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22 October 1992

Jim Maragos
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Pacific Regional Office
1116 Smith Street #201
Honolulu Hawaii 96817
USA

Dear Jim,

Enclosed is the final version of the report resulting from my participation in the expedition to the Southwest Island of Palau, June 1-19, 1992.

This report is entitled 'Marine Turtles in the Southwest Palau Islands'. I have enclosed a hard copy as well as a disc copy accessible on the software Wordperfect 5.1. The disc copy, however, does not contain Figures 1,2,3 and 5.

I would like to thank you once again for allowing me the opportunity to participate in such an informative and exciting expedition.

Regards,

Suzie Geermans

Suzie Geermans
Turtle Conservation Consultant
South Pacific Regional Environment Programme (SPREP)

MARINE TURTLES IN THE SOUTHWEST PALAU ISLANDS

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Abstract

Green turtles, *Chelonia mydas*, nest on all of the islands in Southwest Palau in varying abundance, generally between the months of March and July. The largest nesting area for the region surveyed is Merir Island, which hosted an active nesting population of approximately 50 green turtles for the 1992 season. Helen Island also supports a small population of nesting green turtles, and Helen Reef accommodates a resident feeding population of both *C. mydas* and hawksbill turtles, *Eretmochelys imbricata*. Even though *E. imbricata* feed in the reef areas, this species is not known to nest on any of these islands. The fluctuation of green turtle nesting numbers is regulated by the El Nino Southern Oscillation (ENSO) in Australasia. It appears that the population of the Southwest Islands is also influenced by this phenomenon.

Both species of turtle and their eggs are a food source for the islanders. It was estimated that 75-300 turtles per year are taken for subsistence use in the Southwest Islands, not including the numbers taken by poachers. The legislation governing the take of turtles and turtle eggs is ineffective in such remote areas due to lack of enforcement.

Introduction

The Republic of Palau (Belau) is situated north of the equator at the westernmost edge of Micronesia (Figure 1). Spain claimed authority over Palau in 1686, but no development began until the islands were purchased by Germany in 1899. Copra plantations and phosphate mining were then introduced on some of the islands. The Japanese took control of Micronesia in 1914, and occupied Palau until the end of World War II. Palau was a part of the Trust Territory of the Pacific Islands, becoming a semi-independent republic in 1986.

The Southwest Islands of Palau consist of six small islands; Sonsorol, Fana, Pulo Anna, Merir, Tobi and Helen (Figure 2). All of the islands except for Helen are surrounded by fringing reefs that form rocky flats when exposed at low tide. Helen Reef is an atoll with Helen Island as the only exposed land mass situated at its northern end.

Pritchard (1977) indicated that in Palau, most green turtle nesting takes place on Merir and Helen Islands, with sporadic nesting occurring on Tobi, Pulo Anna and Sonsorol. He estimated that several dozen turtles were nesting on Helen and Merir during peak season, and that Helen Reef may also be a resident feeding area for green and hawksbill turtles.

A survey undertaken in early 1991 through Indonesia, the Philippines and Palau by the South Pacific Commission Regional Tuna Tagging Project, provided some interesting information regarding green turtle nesting. A memo resulting from the survey indicated there had been recent nesting activity on Helen and Merir Islands, and the chief of Merir had estimated that there had been 2900 turtle tracks on Merir Island between January and April (Itano 1991). Realising that green turtles nest 4-6 times per season and that the nesting success is approximately 30% (see Figure 4), this figure translates to 150-250 nesting green turtles for the year. This information indicated that Merir Island could host the largest population of nesting *C. mydas* in Micronesia.

Turtles have always played an important role in Palauan culture. Until

German occupation, only high chiefs could eat turtle meat. Since that time, the meat and eggs of both green and hawksbill turtles have been used as a food resource by most Palauans.

Tortoiseshell, developed from the scutes of *Eretmochelys imbricata*, was used to make fishhooks, spoons, bowls, jewellery and combs. The jewellery was only worn by the high chiefs, and 'toluk' (a type of bowl) symbolised the wealth of a woman. Tortoiseshell combs and jewellery are now worn by many people and are frequently sold to tourists.

The main objectives of this survey were to determine the population of nesting females of the Southwest Islands, and to estimate the amount of local harvest.

Methods

This report is based on the field survey undertaken from 1-19 June 1992 aboard the MV Pegasus II. During the survey, at least one day and one night was spent on each of the six islands by the author. Upon arrival to each island, a perimeter walk was undertaken in order to evaluate nesting turtle habitat by identifying nesting and hatchling tracks. Further information was obtained by talking with the local people. Island perimeters were walked each morning to count fresh tracks from the previous night. After dusk nesting areas were surveyed to search for both nesting and hatchling turtles.

All turtles encountered were double tagged using 4.1g titanium tags (Stockbrands Co. Pty. Ltd.) supplied by the South Pacific Regional Environment Programme (SPREP). Tags were applied adjacent to the proximal scale on the trailing edge of each front flipper, and all turtles were released wearing two tags. The midline curved carapace length (CCL) of each turtle was measured using a flexible tape measure ($\pm 0.5\text{cm}$), and damage and fibropapillomas were noted.

A clutch count was undertaken for those turtles that laid successfully. A sample of ten eggs from each clutch was measured and weighed using vernier calipers ($\pm 0.05\text{cm}$), and a Pesola spring balance ($\pm 0.5\text{g}$), respectively.

At Helen Reef a turtle rodeo was undertaken, where turtles were captured in the feeding ground by jumping on them from a speedboat (see Limpus 1978). These turtles were tagged, measured and checked for damage and fibropapillomas. The length from extended tail tip to the carapace (TLC) was measured using a flexible tape measure ($\pm 0.5\text{cm}$). The turtles captured in the rodeo were not identified to a particular sex, except for those with a tail length greater than 25.0cm. These turtles were recorded as adult males (see Limpus & Reed 1985).

Additional information was supplied by the marine team, who recorded sightings of marine turtles in the dive transects of each island.

Results

Tobi Island : 3°1'N 131°11'E

At the time of the survey 27 people inhabited Tobi, making it the most densely populated island in the Southwest group.

