appears to lack a trunk, with its leaves growing straight out of the ground. In fact, its trunk is horizontal and lies underground. The trunk branches and each branch ends with a bunch of fronds.

The base of the frond is air-filled to help it stay upright. This habit of growing from underground stems results in almost pure stands of Nipah Palm.

Uses as food: Before the inflorescence blooms, it is tapped to collect a sweet sap. Young Nipah Palm shoots can be eaten. The petals of the flower can be brewed to make an aromatic tea.

Animals [32]


Male proboscis monkey

1) Local name : Proboscis monkey

Scientific name : *Nasalis larvatus*

The real celebrity of Weston. An endangered specie found only in Borneo. Their Big noses and big bellies fuel scientific curiosity. Is the nose big purely for sexual appeal or as a sounding box, or simply a cooling apparatus for the overbearing tropical sun? And how about their bellies that look as if they are more than a regular pub goer! Sexually, each mature male monkey runs marathons with his own harem of up to 20 wives. That somehow gets human interested in what they eat! Proboscis monkeys are more easily seen on trees at the water edge in the two hours after sunrise and the 2 hours before sunset. So plan your visit appropriately.


Monitor lizard

2) Local name : Monitor lizard
Scientific name : *Varanus salvator*

Among the largest lizards in the world, Malayan Water Monitors can survive in habitats that wouldn't be able to support other large carnivores. They are so successful because they are cold blooded and hence make more efficient use of food. In addition, they eat anything that they can swallow. From tiny insects, to crabs, molluscs, snakes, eggs (of birds and crocodiles), fish including eels up to 1m long. They also eat birds, rodents, small mouse deer, even other monitor lizards. They are particularly fond of carrion. They even eat rubbish and even dead bodies. They eat prey almost as big as themselves: one 1.2m long ate a snake 1.3m long.


Long tail Macaque monkey

3) Local name : Long tail Macaque monkey
Scientific name : *Cebus olivacea*

There are more of them than the people living in Weston. It is interesting how the dominant male acting out his role in the group which he lords over. Notice how he hisses at the underlings he disapproves. And watch how childcare responsibility is shared amongst the females and how bonding is achieved through mutual grooming.


Flying fox

4) Local name : Flying fox
Scientific name : *Pteropus poliocephalus*

They darken the evening sky of Weston as they return to their homes in the nearby jungles, fluttering their wide webbed wings . A truly wonderful spectacle. Unlike their smaller cousins, the bats, flying foxes roost outside in the sun rather than in caves. High above the rainforest floor, camps of flying foxes hang upside-down together, sometimes in groups of as many as a million! These camps can be loud with bickering shrieks and calls. Flying foxes use their excellent eyesight more than echolocation, or bouncing sounds, to locate their food at night. These creatures are frugivores, that means they eat fruit! They also eat flowers and pollen, and help to pollinate flowers in the same way bees do. Flying foxes have a long bristly tongue that's great for lapping up juicy fruity food, and for licking and grooming themselves and their friends.


Smooth otter

5) Local name : Smooth otter
Scientific name : *Lutra canadensis*

Smooth Otter sighting really makes your day, even if it's just a little peek! Smooth Otters are the largest otters in Southeast Asia. They are named for their shorter, smoother coats which appears velvety and shining Smooth Otters like to eat fish but they eat whatever is plentiful and easy to catch. Prey include crustaceans, frogs, water rats, turtles and even large birds. They may hunt as a family group, using teamwork to catch their prey. A group usually have a feeding territory of 7-12 sq. km and they hunt both during the day and night.


Stock billed Kingfisher

6) Local name : Stork-billed Kingfisher
Scientific name : *Halycon capensis*

Stork-billed Kingfishers are the largest Kingfishers found in Borneo. They eat mainly fishes, using their large heavy bills to good effect to catch and kill their prey. From their perch, usually about 2-4 m above the water, they will plunge into the water. They also eat crabs, insects, frogs, mice, lizards, birds and their eggs. Prey is brought back and whacked senseless against the perch. They usually hunt near water both freshwater and along coasts and mangroves, particularly in habitats with suitable perches. Stork-billed Kingfishers are rarely found near urban areas.


