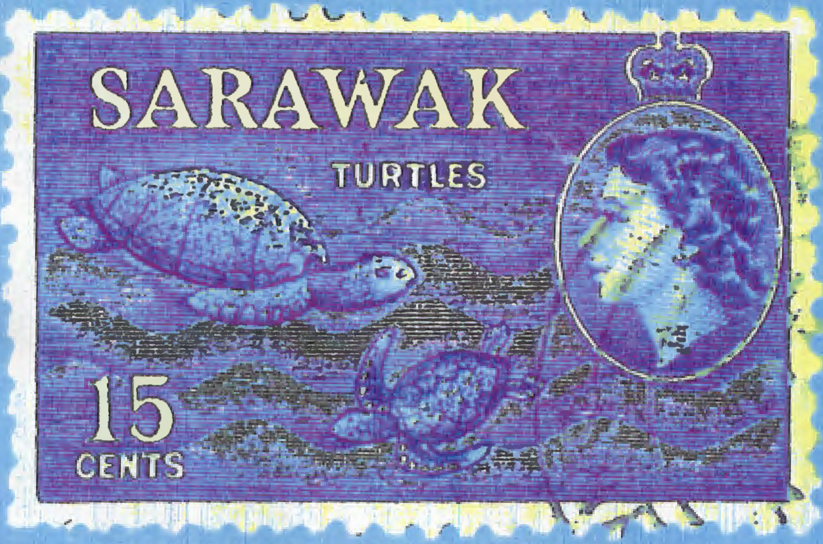
RECOMMENDATIONS

FOR

THE CONSERVATION AND TOURISM USAGE

OF

THE SARAWAK GREEN TURTLE POPULATION



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EXECUTIVE SUMMARY

CONSERVATION PRINCIPALS FOR SARAWAK GREEN TURTLE ROOKERIES.

LIFE HISTORY SUMMARY

Marine turtles are long lived, migratory animals that breed at traditional nesting beaches. They migrate to these breeding grounds from feeding areas up to 3000 km distant. They commence breeding at about 30 - 50 yr old. Their breeding strategy includes each female laying approximately 6 clutches of eggs per breeding season, each clutch containing approximately 105 eggs, with 4 or more years between breeding seasons (See Chapter 1, Figure 1). The adult female should have a long breeding life. Their life history is adapted to allow for an appreciable mortality among the eggs and early life stages and very low mortality in the near adult and adult stages. This life cycle has been very successful for marine turtles. They have survived to present times from the age of the dinosaurs. Some major green turtle rookeries have been in continuous use for thousands of years.

It is now apparent that any human interference which causes a significant increase in mortality at any stage in the marine turtle's life cycle can cause a population decline.

SARAWAK : A SPECIAL PLACE FOR GREEN TURTLES

Marine turtles do not breed just anywhere. About a century ago, there were approximately 20 major breeding aggregations for the green turtle, *Chelonia mydas*, throughout the world. Genetic studies show that each of these major breeding aggregations is reproductively self sustaining and essentially genetically isolated from the other. World wide there has been only a small number of major breeding units for the green turtle.

- **The Sarawak Turtle Islands (P. Talang Talang Besar, P. Talang Talang Kecil, P. Satang Besar) and the adjacent coast is part of one of these few rare major breeding units for green turtles.**

POPULATIONS IN DECLINE

Long term and large scale harvesting of green turtles and/or their eggs have caused the decimation of most of the worlds major green turtle breeding aggregations. Where the harvest was directed at the nesting turtles, some of these major breeding populations have now been harvested to extinction. All rookery regions subjected to prolonged large scale egg harvesting during this century have now declined to approximately 10% or less from the population levels at about the time of World War II. Where these egg harvests are continuing, the population declines are still in progress.

> **The Sarawak Turtle Islands is one of the major breeding areas subjected to long term egg harvesting which has undergone a 90% decline in nesting population during the latter half of this century (Figure 2).**
>
> **The Sarawak green turtle annual nesting population has declined from several thousand females early this century to a few hundred at the present time.**

The opinion has been expressed that the Sarawak green turtle population has stabilised in recent years (Leh 1989). However, this does not mean that the full effects of previous excessive egg harvesting have past. The apparent stabilisation in egg production that occurred in about 1970 must be viewed in terms of hatchling production from some 30 to 50 years before, i.e. about 1920 to 1940. In these years there was almost total egg harvest at the Sarawak green turtle rookeries (Figure 2). The declining egg production that has been identified since about 1950, with the associated minimal and declining hatchling production (estimated at about 1% of total egg production) from 1951 to 1980, almost certainly has yet to produce an effect on the nesting population. A further decline in the nesting population is expected, The positive impact of the increased hatchling production since 1980 (Leh 1989) can be expected to slow, or possibly halt the rate decline in the number of nesting turtles returning to the islands early next century.

> **The Sarawak green turtle population is still at great risk to further population decline.**

CAN THE SARAWAK GREEN TURTLE SURVIVE IN THE LONG TERM?

Yes, but the choice is in the hands of us today.

> **If the Sarawak green turtle rookeries had continued to be managed as they were up until recent times, there was a high probability that the annual nesting population would have approached extinction within our life time.**
>
> **If a positive strong conservation management program is applied to the Sarawak green turtle rookeries for at least one turtle generation period (30 to 50 yr), it is expected that the current population decline will be turned around and a stable or increasing population maintained.**

RECOVERY PROCESS

If the choice is made to stop the population decline then every effort should be made to maximise its chances of success. A recovery plan should be implemented that contains the following elements (See Chapter 2 for greater details).

A. Biological issues:

1. Manage all the turtle rookeries of the region as a single integrated breeding unit.

2. Manage the marine habitat up to 15 km radius of the rookeries to minimise disturbance to both the mating turtles and the females while they are preparing their eggs for laying.

3. Manage the habitat and environment of the rookeries to provide optimal nesting habitat for the turtles while reducing those features which can discourage turtles from nesting at these sites.

4. Maximise the production of healthy hatchlings into the open sea.

5. Ensure a regional hatchling sex ratio that is not biased too far towards either sex (60 - 70% female is recommended).

6. Minimise any possible disruption to the imprinting process that enables the turtles, when they grow up, to find their way back to the Sarawak Turtle Islands.

B. Administrative issues

1. For the three turtle islands, P. Talang Talang Besar, P. Talang Talang Kecil, P. Satang Besar, the primary objective of administration and development should be the conservation of the Sarawak green turtle population.

    This requires a commitment to conservation management of approximately 5 hectares of sand beach on three small islands to save the green turtle for posterity in Sarawak.

2. Establish a single management authority responsible for the conservation and sustained utilisation of marine turtles in Sarawak.

3. Appoint a marine turtle specialist to the management authority to provide in depth and up to date scientific advise on turtle biology and conservation.

4. Establish a planning process that is committed to units of five years of planning to span a minimum of thirty years.

    When an existing egg harvest is discontinued, the population continues to decline for some time. The benefits of cancelling an egg harvest will not be seen among the nesting turtles until the new generation returns (approximately 30 yr). Five years is the most common interval between breeding seasons for a female green turtle.

CHAPTER 1

THE GREEN TURTLE LIFE CYCLE.

Marine turtles all have a similar life cycle (Figure 1) and the following general description has been developed particularly from studies of the green turtle.

Marine turtles utilise feeding grounds often far removed from the nesting beaches. With the onset of the breeding season adult males and females migrate to copulate near the nesting area. There is no pair bond between individuals and copulation with a number of different partners during the mating season is normal. The female stores the sperm from her several mates for use later in the breeding season. At the completion of mating the males depart, presumably returning to the distant feeding grounds. Each female moves to an area adjacent to her selected nesting beach and commences making eggs, fertilising them from her sperm store. Because of the mixture of sperm she carries, several males usually contribute to the fertilisation of any one clutch. The female comes ashore, usually at night, to nest several weeks after her first mating. For those beaches fronted by reef flats, nesting coincides with the higher tidal levels. Within the one nesting season each female typically lays several clutches at about two weekly intervals. During that two week period she does not need to find a new mate, she moves just offshore from the nesting beach to make the next clutch of eggs, again fertilising them from her sperm store. The breeding turtles do not feed, or else feed to only a limited extent, while migrating, courting or making eggs at the nesting beach area. They live off the stored fat reserves they deposited before the breeding season began.

Each female usually chooses to return to the same beach or island to lay several clutches within the one nesting season. However, several percent of females can be expected to lay on more than one beach within 100 km of the initial nesting site. At the completion of the nesting season the females do not use the adjacent shallow water habitats as year round feeding grounds but return to their respective distant feeding grounds, each to the same area that she left at the start of her breeding migration. After two to eight years (usually 4 - 6 yr) many of these females will make yet another breeding migration, each generally returning to nest on the same beach as before. This behaviour and the annual use of traditional nesting beaches has led to the assumption that a marine turtle returns to nest on the precise beach of her birth. In reality the homing is often not that exact. Genetic studies suggest that the female returns to breed in the general region of her birth. For example, a turtle born at one of the Sarawak turtle islands, when it grows up, should return to breed at any one of the Sarawak turtle islands.

