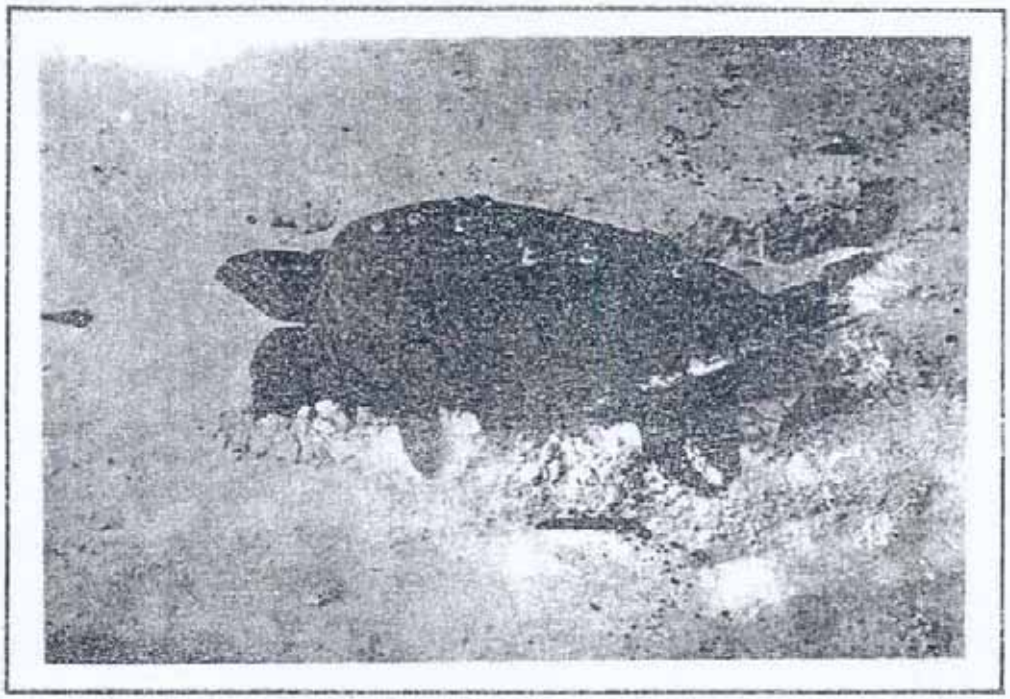
MARINE TURTLES : a review of their Status and Management in the Solomon Islands



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HONIARA, Solomon Islands 1981

MARINE TURTLES : a review of their Status and Management in the Solomon Islands

PRESENTED TO: The World Wildlife Fund; Project No 1452
The Foundation for the Peoples of the South Pacific, and
The Ministry of Natural Resources

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ABSTRACT

The results of a two year project on marine turtles are presented. These include the present status of the Arnavon Islands Sanctuary and work conducted there, as well as the results of a three month survey of Santa Ysabel and Western Provinces. A review of all work conducted to date in Solomon Islands, an evaluation of the present status of marine turtles and recommendations for further work and management policies are also included.

DEDICATION

Historically, the people of Santa Ysabel Islands were mostly "bush" people and lived in the mountainous forests of the islands. A custom story claims that one day a group of men were successful in capturing a turtle, and they decided to carry it back to their village high on the mountain. Part way back, the group decided to rest, and they set the turtle on its back while they sat down to "story".

The turtle is still there today, near Tithiro, for the magic of the spot turned it to stone. This report is dedicated to the people and their descendants who carried the turtle, and to the traditions of Solomon Islands, in which marine turtles play a significant role. It is dedicated to the idea that now, in the time when turtles are in need, Solomon Islanders will once again carry them to a permanent place in the life of the islands.

ACKNOWLEDGEMENTS

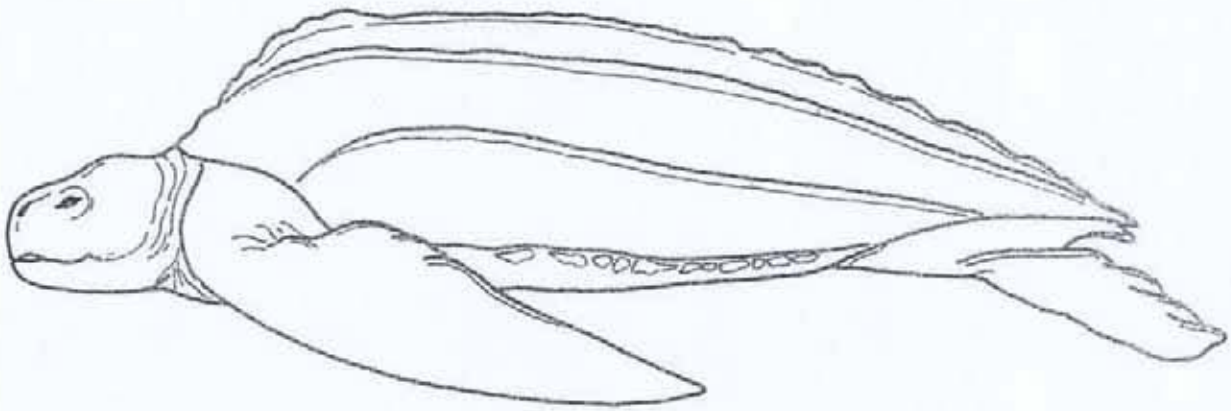
This report is the product of the efforts and help of many people. Special thanks must go, however, to the far sighted men of the Ysabel Provincial Assembly who helped to create the Arnavon Wildlife Sanctuary; foremost amongst them, Mr Edward Vunagi, President of the Assembly.

Funding was made available through: The World Wildlife Fund, The Foundation for the Peoples of the South Pacific, The U S Peace Corps and Fisheries Division, Ministry of Natural Resources. The financial support of these groups has been greatly appreciated.

Andrew Age and Drummond Tealoa deserve recognition for the work they did on the Arnavon Sanctuary. David Evans contributed valuable support from Honiara.

Peter Dunkley deserves thanks for the work he did with my sand samples.

Most of all, I would like to thank the people of Kia and all of the villages which we visited while touring. Food, housing, information and help were always offered with Melanesian hospitality. This co-operation greatly aided our work.



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INTRODUCTION

The Solomon Island Turtle Project is now in its sixth year, although during parts of this time funding was not available to staff it. The original need for the project was identified by Seamus McElroy in the early 1970's when he, working as an Assistant Fisheries Officer in development, heard reports of dwindling turtle stocks. From 1975 to 1977, Andrew McKeown worked on the project doing tagging studies on the Arnavon Islands. An investigation into the turtle shell trade and nesting areas was also undertaken. In 1979, Peter Vaughan was recruited to re-start the project at Arnavon Islands and to conduct a survey throughout the Solomon Islands.

There are two papers which the interested reader is referred to:

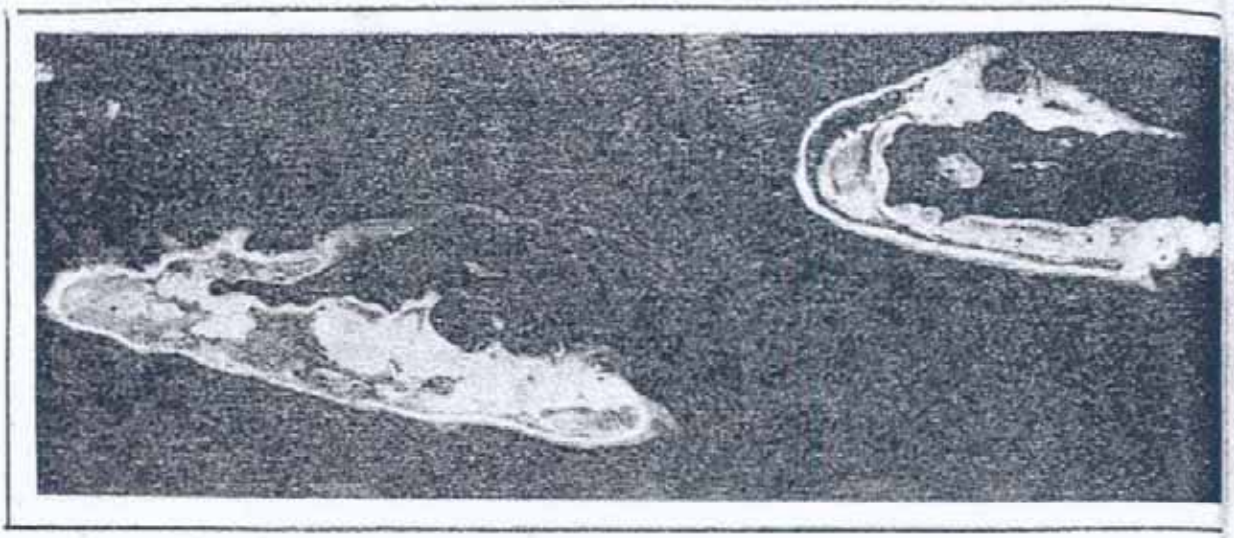
(a) Marine Turtles of the Solomon Islands, by A McKeown. Government Press, 1977.

(b) Marine Turtle Resources of the Solomon Islands Region, by J McElroy and D Alexander. SPC-NMFS/Turtles/WP.11, 1979-

The importance of marine turtles in the day-to-day as well as ceremonial lives of coastal villagers has been discussed by both of the above authors, but it is worth mentioning briefly here, and will be discussed in greater detail later. Turtles have played a significant role in the culture of Solomon Islanders, and this heritage is manifested in the ancient artwork found in museums as well as in the proliferation of turtle figures in contemporary carving. Turtle feasts remain an integral part of ceremonial life today. Any loss or further reduction of the abundance of these reptiles would result in an increasing cultural and nutritional poverty for subsistence level villagers.

The ultimate goal of the present work is to introduce management policies which negate the pressures which have caused recent declines, and which at the same time interfere as little as possible with those traditions still practised today.

THE ARNAVON ISLANDS & THE TURTLE PROJECT



Aerial view of Sikopo (left) and Kerehikapa, Arnavon Islands

NATURAL HISTORY AND PHYSICAL DESCRIPTION

As can be seen from Plate 2, the Arnavon Islands consist of two, slightly raised coral reefs. They lie in the Manning Strait at 7.30 S and 158 E, about 25 km distant from both northern Ysabel and eastern Choiseul (see map 1). A strong south-easterly current is funnelled through the strait which causes frequent rough seas in the passages between the islands. There are several other submerged reefs in the area. The fringing reefs of all of the islands are very attenuate and have extremely steep fore-reef slopes.

The atoll substrate is mostly coral rock and sand. The elevated, vegetated areas have accumulated organic matter, but sand remains a large component, and the soil is very salty. Maximum elevation of the atolls is approximately one metre at high tide, and there is evidence that the islands are completely flooded occasionally. There is also evidence that the islands have sunk slightly in recent years, as the internal, tidal lagoons have expanded killing a large number of trees at the periphery of the lagoons on two of the islands.

The biota of the islands is both diverse and abundant. Many rare species live in, breed on or visit these islands. The tridacna clam and trochus shell are still abundant here, though said to be declining elsewhere. The ebony tree is a common part

of the flora. Many birds, including the sanford eagle, brahmany kite, osprey, megapode, two species of terns and several species of pigeons nest here. Many migratory shorebirds such as the whimbrel, long-billed curlew and the common sandpiper use the islands and tidal flats as feeding and resting areas during the months November to January.

The marine crocodile no longer inhabits these islands. This is the result of extensive skin hunting in the 1960's and early 70's.

TURTLES

Nesting by hawksbill *(Eretmochelys imbricata)* and green *(Chelonia mydas)* turtles occurs throughout the year. In the 19 month period from May 1979 to December 1980 (excluding December 1979), 656 hawksbill nests and 53 green nests were recorded in the group. Using this data, and an estimate for the area not recorded (see below), an annual estimate of 560 hawksbill nests and 45 green nests is derived for the group. This agrees very well with McKeown's estimate of 600 nests per year. (McKeown, 1977).

Estimates on nesting beach use are hard to calculate and often not given. A review of the literate presented at the SPC, Noumea Conference on Marine Turtles in 1979, however, indicates that the Arnavon Islands may be, as McElroy stated, the most heavily used nesting area for hawksbills in the Oceanic Pacific. (McElroy, 1979). One exception would be Campbell and Long Islands in the Torres Strait, Australia, where Bustard estimated up to 100 nests per night, and which Pritchard called "by far the most densely used hawksbill nesting ground in the world". (Pritchard, 1979a).

In spite of the predominance of hawksbills on the nesting beach, the green turtle is seen much more frequently in the surrounding waters. Immature greens are commonly found feeding in the lagoon, and larger greens are found in the deeper water along the fringing reefs. Hawksbills were rarely seen while diving, and only three were caught in the water during the 19 month period.

HISTORICAL AND POLITICAL STATUS

The history of the Arnavon Islands is both complex and convoluted. Tribal warfare, various ownership claims and time have all had a hand in the shaping of the island's story. One common denominator to each aspect of the story, however, is turtles.

Traditionally, the islands belonged to a clan known as the Galicana Tribe. Migrations, inter-marriage and religious changes have dispersed the members of this group, but today the majority of these people still live in Kia, Santa Ysabel; Keala and Posarae, Choiseul; and Roviana Lagoon, New Georgia.

Legal ownership of the islands, however, has been in the hands of the national government since the 1930's. At that time, no one actually lived there, although there were frequent turtle hunting parties which visited the area. Because of the lack of

permanent settlements, the area was declared "alienated land", and was included in a section of public lands known as "Wagina Block". For the next forty years, the islands were legally open to anyone, and an abundance of trochus shell and crocodiles brought traders to the area in the pre-war years.

In 1963, the first major change came to the area with the re-settlement of displaced Gilbertese from the over-crowded Phoenix Islands. There are now about 800 Gilbertese on Wagina.

A second change came in 1975, when in response to growing evidence that the Solomon Island hawksbill populations were declining, and with the realisation that the Manning Straits might be of unusual significance as a breeding area, the Ministry of Natural Resources (MNR) designated the Arnavon Islands as "off limits" under a trespass law, with the intent of creating a turtle sanctuary. It was at that time that Andrew McKeown began his work there.

In 1979, it was decided by Fisheries Division, MNR, that a more specific designation for the group was desirable. The Ysabel Provincial Assembly was very enthusiastic and in May of that year they moved to include the islands within an already existing "Protected Lands" bye-law. In 1980 they voted to create a "Wildlife Sanctuary" bye-law, and to include the Arnavon Islands in it, in recognition of its importance to significant populations of several breeding species (reptiles and birds).

The implementation of the bye-law has been deferred, however, until an official map of Solomon Islands is adopted by Parliament. Provincial boundaries have not yet been finalised, and the division between Ysabel Province and Western Province will determine which islands of the Arnavon group lie within the jurisdiction of the Ysabel bye-law. (See Appendix 6).

At the time of this writing, February 1981, Lands Division had presented a map to Parliament which placed all of the Arnavon Islands inside of Ysabel Province. Fisheries Division, MNR, Ysabel Province, Western Province and the Galicana Tribe have all given official support to the proposal, and it is assumed that the map will shortly be adopted by Parliament, and the bye-law subsequently signed by the Minister for Home Affairs.

THE TURTLE PROJECT

Two leaf houses with water catchment tanks and assorted out-buildings have been built on Kerehikapa. The island has been staffed continuously since April, 1979.

The training of four local wardens has been given high priority. One of these, Andrew Age, is to take over management of the sanctuary in 1981 and he is currently on a six month training course at the University of Queensland, Heron Island Turtle Project. Training on the island has been informal and mostly on the job. A wide range of topics has been taught, ranging from outboard engine maintenance to methods for recording data to theory of conservation.