The island has an estimated area of 85ha and a perimeter at high tide of approximately 3.7km. The beach consists of sand interspersed with coral rubble, and at the time of the survey much debris was washed up along the vegetation line. In some sections of the island the high tide reaches the shoreline vegetation, which consists mainly of *Cocos nucifera*, *Pandanus* sp., *Argusia argentia*, and *Scaevola sericea*.

Chelonia mydas nests on Tobi, but there is no particular section of beach where the turtles nest. The turtle nesting season on Tobi

extends from March-July, but generally only 5-10 beachings (less than five turtles) occur on the island per year. 1991 was regarded by the local people as a 'very good season' for nesting turtles, with approximately 20 beachings (4-5 turtles), at least 10 of which occurred between September-December. No other community indicated any turtle nesting around that time of the year. According to the local men a turtle last nested on the northeastern tip of the island on 6 April.

No nesting or hatchling tracks were sighted upon arrival to the island, but green turtle bones and scutes were present in the supratidal zone near the dock. The evening of 3 June was spent surveying the beach, but no nesting or hatching of turtles occurred.

On 8 June, Ros Hunter-Anderson from the survey team recorded information regarding a green turtle which attempted to nest on Tobi. The turtle returned the following evening to successfully lay a clutch of eggs. The turtle (CCL=105.0cm) was removed from the beach after laying, and was cooked over an open fire. Mature follicles were present in the ovary, indicating that the turtle would have probably returned to nest later in the season.

The Tobian people have an interest in rearing turtle hatchlings. A week before a clutch is due to hatch, a mesh screen is placed around the nest in order to collect the hatching turtles. Once emerged, they are kept in containers and fed on fish until they are approximately 3" long. After a 'V' is cut into the front flippers as a means of identification, the turtles are then released. This 'project' is undertaken with nearly every clutch, and the local people believe that it reduces the rate of predation on the turtles. Three post-hatchling *C. mydas* taken from a nest that emerged on 7 January (laid 10 November 1991) were still being kept by one of the local women. Unfortunately no written records have been kept regarding the numbers of hatchlings being reared.

As only a few turtles nest every year on Tobi, the majority of turtles are caught while spearfishing. *Chelonia mydas* and immature *Eretmochelys imbricata* are seen feeding in the reef area. The most popular place for catching turtles is on the reef edge at the northeastern tip of the island. Green and immature hawksbill turtles were noted at Tobi island by the dive team whilst performing underwater transects.

Turtle meat is eaten by the people of Tobi Island every 1-2 weeks, which suggests an annual take of 25-50 green turtles (see Table 5). Mainly adult turtles are taken, as there is enough meat in a turtle this size to feed everyone on the island for 1-2 days. If a nesting turtle is taken, she is removed from the beach after her eggs have been laid.

The eggs are also eaten on occasion, but usually only a few eggs are taken from the top of the nest, leaving the rest to hatch.

Helen Island : 2°59'N 131°49'E

Four people reside on Helen Island.

Helen Island is situated at the northern end of Helen Reef, and is the smallest island in the Southwest group with an estimated area of 2.6ha. The perimeter at high tide is approximately 800m, and at low tide there is an exposed sand spit in the south. The beach strand consists of sand with predominant shoreline vegetation of *Cocos nucifera* and *Argusia argentia*.

Chelonia mydas nest on Helen Island from March-July with a peak in May. There is no specific nesting area on the island. An estimate of green turtle nesting numbers was not obtained from the local people, but it is likely to be in the order of 10-20 annually.

No nesting or hatchling tracks were discovered on arrival to the island, but green turtle bones and scutes were present near the housing area. The beach was surveyed every night and following morning between 5-8 June. One *C. mydas* nested on Helen on 5 June, at the northern end of the island. Tag and measurement data for this turtle is shown in Table 1, and clutch information is depicted in Table 2. No other turtles nested and no hatchlings emerged during the time spent on the island.

Approximately 90 *C. mydas* hatchlings had been collected from a recently emerged nest and were being kept in a trough. The people from Helen believe that when the hatchlings emerge they have a scent that attracts fish, and thus are highly preyed upon when they enter the water. It is believed that if the turtles are kept for a short period of time (1-2 weeks) they lose this smell, and therefore will not face as high a rate of predation.

C. mydas and immature *E. imbricata* feed in the reef area all year round. The fishermen catch turtles by jumping on them from a boat, dragging them to the surface, hauling them into the boat, and taking them back to the island to be cooked. There are certain 'hot spots' where the fishermen know they can find turtles sleeping or feeding. Green and immature hawksbill turtles were sighted at Helen Reef by the dive team whilst performing underwater transects

A turtle rodeo was undertaken on 7 June, with the help of the local fishermen. Tag and measurement data for the 12 *C. mydas* turtles captured are shown in Table 3. These turtles caught by rodeo had a mean CCL of 83.99cm (s.d.=6.387, n=12, range=76.0-97.6), and none of the turtles had fibropapillomas. Two turtles were recorded as adult males, as they had a tail length greater than 25.0cm. One turtle was captured with a blade of seagrass, *Thalassia hemprichii*, in its mouth.

Turtle is eaten between 1-4 times a month by the islanders, which translates to 12-50 turtles being killed per year (see Table 5). Nesting females are rarely taken by the fishermen, as they are too large for only four men to eat before the meat spoils. The eggs are sometimes eaten, but are usually left to hatch as the hatchling turtles are collected upon emergence for release 1-2 weeks later.

The Governor's boat from Sonsorol arrived on 7 June. The following morning before departure, one of the crew members was discovered removing turtle eggs from the island. The *C. mydas* eggs were reclaimed and buried back in the original nest. Only four of the eggs were missing, presumed eaten. It is common practice for foreign vessels and local supply ships to utilise the resources of Helen Island and the surrounding reef.

Merir Island : 4°19'N 132°19'E

The chief of the island, Andres Antonio, and his four children permanently inhabit Merir Island.

Merir Island has an estimated area of 109.5ha, and the perimeter at high tide is approximately 5.2km. The beach consists of sand and large areas of coral rubble, to the extent that some supratidal areas are covered with coral from the high tide to the vegetation line. There is a sand spit at the southern end of the island. The shoreline vegetation consists of *Cocos nucifera*, *Pandanus sp.*, *Scaevola sericea*, *Argusia argenticia*, *Vignea marina*, and *Neisosperma oppositifolia*.