Females lay their eggs high up on the beach above the highest tide level, usually within the vegetated strand. No parental care is exercised. The incubation period and the sex of the resulting hatchlings is a function of the temperature of the surrounding sand.

A warm nest at mid incubation results in all or mostly female hatchlings while males come from cool nests. The eggs hatch about 7 - 12 weeks after laying. The hatchling turtles dig their way unaided and as a group through the 50 cm or more of sand to the surface. On surfacing they immediately cross the beach to the sea. This hatchling emergence is almost entirely nocturnal. Sometime during the incubation - emergence - entry to the sea process, the hatchling is imprinted to the region of its birth. The imprinting process is not fully understood, but the hatchling is imprinted to the earths magnetic field as it leaves its nest and probably is imprinted to the smell of the water that percolates through the sand of the nesting beach.

For most turtle rookeries only a small percentage of hatchlings is lost to terrestrial predators during the beach crossing. Immediately the hatchlings reach the water they begin oriented swimming which takes them away from the beach and into deep water. The hatchlings at this stage are living off a yolksac internalised just prior to hatching. They do not feed while on the beach or while swimming out to sea. In coral reef areas when the hatchlings are crossing the reef flat, they are probably exposed to the greatest level of predation during their life cycle, especially at low tide. This is a period of transfer to predatory fish of nutrients derived from adult turtles via eggs and hatchlings. For all except flatback turtles, the hatchlings, on reaching the deep water areas, continue to swim away from the beach and this activity presumably brings them under the influence of the open ocean currents where they drift for the first few years of their lives. The post hatchling flatback turtles remain over the continental shelf. The newly hatched turtles do not feed nor take up residence in the vicinity of where they were born.

When the hatchlings disperse from the nesting beach they are virtually lost to study for the next few years. While in this drifting phase the turtles presumably feed on the macroplanktonic animals at the surface. The young of all marine turtles except the leatherback turtle 'reappear' at about the size of a large dinner plate (curved carapace length 35-40 cm, age undetermined but possibly 5-10 yr old). At this size they take up residence in the shallow water habitats of the continental shelf, feeding principally at the bottom on plants and animals depending on the turtle species. Green turtles feed mostly on seaweed, seagrass, and mangrove fruits; loggerhead turtles feed mostly on shellfish and crabs; flatback turtles feed mostly on soft corals and sea pens; olive ridley turtles feed mostly on small species of crab and hawksbill turtles feed mostly on sponges. These turtles will also eat jellyfish and Portuguese man-of-war on occasions. These immature turtles may remain in the one feeding ground for extended periods, perhaps years, before moving to another major area. At least several such shifts may occur in the life of the turtle in this coastal shallow water benthic-feeding phase. The leatherback turtle, which remains an inhabitant of oceanic waters for almost all its life, feeds mostly on jellyfish.

Tagging studies of turtles living within the Great Barrier Reef, Hawaii, the Caribbean Sea and the eastern USA demonstrate that they are many decades old at first breeding and can have a breeding life spanning many more decades. At no stage in their life are sea turtles free of predation. The young to adult sized turtles are potential prey to large cod, groper, sharks, crocodiles, and killer whales. In many countries, however, man continues to be the most significant predator. Green and olive ridley turtles are harvested in big numbers especially for meat; the hawksbill turtle for tortoiseshell. All species are hunted for leather, oil and their eggs.

Incidental capture of turtles in fishing gear can also cause significant mortalities of marine turtles, especially in prawn trawls, drift nets, large mesh set nets and long lines. In some areas, ingestion of plastic and other debris has been identified as a significant cause of mortality. Boat strikes are common in shallow areas with high density recreational boating.

Wherever there has been organised harvesting or large scale killing of the turtles and/or their eggs over several decades, the turtle population has undergone significant decline. No one has ever successfully managed a marine turtle population at stable population levels while subjecting them to large scale mortalities.

CHAPTER 2

MANAGEMENT RECOMMENDATIONS

FOR THE

SARAWAK GREEN TURTLE ROOKERIES

A. Biological issues

1. Manage all the green turtle rookeries of southern Sarawak as a single integrated breeding unit.

   Recent population genetics studies and long term tagging studies with green turtles have demonstrated that adjacent rookeries are part of the same breeding unit. The turtles will interchange between these rookeries within the one breeding unit. There is insufficient interchange between the more widely separated breeding units to enable interchange to compensate for population declines at a regional level (Bowen *et al.* in press).

   The Sarawak Turtle Islands (P. Talang Talang Besar, P. Talang Talang Kecil, P. Satang Besar) and the adjacent coast is part of one of these few rare major breeding units for green turtles.

   Temperature dependent sex determination studies show that different beaches within a breeding unit provide a range of incubation temperatures and hence variability in hatchling sex ratio (Limpus *et al.* 1983). This is achieved by seasonal differences, between rookery differences, and within rookery differences. Some beaches may produce very different hatchling sex ratios compared to other beaches within the same breeding unit.

   This means that conservation of the regional green turtle breeding units can not be achieved by management of a single nesting beach. All the nesting beaches within the entire breeding unit must be managed jointly.

   Protection of the nesting population and hatchling production should be greatest at the major rookeries within the breeding unit.

   Therefore, conservation management should be applied to the Sarawak Turtle Islands in the following order of importance for egg production : P. Talang Talang Besar, P. Talang Talang Kecil, P. Satang Besar (Figure 3).

   Provide the nesting beaches at Talang Talang with the strongest conservation management for the region.

2. <u>Manage the marine habitat adjacent to the rookeries to minimise disturbance to both the mating turtles and the females while they are preparing their eggs for laying.</u>

Approximately a month before commencing her nesting, the female mates with a series of males while in the vicinity of the rookery. During the two weeks between laying her clutches the female rests in the adjacent marine habitat to the rookery (internesting habitat) up to 15 km off the rookery while she completes the production of each clutch of eggs. The female does not feed to any great extent for the several months she is at the rookery. She lives off her stored fat.

2.1 Commercial fishing:

Ban the use of fishing technology that is likely to kill turtles within a 15 km radius of the major nesting beaches. This includes drift nets, bottom and surface set gill nets, trawls (unless they are fitted with trawling efficiency devices), crab and fish traps marked with light-weight bouylines.

2.2 Toxic and hazardous chemicals:

Avoid the movement and/or storage of large volumes of petroleum and toxic chemicals immediately up current from the turtle rookeries.

2.3 Recreational boating:

Limit the use of highspeed craft, including jet skis, over the reef flats surrounding each of the three turtle islands to minimise collisions with turtles and minimise disturbance to the gravid females in the internesting habitat while they are preparing their eggs for laying.

2.4 SCUBA diving:

Given the extremely small size of the reefs surrounding the turtle islands, SCUBA diving within the internesting habitat surrounding the rookeries should be managed to minimise disturbance of courting pairs of turtles and the gravid females.

Recreational diving should only be permitted on part of Satang Besar reef (preferably off the eastern side of the nesting beach) and totally prohibited on the Talang Talang Island reefs during the courtship period and the principal nesting season from April to October (Figure 3).

2.5 Rock walls and groins:

Rock walls, reclamation works or other structures which impede the use by the turtles of the intertidal and

subtidal waters adjacent to the nesting beaches should be avoided.

In particular, sheltered bays around the islands which will be used for courtship areas and internesting habitat, where the female turtles will rest while they prepare their next clutches of eggs, should not be excluded from turtle access.

2.6 Public access to the islands:

Solid structures on the reef flats can alter the wave deflection pattern over the reef and can cause increased erosion of the sandy nesting habitat of the islands.

If landing stages and/or jetties are built to provide public access to any of the turtle islands from boats, these should only be built to landing points on the island which are not sand beach.

In this way, the structure will have minimal interference with access to the beach for the nesting turtles.

3. Manage the habitat and environment of the rookeries to provide optimal nesting habitat for the turtles while reducing those features which can discourage turtles from nesting at these sites or trap hatchlings on the beach.

3.1 Lighting:

Artificial lighting that spills onto the nesting beach will reduce the number of turtles choosing to nest on that beach. Lights on the beach will also enable the turtle to see people moving on the beach and this also is likely to scare turtles from their nesting attempts.

The same lights which scare nesting turtles will attract hatchlings turtles. Artificial lighting can attract hatchlings, thus preventing them from running to the sea. Illuminated areas on these islands that are visible from the sea can even attract hatchlings back out of the water.