Work at the sanctuary has included the following duties:

(a) Law Enforcement

In spite of the great distance between the sanctuary and the nearest village, the high cost of petrol and the notoriously rough seas, poaching has been a persistent problem. Poachers are interested in megapode eggs, shells, fish and ebony as well as turtles.

(b) Nest Monitoring

Records of nesting on the three larger islands are kept with respect to: numbers of nests, location of the nest on beach, species, number of eggs, incubation period and hatch success, etc. The two small islands and the south coast of Sikopo were not toured due to difficulty of access. Occasional monitoring trips were made to these beaches to estimate their utilisation.

(c) Tagging

Nesting turtles on Kerehikapa, and feeding turtles from the lagoons of all three islands were caught and double tagged with 'monel' tags to provide information on growth, population movements and nesting frequency.

(d) Headstarting

1,250 hatchling turtles were kept for periods of two months in galvanised tanks. They were fed on cooked fish and their growth monitored.

(e) Nest Predator Control

Rat traps have recently been set on Sikopo, and this programme is going to be extended.

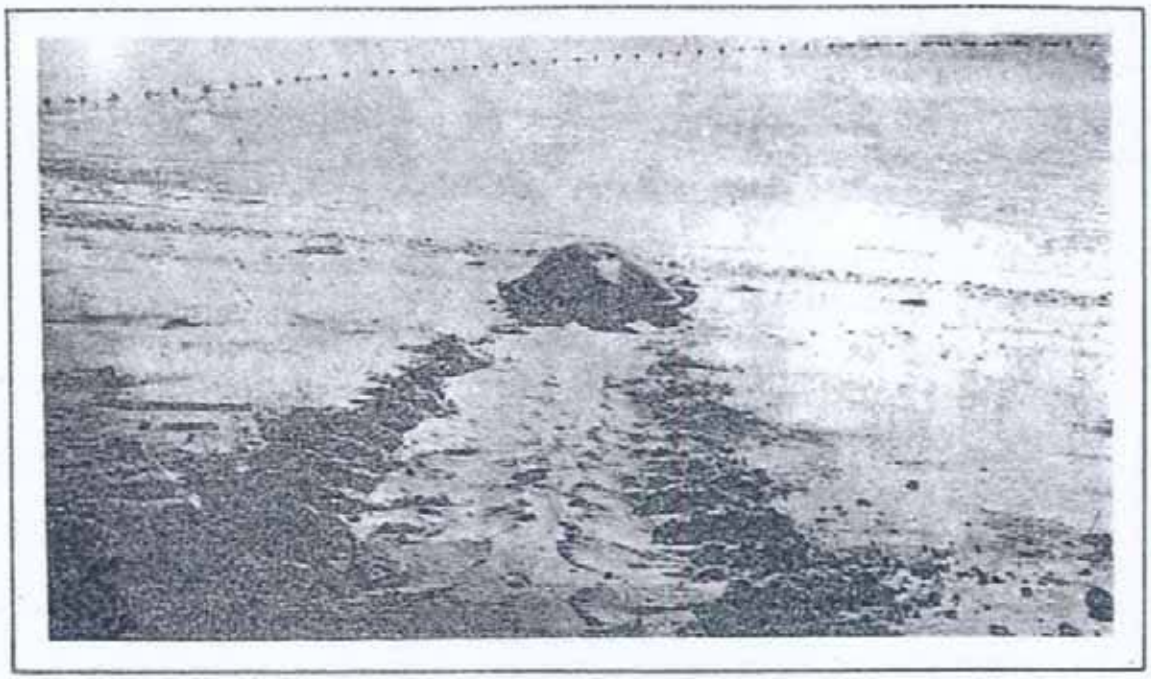
(f) Other

Various other simple experiments, recordings and descriptions were undertaken; these are discussed elsewhere in this report.

(g) Survey

The islands of Santa Ysabel, New Georgia, Choiseul and Shortlands were surveyed by touring villages and nesting beaches in a canoe. Data on nesting and feeding areas, local consumption (traditional, historical and commercial), species and size distribution, seasonality, historical population trends, turtle poisoning, etc., was collected. A presentation on conservation and the turtle project was given to 41 of the larger villages and three secondary schools.

HAWKSBILL TURTLE *(Eretmochelys imbricata)*



Hawksbill returning to the sea

HATCHLINGS

Hatchlings have both the plastron and ventral surfaces of the flippers a uniform, very dark gray. Two slightly raised ridges run longitudinally on the plaston, the crests of which are lighter in colour. The peripheral edges of the marginal scutes and flippers are white, and the lower mandible has a white tip.

The carapace is normally a uniform brown which lightens with age. About 30% of the hatchlings have dark pigment on the anterior central and nuchal scutes. There are three slightly raised longitudinal ridges; one along the central scutes, and one parallel ridge on either side. The ridge crests are lighter in colour.

The dorsal surfaces of the limbs are dark brown, which turns to slate gray after a few weeks. The neck and head are similar in colour to the carapace with darker pigmented areas located medially. On some, the parietal and frontoparietal scales may be reddish-brown. Hawksbill hatchlings average 4.0 cm and weigh 13.2 g (N = 120).

After a few weeks, the interfaces of the carapace scutes become jet black and the white disappears from the lower mandible.

Abnormal scute and scale structures are fairly common in hatchling turtles. The most predominant deformity is the presence of extra central scutes which cause the carapace to appear concave. These hatchlings are often sickly, and die even when kept in tanks. No mature turtles have been seen with this trait. Abnormal head scales are the most frequent aberations in post-hatchling turtles. One specimen had three pairs of prefrontals, and two were seen with fused frontal and frontoparietal scales.

JUVENILES

Juvenile hawksbills have pale yellow plastrons with two parallel and lighter coloured ridges which run from the humeral to the femoral scutes. The plastron is often heavily covered with algal growth. The ventral surfaces of the flippers are a yellow-orange. If melanin occurs, it is usually in the centre of each scale, and is concentrated along the medial line, especially towards the distal end of the flippers.

Carapace scutes can vary from an even light green to a mottled amber-brown. Scutes are heavily imbricated and somewhat sculpted. The central scales have a V like notch in the posterior end, and the sixth through eleventh marginals are sharply serrated.

ADULTS

Mature females have yellowish to orangish plastrons. The centre of each scute is generally brighter, and towards the inframarginals, the colour becomes a pale yellow. There may be some melanin on the anterior scales.

All skin surfaces are a uniform pink and white. The flippers are dark brown dorsally. The ventral surfaces of the flippers are skin coloured at the junction with the body, but distally, brown pigment is found in the centre of the scales, and this covers 100% of the surface at the flipper tips.

Carapace colour varies from a mottled amber and brown to nearly black. The carapace is often scratched, but never has algal growth. Barnacles are present on 55% of all nesting females. 5% have barnacles only on the plastron, 40% only on the carapace and 8% on both. Barnacles normally appear in clusters, and infestation can be very heavy.

Over-the-curve carapace length of 43 nesting females was 84.6 cm (limits 60 to 97.5 cm). It should be noted that the 60 cm specimen beached without nesting; the smallest turtle seen to nest was 72 cm. Average weight was 57.8 kg (limits 36 to 72.5 kg).

McKeown found that in a similarly sized sample (40 individuals), mean carapace length was 88 cm and the mean weight was 66.4 kg. The nature of this discrepancy is not understood. It could be caused by statistical variation due to the small sample size, hunting pressure on the mature females, or some other factor. Both of our figures place Solomon Island turtles in the mid-sized range of known hawksbill populations. Because the author is unfamiliar with other hawksbill populations, comparisons are difficult to make. However, our turtles are smaller than those described for Atlantic populations, and do not have the "intensely black scales on the upper surfaces of head and forelimbs" which Eastern Pacific hawksbills have. (Pritchard, 1979b). If trinominal designation is warranted, *Eretmochelys imbricata squamata* seems most appropriate, which is the designation generally used for the Indo and West Pacific populations.

ECOLOGY AND REPRODUCTION

McKeown noted a peak nesting from May to August and another rise in December. Nesting in any given month can be quite variable; Figure 1 is an average of McKeown's and my data for the time periods of January 1976 to July 1977; and May 1979 to January 1981. The two peaks McKeown noted are seen to be distinct increases in nesting frequency but the highest point represents only a doubling of nesting over the other months. It is interesting to note that those two peaks occur during exactly opposite weather conditions. During December and January, the seas are either dead calm or roiled by the "Koburu" or strong westerly storms. May to August is the time of the south-east trade winds. During both of these periods, however, large rainstorms are frequent.

The mean percent hatch of 222 hawksbill nests was 81.7% (limits 30 to 100%). A few nests fully rotted. Figure 1 also shows that nests laid in September had the highest percent hatch and that June had the lowest. Nests laid slightly later than the peak nesting periods had better success on the whole. June 1980 was unusually wet which might explain its lower average. Many of the really poor nests were those laid in June.

It is also interesting to note on Figure 1 that the mean gestation fluctuates seasonally with the longest gestation period roughly coinciding with the May to August nesting season. June is once again an anomaly but may be explained by unseasonable weather in 1980. Even still, the June gestation is higher than for the months November to April.

Figure 1 raises several questions. On Kerehikapa, peak nesting occurs from May to August but that is not the time when a turtle can expect the best return on its investment. Also, the long gestation period of those months would mean that eggs laid during the nesting season would be exposed to crab predation for slightly longer periods of time.

It is assumed here that there is some factor which makes nesting in May to August attractive. It may be that the time period of our observations was too short from a historical point of view and that on average, turtles can expect the highest percent hatch during May to August. If our records accurately reflect the "normal state of affairs", however, they may help explain why there is year round nesting rather than a single major season. Whatever the benefits are of nesting in May to August, they are somewhat offset by a slightly lower hatch success and a longer gestation period. Thus there are benefits to be gained by nesting in the other months as well. For example, the month of December has a high percent hatch and a low gestation period, which would seem to make it an attractive month for nesting.

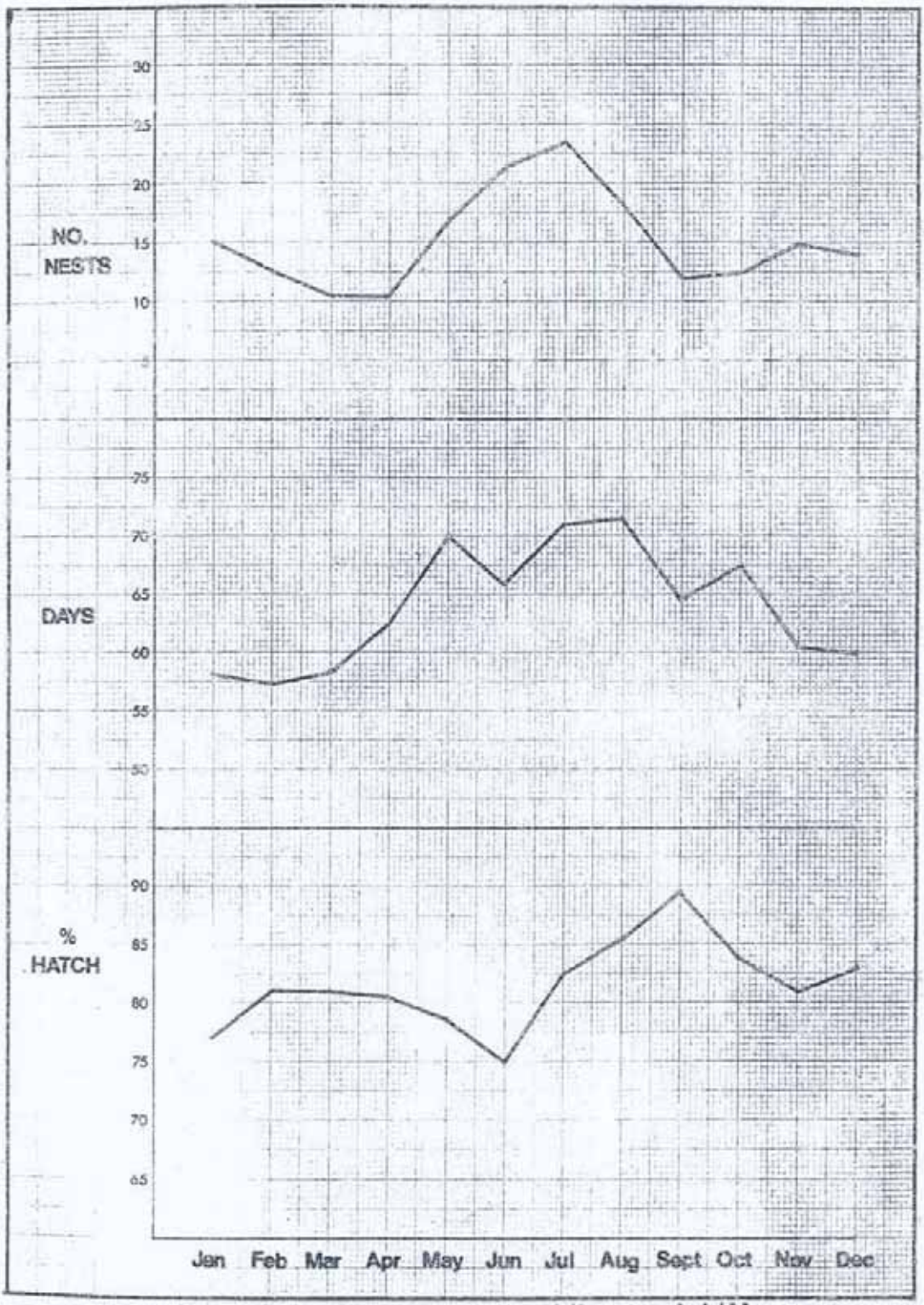


FIGURE 1 : Nesting parameters for Kerehikapa Hawksbills

Line A = Average nesting per major island (N = 906)
McKeown & Vaughan data, Jan. 1976 to July 1977
May 1979 to Jan. 1981
Line B = Mean gestation for nests laid that month (N = 200)
Line C = Mean % Hatch for nests laid that month (N = 217)

198 nests had a mean of 151 eggs (Limits 37 to 234). The largest nest represents the most eggs ever recorded for a single nest. (Pritchard, 1979b). The mean gestation for all nests was 66.5 days. (limits 49 to 91 days). An analysis of the relationship between the number of eggs in a clutch and its gestation period revealed that nests with significantly fewer eggs took about two days longer to hatch. Results are presented in Table 1.

TABLE 1: Gestation periods of different sized hawksbill turtle clutches

Clutch Size	Mean Gestation	No. Observed
Up to 121	68.4	36
122 to 180	66.3	132
181 +	66.6	30

Only ten turtles were seen to beach more than once. Because turtles nest all year round and rarely more than one nests per night on Kerehikapa, the effort to see every turtle seemed greater than the rewards. Tours of the beach were conducted on most nights in the hours between dusk and ten or eleven. As a result, a large number of turtles nested unobserved. Table 2 shows the data from those turtles which were seen more than once.

TABLE 2: Hawksbills seen on Kerehikapa more than once

Tag #	C.L. (cm)	# Eggs	Days Intervals	# Eggs	Interval	# Eggs
1586/1587	89.0	?	26	?	-	-
1588/1589	91.5	149	28	158	-	-
1580/1581	93.5	?	15	no lay	3	188
389/ 390	82.5	84	15	104	44	109
582/ 583	87.5	162	14	226	14	?
1052/1053	81.0	?	13	136	-	-
1056/1057	91.0	no lay	2	163	-	-
1059/1060	89.0	163	52	?	-	-
1066/1069	84.5	no lay	42	168	-	-
1074/1075	89.0	136	16	144	15	no lay

Because not all turtles were seen, it is hard to draw conclusions about the number of eggs laid on the first and second nestings. Successive nests do, however, seem to increase in size. The average carapace length (curved cm) of turtles which were seen more than once was 87.9 cm or 3.3 cm greater than the average for all nesting hawksbills.