Merir is considered the best island for green turtle nesting in Palau. Turtle nesting occurs on Merir between March-July, with occasional nesting in February. An estimate of the nesting population for Merir was attained by using a formula taken from Hughes (1974). For the variables used, this formula gave an estimate of the nesting population of Merir to be approximately 50 for the 1992 season (Figure 4). Andres commented on the vast decline in turtle numbers this season

compared with last year.

There are two particular nesting areas on the island; a 250m stretch of beach on the northwestern part of the island near the house, and a 1.5km section of beach stretching from the southern tip of the island around the eastern side.

Upon arrival to Merir, 54 *Chelonia mydas* tracks were counted; 47 on the main nesting area and 7 on the smaller nesting area. Green turtle bones and scutes were littered about the beach near the house. Andres stated that 6 turtles had nested the night before we arrived (10 June), and that 11 turtles were seen the previous evening (9 June). On 11 June, 3 nesting turtles were recorded for the evening. Another 9 turtles were recorded on 12 June, but no hatchlings emerged either evening. Table 1 contains the data regarding the turtle tag and measurement information. The nesting turtles from Merir and Helen Islands had a mean CCL of 103.5cm (s.d.=5.048, n=8, range=95.6-112.0), and none had fibropapillomas. Three clutches were counted at the time of laying (84, 130, 129 eggs), one of which contained one yolkless egg. The mean egg diameter was 4.2195cm (s.d.=0.0985, n=30 in 3 clutches, range=3.935-4.400), and the mean egg weight was 41.1833g (s.d.=2.48958, n=30 in 3 clutches, range=36.00-46.00), as shown in Table 2. A bar graph depicting the CCL and sex of all turtles tagged during the survey is shown in Figure 3.

On 10 June, during the closed turtle season, a 113.0cm green turtle was 'turned' on the beach before she had laid eggs. The following morning she was taken back to the house and slaughtered as a gift for the Governor of Sonsorol, who had arrived on the island. Several hundred mature ovarian follicles were present, as well as the shelled eggs that would have been laid the previous evening. The turtle's ovaries showed scarring; corpora lutea with a diameter of 5mm, and multiple corpora albucantia approximately 1mm in diameter. This indicates that the turtle had already laid one or more clutches for the season, and she would have returned to lay at least one more clutch had she not been killed. The data also indicated that it was not her first breeding season.

Andres had previously been shown how to tag turtles using SPREP tags, and he supplied a list of the thirty turtles he had tagged in 1991 (Table 4). Each turtle was tagged once through the right front flipper and released. Although he took a keen interest in the number of turtles nesting on the island, he did not usually keep written records of the information.

Chelonia mydas and immature *Eretmochelys imbricata* are seen feeding on the reef throughout the year. Andres did not know of any specific areas on the surrounding reef where turtles were in abundance. Green and immature hawksbill turtles were noted at the dive stations around Merir by the dive team whilst performing underwater transects.

It was estimated by Andres that his family ate turtle about once a month, but one of his sons suggested that a turtle was taken every 3-4 days. This corresponds to an annual harvest in the range of 12-100 adult green turtles (see Table 5).

Pulo Anna Island : 4°40'N 131°58'E

At the time of the survey, 18 people resided on the island of Pulo Anna.

Pulo Anna Island has an estimated area of 42.4ha and a perimeter at high tide of approximately 2.7km. Most of the island is accessible for nesting, as there are only a few areas of coral rubble. The shoreline vegetation consists of *Cocos nucifera*, *Lepturus* sp., *Pandanus* sp., *Argusia argentia*, and *Scaevola sericea*.

C. mydas nest on Pulo Anna between the months of March-June. An

estimate of green turtle nesting numbers was not obtained from the local people, but it is likely to be less than five annually. There is no section of the island where turtles specifically nest.

Upon arrival to the island there was no evidence of hatchling turtles, but one nesting *C. mydas* track, a few days old, was recorded on the south side of the island. Green turtle bones and scutes were found on the beach. No nesting or hatching was recorded for the evening on 13 June.

Green turtles and immature hawksbills can be found feeding out on the reef. However, the chief of the island did not know of any specific areas on the reef where turtles were abundant. Green and immature hawksbill turtles were sighted at Pulo Anna Island by the dive team whilst performing underwater transects, and a couple of pairs of courting *C. mydas* were recorded.

It was estimated that between 1-4 adult-sized turtles a month (12-50 per year) are eaten by the people on the island (see Table 5), and the eggs are also eaten on occasion.

Sonsorol Island 5°20'N 132°13'E

18 people were residing ononsorol at the time of the survey.

Sonsorol Island has an estimated area of 127ha and a perimeter at high tide of approximately 4.6km. Much of the available nesting beach is covered by coral rubble and rock. The predominant shoreline species are *Scaevola sericea*, *Pandanus* sp., *Cocos nucifera*, *Argusia argentia*, *Wedelia trilobata*, *Neisosperma oppositifolia*, *Guettarda speciosa*, and *Vigna marina*.

Green turtles nest on Sonsorol Island between February-August, and it is believed that certain currents will bring nesting turtles from Merir. Last year four turtle tracks were counted on Sonsorol, but at the time of the survey only one track had been sighted for the season. An estimate of green turtle nesting numbers was not obtained from the local people, but it is likely to be less than five annually. The turtles mostly nest on a 1200m stretch of beach around the southern tip of the island.

No turtle tracks were sighted on arrival, but scutes and bones of *C. mydas* were encountered on the beach. No nesting or hatchling turtles were recorded for the evenings of 15 and 16 June.

Chelonia mydas and immature *Eretmochelys imbricata* are sighted on the reef. As few turtles utilise the island for nesting, most turtles are caught by spearfishing. The fishermen tend to concentrate their search around the reef at the south-east tip of the island, where they believe the turtles to be more abundant. Green and immature hawksbill turtles were sighted at Sonsorol by the dive team whilst performing underwater transects.