If buildings are to be constructed on these turtle islands and are illuminated by anything brighter than candles or oil lamps, then the buildings should be constructed well inside the forest and screened from the beach so that no illuminated areas can be seen from the turtle nesting sites and the immediately intertidal adjacent waters.

Lights from boats at anchor off the nesting beach at night can also attract and trap hatchlings within the illuminated area where they are ready prey for fish and sharks.

No boat should be permitted to remain at anchor at night within 2 km of the nesting beaches unless it has no lights visible from the surrounding water other than normal navigation lights as required under marine regulations.

Slow flashing lights with a short duration "on pulse" and a long off interval, irrespective of colour, do not disturb nesting turtles nor do they attract hatchling turtles.

Any navigation lights required in the vicinity of the island should be of "flashing" design.

Similarly, flashing lights can be used on the beach to mark entrances to walking tracks between the beach and buildings. Continuously illuminated lights should not be used for that purpose.

3.2 Rock retaining walls:

The turtles, once they have come ashore on the nesting beach, should be allowed the freedom to select the nesting site of their choice.

Walls, fences and buildings, because they are barriers to the movement of the turtles, result in an artificial concentration of nesting adjacent to the structure. This increased nesting density can result in an increased incidence of digging up existing eggs by subsequent nesting females.

Rock retaining walls, fences and other structures which can obstruct turtle movement should not be built within the nesting area used by the turtles.

> Where erosion is threatening trees, allow the trees to be lost if necessary, rather than impede the turtles and force them to nest in a place not of their choice.

3.3 Debris:

Logs and other large items of debris on and in the sand of the nesting beach can prevent turtles from successfully digging their nests and hence cause turtles to abort nesting attempts. If a turtle encounters too many obstacles to nesting on its preferred beach it is likely to search for an alternate nesting beach.

Buried debris on top of a nest can trap emerging hatchlings and prevent their escape from the nest.

Given the small size of the nesting beaches on the Sarawak turtle islands, every effort should be made to provide the maximum area of suitable nesting beach possible for these turtles by the removal of all large logs and other debris on the nesting areas.

If necessary the logs can be burned in situ during the low density nesting season.

Tin cans, iron and bottles should be removed from the island, rather than be buried on the perimeter of the nesting area.

3.4 Human activities:

Small numbers of people on a nesting beach, if they behave properly can observe/research/manage nesting turtles without adversely affecting their nesting success. However, large crowds or even uncontrolled small numbers of people on the nesting beach can disturb the nesting turtles and even drive them away to use other less appropriate beaches for egg laying.

To conduct research and monitoring studies of the nesting turtles and maximise egg protection it is necessary for the management agency employees to work among the nesting turtles.

To educate the public to support the need for conservation activities for marine turtles, it is desirable that members of the public are able to view nesting turtles and enjoy this wildlife phenomenon.

Rules for human activity in the vicinity of nesting turtles to minimise disturbance of the turtles:

- **Remain at least 20 m away from and to the side of turtles as they crawl up the beach from the sea.**
- **Remain stationary while waiting for a turtle to cross the beach and select a nesting site.**
- **Do not shine torches or attempt night time flash photography while observing turtles that are crossing the beach and searching for a nesting site.**
- **To observe a turtle digging an egg chamber (i.e. preparing the hole in which it will lay its eggs), the observer(s) must remain behind the turtle and preferably out of view of its head.**

  A small torch (e.g. a pen light torch) can be placed immediately behind the turtle such that it does not shine on the turtle's head and illuminate the egg chamber for viewing.

- **People may be permitted to shine torches on the nesting turtle or walk to the front of her only after the turtle has commenced laying her eggs.**

  Shining torches on a turtle once she has commenced laying her eggs, as she conceals the eggs or as she returns to the sea does not disturb the turtle to cause her to abandon her selected nesting beach.

  Similarly, flash light photography of nesting turtles after they have commenced laying their eggs will not disturb the turtles.

  Research and monitoring work can be performed with a turtle once she has commenced laying. Those management activities likely to disturb the laying (e.g. tagging) should be delayed until after she has finished laying and has commenced to conceal the eggs.

- **To avoid disturbance of other nesting turtles on the beach, persons viewing turtles should be limited to weak lighting (recommended maximum : 3 volt incandescent bulb).**

  Fluorescent lights, LPG gas lights and pressure lanterns should not be permitted for use on turtle nesting beaches.

- **Unnecessary disturbance of the nesting turtles should be avoided, e.g. turtles should not be ridden as they return to the sea.**

Activities around the nesting turtles and the nesting success of the turtles requires constant monitoring. Should the nesting success decrease as the result of human activity around the nesting turtles, then the human activities should be modified to remove the cause of the disturbance.

3.5 Tourist limitations:

Because of the small area of the Sarawak turtle islands nesting beaches and the severely depleted turtle population numbers, if tourists are permitted on the turtle islands:

- **Restrict tourist viewing of the nesting turtles to one island only and then only to the one with the smallest number of nesting turtles:**

  LIMIT TOURIST VISITATION TO P. SATANG BESAR.

- **limit the number of night time visitors permitted on P. Satang Besar nesting beach to thirty (30) per night.**

The number of tourists present on the island at night can be regulated by limiting the accommodation available.

- **Limit the number of day time visitors permitted on P. Satang Besar nesting beach to one hundred (100) per day.**

The behaviour of visitors to the nesting beach must be closely regulated to ensure that they do not cause unnecessary disturbance of the nesting turtles. This control is best achieved by having night time visitors to the beach under the control of an interpretive guide.

General night time recreational activities on the nesting beach (fishing, swimming, playing games) should be restricted away from the turtle nesting areas and only permitted along the rocky shore areas of the island.

Day time recreational activities that do not interfere with the incubation process for eggs buried in the beach platform need not be restricted. However, some activities will need to be restricted away from the nesting habitat.

- **Beach umbrellas should not be used above the high tide level if eggs are being left to incubate naturally on the high beach platform**

- **Volley ball and other active games that can lead to compaction of the sand should not be played within the turtle nesting area**

- **Planting of trees for shade or provision of shade areas should not occur within the turtle nesting area.**

4. <u>Maximise the production of healthy hatchlings into the open sea.</u>

4.1 Commit all available eggs to hatchling production.

Until it is clearly demonstrated that the Sarawak green turtle population has ceased its population decline and is actually increasing in population size, there should be total protection of turtle eggs and a maximising of hatchling productivity.

This should include:

- **Total ban on sale and possession of marine turtle eggs.**

- **Replacing the general use of turtle eggs for fights and eating during the Semah festival at the Turtle**

Islands with a symbolic or ritualistic use of the eggs.

- **A ban on the eating of turtle eggs by government employees at the turtle islands.**

  Approximately 5% of the 1982 annual egg production was lost through the provision of a turtle egg ratio to the employees on the islands and other free egg distribution.

- **A ban on the use of probing rods to locate clutches.**

  1% of the 1982 annual egg production was destroyed by the probing method used to find the eggs after the turtle has laid. If turtle eggs must be relocated from the natural nest site, it is possible to train people to find turtle eggs without breaking any them. See also Chapter 3, section 2.1.

4.2 Natural hatching success:

For all species of marine turtles at rookeries worldwide, the hatchling success of undisturbed eggs laid in the normal nesting environment can be expected to have a hatching success of approximately 90% with a few percent of these hatchlings failing to emerge from their nests.

A microscopic examination of marine turtle eggs as they are laid, shows that infertile eggs are extremely rare. As the egg is laid, it contains an embryo that has already developed to a pin-head sized gastrula (Miller 1985). Most failure of an egg to hatch is the result of disruption of subsequent embryonic development - not infertility.

From the species survival perspective, it is worthwhile to investigate incubation success in detail for the marine turtle eggs for the entire breeding unit :

- at each rookery
- at different times of the breeding season
- at different microhabitat within a rookery
- within hatcheries and other manipulated environments.

Where there is consistent high hatching success, marine turtle eggs should be left undisturbed to incubate naturally where the female lays them.

4.3 When should eggs be relocated to artificial nests?:

There are some situations where there will be a consistently poor hatchling production as a result of natural processes. In some instances it is possible to improve the hatchling production from these nests by relocating the clutch to a more appropriate site on the nesting beach.

Some of the typical situations that warrant consideration for relocating clutches:

- clutches laid below the high tide level or below the storm surge / erosion line
- clutches laid in areas with an excessively high probability of being dug into by other nesting turtles
- clutches laid in areas with a high probability of being preyed on by poachers or dogs and similar predators
- clutches laid in sand/soil with a high microbial content

Where consistently reduced hatching success below 80 - 90% is identified, it is worthwhile considering manipulation of those eggs to a more appropriate incubation environment to increase hatchling production.

This should be the underlying principal guiding any decisions to move turtle eggs from the natural nest sites chosen by the female turtle.