The final nesting parameter which was measured was substrate preference of the hawksbill. The results are given in Table 3.

TABLE 3: Substrate parameters for 179 Hawksbill nests

#	Description	Location	% Used	Gestation	% Hatch
1.	Fine gray, some organic, fine roots, 76% .0118cm or less.	Mid or back	71%	68.8	82%
2.	Very fine, white a few large coral pieces. 84% .0118cm or less.	Fore-beach	24%	69.7	78%
3.	Black, organic, more and larger roots. Very fine.	Behind back beach	4%	79.0	79%
4.	White, large, granular. 40% .0236; 30% .0118 or mess	Fore-beach	1%	69.3	83%

The high preference for substrate typel is a reflection of the fact that most turtles nested on the back-beach where this type of sand predominated. There is a slightly higher success rate for turtles which nested here rather than on the fore-beach.

Nests on the fore-beach also ran a much higher risk of being destroyed, lost or soaked by high tides or storms. Although those nests which we were able to observe after being soaked had a similar hatch success as those which were not soaked, many nests which were covered were not seen again, and very likely did not hatch at all. The overall greater risk of destruction by seas and the slightly lower hatch success of substrate 2, offer an explanation for the high preference of substrate 1 and the back-beach.

Substrates 3 and 4 were only used rarely, and the few data points make their figures suspect. It would not be unexpected, however, for substrate 3 to have a longer gestation period as it was located several metres behind the beach, and was always shaded heavily.

It should be mentioned that virtually all hawksbill nesting takes place at night on oceanic atolls or small offshore islands; only six hawksbills were seen to nest during daylight hours. Nesting is usually done on the ocean side of the islands; only one nest in 19 months was laid on the lagoon

side of Kerehikapa in spite of what appears to be suitable beach. There is a small group of islands near Gizo (Cross, etc.) where nesting is said to take place on the lagoon side. Typical hawksbill beaches are remote, short, narrow, have white sand and are fronted by a shallow reef bench. At least five turtles beached on areas of Kerehikapa which had no sand, but only high banks of piled, white coraline rocks. All returned to the sea without nesting or extensive roaming. There are scattered reports of hawksbills nesting on mainland, black sand beaches.

In 1972, Bustard found that mechanical stimulation of turtle eggs near the end of development induced a quickening and synchronisation of development amongst the embryos. (Bustard, 1972). In our observations, it was noted that when excavating a hatched nest, we were more likely to come across undeveloped eggs in the upper part of the nest rather than near the bottom. The question was raised whether the mechanical stimulus or the egg falling from the cloaca to the nest floor might not serve as an impetus to embryonic development, similar to what fetal movement does later on. Our observations of undeveloped eggs near the surface might then be explained by the fact that they fell the least distance and their fall was cushioned by the other eggs.

To test this, an experiment was done in which part of each of five clutches was allowed to fall naturally into the nest, and another part was collected very gently as the eggs emerged from the cloaca. Eggs were collected throughout the egg laying process to eliminate any bias caused by position in the fallopian tube. The collected eggs were then placed into two experimental nests, which were dug to similar specifications as the natural nest. Eggs deposited in Hole A were handled very gently and placed without jostling on the nest floor. Eggs in Hole B were dropped from about 15" above the lip of the nest. The nests were then covered and observed. The results are displayed in Table 4.

TABLE 4: Egg initiation experiment

Control	# Eggs	Gest.	# Hatch	A	# Eggs	Gest.	# Hatch	B	# Eggs	Gest.	# Hatch
1.	36	66	84	1A	48	66	100	1B	48	66	95
2.	31	75	90	2A	34	74	89	2B	35	72	94
3.	71	70	77	3A	46	72	77	3B	46	69	79
4.	64	75	80	4A	40	75	?	4B	40	75	87
5*	52	?	77	5A	40	?	45	5B	42	?	85

* All bad eggs in all three nests showed partial development

A = placed in nest gently
B = dropped from 15" above lip of nest

Generally speaking, eggs which were dropped had a better percentage hatch by seven points and hatched one day earlier than the controls. Eggs which were placed gently (A) had gestation times similar to the controls, but their percent hatch varied widely.

The results of this test are inconclusive, but further testing was not done due to time constraints. What little data is available, however, seems to indicate that the jolt of the egg's fall helps initiate development in some of the eggs and quickens embryonic development slightly. If this is the case, its ecological function might be to facilitate group emergence later on. It should be noted that rotation or jarring has been shown to reduce hatch success in eggs 48 hours after ovipositioning. (Bustard, 1972).

ABUNDANCE AND DISTRIBUTION

Hawksbill turtles are found throughout Solomon Islands, but no nesting aggregations as large as that at Arnavon/Wagina are known. The information presented here is the result of a survey of Ysabel and Western Provinces, and a visit to Makira. No further information, other than what is available in McKeown and McElroy, has been gathered for Guadalcanal, Malaita and Eastern Outer Islands.

SANTA YSABEL

38 nesting beaches are known on Santa Ysabel. The vast majority of these are located on small offshore islands and support less than ten nests per year. Other than Arnavon, the only major nesting area is Ramos Island, which lies about 30 miles east of Poro. Like Arnavon, Ramos is protected by distance, rough seas, conflicting ownership claims and some traditional tabus. No one lives on the island, but people from Poro and North Malaita visit with some frequency. Only one nest was there when I visited the island in September, 1980 but I was told that that was unusual. Estimated nesting is 50 to 100, mostly hawksbills.

Annual nesting estimates were made for all 38 of the beaches by local hunters. The sum of all 38 beaches gives an annual nesting estimate of 800 to 950 nests in the Province, with 650 to 700 (74% to 81%) of these accounted for by Arnavon and Ramos.

What appears to be extensive nesting beaches on southern Ysabel is not, and apparently never has been. Only very rare nesting is reported from the area around Sepi.

A list of all nesting beaches which may account for ten or more nests is given in Appendix 1.

Feeding areas are harder to pinpoint. Hawksbills are found around the island, even in areas where no nesting occurs. Hawksbills are reef dwellers and I believe they are less visible than greens. It is also hard to interpret hunters' stories of success with accuracy. However, the eastern coast, particularly from Ghoveo to Kia, has many offshore islands and reefs; people there had eaten hawksbill more recently on the whole and most shell comes from there. It is believed to have the highest concentrations of feeding hawksbills. Nowhere, however, is the hawksbill as common as the green.

CHOISEUL

15 nesting beaches were identified during the survey of Choiseul. The situation here is similar to Ysabel except that there are more reports of mainland beaches, most of which are no longer used. Total nesting on Choiseul was estimated at 230 to 450 nests per year, with Haycock and the other islands around Wagina accounting for 200 to 400 of these (88%).

Haycock is the best nesting in the Manning Strait outside of Arnavon. One Gilbertese lives there most of the time, and he is reputed to be the most knowledgeable and best turtle hunter in the area. The other islands are owned by people from Wagina. Most have copra and temporary houses, a few have gardens.

Komboro Point is the only other significant nesting area. It is a series of short, white sand beaches on the mainland. All beaches are difficult to get to due to reef and surf, and nobody lives in the area.

Around Wagina, the hawksbill is said to be as abundant as the green. There are many reefs and this is probably the best feeding area for hawksbills in the Solomons. Suri Point on northeastern Choiseul is named for hawksbills but has fewer turtles now than in the past.

NEW GEORGIA

17 nesting beaches were identified throughout the archipelago, but this group of islands is quite poor in this respect. There are no major nesting aggregations anywhere and no nesting at all on some islands such as Kolombangara and Ranongga.

Of particular note is the Helebar group. Both previous authors listed it as an important nesting area but only two of the islands, Mariu and Kulokulo, support any nesting at all. These islands are both tiny and may have about 50 nests between them per year. The people who own these islands live in Mbareho and are SDA. They do not use turtle at all, and have just recently made it tabu for anyone else to go to these islands in an attempt to protect their supply of trochus shell and other marine shells. This may have a beneficial impact on the turtles and I believe these people would be open to the idea of creating a local turtle sanctuary there.

It has been suggested that there are good feeding areas in New Georgia, but I believe this is more applicable to green turtles. Very little shell comes out of this area. An estimate of only 120 to 175 nests per year was derived for the whole group.

SHORTLANDS

The Shortlands have a much larger number of hawksbills than New Georgia. 25 nesting beaches were identified and at least three of these are of some significance. All estimates for the Shortlands are somewhat obscured by the fact that this is one of the few areas where greens nest in numbers with the hawksbills and hunters were lax about differentiating between the two.

Balaka is a very small islet near Oema Island. When McElroy mentioned Oema, he probably meant Balaka, as no nesting occurs on Oema itself. Nesting is estimated at 50 hawksbills per year. When I visited there in December 1980, I found only one old nest but I was assured that there were times when turtles dug up each others nests.

Maifu Island is predominantly green nesting but may get significant hawksbill nesting as well.

The group of islands near Kariki, including New, Samarai, etc., offer the best nesting in the Shortlands with a total nesting for the group of 200 to 250. Altogether, nesting in theShortlands is estimated at 400 to 500 per year.

MAKIRA

Only Three Sisters Islands were toured. These three islands have nesting beaches only on the larger two (Malaulalo and Malaupaina). These have been alienated and under cultivation for some time; at present the owner is considering returning them to provincial control. One of the options being considered by Makira Province is the creation of a wildlife sanctuary. Nesting is by both green and hawksbill turtles and is estimated at about 50 per year.

TAG RETURNS

Four tag returns from hawksbills raise some interesting questions about hawksbill populations here and their dispersal. Table 5 outlines the information of the returns.

TABLE 5: Long distance hawksbill tag recoveries

(1) Tag # 3/4. December 5, 1976, beached without nesting on Kerehikapa.
February 1979, killed at Fisherman's Island, Central Province, PNG.
Distance travelled of 1,400 km. (Vaughan 1980).

(2) Tag #35/42. December 19, 1976 nested on Kerehikapa.
June 3, 1977, killed at Kia, Santa Ysabel.
Travelled about 50 km. (McKeown 1977).

(3) Tag #101/102. February 3, 1977, tagged at Wagina.
Killed on north shore of Choiseul between April and June, 1979.
Travelled about 30 km.

(4) Tag #A2436/A2437. March 31, 1979 tagged at Sakeman Reef, Torres Strait, Australia.
Nested at Kerehikapa, February 16, 1980.
Travelled 3,600 km.

Carapace length:	83.5 cm	84.0 cm	Plastron length:	62.0 cm	63.5 cm
Carapace width:	68.8 cm	70.0 cm	Weight:	63.5 kg	56.8 kg

(Cooper, personal communications).

Hawksbill turtles are not known to undertake long migrations and it is thought that they are the most sedentary of all marine turtles. Although a few long distance tag returns can not answer any questions, they can pose some interesting ones. Both of the international tag returns were from turtles which were in the act of nesting on Kerehikapa and were not nesting at the other point of capture. The two recapture locations were both in the same general vicinity and one turtle swam one way, the other the opposite direction.

Other circumstantial evidence raises doubts about the nesting population at Kerehikapa. McKeown noted that mating hawksbills are rarely seen and it is my opinion that mating greens are more frequently encountered even though they account for only a fraction of the total nestings. Surveys have been conducted at the island by towing an observer behind a canoe along the reefs. Hawksbills were never seen in this manner, although they are occasionally seen surfacing to breathe. Greens were frequently encountered. It does not seem possible that the nesting population is drawn solely from the immediate vicinity. Feeding hawksbills are very common at Wagina and two hawksbills have been recovered from there. It seems possible that at least this short distance is frequently negotiated by turtles.

It should also be noted that immature hawksbills are rarely encountered in the Arnavon Group.

The possibility that at least some of the nesting hawksbills at Kerehikapa come from other localities seems worth investigating further. It has been noted previously that 53% of our nesting hawksbills have barnacles on them. It has been suggested that hawksbills have barnacles because of their sedentary life, whereas greens do not because of their propensity to migrate and thus need to be streamlined. (Carr, 1973). On analysis of our nesting turtles, it was found that the curved carapace length/curved carapace width ratio for turtles with barnacles was 1.09, whereas those without barnacles had a ratio of 1.14 (N = 46). Thus, turtles without barnacles tended to be narrower, or shallower, and thus more streamlined. This is what one might expect of turtles moving long distances.

It is interesting at this point to note that turtle 3/4 did not have barnacles; unfortunately, the curved measurements are not known. Turtle A2436/A2437 had nine barnacles on its plastron, but had a clean carapace. It had a ratio of 1.20 or was very streamlined.

The obvious conclusion to draw from this is that more tagging work is needed. Future work should however, address the question of different nesting populations and the possibility that some sort of movement is taking place.

POPULATION TRENDS

The hawksbill turtle is the one species about which there is little doubt that there has been a significant decline in numbers in recent years. Accurate population censusing methods are not yet available, but the following points summarise what evidence is available. Some of these points are explained in greater detail elsewhere.

(1) It is the unanimous contention of hunters everywhere that the hawksbill turtle is not as numerous as it once was. Although questioning hunters may not be considered a quantitative analysis, it may be the most accurate barometer available today. Hunters are plentiful, persistant in their pursuits, live where the turtles do and many have been active over two or more decades.

(2) Shell exports by one large trader and two co-ops have decreased over the past decade in spite of what appears to be a large increase in the incentive to hunt turtles.

(3) There are many nesting beaches which either have greatly reduced nesting or no longer support any nesting. My survey revealed many examples; three are given below:

(a) Arnavon Islands, Santa Ysabel

Stories abound of very heavy nesting here in times past. McKeown estimated a peak of 100 nests per week. One hunting party took 20 hawksbills off one beach in two nights on Sikopo in 1963. By 1974, one man spent a full month on Sikopo and caught only 16 turtles. Today, he would have to catch every turtle just to equal that.

(b) Haycock Island, Wagina, Choiseul

One man has been living here since 1963. When he first came here, between one and five turtles would nest every night year round. Not a single turtle nested on Haycock in June, 1980.

(c) Furona Island, Santa Ysabel

It is not known how heavy nesting was here in the past, but old men remember going there to wait for turtles in their youth. One man compared the island to Arnavon. Today, there is a village on the island and no nesting has occurred in years.

(4) At least one major feeding ground has been badly decimated at Suri Point on Choiseul. People used to go there at times of feast to spear hawksbills, but it is no longer worth the effort. Suri is the word for hawksbill in the local language.