Adult-sized green turtles are usually taken for food in order to accommodate the number of people on the island. It was estimated that 1-4 turtles are taken for food each month, which corresponds to 12-50 turtles being killed annually (see Table 5).

Fana Island 5°21'N 132°13'E

Fana is an uninhabited island about 2 km north of Sonsorol, with an estimated area of 44.3ha. Although the island has been uninhabited since 1946 (Pritchard 1977), the Sonsorolese usually visit Fana each week to collect fish, coconut crabs, turtles and birds. Supply ships passing through the area also utilise the resources of this small island.

The perimeter of the island at high tide is approximately 2.9 km. Much of the supratidal area consists of coral rubble, and the predominant shoreline vegetation is *Argusia argentia*, *Pandanus* sp. and *Scaevola sericea*.

Green turtle nesting occurs on Fana between February and August, and less than five turtles nest annually. A 500m stretch of beach at the north-west end of the island is utilised by the nesting turtles.

No nesting or hatchling tracks were sighted on the initial walk of the island perimeter, and no turtle bones or scutes were sighted near the shelters or on the beach. This could be due to the fact that the Sonsorolese use the island as a type of reserve, and so any turtles captured on Fana would be taken back to Sonsorol to be shared amongst the village.

No turtles nested or emerged on the evening of June 17. According to the local fishermen from Sonsorol, a green turtle track was last sighted on Fana on 17 May 1992.

C. mydas and immature *E. imbricata* are sighted feeding and sleeping in the reef area. The men from Sonsorol often hunt for turtles on the reef at the southeast end of the island. Green and immature hawksbill turtles were sighted at Fana by the dive team during their underwater transects.

The fishermen from Sonsorol stated that they sometimes captured turtles from Fana Island, either nesting females from the beach or feeding turtles on the reef. The numbers taken is included in the estimation of turtles harvested from Sonsorol.

The area surrounding the islands hosted tiger, grey nurse and reef sharks, groupers and coral trout, all of which pose a threat to hatchlings and larger turtles. Terrestrial predators included ghost and hermit crabs, dogs, rats, cats and pigs; which could all contribute to the predation of turtle eggs and/or hatchlings. However, no non-human predation of eggs or hatchlings was recorded on any of the six islands during the survey.

Discussion

Chelonia mydas is the only species of turtle that nests in the Southwest Islands of Palau. Every island in this group hosts green turtle nesting to some extent. Although both *C. mydas* and *E. imbricata* feed in the reef areas around each of the islands, there has been no recorded nesting of hawksbill turtles. The largest green turtle nesting population in the Southwest Islands is encountered at Merir. Nesting also occurs at Helen Island at a reduced level, while Helen Reef supports a resident population of green and hawksbill turtles. Limited nesting occurs on the remaining four islands. The nesting season generally extends from March-July, with occasional beachings on Tobi between September-December. As there was no record of large numbers of courting turtles or any hatchling emergence at the time of the survey, it is assumed that it was approximately the peak of the nesting season in June.

According to the local people, it appears that there has been a vast decrease in the number of turtles nesting this season compared to last season. This was especially noted at Merir Island, where Andres Antonio claimed there had been 2900 turtle tracks (approximately 150-250 turtles) between January and April 1991. Estimating the stability of nesting *Chelonia mydas* populations is difficult as the numbers are known to vary substantially on an annual basis as portrayed by the population numbers of Heron Island, Australia, depicted in Figure 5. These fluctuations can be correlated to the Southern Oscillation Index (SOI).

The Southern Oscillation (SO) is a pattern of short-term climate variation over the globe. It is related to the El Nino phenomenon; the occasional warming of the equatorial eastern Pacific (Nicholls 1988). The combination of the two is referred to as the El Nino Southern Oscillation (ENSO).

A significant correlation was found between the annual green turtle nesting numbers at Heron and Raine Islands, Australia, and the mean atmospheric pressure at Darwin, Australia, between November and January two years earlier (Limpus & Nicholls 1988). Darwin pressure was used as an index of the ENSO, but the SOI is now more commonly used. SOI is the standardised difference in monthly mean pressures between Tahiti and Darwin (Limpus & Nicholls 1990).

Major fluctuations in the numbers of nesting *C. mydas* occur two years after major variations in the SO. This two year lag is due to the time it takes a turtle to prepare for a breeding season (Limpus & Nicholls 1988). Even though limited data is available on turtle populations within the Southwest Islands, the extreme fluctuation of nesting numbers indicates that this population may also be influenced by the SOI.

Methods of catching turtles are described in Tobin et. al. (1957) and Johannes (1986). Nowadays it seems that the most common way to hunt turtles is to catch them while spearfishing, jump them from a boat, or to simply 'turn' a nesting female on the beach. Green turtles are most commonly eaten by the Southwest Islanders, simply because they are more abundant in the region, as well as having a better taste. The turtle is usually baked whole underground, smoked, or used in soup. The reproductive system and intestines are eaten, the oil is collected, and the fat is melted and fried. The eggs of the green turtle are also eaten.

Hawksbill turtles are captured for their shell so it can be worked into jewellery. The scutes are removed by pouring boiling water over the turtle and covering the shell with a cotton cloth, allowing the scutes to simply be lifted off. In earlier times, the turtle was released, but since it was discovered that the unpleasant smell of hawksbill meat could be overcome by boiling it in several changes of water, these turtles are now eaten when captured. The islanders had no knowledge of hawksbill turtle poisoning.

It is difficult to get an accurate overall estimate of the number of turtles being harvested by the Southwest Islanders, as many of them stated that they ate turtle "from once a week to once a month". This can be approximated to 75-300 turtles (mainly adults) being harvested by the islanders per year, where as the number of nesting turtles is only between 80-190 per year. These figures illustrate that if the level of harvest continues at its present rate, the number of nesting green turtles will continue to decrease, and eventually the population will be completely eradicated.

These turtles are being harvested at a non-sustainable rate.

To control the amount of harvest, the legislation regarding the capture and utilisation of marine turtles in Palau needs to be carefully investigated, and possibly re-written. However, the legislation will only be as effective as the enforcement permits.

Three types of legislation are implemented in Palau; traditional law, Micronesian law and US Federal law.