If a clutch is to be relocation to an artificial nest, then the following guidelines should be followed closely:

- **complete the relocation within 2 hr of the eggs being laid**
- **avoid vertical rotation of the eggs. Use a stiff sided container to carry the eggs**
- **do not wash the eggs, especially not in sea water**
- **relocate the clutch to a similar habitat with respect to depth, shade, and sand texture.**

The longer the time from being laid to the relocation of the eggs, the greater the probability that the movement will kill some or all of the eggs (Limpus *et al.* 1979, Parmenter 1980, Chan 1989).

4.4 Hatchling emergence:

The following guide lines should be followed concerning hatchling emergence:

- **Hatchlings should be allowed to emerge from nests naturally and proceed immediately to the sea.**

This ensures that natural imprinting processes are not disrupted.

- **No bright lights or camp fires should be visible from the nest sites at hatchling emergence time.**

    Artificial lights can attract hatchlings inland and prevent them from finding the sea.

- **Where a cage is necessary to capture hatchlings emerging from a clutch, the cage should be made of plastic mesh not metal.**

    This will minimise interference with the natural imprinting of hatchlings to the earth's magnetic field at that rookery.

4.5 Hatchery:

If a hatchery is constructed to receive relocated clutches, the following guidelines should be followed:

- **The sand temperatures at nest depth within the hatchery(s) should reflect the range of sand temperatures and nest depth that occur at the entire rookery. More than 1 hatchery may be necessary to achieve this.**

    This will reduce unnatural bias in hatchling sex ratio.

- **The same hatchery location should not be used for more than 2 successive seasons.**

    This will reduce fungal and bacterial accumulation on the site that can reduce hatching success.

- **Clutches should be spaced widely enough apart to avoid interference with adjacent nests when excavating emerged clutches to assess hatching success.**

    Recommended 70 cm spacing for clutches.

- **After a clutch has emerged from a hatchery, the remaining shells, dead hatchlings and unhatched eggs should be dug up and removed within a few days of emergence.**

    This will minimise the accumulation of microbial agents within the sand of the hatchery.

    It is recommended that old eggs and shell be buried below the high tide level.

4.6 Care of hatchlings:

The best care of newly emerged hatchlings is to ensure they are free to scramble to the water as soon as possible after their emergence from the nest.

Hatchlings have their maximum vigor when as they emerge from the nest. When retained for only a brief period, they become less vigorous. The longer they are held in captivity, the greater the amount of stored yolk sac that they will have used before they begin their sea-ward swim. This will limit the distance they can travel into the open ocean before they have to commence feeding.

If hatchlings are retained in captivity for a period then:

- their captivity time should be kept to a minimum
- the hatchlings should be kept cool
- to keep hatchling mortality to a minimum, they are best released at night at the higher levels of the tidal cycle.

If hatchlings are kept in captivity for more than a few hours then they should be provided with sea water to swim in. If kept for more than three days, they will need to be fed.

4.7 Predator control:

Dogs can be egg predators and cats can be hatchling predators (Chapter 3)

Non natural predators (cats, dogs, rats) should be eliminated from the nesting beaches.

Staff living on the island should not be permitted to have cats or dogs on the islands.

Native predators of turtles on the beach and/or of their eggs should be controlled to favour an increasing turtle population, unless the native predator is itself a rare or threatened species.

5. <u>Ensure a regional hatchling sex ratio that is not biased too far towards either sex (60 - 70% female is recommended).</u>

Continuing studies in eastern Australia are demonstrating that the sex ratios of wild populations of marine turtles in their home feeding areas are not 1:1. For green turtles in feeding areas throughout eastern Australia the sex ratio is usually in the range of 60 - 70 % female

(Limpus and Miller unpublished data; Limpus and Reed 1985). Until a value is measured for the Sarawak green turtle population, the value recorded in eastern Australia can be used as an approximation.

The sex of hatchling sea turtles is determined by the temperature of the nest during mid incubation (Miller and Limpus 1981, Yntema and Mrosovsky 1980 and 1982). Current studies in eastern Australia demonstrate that there is not a single pivotal temperature (the temperature that yields a 50:50 sex ratio) that applies to all species. Similarly, the pivotal temperature varies between different breeding units for the same species. For example, green turtles from the northern Great Barrier Reef breeding unit have a pivotal temperature of 29.7°C while those from the southern Great Barrier Reef breeding unit have a pivotal temperature of 27.6°C (Limpus and Miller unpublished data).

Therefore, the pivotal temperature for the green turtles that nest in the Sarawak turtle islands can not be extrapolated from research done at other rookeries. **The pivotal temperature will need to be measured for the Sarawak green turtle breeding unit.**

Based on the study by Leh et al. (1985), it is estimated that the pivotal temperature of the Sarawak green turtle breeding unit will be between 29 and 29.5 °C.

Sand temperature measurements at nest depth on the Sarawak nesting beaches indicate that the eggs laid during the dry season with the associated warmer nest temperatures are likely to produce mostly female hatchlings (Leh *et al.* 1985) while the wet season with its associated cooler sand temperatures (Chapter 3) is likely to produce mostly male hatchlings.

Recent management at the turtle islands has shifted all eggs for incubation to hatcheries. All hatcheries are in the open sunny areas of the beaches. Therefore the natural production of male hatchlings from shaded (therefore cooler) nests during the dry season is precluded.

The current practice of only selecting eggs from the dry season for incubation and then incubating them all in the warmer open sunny habitat must be biasing the hatchling sex ratio away from the natural values.

Leh *et al.* (1985) recorded 81% to 91% female hatchling production from hatchery nests. It is my opinion that this sex ratio is too strongly biased to females. There must be an adequate supply of both males and females for the population to survive.

Management of the Sarawak green turtle rookeries should

be changed to ensure a more natural hatchling sex ratio is produced.

- **Clutches must be allowed to incubate from nests that reflect the full temperature range of the Sarawak green turtle nesting beaches representing :**

  - **all seasons**

  - **both the shaded and sunny nesting habitats.**

The nesting beach on Talang Talang has been altered by the construction of rock walls and the introduction of a dense coconut grove along the margin of the sandy nesting habitat. These changes have excluded the possibility of the females selecting cooler nest sites within the forest margin of the nesting beaches (where a greater proportion of male hatchlings would be produced).

When management policy changes so that nests are allowed to incubate where the female turtles lay them, it will be necessary to remove some of the obstructions to nesting that prevent the female turtles from nesting in the forest margin.

Because shade lowers beach temperatures at nest depth, no provision of shaded areas for tourist visitors on the nesting beaches should be considered.

In the past, when green turtles nested in high density on the Sarawak turtle islands, they prevented the growth of young trees and shrubs on the sandy nesting habitats. Now that the nesting population is greatly reduced, it can be expected that seedling trees and shrubs will survive through the main nesting season. This has the potential for a forest to over grow the nesting areas as the nesting population continues to decline. If this happens, then the nesting habitat could be altered to mostly shaded cooler habitat that would be expected to produce mostly male hatchlings. This would be undesirable.

The sandy nesting habitat that forms the major part of the Sarawak turtle nesting beaches should be maintained as habitat of similar structure as that described by Hendrickson (1958) and Harrison (1950,1955) when there was high density turtle nesting.

- **The open sandy nesting habitats must not be allowed to be over grown with trees or shrubs.**

6. <u>Minimise any possible disruption to the imprinting process that enables the turtles, when they grow up, to find their way back to the Sarawak Turtle Islands.</u>

Hatchling sea turtles are imprinted to their natal nesting area by at least two processes:

- magnetic imprinting to the earths magnetic field as the hatchling leaves the nest (Lohmann 1989)
- chemoreception, where by they can recognise the odour of the water associated with the nesting beach (Grassman *et al.* 1984).

6.1 No wire cages in hatcheries:

Within the hatcheries, wire cages are used to surround nests and capture hatchlings as they emerge from a nest and restrain them for several hours. These wire cages will also act as an electromagnetic shield surrounding the hatchlings. These cages will be altering the magnetic fields that the hatchlings are exposed to on emergence and hence altering their imprinting process.

Nests should not be surrounded by wire cages to collect and/or restrain hatchlings.

- If cages are to be used around nests, they should be constructed of plastic mesh or other non magnetic material.

6.2 Rapid entry of the hatchlings from nests in the sea:

There is uncertainty as to when the chemosensory imprinting of hatchlings to the smell of the waters of the nesting beach occurs. Until there is better knowledge of this and unless absolutely necessary :

- **Do not restrain hatchlings in cages in hatcheries.**

- **Do not hold hatchlings in captivity for the first few days or even the first few hours after leaving the nest.**

Allow hatchlings to leave their nest naturally and proceed immediately to the sea.

CHAPTER 3

PERSONAL OBSERVATIONS AT THE SARAWAK TURTLE ISLANDS

14 - 15, 22 November 1991

1. TALANG TALANG Islands and SATANG BESAR Island

1.1 Nesting and hatchling emergence frequency

The number of nesting turtles coming ashore per night and the number of clutches per night emerging from the hatcheries were recorded during this off-peak nesting season visit.