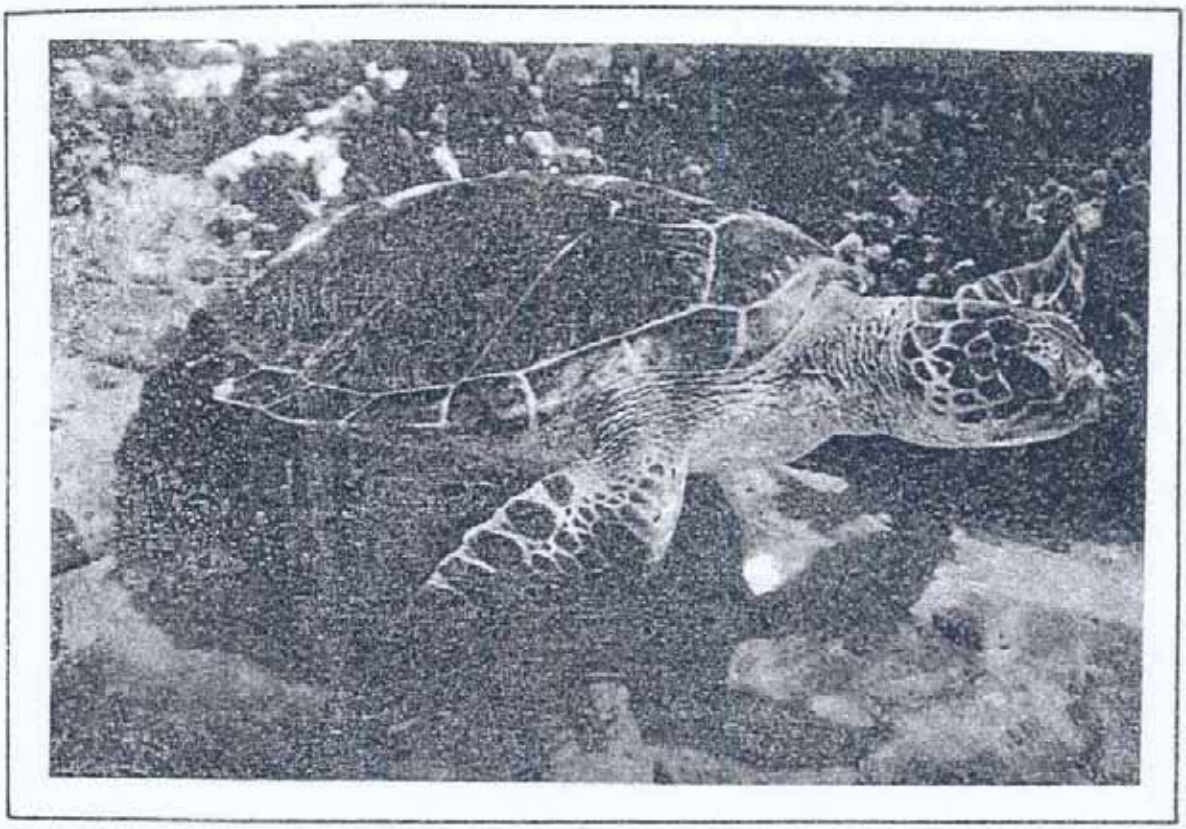
(5) New methods of hunting hawksbills have been devised, ostensibly because not enough turtles could be taken to satiate the demand. The technique is to dive at night with a torch: it was started by the Gilbertese and is now widespread in Western Province.

(6) One of the major traders in turtle shell believes turtle populations are declining and that it is reflected in his trade.

(7) Hawksbill nests have been exposed to heavy human predation since W.W.II and this is bound to have an effect on adult populations eventually.

(8) The mean carapace length of hawksbills nesting on Kerehikapa has decreased over the past six years. This may be an indication that too many are being taken and that turtles are not being allowed to reach old age. If this is the case, it would be particularly serious because it is these large individuals which have been seen to lay multiple clutches.

GREEN TURTLES *(Chelonia mydas)*



Immature green turtle in shallow water

NATURAL HISTORY AND DESCRIPTION

Hatchling green turtles have the typical colouration noted in other populations. The dorsal surfaces are dark gray to black; the ventral surfaces are white-cream. They are larger than hawksbills, averaging 4.8 cm in carapace length and weighing 20 g. (N = 25, from one nest).

Immature turtles normally have clean carapaces, free of barnacles and algae. Each scute has a "half moon" base of solid colour (yellow, light or dark brown) located at the centre of the posterior edge. This colour radiates out with a "bomb-burst" affect. The background of these radiating streaks (which lighten with distance from the base) is normally dark forest green. In a few individuals, the background is yellow-brown or dark brown. Marginal scutes are dark brown.

The dorsal surfaces of the head and flippers are dark brown and the sides of the head and frontal scale is black. The interfaces between scales are yellow.

Skin surfaces tend to be cream to yellow and brown above. There are often barnacles imbedded in the skin. Each flipper has a narrow light stripe along the medial line of its ventral surface which is flanked by yellow or orange. The tips of the flippers are brown.

The plastron is an even pale yellow, the pigment slightly more concentrated in the centre of each scute. Scute interfaces are ivory coloured. Algal growth is not uncommon.

The colouration in mature turtles is similar to that of the smallerturtles, the major difference is that the carapace is less spectacular and is often mottled and quite dark.

Barnacles were found on 8% of all turtles but infestation of carapace and plastron is always slight. This figure does not include skin barnacles which are much more common.

Turtles with abnormal scutation are rare, but two immatures have been found with a small extra central scute inserted between the fourth and fifth central scutes. The extra central scute has been noted in other populations as well (Pritchard, 1979b) and McKeown saw it in one batch of hatchlings on Kerehikapa. (McKeown, 1977). As McKeown also noted, we have seen some turtles with a small, posterior pair of fifth inframarginals.

Only one nesting female was observed and she had an over-the-curve carapace length of 110 cm. This is significantly larger than any McKeown reported, but means nothing because of the tiny sample sizes. This was the largest green ever measured, including 80 mature turtles which were caught by villagers for feasts.

ECOLOGY

Because green turtles nest only occasionally in the Arnavon Islands, very little data has been collected on them. What is available is listed in Table 6.

TABLE 6: Green turtle nesting on Kerehikapa

Parameter	Mean	Limits	(N)
Clutch size	97.3	37-143	8
Percent hatch	78.9%	30-95%	8

56 green turtles nested in the sanctuary from May 1979 to January 1981. Of these, 44 (79%) nested in the months of September to March. The months of May to August (hawksbill season) accounted for only 7 nestings (13%). This loosely conforms to local theory that greens nest "around Christmas".

75 green turtles were caught by diving on them from canoes in the shallow lagoons of the Arnavon Islands. These were double tagged with monel tags and released from the station. 17 turtles were caught twice (23%), 8 caught three times (11%) and two were caught four times (3%), with the intervals ranging from one day to over 16 months. The data from this tagging work is printed in Appendix 2.

There are no turtle-grass flats at Arnavon and the shallow lagoons have only sparse algal growth on which turtles have been observed feeding. On the basis of the probability of catching a turtle once, twice and three times, it has been roughly estimated that 120 to 150 green turtles use these laqoons to feed. This figure does not include the larger turtles which tend to come onto the flats less often and are harder to catch. Nor does it take in the possibility that some turtles may have left the area and others taken their place.

Growth measurements were made on all captured turtles. It has been pointed out that measurements over the curve are prone to qreater error due to bias involved in the positioning of the flexible tape. (Balazs 1979b). This proved to be a problem, especially as the growth being measured was so small and some of our workers were inexperienced in working with measurements. In spite of these limitations, it is apparent that growth rates in immature green turtles at Kerehikapa are low. 30 growth measurements where the interval was qreater than one month had an average elongation of the carapace of 1.8 mm per month (limits 0 to 12 mm). This is comparable to the slowest growth rates measured at French Frigate shoals. (Balazs 1979b).

The implications of a slow growth rate on tne ecoloqy of green turtles has been discussed by other authors (Balazs, 1979b; Bjorndal), and I will not comment on it further than to say that Solomon Island green turtles appanently follow qrowth patterns similar to other populations. A 48 cm turtle which attains maturity at 85 cm (McKeown's mean for four nesting green turtles at Kerehikapa) will take approximately 18 years to mature if it maintains an average growth rate of 1.8 mm per month.

It is also interesting to note that individual qrowth rates varied greatly and some individuals qrow more quickly than others. This has been observed in hatchlings as well and an average growth rate may not accurately describe the development of an individual.

Our study area was divided into five large zones. Of the 39 re-captures, all but one was in the same zone from which the turtle originally came from. Because all turtles were released from the station which was located between two of the zones, this indicates that somehow the turtles were able to return to the same qeneral area from which they came. The one turtle which came from a different zone was recovered after only one day and he was caught in the zone adjacent to his "home zone". This homing instinct has been noted in other populations and in nesting turtles as well. (Carr 1973). Turtles are also known to have favourite locations and one man from Gizo has taken twenty turtles from one rock over the years.

DISTRIBUTION AND ABUNDANCE

Green turtles are very common throughout Solomon Islands and they are the turtle most often encountered and most used as food.

Nesting areas, however, are scarce. The greens which do nest often choose the same beaches as hawksbills and leatherbacks. Only a few beaches are predominantly green areas. The one factor which all green beaches have in common is that the approach to the beach is deeper than it is to those which support only hawksbills. If a reef is present it is always enough submerged so that there is still live coral on it. Most of the green nesting done at Arnavon is on those patches of beach where there are broad channels through the reef.

Juvenile greens tend to be found in lagoons and passages between islands. Sub-adult and mature turtles tend to stay on the ocean side of fringing reefs and on both sides of barrier reefs, but also come onto grass flats to feed at high tide.

SANTA YSABEL

Hakelake is the only island where green nesting predominates. It supports 15 to 20 nests per year, but is heavily utilised by the custom owners who live in Ghoveo.

The major feeding areas stretch from Baolo around to Dedeu. Here, there are long reefs with flats behind them where turtles can feed. Ghoveo, Poro and Thousand Ships Bay are also excellent feeding areas but the turtles in Thousand Ships Bay are mostly immature.

CHOISEUL

Greens nest on the islands around Wagina in about the same proportion to hawksbills as they do at Arnavon. This means 10 to 15 nests per year. There are no other significant beaches, though occasional nesting is recorded from several areas.

The north side of Wagina has excellent feeding grounds. Also, the whole north coast of Choiseul has shallow flats. People here eat turtle regularly and I believe turtle concentrations to be much higher along this coast than on the south shore which has few reefs and a rugged shoreline.

NEW GEORGIA

There are no significant nesting grounds for greens. Several excellent feeding areas exist. The West is an archipelago of many islands and lagoons. Ndovelle, Vori, Roviana and Marovo are all excellent feeding lagoons. Additionally, many people in the area are SDA and thus, hunting pressure is lower here than it might be.

There is a time in September when large quantities of rubbish and small jellyfish are concentrated in Munda Passage near Munda Bar at low tide. People in the area take advantage of this to spear large turtles very easily. Many turtles are said to have their eyes swollen shut by the jellyfish stings.

SHORTLANDS

Three islands deserve special mention for their nesting:

(1) Ausilala (listed as Autarara by McElroy)

These are two very small islands situated directly on the border with PNG. Rough seas and lack of anchorage prevent people from going there more than a few times a year and prevented me from going ashore. Only greens nest here and the estimate is vague but in excess of 100 nests per year.

(2) Maifu

This is owned under custom law by people from Malesi and is heavily used. There were eight nests there in November 1980. Annual estimate is 100 nests per year.

(3) Balaka

Discussed under hawksbill turtles but more greens nest here than hawksbills.

Evidence collected while touring suggests that populations of green turtles are heavy throughout Shortlands and are larger than any other area with the sole exception of the area around Wagina. The myriad of small islands and bays, and few villages all contribute to the health of the population here.

It has been suggested that two populations of green turtles reside in Solomon Islands; one which nests here and one which migrates here to feed. (McElroy 1979). The suggestion is made primarily on the grounds that nesting is sparse and does not seem sufficient to account for the large populations seen in coastal waters. The report also mentions that other populations, such as the Ascension Island turtles, have been shown to migrate. One international return is known from a turtle which was tagged in French Polynesia in August, 1973 and was killed in Malaita in August, 1975. (McKeown 1977). The fact that our most common aberrant scutation is the same as in other populations would suggest that our turtles have had some intercourse with other populations.

Many areas have several names to describe the various colours and sizes of green turtles; on Ysabel, however, two distinct carapace shapes are identified. One is short and broad and is called "Seru kuta", the other is elongate and called "Seru venu", which means "turtle related to the dugong". "Seru venu" is more common and it is also the one known to nest at Hakelake. This last fact is the one which does not quite fit the theory as one would expect the nesting species to be less common.

In an effort to clarify this, 174 turtles of all sizes and from throughout the Solomons were examined and five different ratios of various physical parameters were calculated for each turtle. Distribution graphs of these five ratios showed a consistent bell curve for all but one, the ratio of curved carapace length to curved carapace width (CL/CW). Figure 2 is a distribution curve for this ratio and it can be seen that a small percentage (approximately 7.5%) of the population is significanti

narrower (ratios of 1.5 or larger). It should be noted here that there is no correlation between this ratio and the size of the turtle.

The one turtle we measured while nesting had a ratio of 1.16. This would seem to conflict with what people had observed at Hakelake, but would conform to the theory that the less common turtle nests locally. The nesting turtle was also one of the few which had barnacles which might be an indication that it had led a sedentary lift. The mean ratio for all turtles with barnacles was 1.08 (limits 1.01 to 1.35), however, which is the same as the population at large.

No clear generalisation can yet be made about the physical differences of the green turtles which nest here. It does seem, however, that a small portion of the population has distinctly elongate shell conformations.

POPULATION TRENDS

There is less general agreement as to the current status of the green turtle. Some people feel that they are as plentiful as ever, others feel that there has been a significant decline. I believe that there has been a slight general decline and that this is more pronounced in areas of high human concentration than in sparsely settled areas.

One example of this would be the common practice of people who eat turtles to travel to SDA areas to hunt turtles. The reason given is always that there are more turtles there.

The fact that there is, as yet, almost no market for green turtles may help explain its stable population. The human population is also still quite low compared with most places. There is also, the possibility that Solomon Island greens nest in areas such as Australia where they are largely protected and thus the depredations of human egg eating may not be as severe as it is on the hawksbill.