Giant mudskipper

7) Local name : Giant mudskipper
Scientific name : *Periophthalmodon schlosseri*

Easily seen in water channels flanked by stilted roots of Bakau trees. In Weston, they reach the size of 8 to 10 inches. They are certainly one of the largest of the mudskippers in the world. Giant Mudskippers dominate the mudflats and move about openly. At high tide, they may remain at the water surface, near their burrows, resting on roots, rocks or other surfaces. At low tide, they forage actively on the mudflat or perch at the entrance of their burrows. Giant Mudskippers are carnivorous, aggressively hunting mainly arthropods (e.g., insects) and crustaceans. These are caught on the mud, or while the fish is swimming in the water. They may even eat smaller mudskippers.


Mangrove skink

8) Local name : Mangrove skink
Scientific name : *Mabuya brachypoda*

These handsome shiny bronzy lizards are active during the day and can often be spotted sunning themselves on a hot day on branches or mud lobster mounds. When alarmed, they quickly slip away. Skinks belong to the lizard family but unlike lizards, are covered with smooth, overlapping scales, and don't have obvious necks. The Mangrove Skink feeds mainly on insects such as mangrove crickets and small crabs, hunting for them on the mudflats at low tide. Although Mangrove Skinks can swim well, they prefer to retreat to higher ground at high tide.


Mud lobster

9) Local name : Mud lobster
Scientific name : *Thalassina anomala*

These modest, shy creatures are responsible for the strange volcano-shaped mounds that are commonly seen in the back mangroves. Mud lobsters are believed to eat tiny organic tidbits in mud. To get enough nutrition, they have to process huge amounts of mud and sand. Processed mud is piled around their burrows as they eat-and-dig through the mud. Their mounds can reach 3m high.


Fireflies light up a tree

10) Local name : Firefly
Scientific name : *Photinus pyralis*

At Weston Wetland Retreat, the fireflies light up the trees surrounding the Kingfisher Lounge. At light off, the lounge is quickly filled with the bugs reflecting their lights on the silvery surface of the specially designed ceiling. Quite a sight!

The firefly, or lightning bug, is neither a fly nor a bug, but a flying beetle. These twinkling beetles can produce a cold, almost perfect light that lights up the night.

Introduction to Ecotourism

Definition of ecotourism in general [33]

The International Ecotourism Society proposed one of the 1st definitions in 1991:
"Ecotourism is responsible travel to natural areas that conserves the environment and sustains the well being of local people."
Many tour operators and promoters have hijacked the term in order to try to attract travelers to a growing segment of the tourist market, which stems from an increasing number of travelers who are concerned about the social and environmental impact of their trip.
If an activity occurs outdoors in a natural setting, it is often called "Ecotourism" by many, including even 4-wheeling through the rainforest.

The Ecotourism Society (cited in Institute for Ecological Tourism website listed in Reference) defines Ecotourism as purposeful or responsible travel to natural areas to understand the culture and natural history of the environment, taking care not to alter the integrity of the ecosystem while producing economic opportunities that make the conservation of natural resources beneficial to local people.

Said in another way, the environment benefits from visitors because they help to conserve the environment; they in turn benefit from their non-consumptive use of the resource (which economists refer to as use value) as they increase their knowledge about the site visited; and this raises their utility level.

Generally speaking, ecotourism focuses on volunteering, personal growth, and learning new ways to live on the planet; typically involving travel to destinations where flora, fauna, and cultural heritage are the primary attractions. Sustainable development needs to social, economic and environmental needs all together to occur. [34]

Components of ecotourism: [35]

- Contributes to biodiversity conservation
- Sustains the well being of the local people
- Includes an interpretation/learning experience
- Involves responsible action on the part of the tourists and tourism industry
- Is delivered mainly to small groups by small-scale business
- Requires the lowest possible consumption of non-renewable resources
- Stresses local participation, stewardship, and business opportunities, particularly for rural people.