Traditional law is enforced by the chief of each island or village, and permission must be sought to take turtles. It is unclear as to what extent traditional law is enforced, but Tobin et. al. (1957) states that there was never any restriction as to who could catch or kill a turtle.

Micronesian law (Trust Territory Code Title 45, Section 2) sets regulations for the take of turtles. The law states that the taking of *E. imbricata* <27" long and *C. mydas* <34" long is prohibited, as is killing nesting turtles, collecting eggs, or the taking of turtles

during the closed season (1 June-31 August and 1 December-31 January). The US Endangered Species Act classes *E. imbricata* as endangered, *C. mydas* as threatened, and prohibits the sale of all turtle products. This law applies to Palau, but there is a special exemption to allow a subsistence take of green turtles.

In the Southwest Islands, Micronesian and US law are practically ignored. During the survey, two nesting females were slaughtered during the closed season and a clutch of eggs from Helen Island was removed by poachers. It is also common practice for supply ships and foreign vessels to utilise the resources of these islands. There is no enforcement of the legislation in remote islands such as the Southwest group. Islanders and poachers decide the number of turtles eaten for the islands, possibly without realising the consequences of overharvesting the population. Unfortunately, the decline in turtle numbers will not be evident for several decades due to the long lifespan of the animal.

Recommendations

1. Education materials should be distributed among the islands with respect to the decline of turtle populations and what it will mean if they continue to overharvest the turtles.
2. Introduce Merir and Helen Islands as nature reserves or wildlife sanctuaries, as Merir is the only island in the Southwest Group which has substantial green turtle nesting, and Helen Reef supports a substantial green and hawksbill feeding population. Ideally, these islands should be uninhabited.
3. Establish a tagging study of nesting turtles on Merir and Helen Islands to determine the population numbers and fluctuations, and migratory habits. This should be incorporated with a genetic study of the populations, where samples can identify world populations to a specific gene pool.
4. Review the current legislation regarding the taking of eggs and turtles in Palau. A limit to the number of turtles taken per island per year is one alternative, rather than having size constraints and closed seasons. However, enforcement of the legislation is always going to be a problem in remote islands such as the Southwest group.
5. Establish a tagging study of feeding green and hawksbill turtles on Helen Island to determine the population numbers and migratory habits.

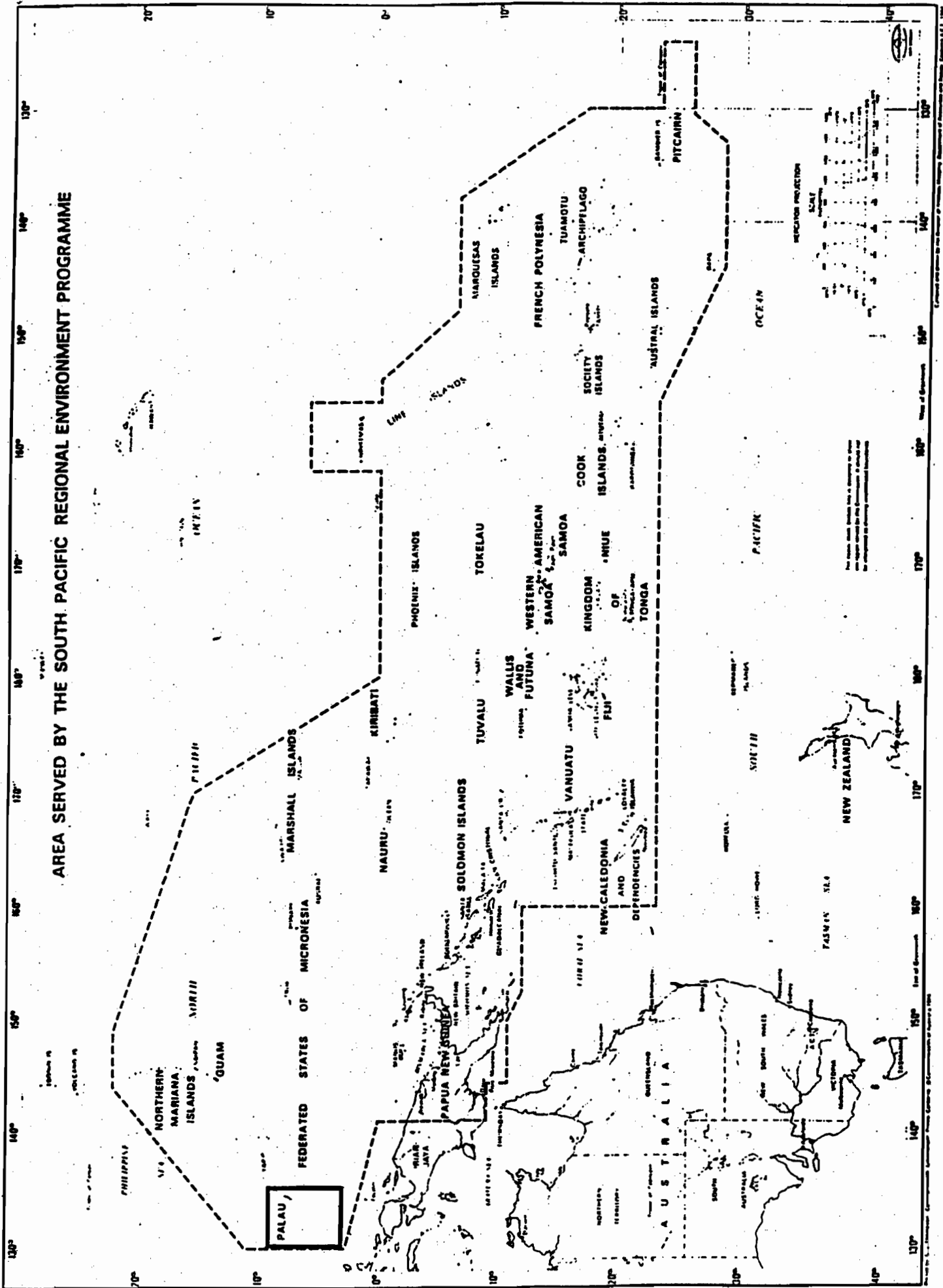


Figure 1. Map of countries within the South Pacific Ocean. The dotted line represents the area served by SPREP.