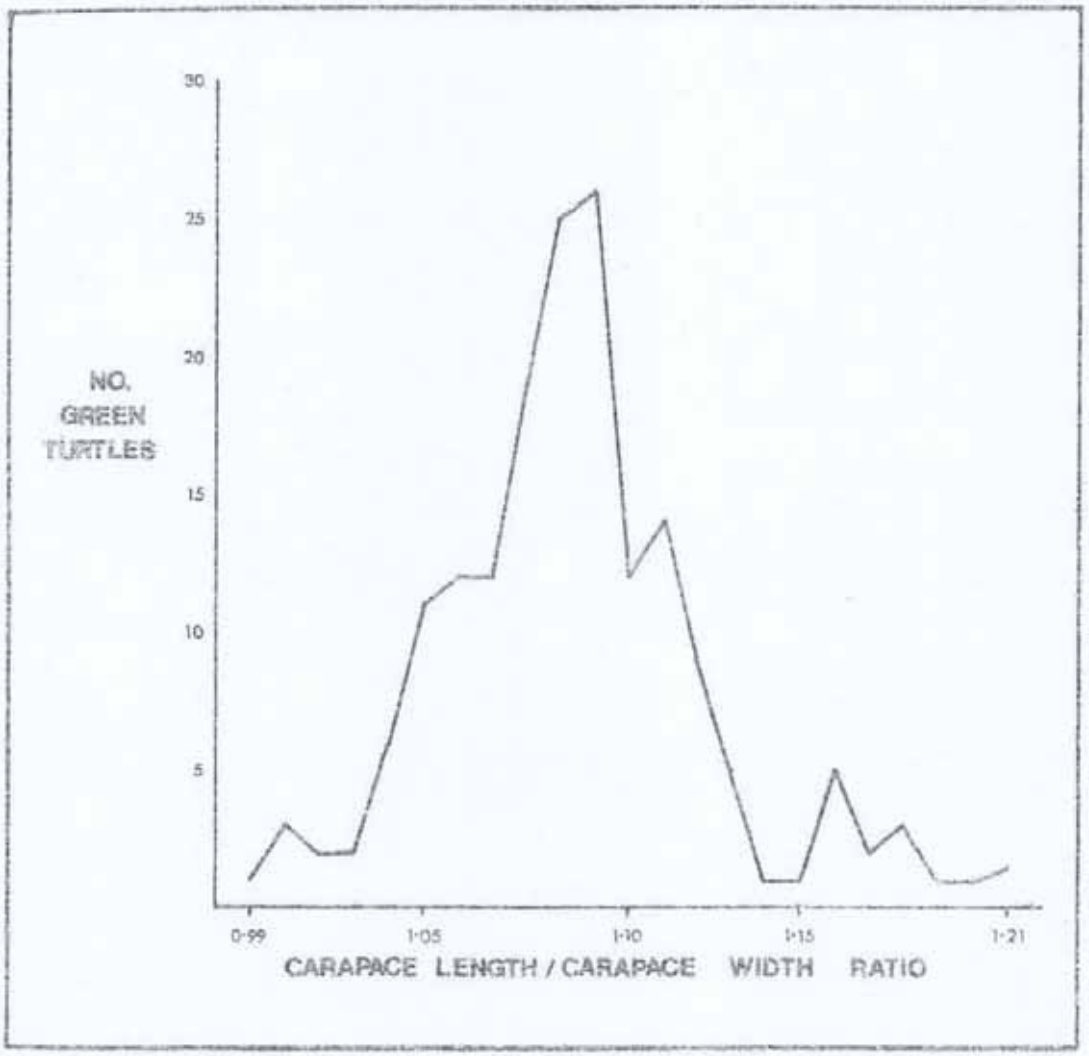


Figure 2: CL/CW Ratio Distribution Curve (N = 174)

Two points not on Figure : One at 0.97
One at 1.35

LEATHERBACK TURTLE *(Dermochelys coriacea)*

DESCRIPTION

Only mature females have been observed. They are very fleshy and more tapered than the other turtles. The whole of the dorsal surface is dark gray with large (diameter 2 cm) white-pink spots scattered unsymmetrically. 5 longitudinal ridges (McKeown reported some with 7) run the length of the carapace and are knobbed, or bluntly serrated. The head is similar in colour and the number and size of the white dots increases towards the crown. There is a large, white-pink star in the centre of the dorsal surface of the head.

One female measured 165 cm long, had a head width of 16 cm and a flipper span of roughly 269 cm.

ECOLOGY

Nesting behaviour for the leatherbacks is different from that described for greens and hawksbills. (See McKeown 1977). The following differences were noted:

(1) The turtles were slow to beach and ascent the beach

(2) Choice of nest location is open part of beach

(3) Prominent body-pit is excavated

(4) Turtle keeps a constant rhythm while digging and does not stop to rest

(5) The tail is used to prevent sand from falling into the hole and to push sand to one side

(6) During ovipositioning, the cloaca is set to one side and the opposite flipper is used to "shade" the nest

(7) Great effort is put into disguising the nest

(8) Very few false crawls are seen

It has been noted by other authors that leatherbacks nest predominantly on black sand beaches in Solomon Islands. (McKeown 1977; McElroy 1979). Other common characteristics of nesting sites are listed as - association with river mouths, beach platforms free of vegetation, deepwater approach and steeply sloped high energy beaches.

Examination of 22 beaches, however, revealed that only two characters were present at 100% of all beaches; the river mouth and deepwater approach. These two may be inter-related as coral has a low tolerance for fresh water. The absence of coral and rock would be an advantage to this large, soft shelled species.

Analysis of the sand at nine of the leatherback beaches showed that they are predominantly black, lithic sand with feldspar, pyroxene and olivine as major components. Small amounts of calcareous sand is present in most. Magnetic oxides made up 5 to 25% of the sand on at least six of the beaches.

The possibility that this magnetic oxide could serve as a clue for nesting leatherbacks has been considered. There is, however, little correlation between the percent of magnatite and the use of the beach. Litoghahira has a 20% concentration and high nesting activity but Kabilaba has a 25% concentration and much less nesting. (Appendix 4 gives full details of the sand composition).

One surprising fact is the large number of beaches which leatherbacks utilise. 61 beaches were identified in Ysabel and the West as having nesting: 15 of these as having significant nesting (10 or more per year). Most beaches report only one or two nests per year and beach selection seems to be more "opportunistic" than not. There are many stories of people marking turtles and later hearing reports of their renesting elsewhere, McKeown recorded one story on Ysabel and I know of another which tells of a turtle which nested at Tangarare, Guadalcanal and was later seen nesting on Makira. No tagging studies have been done to test these stories.

LAWS, REGULATIONS AND THE NEED FOR CHANGES

Since 1971 leatherbacks have been fully protected by Fisheries Regulations. This law is now widely known, has been enforced several times and numerous warnings have been issued to first time offenders. I believe, however, that the law does not serve either the best interests of Solomon Islanders or the turtles.

For reasons of taste not everyone eats leatherbacks. Those that do consider it a special treat and a very strong part of their traditions and rights. The present law cuts across the traditions of these people and offers no hope or promise of future compensations. Observation of the law will win the person nothing and disobeying it means only a very slight chance of penalty. The argument that the law is there to keep the turtles from disappearing holds little water because if the law is obeyed it means that the turtles totally disappear from the lives of Solomon Islanders, right now!

Thus, the law is seldom obeyed and makes people criminals for following their ancestral ways. The law also creates a lot of discord where there should be harmony (between fisheries development workers and village fishermen) and probably keeps a few turtles from being killed. Leatherbacks are so big and so few people like them anyway that it seems that it should be possible to create a situation where a few leatherbacks are killed, a lot of people satisfied and the turtle population not unreasonably endangered, perhaps even less so than at present.

It has been proposed that the best way to get people to conserve is to get turtle hunters involved and show them that they stand to benefit from conservation measures. (Mrosovsky 1979; Bustard 1980). They must, of course, then be allowed to benefit. I believe this sustained yield concept would be more acceptable and effective than the total ban now imposed. People would be more willing to forego the eggs if they knew they could eat the meat. This would also follow old customs in many places; it is logical, makes sense to villagers and is easily explained and, above all, it is not offensive to the lifestyles of subsistence peoples. Enforcement might also be less of a problem, as such a law would have the support of local leaders who wield much control over their villagers; policemen would be more willing to enforce such a law and magistrates would be more inclined to punish offenders.

Because the ecology of leatherbacks is poorly understood, certain precautions should be taken first but I believe the following plan is workable in Solomon Islands.

(1) The largest most important nesting beaches should be fully protected under national or provincial law. These should include Litoghahira and Sasakola in Ysabel, Tetepare and Vacho in the West. The best beaches on Malaita, Makira and Guadalcanal should be identified and also included in this list.

(2) Eggs should remain totally protected.

(3) A small number of licenses should be issued for each island through fisheries extension officers. The fee should be about $20, large enough to dissuade people who do not really care but not too large for villages who do. No more than 15 permits per major island should be allotted per year.

(4) Extensive advertising of the law through posters, radio and local fisheries staff should go on each year until the law has been well aired.

(5) Very heavy fines should be imposed and enforced on violators. These cases should be advertised.

DISTRIBUTION AND ABUNDANCE

Nothing is known about leatherbacks except where they beach to nest. No feeding grounds are known.

YSABEL

There are four important beaches on Ysabel but Litoghahira has the heaviest nesting. 12 nests were laid on the nights of the 22nd and 23rd December 1980 and another 40 nests were present on the beach. A return trip on January 26 showed that an additional 25 nests had been laid, to make a season total of at least 77. There is copra but no permanent resident at the beach; the owner lives in Fia some 45 miles away. Utilisation of the beach by men is moderate.

Lilika, Sasakola (Allardyce) and Katova are all about the same, with Sasakola slightly better than the other two. There is a village at Katova but I believe local enforcement of the law has been good. There were 20 nests at Sasakola on 24 December 1980.

CHOISEUL

Only one major beach at Vacho, where 50 to 100 nests are laid annually. There were 18 nests there in June 1980. The owners live in nearby Vuranggo and the beach is heavily used; turtle eggs and meat are considered a delicacy.

NEW EGORGIA

Only Tetepare and Mbaniata are important. Tetepare is uninhabited and only rarely visited; nesting is estimated at 50 to 100 but could be more. Mbaniata has a village on the beach and the area is heavily used. Nesting is less than 50 nests per year.

SHORTLANDS

No important nesting but leatherbacks are occasionally seen at sea. Significant nesting on nearby Bougainville.

MAKIRA

Two beaches are said to have more than ten nests per year, they are Nanata and Nuelili. Time did not allow a visit here and it is not known what sort of utilisation the areas receive.

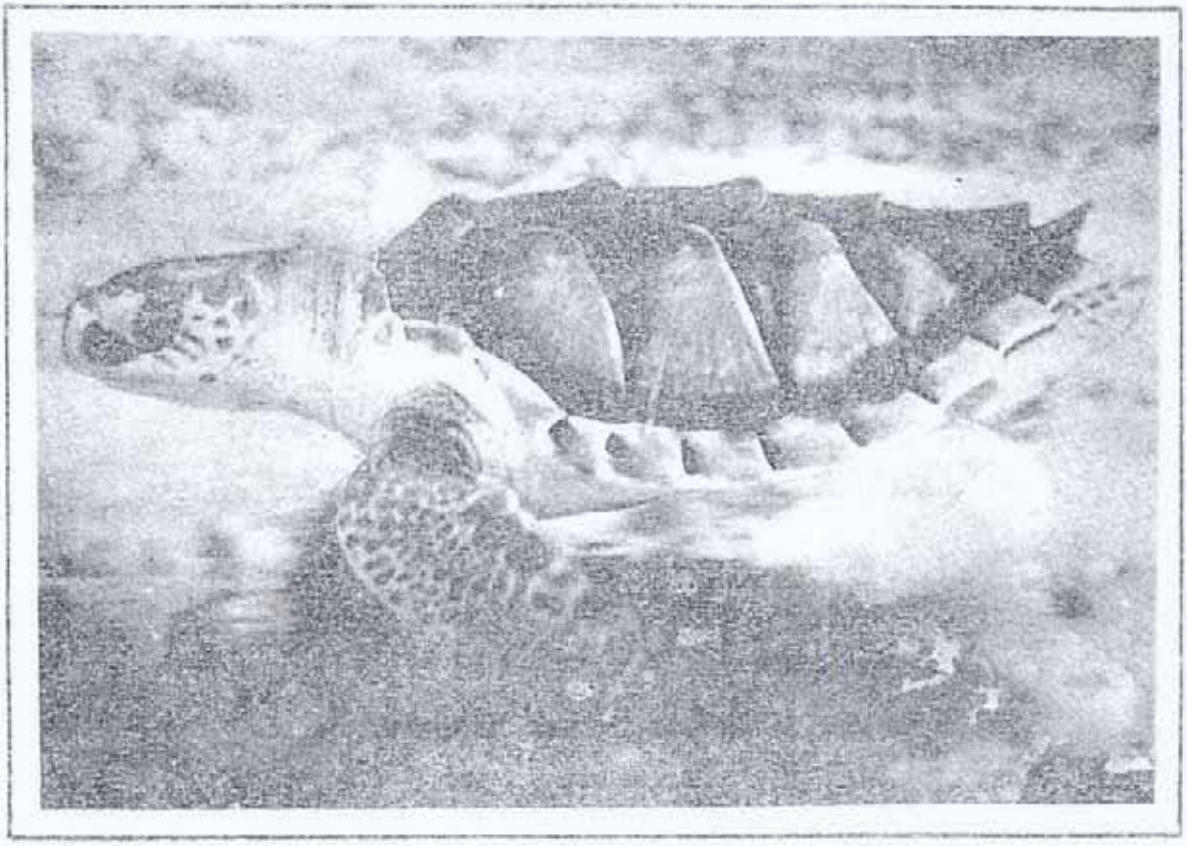
POPULATION TRENDS

Again, this can only be discussed in terms of nesting females and opinions are quite varied. Certainly no precipitous decline similar to the hawksbill has taken place but, I believe a very gradual decline in nesting has occurred over the past forty years.

At least two beaches, Mbaniata and Katova, have decreased in fertility since the war. Both of these beaches are associated with villages and the information comes from old men who have lived there their whole lives. It is not known what the situation is on isolated beaches such as Litoghahira but no decline is reported.

Any decline which has occurred is attributed to a breakdown in old customs, an increasing human population and a decreasing number of remote beaches.

OLIVE or PACIFIC RIDLEY TURTLE *(Lepidochelys olivacea)*



Rare photograph of Pacific Ridley

McKeown reports three of this species, a mating pair from Guadalcanal and a juvenile from Makira. I identified five hatchlings from a nest at Kirakira, Makira in December 1980. The carapaces were dark green-gray and the plastrons a pale yellow. They walked on land with an alternate flipper gait. Coastal scute counts ranged from six to seven and central scute counts from five to seven.

Two other successful nestings by ridleys have been reported to me from Makira since 1976 and one hatchling was seen in Shortlands in early 1981. (Mike McCoy, personal communication).

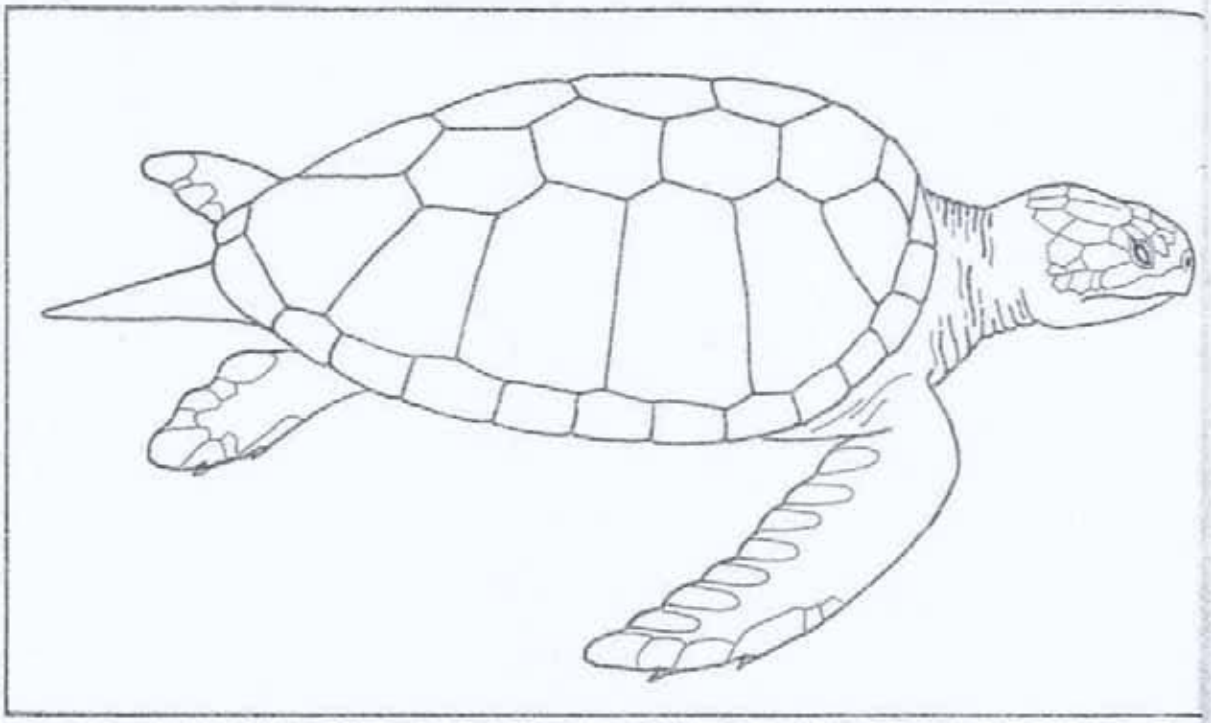
TABLE 7: Data on five, 17 month old, domesticated ridleys*

#	CL	CW	PL	PW	#Costal	#Central	Growth Rate**
1.	28.5	30.5	22.8	26.9	6	6	1.4 cm/month
2.	21.7	22.2	18.0	20.5	6	7	1.0 cm/month
3.	25.2	25.8	21.0	23.5	7	6	1.3 cm/month
4.	19.0	19.8	16.0	18.3	6	5	0.9 cm/month
5.	26.8	28.2	21.9	25.5	7	7	1.3 cm/month

* The turtles were being kept by Mr Mathias Ramoni, President of Makira Ulawa Province, in a wire enclosure in a protected grass flat. They had been fed shellfish originally and papaya and raw fish more recently. They hatched from a black sand beach directly in front of Kirakira on 7 July 1979 and appear to be very healthy.