	Talang Talang		Satang
	Besar	Kecil	Besar
Turtle numbers (clutches laid)			
Nov 13	2 (2)	1 (-)	
14	9 (7)	2 (2)	
22			0
Clutch emergence			
Nov 13	11*	-	
14	1	3?	
22			1

* There is the possibility that this may represent the accumulation of more than 1 single nights hatchlings.

No clutches were found emerging from out side the hatcheries on these nights.

1.2 Beach description

The nesting beaches consist of fine grained, light brown coloured sand. In composition, the sand is a mixture of mostly quartz and other minerals derived from the granitic parent rock and some calcareous sand derived from coral and molluscs.

Sand temperatures at nest depth was relatively uniform within the hatcheries at all three islands. This may have been partly the result of the heavy rain causing uniformity of temperature. In the dry season, it is expected that Talang Talang Kecil with its more westerly aspect than the other two nesting beaches will be cooler. There was greater variation in sand temperature between the open sand areas and adjacent/under the forest canopy on the one island than between the open sand areas across the islands (Table 1).

These temperatures are at the lower end of the temperature range recorded in the Talang Talang Besar hatchery in 30 August - 26 October 1984 (Leh *et al*. 1985). It suggests that a higher proportion of male hatchlings would be produced from nests incubated in the more shaded areas of the beaches and during the wet season. The placing of hatcheries in the uniform higher temperature habitat of the open sand flats of these islands for many decades must have resulted in the hatchlings sex ratio being strongly biased to females. This strong female hatchling bias has been demonstrated by Leh *et al*. (1985).

Table 1. Sand temperatures (°C) at nest depth (at 50 cm depth)*

	Time (hr)	Talang Talang Besar	Talang Talang Kecil	Satang Besar
Within hatchery				
	1935	29.2		
	1941	29.0		
	1005		28.8	
	1010		28.6	
	1315			29.0
Open beach platform				
	1245			28.8
5 m back from vegetation line				
	1947	28.0		
	1955	28.2		
Under Casuarina canopy				
	1250			27.8

* This is the standard depth used for between rookery comparison of nest temperatures within the Queensland Turtle Research Project.

On Talang Talang Besar, a rock retaining wall has been constructed in front of some of the buildings. This wall restricts the nesting turtles to the open beach area and prevents them from nesting in the "old forest area" where the buildings now stand.

On both Talang Talang islands the dense root systems of the coconut palms along the forest margin are impeding turtle nesting back into the forest.

Both these latter factors will contribute to the crowding of turtle nesting onto the more open sand areas and will contribute to the reduction of the proportion of male hatchlings produced if eggs are ever left to incubate naturally on the beach.

1.3 Measurement of the turtles

Nesting females
Curved carapace length :
mean = 96.7 cm (SD = 6.20, range = 87.5 - 102.9, n = 4)

Eggs
Egg diameter :
mean = 4.015 cm (SD = 0.1999, range = 3.65 - 4.415, n = 60 eggs, 10 eggs/clutch)

Hatchlings
Hatchling straight carapace length :
mean = 4.56 cm (SD = 0.1957, range = 4.09 - 4.95, 37 hatchlings from 20 clutches)

Hatchling scute counts (29 hatchlings from 20 clutches)

	Count	frequency
Nuchal	1	29
Vertebral	5	27
	6	2
Postcentral	2	29
Costal	4/4	29
Marginal	11/11	29
Postoccular	3/3	1
	3/4	2
	4/3	2
	4/4	22
	4/5	1
	5/4	1
Prefrontal	2	29
Preoccular	0/0	29
Postparietal	Symetrical	
	2	20
	4	4
	Assymetrical	
	3	5
Inframarginal	4/4	29

2. TALANG TALANG BESAR : 14 - 15 November 1991

2.1 Egg harvest

No more clutches were being buried in the hatchery at this time. The reason given was that the nesting season had effectively finished and the late season clutches do not have a good hatching success.

The 2 clutches laid on the night of 13th November were dug after the hatchlings had been removed from the hatchery, at approximately 1000 hr. The eggs were stored on covered plastic bins in an enclosed room at the camp. Before being stored, the eggs were washed of sand by dunking the carry bag in the sea several times. Several days eggs were already in storage.

Clutches were located on the beach by probing with a metal rod. 1 or more eggs were broken with each clutch probed. (Note: this suggests that several thousand eggs are broken during the collection process each year.)

6 of the 7 clutches laid on the night of the 14th were collected, washed and stored as above. One clutch (known to exist because it was photographed as it was laid the previous night) was not located by the employee and therefore was left to incubate naturally on the beach.

2.2 Hatchery management

14th November
On our arrival on the island at 0900 hr there were 11 clutches of hatchlings in their cages in the hatchery. These hatchlings were collected from the hatchery at 0930 - 0945 hr. The hatchlings in each cage were counted and recorded to the nest number of the cage.

The hatchlings were stored in open plastic bins in the shade beneath the employee's house.

The hatchlings were released at approximately 1600 hr at low tide from the western beach of the island. The hatchlings were released as a single group.

The employee reported that this was the standard release procedure recently. The employee also reported seeing sharks preying on some hatchlings as they swam through the shallows.

15th November
1 clutch and 7 late emergence hatchlings were gathered from the hatchery at 0700 hr (approximately). At our request the hatchlings were released from the beach at the eastern side of the island immediately so that photographs could be taken of hatchlings crossing the beach. No predation by sharks/fish

was visible at this release near the top of the tidal cycle. There was no predation of the hatchlings by the white bellied sea eagles following this release although they circled over this side of the island approximately half an hour later.

Following hatchling emergence, the nests within the hatchery were not dug to determine the hatching success or cause of death of eggs and hatchlings within the nests.

2.3 Ants attacking hatchlings

On both mornings there were large numbers of ants biting at the hatchlings contained in the hatchery. Many hatchlings had ants biting at their eye lids. I have never seen this many ants at any other turtle rookery that I have visited.

The ants appear to be concentrated in the hatchery area rather than out on the remainder of the high beach platform. It should be checked whether the ants are attracted to the dead eggs and dead hatchlings left in the nests after the hatchling emergence.

There was no indication that the ants were directly killing the hatchlings. However, I can find no report to demonstrate that this excessive attack by ants on the hatchlings, sometimes for hours on end, has no detrimental effect on the vision of the hatchlings, and hence their eventual survival.

2.4 Dog predation on eggs

14th November
2300 hr: A natural turtle nest outside the hatchery was found to have been dug into by a dog (identified from tracks). 7 freshly broken egg shells, some still blood stained, were adjacent to the nest. Several broken eggs were also visible on the top of the remaining eggs in the nest.

The remainder of the nest was reburied. There was 1 dog at the camp.

2.5 Cat predation on hatchling turtles

14th November
1200 hr (approximately): While examining the hatchlings stored in a large plastic bin beneath the house, I observed a cat to jump into the bin, take a hatchling in its mouth and leap out of the bin and carry it off. Photographs taken.

1300 hr (approximately): Again visited the stored hatchlings. The same cat was inside the bin and there were at least 5 dead hatchlings with their heads and/or anterior body eaten off. It was chewing the head of another. It killed several more hatchlings before it left the bin, taking another hatchling with it.

At this time we covered the bin to prevent further hatchling predation by the cat. The employee did not display concern that the hatchlings were being eaten and did not appear to adjust his tally of hatchlings for release to take into account the predation loss.

Numerous hatchling carcasses that were missing their head and front flipper area were scattered about the hatchery. These had been eaten in the same way as the hatchlings observed preyed on by the cat. I have never seen crabs prey on hatchling turtles in this manner. There were cat tracks in the sand between the cages in the hatchery.

15th November
At daylight, fresh cat tracks from at least two different sized cats were visible among the hatchery cages. Tracks concentrated around the 2 cages with hatchlings. A cat appears to have entered at least one cage that contained hatchlings.

At least 2 adult cats and a kitten were at the camp.

2.6 White bellied sea eagle predation on hatchling turtles

14th November
Hatchling release:

1600 hr (approximately): 11 clutches of hatchlings, collected from the hatchery in the morning, were released from the western side of the sand spit at low tide. No other hatchlings departed from the island during this afternoon.

Predation observations:

1700 hr (approximately): White bellied sea eagles were seen regularly flying over an area of sea just offshore adjacent to the southern and south western side of the sand spit. They repeatedly flew back to a site high in the canopy on the western side of the island. On each flight, the eagle swooped to take prey from the sea before flying back to the island. Two birds were alternating in flights out to forage.