Ecotourism [36]

by Ahmad Mahdzan Ayob

Motives for Promoting Ecotourism

Should ecotourism be seen or interpreted as ecological or "economical" tourism? Should it be viewed in this way, as "either-or" or a dichotomy? The answer is not so simple. According to the Quebec Declaration on Ecotourism (2002), the stakeholders, such as ecotourism businesses must be able to make profits to be sustainable, and the environment too must not suffer as a result of ecotourism activities, while the local community must also benefit financially from the activities being promoted. In other words, the three-way symbiosis mentioned earlier in this paper must continue to function in order for ecotourism to be sustainable. One entity cannot take advantage of the other; otherwise the entire system simply collapses.

Thus, one may conclude that economics and ecology must go hand in hand in the development of ecotourism. Economic logic (eco-logic?) should be applied in trying to build ecotourism projects. A simple economic logic is that if the returns exceed the costs, leaving a sufficient surplus for entrepreneurship, then one should proceed with the project. If not, the project will not be viable to the private sector; hence it will not contribute to economic growth, which it was intended to do. Similarly, if the benefit to the environment is greater than the damage done to it, then proceed with the project.

The driving force behind any business is consumer demand. In the case of ecotourism, the consumers are the nature- or eco-tourists. They normally constitute a small group within the tourist population; in marketing they form a niche. It is they who will determine whether or not to visit a certain site for their outdoor recreation. They have many kinds of competing sites to choose from – sandy beaches, waterfalls, state woodland parks, jungle trails, marine parks that allow snorkeling or scuba diving, bird watching at bird sanctuaries, inland wetlands, mangrove forests etc.

On the supply side, the authorities will have to scrutinize any proposed project so that it does not damage the protected area. There is thus a "balancing act" that has to be done by the government as a custodian of the natural heritage on behalf of future generations. In this "act" the interests of the private sector, the environment and the local community will have to be safeguarded in the name of "sustainability." The Brundtland Report defines sustainable development as one that "meets the needs of the present without compromising the ability of future generations to meet their own needs (Weaver, 2001).

What does a mangrove swamp has to offer?

Mangroves are basically for the "scholarly" type – those who want to learn the scientific aspects of the forest (flora and fauna), the economic and ecological benefits of mangroves to man, etc. Mangroves provide "educational recreation" – if there is such a term. Some of the "interesting" discoveries one can make by visiting a mangrove with a trained guide or a forester are:

- There are many other species of plants growing in mangroves besides the bakau; for example the Nipah palm (Nypa sp.), rattan (Calamus sp) and nibong (Oncosperma sp), and some ferns (piai or Acrostichum spp.) can be seen growing among the bakau species. These have little economic value and are left to grow for the sake of biodiversity.

- The "seeds" of the bakau, known as propagules, start to germinate on the trees; and when they drop, the long root is "designed" to stick into the mud, thus ensuring its survival. Crabs are its worst enemy! When young they are succulent and provide food for these crustaceans.

- Mangroves have the ability to grow in salt or brackish water and are a life support for various types of fish, mollusks (seashells), and crustaceans (crabs, prawns and shrimps).

- In addition to controlling coastal erosion the mangroves can expand into the sea, a process known as accretion; this results in an increase in area of mangroves – a sort of natural land reclamation!

- The root system of the bakau (Rhizophora spp.) is unique, or even "weird" as the modern youth would have it, compared to most inland tree species; but it is quite "interesting" to look at the stilt roots (this is an opinion!).

- The Matang Mangrove is actually a charcoal production "complex" – its uses a renewable resource, unlike coal mining in other countries where coal deposits are extracted, leaving the country "poorer" from the perspective of resource endowment.

Valuing Tourists' Satisfaction From Ecotourism

If one is interested in finding out whether visitors have enjoyed their visit to a mangrove site, a simple survey can be conducted among a sample of the visitors. Several aspects of the visit can be evaluated, such as the quality of the interpretation session, the friendliness of the tour guide, punctuality of the organizers in the various schedules, quality of food served during the trip, the entrance fee charged, opportunities to ask questions, clarity of the answers, etc.

The main purposes of such a survey are to identify strengths and weaknesses of a service provider and then to capitalize on the strengths and rectify weaknesses for future tourists.