** Assumes an original hatching size of 4.0 cm.

LOGGERHEAD TURTLE (*Caretta caretta*)



No specimens, shells or stories of recent capture were gathered during the survey. It is positively identified only from one individual and one skull. (McKeown 1977).

The loggerhead is known and named in some villages but there are also large areas where people misidentify the picture and have no knowledge of it.

People who do recognise it and are able to describe it, report only having seen one or two. It is recognised as a "devil turtle" in many areas, is blamed for the drowning of a man in Kia and is considered by many to be poisonous. In Poro, Santa Ysabel, the capture of one is a good omen for the prospects of the green turtle hunt.

No nesting has ever been recorded. The loggerhead is considered very rare in Solomon Island waters.

HATCHLING TURTLES & HEADSTARTING

Rare emergence during daylight hours

Numerous reports of hatchling sized and slightly larger turtles were received from fishermen in various places, but most notably from both coasts of Choiseul. These young turtles off Choiseul are possibly those from Arnavon Sanctuary. A very strong current sweeps past these islands, and drift-bottle tests indicate that small bottles dropped off the nesting beach end up on the shores of Choiseul and one was found in New Ireland.

The turtles are always reported to be drifting amongst the long skeins of rubbish and seaweed which are concentrated by currents and wind, and are almost always said to be at least a mile from shore in the deep ocean. They have been reported singly and in small groups. One man reported catching two small greens that were adrift on a log in Vella Gulf.

On February 4 and 5, 1981 four half hour test nettings were done on the north coast of Ysabel, down current from Hakelake. In each test, a 2" mesh trawl net was pulled through long skeins of algae and rubbish at distances varying from 1/2 to 5 miles offshore.

No small turtles were seen or caught but three large green turtles were spotted near the skeins.

HEADSTARTING

Four batches of approximately 300 hatchlings each were kept for periods of two months. They were fed on cooked fish and weekly growth measurements were taken. They were eventually released in the deep water just off the nesting beach at Kerehikapa.

Individual growth varied greatly but an average growth rate of 3.7 mm/week was achieved. There was an average increase in weight of 3.4 g/week. These are comparable figures to those McKeown found and also to the growth of the young ridleys kept at Makira.

An overall mortality rate of 15% was experienced. Most deaths were of indeterminate causes. We had no trouble with fungus infections as water was changed daily, and the tanks treated once weekly with disinfectant. It was found that if food was kept in the tank for all of the daylight hours, the degree of aggressiveness and resulting flipper bites was greatly reduced.

There was a marked correlation between the original size of a hatchling and its chances of survival in the tank. Figure 3 shows the chances of survival of a turtle vs its carapace length at hatching. Smaller hatchlings had a markedly greater mortality rate. The one batch which registered a very high mortality rate (41%) came from a nest in which there was only a 53% hatch success and virtually all of the failed eggs were either near full development or had hatched but died in the nest. This batch was the smallest we measured at only 3.6 cm in length.

It is likely that this low survival of small hatchlings would be seen in the wild as well. Although conditions in the sea are probably much different from the conditions in the tank, I would presume that they are more demanding on the whole. This high mortality rate of small hatchlings may act as one of the parameters which determine the relationship between the number and size of turtle eggs in the full complement of each clutch. It was also noted, though not tested, that the turtles which died from batches of large mean carapace length, tended to be the smaller turtles. It is not known whether the small size in these turtles was solely genetic or simply a symptomof some other underlying malady which proved fatal.

The ecological impact and conservational benefits of head starting are controversial topics. The basic idea is to give a significant number of turtles a hand over the first few months of life, which are considered to be the most critical. What is not known is how the rearing affects their ability to survive in the wild or later come back to nest. Many objections have been raised and some few benefits proposed; a full discussion of the topic is beyond the scope of this paper.

There has, however, been one very noticeable and positive effect of headstarting programme we have undertaken. It has opened up a route of communication and education between the project manager and the project workers, and thus to the villagers who the project is supposed to benefit as much as the turtles. Dr Carr stated that his "Operation Green Turtle" did a lot more than drop off a bunch of turtles around the Carribean, but also helped to ease tension and foster goodwill between people of different nations. (Carr 1973). I believe that a well run headstarting programme can serve a similar, if more modest, function in Solomon Islands. A batch of young turtles is the perfect starting point and prop for a discussion of conservation and it shows that we are doing more than just making laws which say people can not kill turtles.

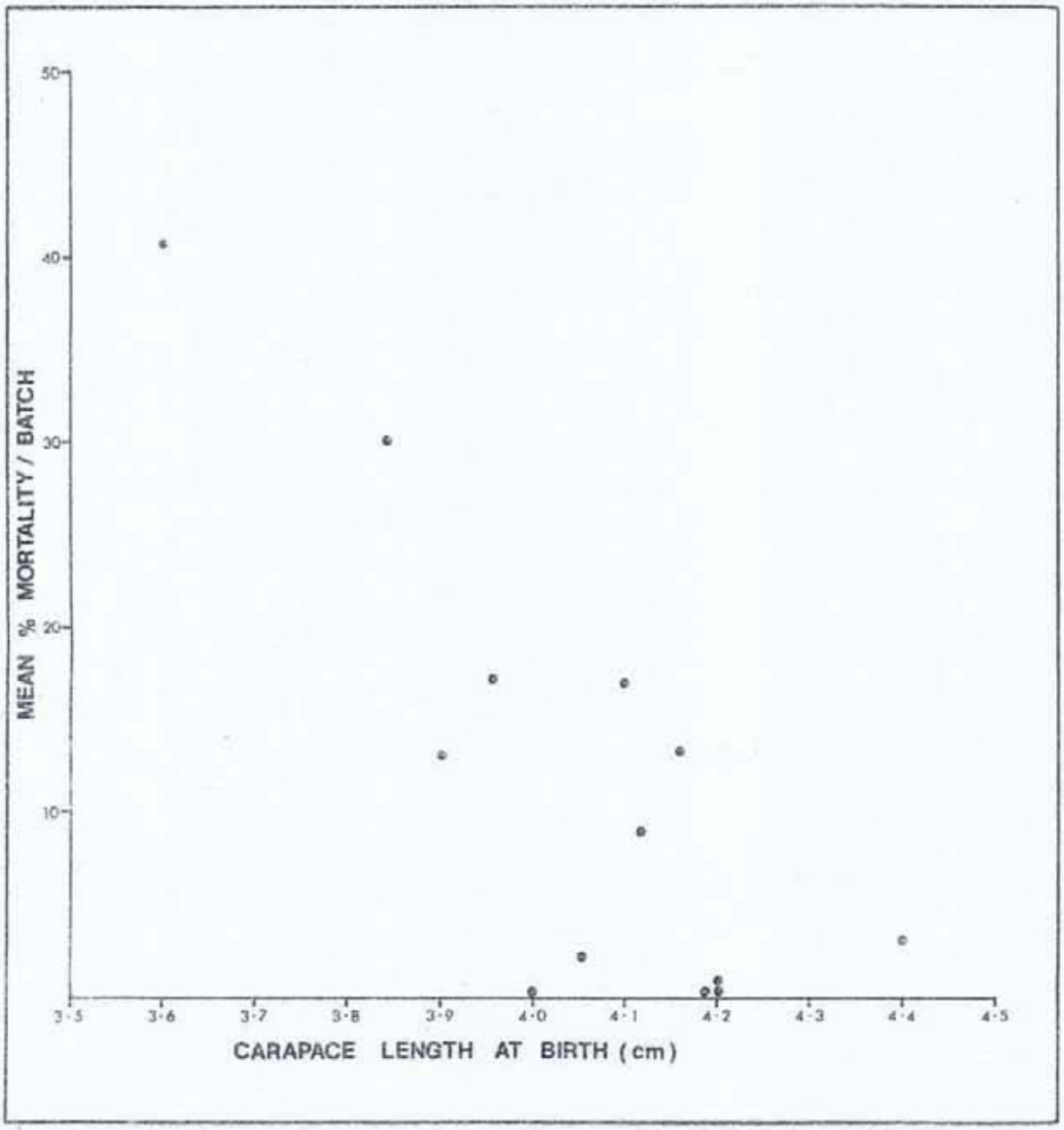


Figure 3: Mortality rate vs Carapace Length (at birth) for Hatchling Hawksbills

(N = 749 turtles in 15 tanks)

Average mortality = 15%

POISON TURTLES

Human illness and death caused by the consumption of turtle is an infrequent but widespread phenomenon, (from a letter by Dr J R Hendrikson; Annon 1969). No work as to the cause of the poisoning has been done in Solomon Islands but a cataloguing of the information available is here presented.

It should be noted that the vast majority of Solomon Islanders have never heard of a case of poisoning and are incredulous that I ask the question. The most frequent response to my questions is a laugh and a joke about the good taste of the flesh.

Unless otherwise cited, these cases were reported to me by villagers. Documentation of these cases has so far proved impossible. Most of the incidents occurred some years ago and in many cases there was no known attending physician and, even if there was, he has very likely left the Solomons by now. Many of the cases, however, were known to people in more than one village and the stories usually substantiated each other.

POISONING

(1) "In the past decade (1959-1969) there have been three recorded deaths here resulting from poisoning after eating turtle". (From a letter from the Western Pacific High Commission. Anon. 1969).

(2) 1957-58, Ghupuna, Santa Ana. One man died quickly after eating an unidentified turtle. "Turtle looked different".

(3) 1963, Lilisiana, Malaita. Five members of a family died from eating one turtle. The turtle implicated was a loggerhead; in 1964 another specimen was taken to the police in Auki so that they would know to warn people. The original turtle was said to have very short and straight intestines. Dr John Kilatu from Sikiana was the attending physician.

(4) 1970, Raja Plantation, Santa Ysabel. One man died and several took ill after eating a leatherback that nested there.

(5) 1970, Mbopo, Vangunu. Several people are said to have died after eating an unidentified turtle.

(6) 1972, Kwai, Malaita. Six persons are said to have died and several taken ill after eating an unidentified turtle.

(7) ?, Nggela. One death and three illnesses after eating an unidentified turtle. Dr Francis Kikolo was the attending physician.

RELATED INCIDENTS

(1) At Easter, 1980, a green turtle was killed at Ramos Island, Santa Ysabel, by people from Poro. The meat was so bitter it was discarded; no illness resulted.

(2) Occasionally, hawksbill are caught which have unusually pale plastrons and very short, straight intestines. These are considered poisonous and are not eaten. This was reported from villages on three islands.

(3) Many people consider the loggerhead to be a "devil" turtle and its meat is thought to be poisonous.

(4) Gilbertese suffer occasional illness after eating salted and dried turtle.

(5) 1972, Kariki, Shortlands. A dead hawksbill floated ashore; cause of death unknown. The men who found it claimed it did not smell and they cut it up to eat. Eight dogs who got into some of the meat got sick, however, so the men did not cook the flesh. After three days all eight of the dogs died.

The only lead as to the cause of the deaths is the fact that it is widely believed that poison turtles, particularly hawksbills, have short straight intestines. It is conceivable that such a deformity could somehow help to concentrate poison that the turtles pick up in their food. Because of the nature of their diet, this might be particularly true in hawksbills.

NB: Since this report was written, Fisheries Division has received a communication on the subject from Dr John Kilatu. He states that the information relating to Lilisiana in 1963 is erroneous. He added, however, that Dr Enele Karuru attended a fatal victim of turtle poisoning on an artificial island (Saua) at Tae, North East Malaita in mid-1956. Apparently, the whole liver of a hawksbill was lightly grilled and eaten. The man died 2 hours later. Dr Kilatu reported that "some" people of Perasubua were also "lost" after eating meat from the same turtle.

In Dr Kilatu"s opinion the principal agents of poisoning are the poisonous jelly which is eaten along with seaweed in the debris skeins. These, he suggests, contain lethal toxins which are accumulated in the liver and slowly excreted through the bile. Usually people of Malaita are very careful not to rupture the gall bladder when removing it or do not eat the liver. However, he added, that he has seen some people of Ysabel purposely break the gall bladder and mix the bile with the blood and fat in the shell during butchering. This, they say, will make the "turtle taste nice".

NATURAL PREDATORS

It is generally believed that natural predators play a significant role in the ecology of marine turtles, but are not responsible for recent population declines. (Stancyk 1979).

NEST PREDATION

Observations made on nesting beaches in Solomon Islands support the theory that human predation on nests is more significant than non-human predation.

(1) Iguanas

Iguanas are present on all mainland beaches and approximately 50% of the offshore islands. Local people credit this reptile with a great deal of nest predation, but of 112 nests (all three species) seen during the survey, only three were known to have been excavated by iguanas. Iguanas do not occur in the Arnavon Islands.

(2) Crabs

Ghost crabs (*Ocypode spp.*) burrow into the nests individually although sometimes two or three crabs may attack a nest simultaneously. 64 of 341 hawksbill nests (19%) on Kerehikapa were dug into either by ghost crabs or hermit crabs (*Coenobita spp.*) which attack "en masse". Figure 4 shows that there is no correlation between the age of the nest and the probability of its being located by ghost crabs.

Untested observation suggests that hermit crabs, who account for only a small fraction of all initial attacks, tend to attack those nests which are near the surface and usually within a few days after ovipositioning. It is also thought that they are more likely to enter a nest after a ghost crab, rat or something else has penetrated the nest. This has been observed for other predators. (Stancyk 1979).

In all cases where crabs entered nests, they were dug out. Of the recovered nests, 12 (19%) were excavated a second time and 2 (17%) had a third excavation. These are the results one would expect if one excavation bore no relationship to another (after reburying) and if the age of the nest did not affect the ability of crabs to find it.

Of 64 hawksbill nests infested with crabs, only 12 (19%) were completely destroyed as a result of crab predation. Our activities most likely served to lower this rate to a point below what it would have been in undisturbed circumstances.

(3) RATS

Rats are not normally mentioned as nest predators by Solomon Islanders, but Hendrikson lists them as a predator in Malaysia (Stancyk 1979) and they are suspected of quite heavy predation on Sikopo, Arnavon Islands. Trapping of rats has just recently been begun on Sikopo and no assessment of its impact on nesting success can yet be made. Observation suggests that rat predation is heaviest in the first week after nesting.