1730 hr (approximately): Commenced observing the eagles through binoculars. The eagles were taking hatchling turtles from the sea surface. The eagles flew directly from the island to an area of sea between the two islands and to the west of that line. Each would dive from about 100 m hight to pluck a hatchling from the surface and return to the island with the catch. (It is presumed that the eagles were feeding chicks at a nest.) After 8 hatchlings were observed taken back to the island, the eagles predation rate was timed. The next 6 flights to catch hatchlings were completed in 19 minutes, i.e. 1

hatchling was taken every 3.2 minutes. The last successful flight to capture a hatchling was made at 1815 hr. One unsuccessful foraging flight was made after this time.

These 2 eagles may have taken approximately 50$^+$ hatchlings until it was too dark for them to prey successfully.

Why were the hatchlings still so close to the island?
I have never observed hatchlings to remain adjacent to the beach after entering the sea at any other turtle rookery I have examined. The hatchlings should have dispersed further from the island than they had. They had been released from the western side of the island and typical of hatchlings they had headed straight out to sea from the beach. In doing this, they were swimming directly into the wind driven surface drift and the incoming tide. It appears that these currents retained the hatchlings in the vicinity of the island at least for approximately two hours, preventing their rapid dispersal to sea.

2.7 Disruption of hatchling imprinting

The clutches in the hatcheries were surrounded by wire cages for retaining the emerged hatchlings. Most hatchlings emerge from their nests in the early part of the night. They are regularly contained within these wire cages for many hours until after daylight. Given that :

- hatchlings marine turtles are imprinted to the earth's magnetic field at the rookery as they emerge to the beach surface from the nest (i.e. when they make first contact with light),

- wire mesh cages can act as shields or alter the strength and orientation of magnetic fields within the contained space,

there is a high probability that the wire cages are interfering with the natural imprinting of these hatchlings to their ancestral beach. It is a distinct possiblity that these turtles, on reaching maturity, may have problems in relocating their ancestral rookery region.

Until this issue can be investigated further, it is recommended that any cages used to contain the hatchlings should be made of plastic mesh.

3. **TALANG TALANG KECIL** 15 November

3.1 Hatchery management

On our arrival at the island at approximately 1000 hr, all hatchlings that had emerged from the previous night had been removed from the hatchery and released into the sea. The emerged clutches were not being excavated to determine the emergence success and cause of death of the eggs and hatchlings.

3.2 **Post emergence hatchling mortality**

There were approximately 15 recently dead hatchlings in the hatchery outside the cages that had their head and front flippers eaten. These hatchlings resembled the hatchlings observed being eaten by the cat yesterday. There were numerous cat tracks within the area of the hatchery.

There were approximately 6 freshly dead hatchlings on the tide line in front of the hatchery adjacent to the stated release point. These dead hatchlings showed no external signs of injury.

4. **SATANG BESAR** 22 November

On our arrival at the island at approximately 1245 hr, all hatchlings that had emerged from the previous night had been removed from the hatchery and released into the sea. The emerged clutches were not being excavated to determine the emergence success and cause of death of the eggs and hatchlings.

There were no ants concentrated in this hatchery. There were no dead hatchlings in the hatchery. There were no cat tracks in the hatchery.

CHAPTER 4

IDENTIFICATION OF GREEN TURTLE BREEDING UNITS

Introduction

The University of Queensland and Queensland National Parks and Wildlife Service are jointly conducting a population genetics study of green turtles of the Australasian region to delineate the boundaries of the breeding stocks for the species. The study is using mitochondrial DNA fragmentation analysis to identify genetic relatedness of the green turtle rookeries. The team is also collaborating with the University of Georgia team in USA who have also been studying green turtle population genetics on a global scale.

As an extension of this study, turtles being killed for food in various countries, including the Bali slaughter houses are also being sampled. Using the unique genetic tags for each rookery region it is possible to identify the rookery from which each of these turtles originates. The Indonesian harvest is of particular interest because international tag recoveries have identified that green turtles tagged at nesting beaches in Australia, Sabah and Sarawak have been captured in Indonesia. The Bali green turtle slaughter has expanded from a village based harvest of local turtles to the largest kill of green turtles in the world. In the last 20 yr the Bali slaughter has expanded to a kill of 20 000 to 34 000 green turtles annually with these being harvested throughout Indonesia.

The Sarawak study

This study was undertaken with a permit issued by the Director of Forests, Sarawak (NPW.156.2.5-85; 22 Nov.1991). Permission to visit the Turtle Islands was obtained from the Turtle's Board. Deformed and/or weak hatchlings were collected, one per clutch, from each of the Sarawak turtle islands. The hatchlings were killed by pithing and the liver and heart of each stored in liquid nitrogen for return to the University of Queensland.

A sample of 22 non sibling green turtle hatchlings was obtained from the 3 Sarawak turtle islands as follows:

Date	Talang Talang Besar	Talang Talang Kecil	Satang Besar
Specimen numbers			
Nov 14	1-13		
15	14-16	17-20	
22			21-22

See attached permits.

The samples will be studied using mitochondrial DNA fragmentation analysis to describe the unique genetic characters for this rookery and identify the extent of interbreeding that occurs between this rookery region and other rookery regions for green turtles in the Australasian region.

When linked to the study of the harvested turtles, this study has the potential for identifying whether turtles from the Sarawak breeding unit are being harvested in any part of their distant feeding area within Indonesia and transported to Bali.

Future Research:

Sample the green turtle nesting population in the adjacent Indonesian islands to determine if they are part of the same green turtle breeding unit as the Sarawak Turtle Island.

CHAPTER 5

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Figure 1. The green turtle life cycle.

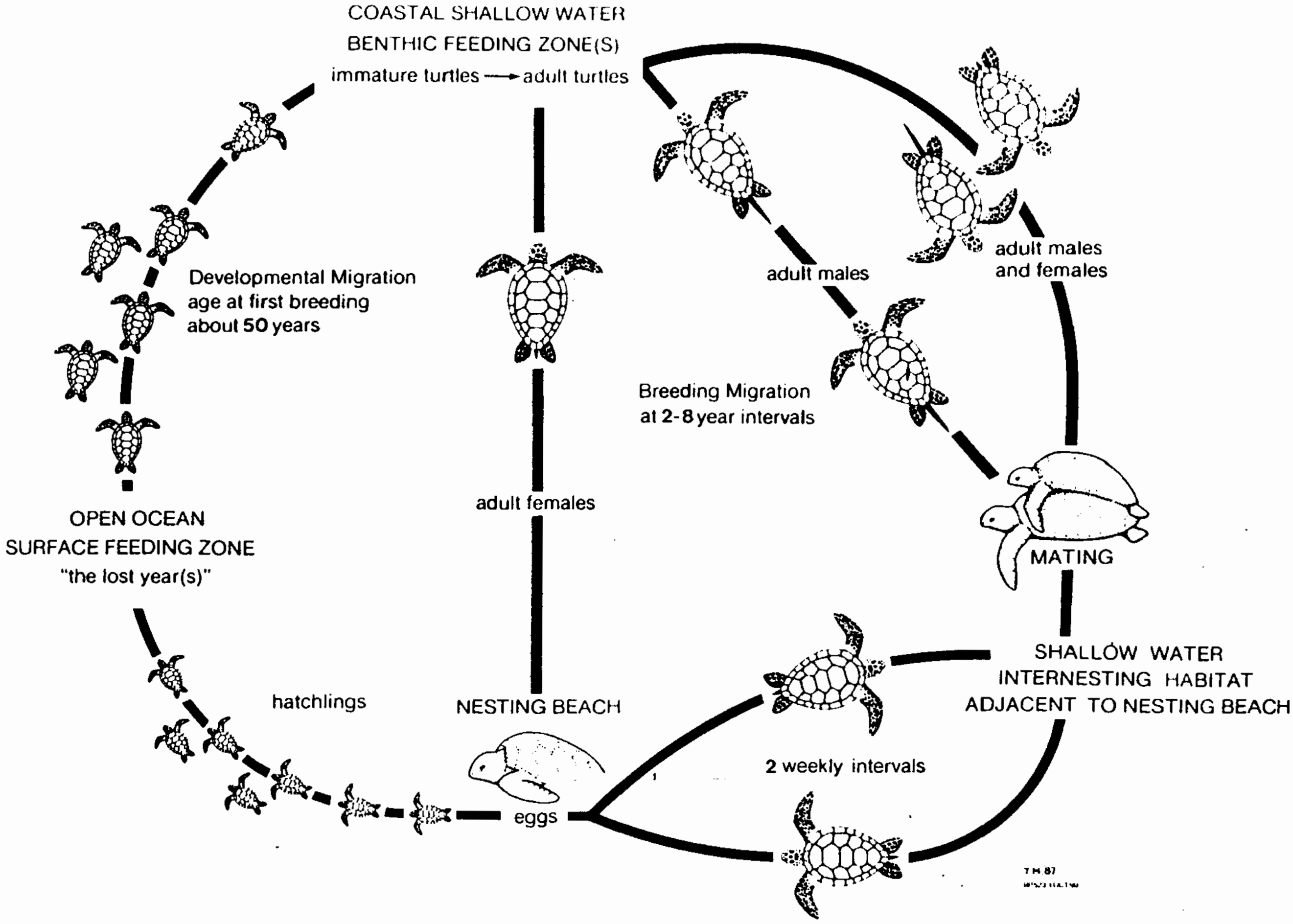

Figure 2. Decline in the annual nesting population of green turtles at the three Sarawak Turtle Islands as indicated by the decline in recorded annual egg production (Banks 1937, 1986; Harrison 1947, 1962; Chin 1969, 1975).