If one is interested to go further as to put a dollar value to the site, there are two major methods to do it. The first method involves survey of visitors to find out how many visits have they made to the site, how much they have spent on transportation, food, accommodation, time taken to arrive at the site, socioeconomic characteristics, etc. The idea is to trace a demand curve and then try to compute "consumer surplus" which reflects the sum total of the value of the site.

Likely Visitors' Expectations: Role of Government and Private Sector

What do ecotourists expect from a visit to mangrove sites? The answer will depend on their interest and educational background.

Some visitors would just love to enjoy "trekking" on the boardwalks prepared by the Forestry Department, while listening to the songs of birds, which are often too small to be seen without a pair of binoculars! Others look forward to the boat ride in the estuaries and waterways between the little islands (referring to the Matang Mangroves, of course.) Some might enjoy watching cockle harvesting in the brackish water or getting a free Kerapu fish, through the good office of the Forestry Department!

The true ecotourist would like to meet with the local community (preferably indigenous people) to see how they live, how the mangroves support their livelihood, and watch their culture.

The government's role in making ecotourism more enjoyable is to put in place the infrastructure: the boardwalks, automatic listening devices, an interpretative center, jetty, clearing the streams of broken branches, building landing places along the boating route, etc.

The private sector will arrange the tours and bring the tourists to the various spots of interest, provide trained guides and gives a running commentary as the boat passes an interesting spot.

Another vital of the government is to monitor the operators so that they comply with the principles of true ecotourism (Wallace, 2003). These include the following:

1. Entails a type of use that minimizes negative impacts to the environment and to local people.
2. Increases the awareness and understanding of an area's natural and cultural systems and the subsequent involvement of visitors in issues affecting those systems.
3. Contributes to the conservation and management of legally protected and other natural areas.

4. Maximizes the early and long-term participation of local people in the decision-making process that determines the kind and amount of tourism that should occur.
5. Directs economic and other benefits to local people that complement rather than overwhelm or replace traditional practices (farming, fishing, social systems, etc.)
6. Provides special opportunities for local people and nature tourism employees to visit natural areas and learn more about the wonders that other visitors come to see.

Why bring Tourists to Mangroves ?

The main purpose of ecotourism is to conserve nature and make up for the degradation of the environment brought about by mass tourism. This is because the tourists pay fees in order to enter the wetland. The fund collected will then be used to protect the islands and their unique flora and fauna, which are endemic to these islands.

There is an economic basis for charging tourists a token fee to cover maintenance costs of infrastructure built by the government, especially if the purpose is conservation. Privatization is aimed at making users pay for a service or to use a facility. A two-tier system should be tried whereby foreign tourists pay slightly more.

Local Authority's Plans along the Coastlines of Sabah [37]

Here are some of the plans that have been made:-

• Menumbuk-Beaufort Highway • Sindumin-Mempakul Highway • Pulau Tiga Park • Kuala Penyu Private Farm & Sugar-Cane Factory • Forestry Project - a forestation programs • Rubber Process Factory	• Major district hospital already in place • Gateway to Borneo through Pan Borneo highway • BIMP-EAGA projects and proximity to Labuan IOFC and Brunei • Big scale industrial activities such as the SFI and the other proposed new industries. • Existing ports facilities.

West Coast South (Beaufort, Kuala Penyu, Sipitang)

1. The fruit orchards in Beaufort area to be increased to sustain downstream processing.

2. Coastal beaches to be promoted for recreation and leisure

3. Aquaculture development within identified area to be accelerated.

4. Development of idle lands for food and cash crops

Effects of the Plans towards Ecotourism [38]

1. It will increase economic benefits to the people in Beaufort in terms of employment, business growth and allow new businesses to be developed.

2. The promotion of beaches will attract more tourists to the area especially the west coast south.

3. Artificial reefs will be built to promote marine life such as barnacles, corals and oysters. These reefs will also be useful to decrease the rate of erosion.

4. Idle land will be utilized for good use. The product from the use of the lands can improve the state and country's gross domestic products (GDP).

5. Forestation has been done and this can avoid the extinction of certain plants and animals.

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