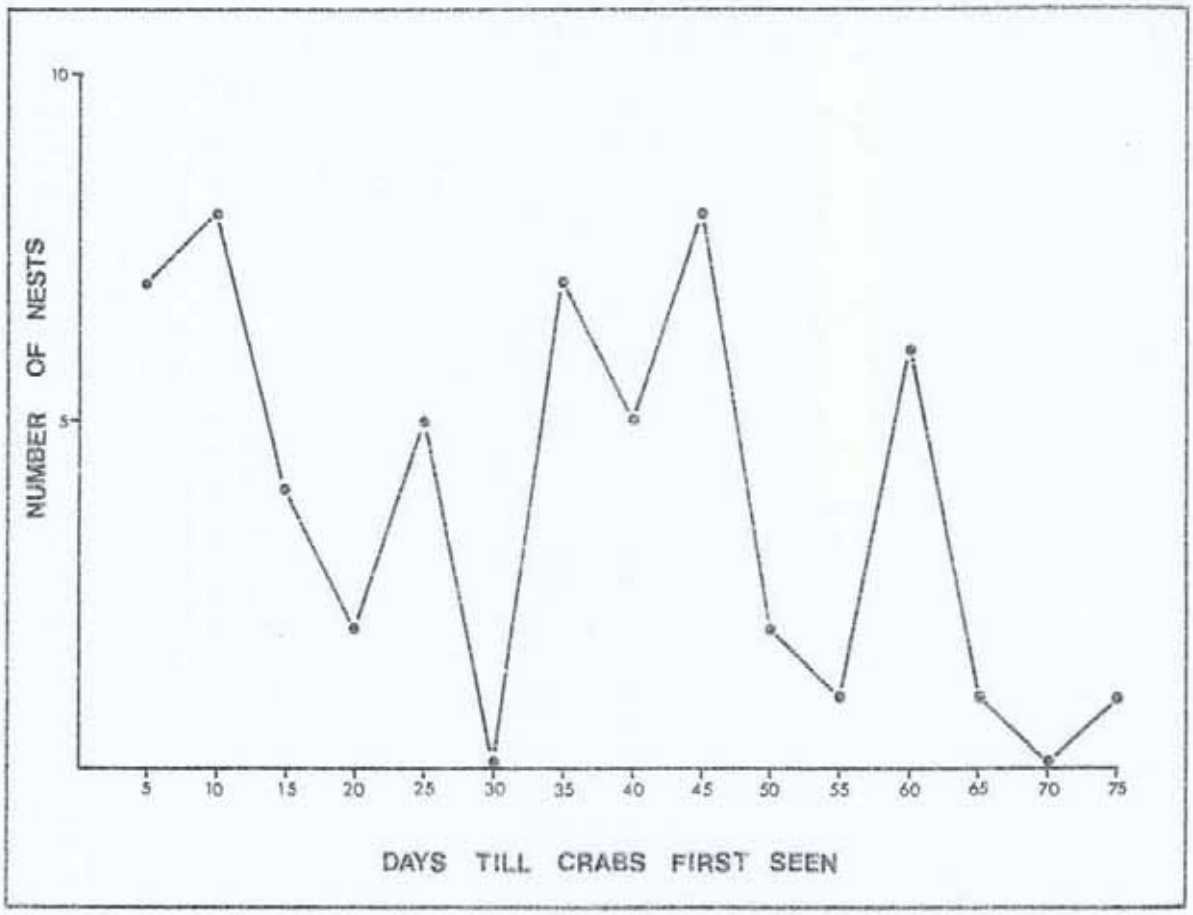


Figure 4: Crab Predation on Hawksbill Nests

(N = 64 nests = 19% of all nests)

(4) Other Mammals

Pigs and dogs are the only other mammals which might be responsible for nest predation on mainland beaches. I have never heard either accused but both have been implicated as nest predators elsewhere. (Stancyk 1979). Pigs are heavily hunted; it may be that they avoid beaches because of the high likelihood of encountering men. I have even seen wild dogs roaming beaches but have not seen evidence of them digging up a nest.

(5) Incidental

Two hawksbill nests were dug up on Kerehikapa by other nesting turtles and three were dug into by nesting megapodes (*Megapodius freycinet*). While excavating a hatched nest on Sikopo, a megapode egg was found amongst the shell cases.

(6) Physical Factors

52 hawksbill nests (15%) were either destroyed or lost trace of due to storms, high tides and sand displacement. A slightly higher percentage of green nests were lost; it is assumed because they tended to nest lower on the beach.

HATCHLING PREDATION

Terrestrial predation on hatchling turtles is minimal on Kerehikapa. The beach is very narrow and hatchlings are able to traverse it in a few minutes. Most hatchlings emerge at night, and this may give them some protection. (Balazs 1979a). Only a few nests were seen to emerge during the day. No predation by birds, rats or crabs has been directly observed, but studies of tracks indicates that all three may be predators.

Black tipped reef sharks have been observed feeding on hatchlings inside the surf. After taking the initial turtle, the shark will circle in the area looking for others and several are often taken.

Roughly 200 reef fish were caught off the nesting beach for our consumption but only one, a red snapper (*Lutjanus sebae*), had two hatchlings in its stomach. Possible explanations of this are: too small a fish sample taken, short gut retention of the hatchlings, or a low rate of predation (for any number of reasons). Lack of evidence for predation by reef fish was also noted by Balazs in Hawaii. (Balazs 1979a).

MATURE TURTLE PREDATORS

Sharks are the major known predator of post-hatchling turtles. Many people have witnessed shark attacks on turtles, and are always impressed with the intensity of the attack.

Of 161 hawksbill and green turtles, 20% of the greens and 24% of the hawksbills had some form of predator damage. This is roughly twice the figure found by Balazs in Hawaii. (Balazs 1979a). Most commonly, the rear flippers and posterior carapace were involved but one large green turtle was found floating alive in the Shortlands with both fore-flippers completely severed.

One attack which was described to me revealed behavioral defence by the turtle. An eight foot shark attacked a large hawksbill in the "Slot", off of Choiseul, three times. At the last second of each charge, the turtle rotated its body so that the broad dorsal surface of the shell lay perpendicular to the angle of attack. The shark was unable to close its jaws on this surface. Between attacks the turtle did not try to escape and eventually the shark left.

Fisheries Division is planning a survey of sharks caught on longline tuna boats. It is hoped that Solomon Taiyo will aid in doing the census of stomach contents which might help reveal the extent of shark predation in Solomon Islands.

I have heard two accounts from separate areas of Santa Ysabel of leatherback turtles being attacked and killed by crocodiles while the turtle was eating.

CULTURAL SIGNIFICANCE OF AND SUBSISTENCE IMPACT ON MARINE TURTLES

> "The green turtle was a human being. People want to swim and they pushed the turtle into the ocean where it sank, becoming something belonging to the ocean. It just stayed and lived in the ocean and became a fish, but originally it was a human being. When it was pregnant it came back ashore here. It dug a hole, laid its eggs into it and went back to the ocean. The turtle is like this; a person which went and fell into the ocean and became a fish; but it thinks about returning to the seashore to find an island home. When pregnant it comes ashore, lays its eggs and returns to the sea. This is the ending".
>
> (Kuschel, 1975 - Animal Stories from Bellona).

The close traditional affinity people feel for turtles is manifested by this short story. The relationship of men to turtles has, however, been greatly changed by external forces over the years. Western culture has influenced the people of Solomon Islands since the days of Mendana, but the greatest impact has been felt since the conclusion of W.W.II.

One fundamental change was the mass migration of people from the bush to the seashore to take advantage of shipping. Often, whole villages moved, leaving the bush almost totally unpopulated on some of the islands and concentrating populations on the coast. With this movement, people used sea products more frequently and as many of the villages relocated on sand beaches, utilisation of nesting turtles and turtle eggs increased. Today, 53% of all villages on Choiseul and Ysabel are located on beaches.

Another, very much related problem, is that as a result of vastly improved medical care and other factors, the Solomons is experiencing an annual growth rate of 3.4%, which ranks it as one of the world's fastest growing nations. The human population has grown from 161,000 in 1970 to 221,000 in 1979. (MacFadden 1979). The vast majority of these people still rely on subsistence food for a major part of their diet, which is reflected in the fact that 5,005 villages (99.3% of all villages) have fewer than 300 inhabitants. New villages are constructed constantly to provide garden and fishing space; two were begun near Kia during the course of the study. Although these villages are usually small, their impact on turtles is potentially great. The villages are often located on sand beaches which decreases that beaches' fertility. At present, there is a village, on average, every two miles along the whole of the Choiseul coastline and this is one of the least populated islands.

The nature of Solomon Islands lifestyles must also be examined to fully understand the impact of subsistence use of turtles. Sand beaches receive an inordinate amount of use for the following reasons:

(a) Most beaches are not alienated land but are owned by custom law. Permission to use them and their resources is almost always granted to anyone who asks.

(b) Beaches are often used as roads between villages.

(c) 70 to 85% of all beaches have copra, a temporary house (often used to wait for turtles) or a permanent village on them.

(d) Beaches are the location of many resources other than turtle eggs, such as megapode eggs, shells and clams. A great deal of beach combing is done by villagers.

(e) Beaches are a favourite location for picnics and other forms of recreation.

(f) Beaches are often the only safe spots for canoe landings.

What this all adds up to is that the beaches are not as remote as they appear and most of them are heavily used as a result of widespread search patterns by a large number of widely dispersed villagers. In fact, 67% of the 76 nesting beaches which were toured were given a "high" human useage rating, which we defined as a visitor per week or more. This is the approximate length of time that a turtle nest remains highly visible and easy to locate.

The increased use of outboard engines and fibreglass canoes has facilitated the expansion of beach use, but increased petrol prices and decreased copra prices may restrict engine travel in the future.

Because the utilisation of beaches is high, the utilisation of turtle nests is correspondingly high. Turtle eggs of all species are eaten and they are always taken if they can be found. Only two exceptions to this were noted. A few Gilbertese on Wagina leave occasional nests to hatch. I believe this is a recent development and may have been influenced by the presence of a conservation officer there from 1975 to 1977. Villagers of Ghaumai, Shortlands, always open one egg before excavating the nest; if it is too developed the eggs are reburied rather than dug up only to be thrown away later. Even many people of the SDA faith eat turtle eggs.

During the survey, 124 leatherback nests were seen; of these, at least 51 (41%) were dug for and 31 (25%) had been found. Of 60 hawksbill and green nests, 30 (50%) had been dug for and 26 (43%) found. These figures are probably somewhat lower than actual rates, as many of the nests were too old to tell for sure. Excavations were identified by obvious digging signs, footprints, the presence of pointed sticks, etc. Successful excavations were identified by broken egg shells and were usually substantiated by local people. Any doubtful nest was counted as undisturbed.

It should be noted that on beaches near human habitation, human nest predation was much higher. At Allardyce, 17 out of 20 leatherback nests had been excavated on 22 December 1980. At Maifu, six out of eight green nests had been plundered in early December 1980.

With people living on the coast, contact with Europeans increased and missionary teachings broke down many of the old traditions, some of which played conservationist roles. This has been noted in PNG as well. (Spring 1979).

Very few of the old tabus are still in effect and most of them died a long time ago. In Mbaniata, I talked to one old man who was about 70. He related that the leatherback eggs of his village beach had once been totally protected by village elders and only a few mature leatherbacks could be killed each year. When he had completed his story his 50 year old nephew told me he had never been told of the tabu before. Many other restrictions on land use have broken down giving rise to increased exploitation of nesting beaches. Other areas, such as Koliae, used to regulate the turtle catch, but no longer do. Levaleva, Choiseul, still protects hatchlings and will not allow children to keep them as pets.

Perhaps the greatest significant change caused by western influence is the introduction of cash economies, manufactured goods and a market for turtle shell. This is covered under a separate heading.

In spite of all of the changes, one thing has not altered; the villagers enthusiasm for turtle meat. The green turtle is the favourite of most people and only people who have adopted the SDA faith do not eat it. Christmas, Easter and other religious holidays are times when many villagers conduct two week long, large scale hunts for green turtles. 49 were caught in Furona, Santa Ysabel, for Christmas in 1980. (Ancn. 1981). In all areas, greens are taken individually by interested hunters throughout the year.

Most people also relish hawksbill flesh but for some the taste is too strong. These people often claim that nesting females taste much better. Rarely do groups go hunting specifically to feast on hawksbill, although this used to be done by a number of peoples in the Arnavon Islands and elsewhere. Hunting is usually done now by individuals who are looking for shell. Many hawksbills are also taken incidentally by people diving for fish or shells.

The leatherback is more selectively taken. Many people do not like the taste or smell and do not eat the flesh. Others use the leaf of the "sabota" tree to cleanse the meat, before eating it. Those that do eat the meat are very enthusiastic about it and consider its consumption to be an important aspect of their heritage. Leatherbacks are usually taken opportunistically when they beach to nest; the killing of one of them is often cause for the holding of a feast and usually involves two or more villages.

The loggerhead and pacific ridley are viewed with some suspicion because of their scarcity. They are mostly not eaten.

Nobody in Solomon Islands depends on turtles for the majority of their protein. Little work has been done to determine the contribution of turtle to the overall diet of Solomon Islanders but some information can be gleaned from the answers to one of the survey questions. A few people eat turtle once a week or more (Wagina, Kia, Ghaomai), most people eat turtle once per week to once per month and a very few have it only once per year or less. City dwellers rarely eat turtle. Turtle should be considered an important source of supplemental protein for subsistence peoples. It also has a great psychological benefit because it offers a delicious diversion to peoples routine diet. A turtle meal is much looked forward to and discussed afterwards.

The consumption of turtle at feasts the communal hunting parties and the folklore of turtles serve an important stabilising and cohesive role for people who have had so many of their beliefs changed in recent decades. Turtles are one of the few remaining strings which connect people to their heritage and which can help them maintain their identity in an increasingly complex and fast changing social environment.

HUNTING METHODS

(1) Nests

The exact location of a nest is determined in a number of ways. The most common is by reading the tracks and combining this with an understanding of how turtles dig nests to interpret sand displacement. People also employ long sharp sticks which are used either to penetrate the nest or to identify the softer ground at the neck of the nest. To a large degree, the ability to locate a nest is a function of a person's experience.

People from Poro, Santa Ysabel, identify nests by looking for a spot of sunlight, which by custom should pinpoint the nest.

The eggs of all species are eaten; only the polar eggs of leatherbacks are discarded.

(2) Nesting Turtles

Nesting turtles are found by accident; on a planned trip during a known nesting season or by predicting the return of a turtle after a first nesting. Hawksbill turtles lay successive nests at about 14 day intervals; leatherbacks at 9 day intervals. Two methods are used to age eggs; boiled eggs are opened to determine the degree of attachment of the embryo to the shell, or the same measurement is taken in raw eggs by noting the size of the white spot on the top of the egg. Maximum attachment occurs at about five days. A piece of rope with a knot tied in it for each day until the expected return of the turtle is used to mark the passing of the days; one knot is cut off each morning.

Nesting seasons were determined in several different ways in the pre-calendar days. On Choiseul, a certain type of lightning ("heat lightning", which occurs mostly in December and January) is said to mark both the time and place of a leatherback emergence. In Kia, Santa Ysabel, the flowering of a certain tree (in December) marks the season.

(3) Diving

Diving for turtles is a method which evolved only a few years ago in response to the increased price of turtle shell and the decreased number of nesting hawksbills. The Gilbertese are credited with discovering the technique and later taught Melanesians. It is now widely used, particularly in the West. People dive both during the day (which is traditional) and at night with torches along the ocean side of reefs. Mostly hawksbills are taken as they sleep in their holes. In many cases, turtles are only an incidental catch made by people diving for fish or shell. Often, large shark hooks are used to pull the larger turtles to the surface.