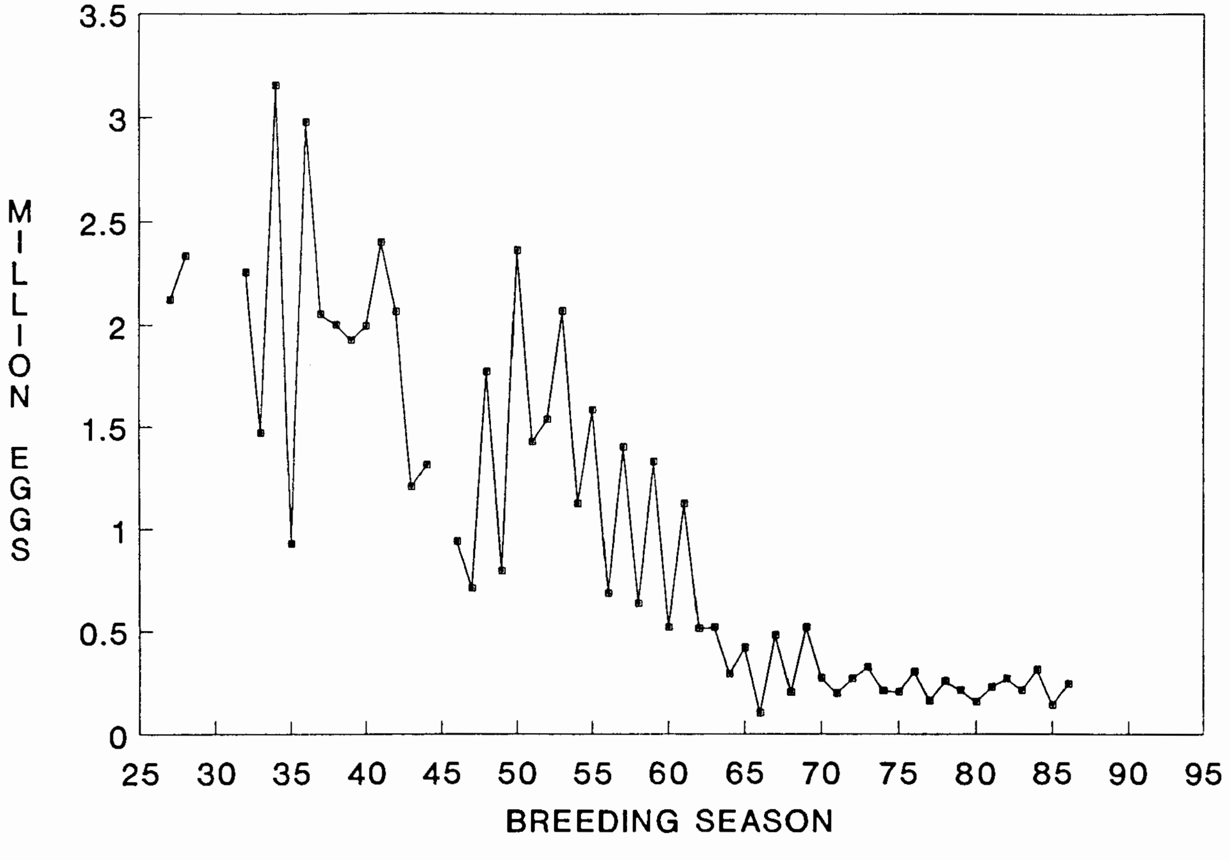

Figure 3. Relative importance of the individual Sarawak Turtle Islands with respect to egg production.

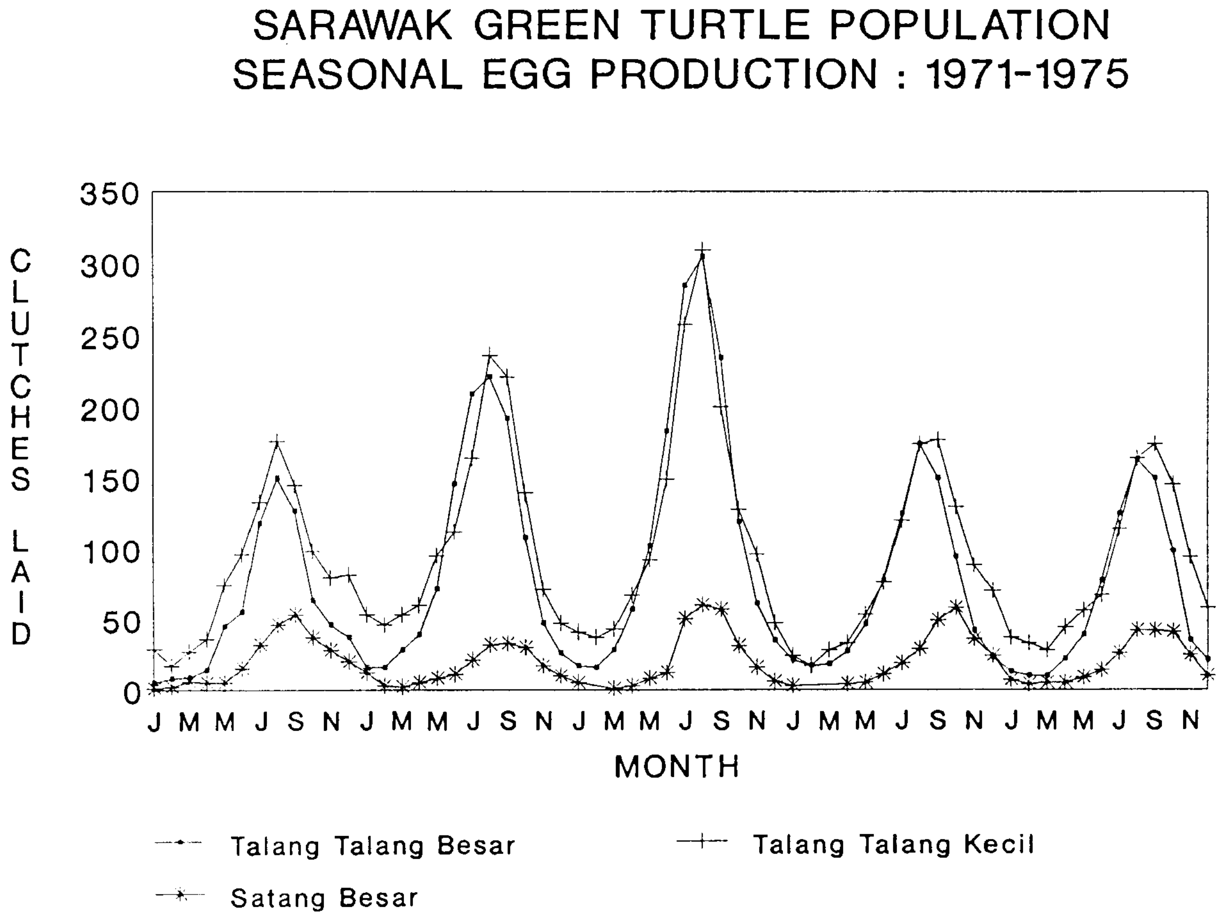

Figure 4. The green turtle (<u>Chelonia mydas</u>), adult and hatchling, from Talang Talang Besar, November 1991.

Figure 5. The Sarawak turtle islands:

A. Talang Talang Besar with Talang Talang Kecil in the distance.

B. Satang Satang Besar.

Figure 6. Hatchery management, Talang Talang Besar, 14 November 1991.

A. Green turtle hatchlings which emerged during the previous night were restrained in wire cages which surrounded each clutch within the hatchery.