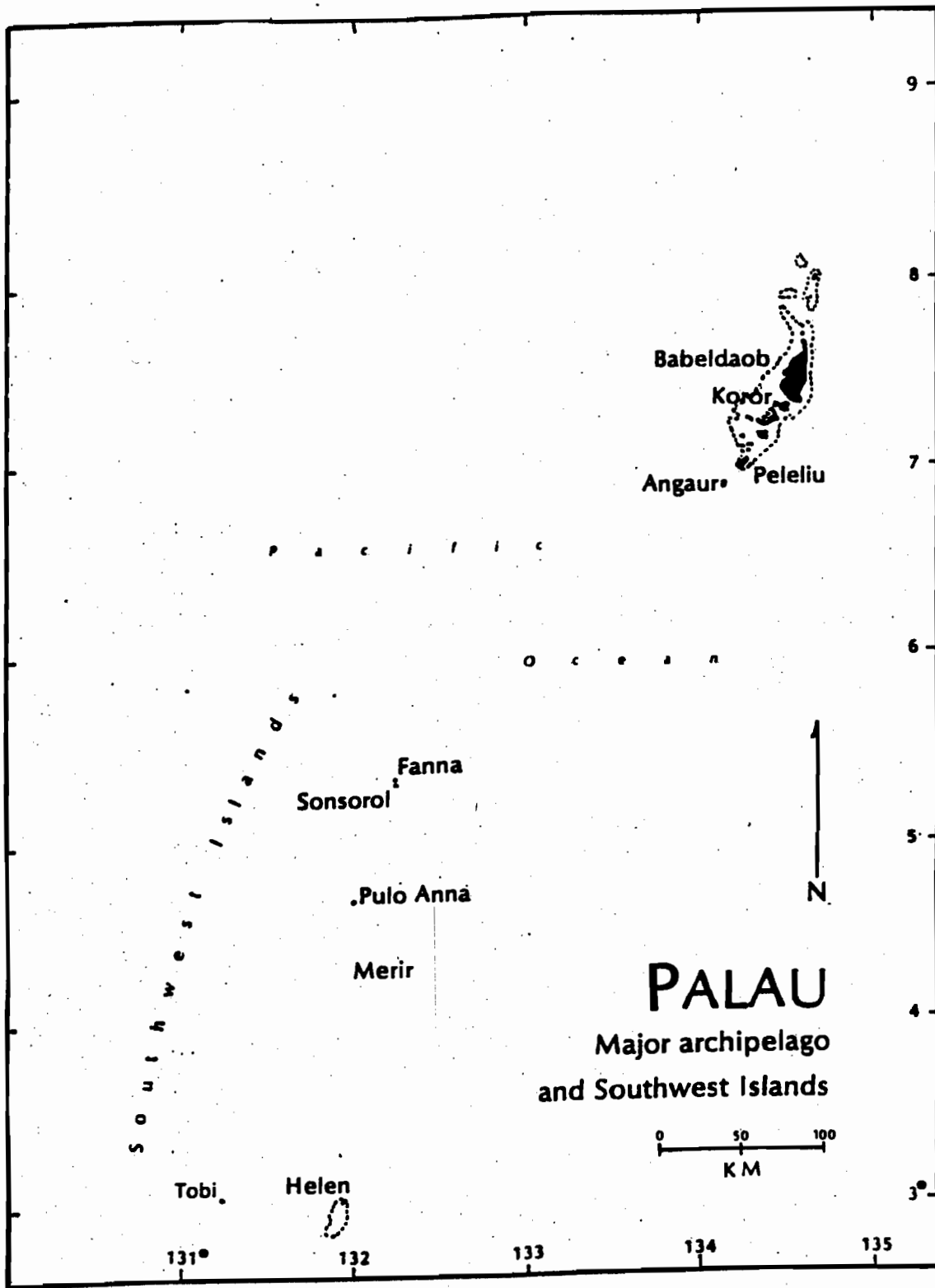


Figure 2. Map of Palau, including the Southwest Islands

Figure 3.
 Sex and size of green turtles captured
 in the Southwest Islands of Palau (n=18)