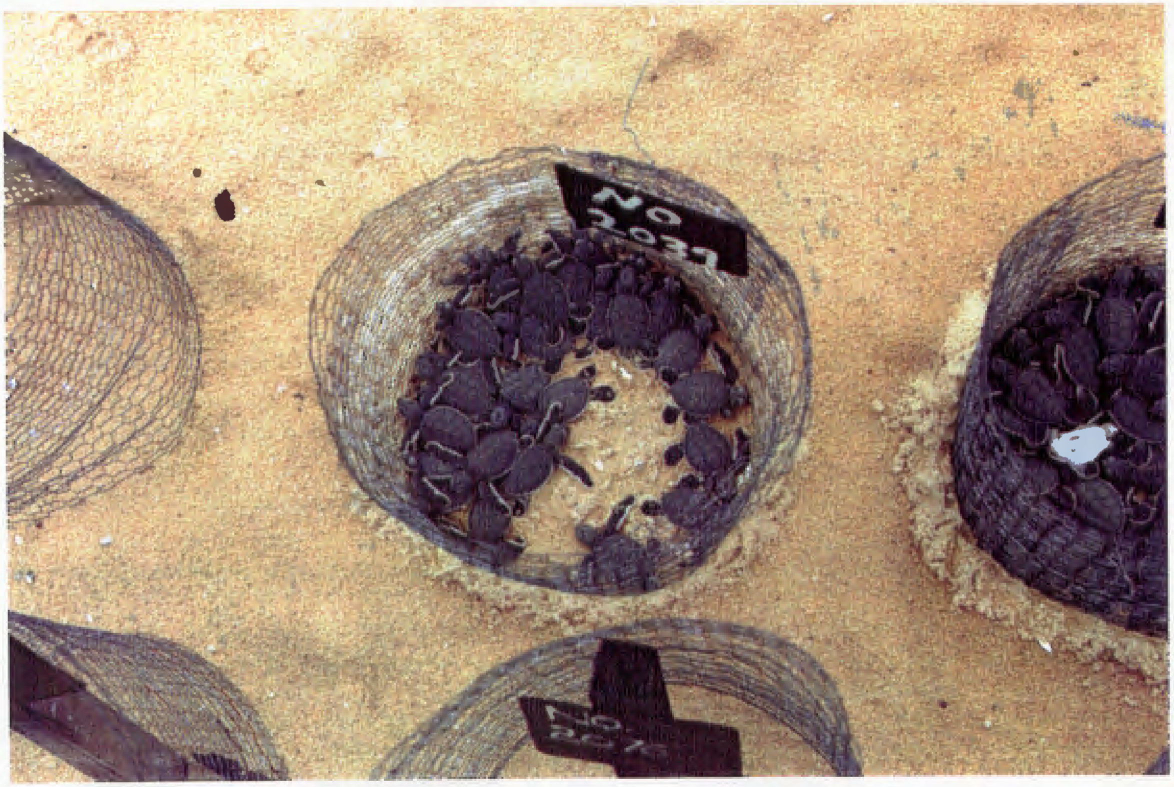

Figure 6 (cont.). Hatchery management, Talang Talang Besar, 14 November 1991.

B. The hatchlings were counted and removed from the hatchery several hours after daylight.

Figure 7. Cat predation on green turtle hatchlings at Talang Talang Besar, 14 November 1991. The hatchlings were kept in plastic bins under the house until their release in the late afternoon.

Figure 8. Collecting eggs for sale, Talang Talang Besar, 15 November 1991.

A. Probing for eggs. Broken eggs wet the probing rod.

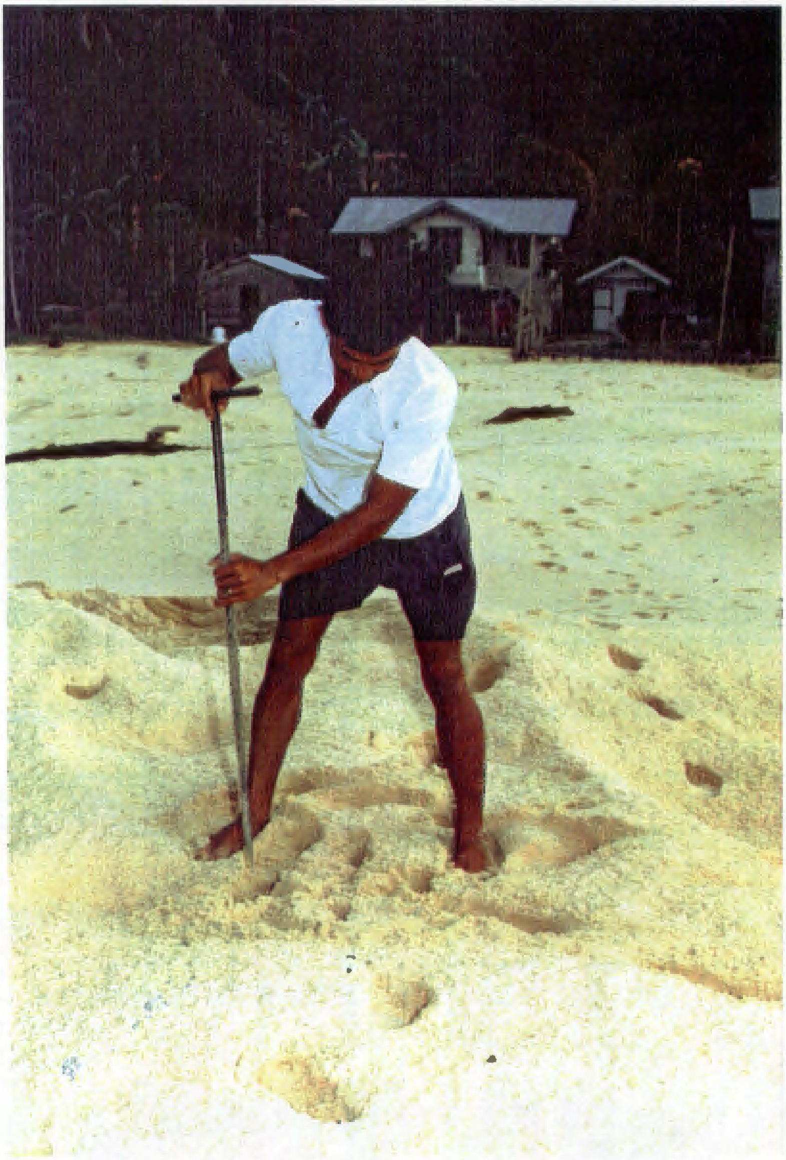

Figure 8 (cont.). Collecting eggs for sale, Talang Talang Besar, 15 November 1991.

B. Counting eggs from a nest prior to their washing and storage.

ACKNOWLEDGEMENTS

This report is produced in response to my visit to the Sarawak Turtle Islands in November 1991 at the request of the Sarawak Minister for Environment and Tourism and the National Parks Office of the Forestry Department.

Premission to visit the Turtle Islands was granted by the Turtles Board.

Office facilities in Kuching were provided by the National Parks Office. Colin Reynolds acted as guide and translator. Dr. Charles Leh of the Sarawak Museum provided background information on the operations of the current conservation and turtle egg harvest program at the three turtle islands.

Historical data on this turtle population was obtained via published reports and scientific papers. Egg production data from the 1982 nesting season was obtained from Forestry Department files.

This assistance is gratefully acknowledged.

Dr. Colin James LIMPUS

Principal Conservation Officer (Research)
Division of Conservation
Department of Environment and Heritage

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Ruj. Kami: NPW.156.2.5-85

Tarikh: 22.11.91

To whom it may concern,

1. In accordance with Subsection (1) of Section 21 of the Wild Life Protection Ordinance (Cap. 128), permission is hereby given to Dr Colin Limpus of the Queensland National Parks and Wildlife Service (Australian Passport No. J1096765) to have in his possession, and export, biological samples taken from Green Sea Turtle (Chelonia mydas) hatchlings.

2. Appropriate CITES documentation has also been provided to Dr Limpus.

"BERSATU BERUSAHA BERBAKTI"

(Abang Haji Kassim Bin Abang Morshidi)
Ag. Director of Forests, Sarawak.

Ref: NPW.156.1.2(IV) - 56

FOREST DEPARTMENT, SARAWAK.
(National Park and Wildlife Section)
(CONVENTION OF INTERNATIONAL TRADE IN
ENDANGERED SPECIES OF WILD FAUNA & FLORA)

(PERMIT TO IMPORT OR EXPORT)

Permit is hereby granted to;

Full Nama ; Colin Limpus

Occupation ; Principal Conservation Officer (Research)

Address ; Queensland National Parks and Wildlife Service (AU 130A)

to ~~xxxxxxx~~ / export the specimen(s) or part(s) listed below,

(Species-common and scientific name)	Quantity	Description	Country of origin	Importing ~~xxxxxxxxxx~~ country
Green Turtles (Chelonia mydas)	22 (Twenty-two)	Frozen , tissues	Sarawgk	Australia

Note:

Permit is granted on the ground that the tissues are to be used for research purposes.

Signature of applicant for permit

Date: 23.11.1991

Signature and Stamp of Authority ~~issuing~~ import / export * permit

MANAGEMENT AUTHORITY CITES SARAWAK

Date: 23.11.1991

* Delete wherenot applicable