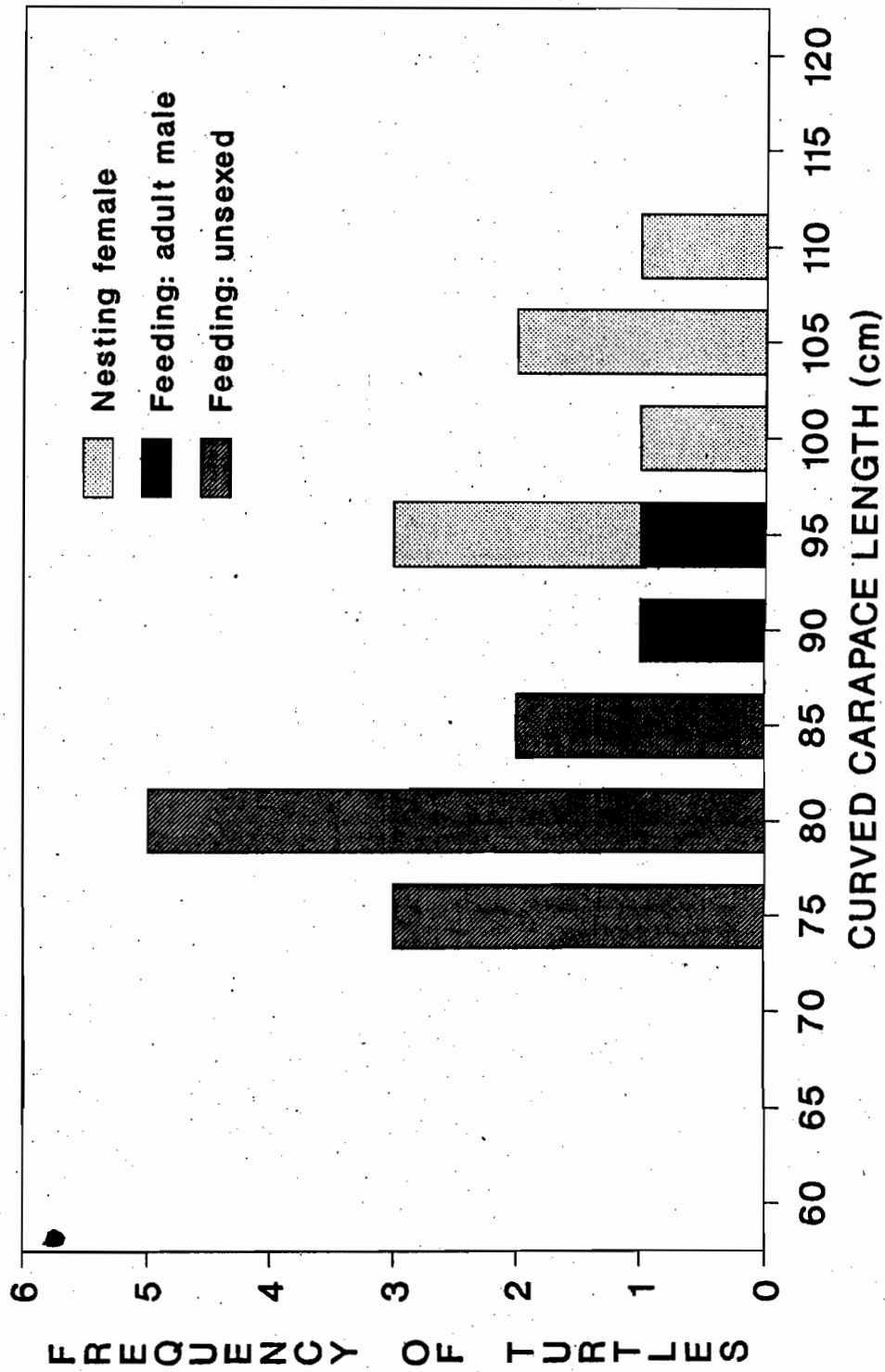


Figure 4. Estimate of nesting population for Merir Island, Palau for the 1992 season

$$\text{No. active } \varnothing = \text{estimated nightly emergence} \times \text{nesting success (\%)} \\ \times \text{re nesting interval (days)}$$

The figure obtained represents approximately 70% of the total nesting population (Hughes 1974).

In both equations re nesting interval was taken to be 12 days, and nesting success to be 31% (average of nest success over the two-night survey).

1. Using number of turtles sighted by the author and Andres Antonio

$$\begin{aligned} \text{estimated nightly emergence} &= 29 \text{ turtles in 4 days} = 7.25 \\ \text{nesting success} &= 31\% \\ \text{re nesting interval} &= 12 \text{ days} \end{aligned}$$

$$\begin{aligned} \text{No. active } \varnothing &= 7.25 \times 0.31 \times 12 \\ &= 26.97 \end{aligned}$$

Total nesting population for the 1992 season = 38.53

2. Using numbers of nesting turtle tracks counted by the author

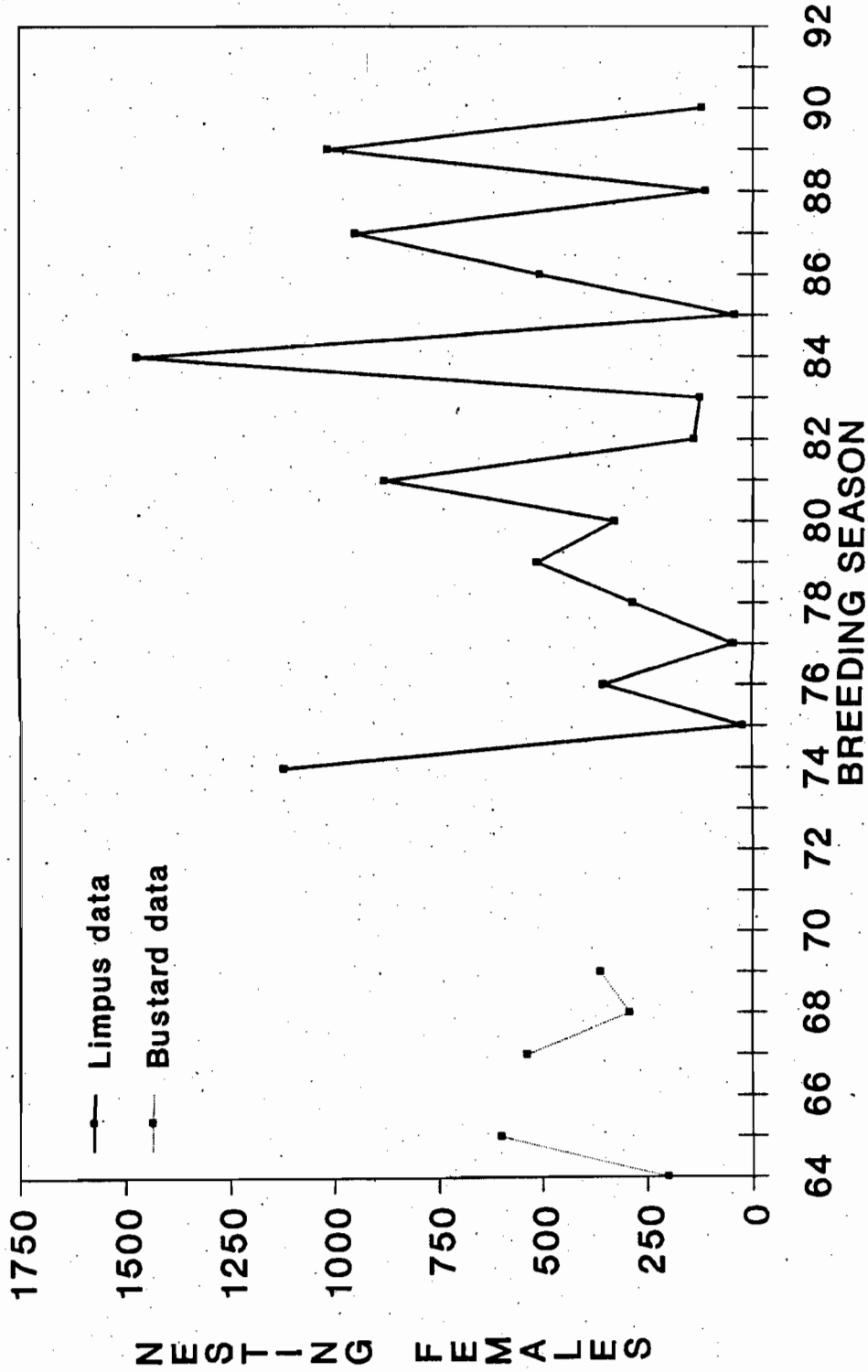
$$\begin{aligned} \text{estimated nightly emergence} &= 66 \text{ tracks in } \sim 7 \text{ days} = 9.43 \\ \text{nesting success} &= 31\% \\ \text{re nesting interval} &= 12 \text{ days} \end{aligned}$$

$$\begin{aligned} \text{No. active } \varnothing &= 9.43 \times 0.31 \times 12 \\ &= 35.08 \end{aligned}$$

Total nesting population for the season = 50.11

Estimate of the total population for Merir Island in the 1992 season is in the range of 39-50 nesting green turtles.

Figure 5.
Annual breeding numbers of green turtles
at Heron Island, Australia



(Limpus & Nicholls 1990)

Table 1. Measurements of nesting *Chelonia mydas* on Helen and Merir Islands, Palau

APPLIED TAG NUMBERS	DATE	LOCALITY	CCL (cm)	NOTES
R7026/R7027	05.vi.92	Helen I.	112.0	Clutch laid Egg measurements
R7031/R7033	11.vi.92	Merir I.	95.6	False crawl
R7126/R7173	11.vi.92	Merir I.	99.5	False crawl
" "	12.vi.92	Merir I.		Clutch laid Egg measurements
R7035/R7172	11.vi.92	Merir I.	108.5	Clutch laid Egg measurements
R7156/R7161	12.vi.92	Merir I.	105.7	False crawl 2 egg chambers dug*
" "	12.vi.92	Merir I.		False crawl 5 egg chambers dug
R7036/R7171	12.vi.92	Merir I.	101.0	False crawl <i>Chelonibia testudinata</i> present

* this turtle returned to the water before attempting to nest later that same evening

Table 2. Measurements of egg diameters and weights from nesting *Chelonia mydas* on Helen and Merir Islands, Palau

TAG NUMBERS APPLIED	DATE	LOCALITY	EGG COUNT	EGG DIAMETER (cm)			SAMPLE SIZE (n)	EGG WEIGHT (g)			SAMPLE SIZE (n)
				MEAN	S. D.	RANGE		MEAN	S. D.	RANGE	
R7026/ R7027	05.vi.92	Helen I.	84	4.2650	0.1253	3.935- 4.400	10	42.900	3.0074	36.00- 46.00	10
R7035/ R7172	11.vi.92	Merir I.	130	4.2480	0.0537	4.145- 4.325	10	41.300	1.5129	39.00- 44.00	10
R7126/ R7173	12.vi.92	Merir I.	129*	4.1455	0.0583	4.060- 4.215	10	39.350	1.2704	37.00- 41.50	10

* This clutch also contained one yolkless egg

Table 3.

Measurements of *Chelonia mydas* captured in the feeding ground at Helen Reef, Palau

TAG NO.	DATE	CCL (cm)	AGECLASS	SEX	NOTES
R7001/R7003	07.vi.92	97.6	ADULT	MALE	TLC* = 30.0cm
R7004/R7005	07.vi.92	76.0	SUBADULT	UNSEXED	
R7006/R7007	07.vi.92	83.7	SUBADULT	UNSEXED	
R7008/R7009	07.vi.92	85.5	SUBADULT	UNSEXED	
R7010/R7011	07.vi.92	83.5	SUBADULT	UNSEXED	
R7012/R7013	07.vi.92	76.8	SUBADULT	UNSEXED	
R7017/R7018	07.vi.92	81.5	SUBADULT	UNSEXED	
R7019/R7020	07.vi.92	77.0	SUBADULT	UNSEXED	
R7021/R7022	07.vi.92	86.6	SUBADULT	UNSEXED	Food in mouth - <i>Thalassia hemprichii</i>
R7023/R7024	07.vi.92	84.2	SUBADULT	UNSEXED	
R7025/R7028	07.vi.92	82.5	SUBADULT	UNSEXED	
R7029/R7030	07.vi.92	93.0	ADULT	MALE	TLC* = 28.5cm

* TLC = length of tail from carapace

Table 4. Information received in June 1992 for nesting *Chelonia mydas* tagged by Andres Antonio between April-May 1991 on Merir Island, Palau

TAG NUMBERS	DATE
R420	27.iv.91
R421	27.iv.91
R422	27.iv.91
R423	27.iv.91
R424	27.iv.91
R425	27.iv.91
R426	27.iv.91
R427	27.iv.91
R428	27.iv.91
R429	27.iv.91
R430	27.iv.91
R431	01.v.91
R432	01.v.91
R433	01.v.91
R434	01.v.91
R435	01.v.91
R436	01.v.91
R437	01.v.91
R438	01.v.91
R439	01.v.91
R440	02.v.91
R441	02.v.91
R442	02.v.91
R443	02.v.91
R444	02.v.91
R445	02.v.91
R446	02.v.91
R447	02.v.91
R448	02.v.91
R449	03.v.91
R450	03.v.91

Table 5. Summary of estimated nesting and harvest numbers of *Chelonia mydas* for each of the Southwest Islands, Palau

ISLAND	NO. NESTING TURTLES / YEAR	NO. TURTLES HARVESTED / YEAR
Tobi	<5	25-50*
Helen	10-20	12-50
Merir	50-150	12-100*
Pulo Anna	<5	12-50*
Sonsorol	<5	12-50*
Fana	<5	included in Sonsorol estimate
TOTALS:	80-190	75-300

* This denotes a harvest of principally adult or adult-sized turtles

Note: This data relies purely on information obtained from discussions with the local islanders. These values do not include estimates of the number of turtles taken by poachers.

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