(4) Spears

Spears are used on both greens and hawksbills and in many places this is the most popular hunting method. There are two basis designs of spears. The first and most common is used throughout the country and is made from a long brass or metal shaft which can be barbless, or have either a fixed or moveable barb. The spear is about 12 feet long and is attached by rope to a float. Turtles are harpooned and usually die as a result of their wounds.

The second type of spear is restricted to Ghovec and Sisiga on Ysabel. It has a detachable point which is cut from a copra knife. A 'V' notch in the blade allows the point to penetrate only 1.5 inches and the turtle can be kept alive for a long period as if it were caught by hand.

Hawksbill turtles are harpooned when they surface to breathe on the ocean side of reefs. Greens are more commonly taken at night or at high tide when they come onto grass flats to feed. In a few areas, five may be taken in a night but more commonly only one or two are caught.

Leatherbacks are rarely speared because of their size and power and they are only occasionally encountered at sea. In Shortlands, however, several men will spear a leatherback and each spear is attached to a separate float. The ropes are marked at a certain length so that when the turtle tires the hunters will know when he is close enough to the surface to dive on and dispatch.

(5) Nets

This method is widely used but especially on Ysabel and Choiseul. In a few places it is tabu to allow a hawksbill to enter the net and normally only green turtles are caught. Both custom rope and synthetic ropes are used to make the nets and most villages have a turtle net which is used three to four times a year at the discretion of the chief.

Nets vary in length from 20 to 60 fathoms and are usually made in four sections which are joined in the water when used. They can be up to five fathoms deep. During the day, hunters go to feed areas and wait to see a turtle surface. When one is spotted, the net is set from two canoes in a semi-circle. Two men are stationed at the net while the others move behind the turtle from where they scare it towards the net. Often, more than one turtle can be caught at one set.

The same procedure can be followed at night but turtles are not spotted first, the net is simply set over the feeding grounds and men wrap themselves in the net so that they can feel a turtle hit the net. Sharks can be distinguished from turtles by the way they enter the net, and how they react once in the net. (Sharks usually hit the bottom and give a wild straight pull; turtles hit the top and their pull is jerky). A last safety check is to use a stick to feel for a shell.

Nets are often used over a two week period to catch turtles for a large feast. The captured turtles are kept alive in corrals on land.

Most of the greens taken by net are mature or sub-adult because the nets are normally set on the ocean side of reefs or in channels leading onto grass flats. The mesh size also allows small turtles to escape.

(6) Dropline

In Sasamunga, Choiseul, greens are sometimes caught on a fishing line which is baited with fish, papaya or banana.

(7) Canoe and Outboard

This is a method which is gaining in popularity. A canoe with engine goes onto a grass flat at high tide; when a turtle is spotted it is chased down and either speared or jumped on. Most of the turtles taken in this manner are greens of about 50 cm carapace length.

VERNACULAR NAMES

All coastal villagers have language names for the three predominant species; the leatherback, the green and the hawksbill. A few names are known for the loggerhead; no names are known for the pacific ridley. The same names are often used in several languages in adjacent areas. In a few cases, widely dispersed people use the same name. The loggerhead is known as "Kakapodoko" in both Kia and Roviana Lagoon, (some of these people are related). The word "Honu" is used by Polynesian peoples in Sikiana and in Hawaii for the green turtle. (Balazs 1979a).

It is very common in all language groups to have a general name for turtle which refers only to the green and hawksbill. Examples would be: "Tenge" (Choiseul), "Vonu" (New Georgia) and "Teon" (Gilbertese). This grouping of animals along scientifically recognised taxonomic lines is consistent with what Diamond found in PNG. (Diamond 1965).

Names often have a reference to a characteristic of the turtle. The words "Ngapo" (Ysabel) and "Tango" (Choiseul) refer to the thick shell of the hawksbill. The word "Igana" (Choiseul) means fish and refers to the fact that the green turtle is often caught in nets, like a fish.

The word "Kakapodoko" mentioned above for the loggerhead means "Brother of all turtles" and is a reference to the belief that the loggerhead is a hybrid between the hawksbill and green. The belief in hybrid turtles is widespread and has been noted in the Carribean where local people offer it as an explanation for the ridley. The belief has no known scientific base and is probably explained by the fact that people did not see it nesting, but needed a plausible explanation for its existence. (Carr 1973).

An expanded (from McKeown) listing of vernacular names is presented in Appendix 5.

COMMERCIAL INFLUENCES ON MARINE TURTLES

> "Now times have changed. The hawksbill is heavily persecuted. Its predicament in American waters can be clearly shown in dollars and cents. In 1934, hawksbill had no value; now a big one is worth a week's wages in many places in the Carribean. Under optimum conditions, when the shell of the turtle is prime, and when buyers for the by-product are available, a hawksbill will bring as much as fourteen dollars". (Carr 1973).

Dr Carr's statement is as applicable to Solomon Islands today as it was to the situation in America in 1967. The only substitutions to be made make the situation even more dire; a large turtle today may mean as much as fifty dollars to the hunter and much more for the trader.

In 1977, McKeown wrote "It is extremely difficult to gather accurate information here as in the export statistics turtle shell is lumped within the category "marine shells" and so I am very much dependent on the traders themselves to provide information". (McKeown 1977). Unfortunately, this is still very much the situation today. It is useful, however, to examine the information which is available.

SUPPLIERS

The vast majority of all turtle shell comes from the Manning Strait and surrounding areas. All four of the active traders (see below) listed either Kia or Wagina as their major source of supply. In 1979, 90% of shell received by trader No. 3 came from Choiseul. Shell is, however, bought throughout the islands; the normal channel being that the hunter sells to a local co-op or private store which then deals with the traders. Some direct dealing between hunter and trader is done in Gizo and Honiara.

The turtle hunters are mostly subsistence level villagers; there are no commercial turtle boats. There is, however, a large number of people who hunt turtle only for the shell. This group is comprised of people who do not eat hawksbill meat either for reasons of personal taste or religious convictions. (Approximately 10% of the population is SDA). (Macfadden 1979).

More significant is the increase in hawksbill hunting by meat eaters as a result of the shell incentive. In this group, the meat is normally consumed but most hunters listed money as the major reason to go hunting. This is in direct contrast with the incentive for green turtles which, with few exceptions, is for food.

At one time, several families on Wagina supported themselves solely on the sale of turtle shell and a few other marine shells. With the closing of the Arnavon Islands and a general decrease in the number of turtles, no one now relies solely on turtle shell. Even with the new high price the time required to find enough shell is prohibitive and so the shell is now used mostly as a supplement.

A somewhat less significant amount of hunting is done by wage earners on weekends and holidays to supplement their salaries.

BUYERS

There are thirteen traders in Solomon Islands licensed to deal in marine shells. Of these, eight responded to a questionnaire sent out in early 1980. The results are presented Table 8.

TABLE 8: Traders in Turtle Shell

Trader	Years Trading	Export to	Product	Suppliers	1979 (kgs)
1.	6	Pacific Is.	Artifacts	Kia, Marau	33
2.	4	Japan	Artifacts	Ysabel	82
3.	7	Japan	Bulk shell	Choiseul	594
4.	4	Japan	Bulk shell	Ysabel, Malaita, Florida	196
5.	Stopped trading due to confusing laws.				
6.	Stopped selling.				
7.	Does not trade.				
8.	Does not trade.				
9-13.	No response.				

Of the five traders who did not respond to the questionnaire, at least one is known to deal in turtle shell in quantities similar to trader No. 3. It is unknown about the other four but no fisherman I met mentioned selling to them. It is assumed here that their contribution is insignificant.

It is also not known what percentage of the total trade turtle shell comprises for the traders involved. The international market price for shell was approximately US $45 per pound in 1979, which represents a 300% mark-up for these traders; it is probably an important source of profit for them.

The vast majority of the shell is sold in bulk to Japan (85%), this includes the carapace scutes, plastral plates and marginal scutes.

Most of the worked artifacts are sold to tourists and tourist shops in Honiara, Fiji and Vanuatu, etc. The quantities are small and only a few artisans are employed in it.

IMPACT

It is difficult to accurately judge the full impact of commercial hunting on hawksbills. Reliable population censusing methods have not yet been developed, no official records are available and the little data that is available is often from partisan sources. What has been gathered is presented in Table 9 and Figure 5.

TABLE 9: Trade in Turtle Shell kg. (see Figure 5)

Plot (line #)	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
(1) Oronoa Co-op.	-	-	-	-	-	-	-	-	-	-	298	175	241	139	55*
(2) Nikumarore Co-op	-	-	-	-	-	-	436	258	288	152	91	172*	-	233*	200*
(3) Trader	-	-	-	-	-	-	-	735	1175	682	535	577*	-	594	-
(4) Solomon Is. *** **	-	-	-	-	1136	1636	3181	1818	3818	-	-	1363	1181	1363	-
(5) Solomon Is. ****	63	901	1233	1213	1469	816	1590	378	657	846	873	756	528	799	
(6) Village Price S.I. $	-	-	-	-	-	-	.90	1.00	1.70	1.60	3.50	3.50	6.50	6.50	7.00

* These figures are estimates made from the data available for partial years. In no instance is the data from fewer than five months. Seasonal variations in shell collection were found to be inconsistent, although widely fluctuating; each month was weighted equally in all calculations.

** Much of this data, pre-1979, is available in McKeown's Figure 17 (McKeown 1977). Our Oronoa Co-op figures vary because he used their sales to Trade #3(A) whereas I have used their total sales to all traders.

*** The years 1970 to 1977 are based on McKeown's unpublished data. All estimates are based on known transactions multiplied by an estimated percentage of the total.

**** Taken from IUCN figures; based on figures of importing countries. (Mack 1979).

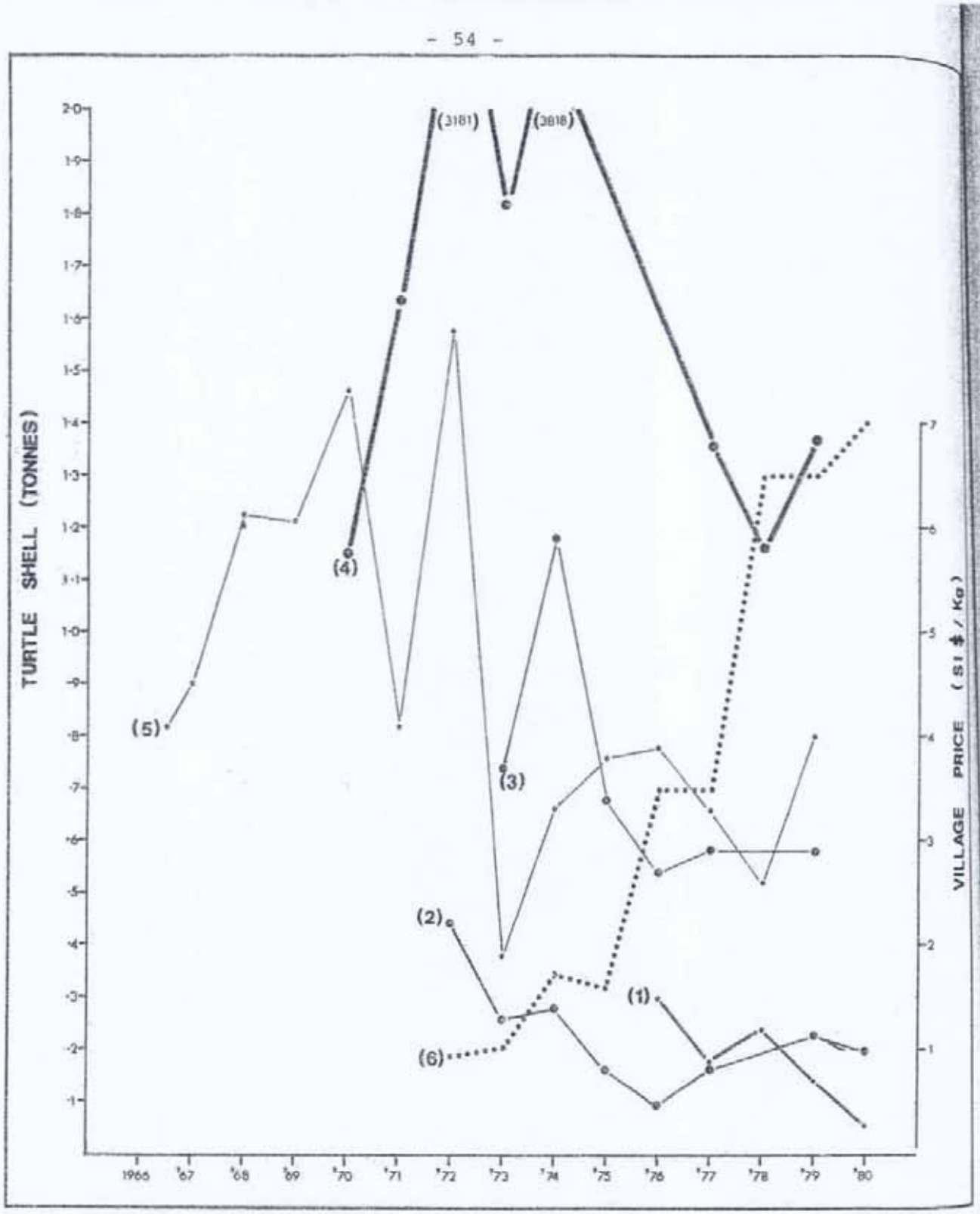


Figure 5: Trade in Tortoiseshell

Line 1. Oronoa Co-op (Kgs)
Line 2. Nikumaroro Co-op (Kgs)
Line 3. Trade No.3 (Kgs)
Line 4. Solomon Islands Total
Line 5. Solomon Islands Total
Line 6. Village shell price (SI $)

Price increases in 1976 stimulated the production of shell in Western Province. The fact that no patrolling of the beaches in the Arnavon Islands took place from 1977 to early 1979 may help to explain the increases both co-ops showed during that time, as both are located on Wagina, near Arnavon Islands.

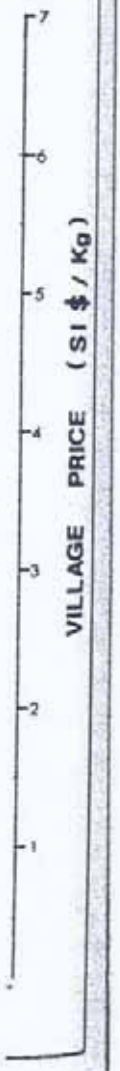
Although there have been fluctuations in all four of the indices used to show shell production, it should be noted that each of them has decreased from its original position, the two co-ops on Wagina dramatically so.

Obviously, there are many factors which influence hunting pressure and success other than the price of shell and the numbers of turtles which are available. Two other major changes have taken place and would have served to increase hunting pressure. First is population growth, which at an annual rate of 3.4% is high enough to be significant during a time span as short as a decade. Secondly, there is no continual increase in the use of and dependence on cash. One major factor has acted to decrease hunting pressure. It is more and more common for young men to take wage earning jobs which reduces the time they have for hunting turtles. This group, however, still contributes to the hunting during spare time.

In this case, with the given parameters, I believe it is fair to say that a manifold increase in the incentive to hunt hawksbills has occurred over the past decade. In spite of this large increase, there has been a marked decrease in all of the indices used to show shell availability. The only conclusion to be drawn is that the numbers of hawksbills has decreased significantly in recent years. This is the same conclusion that McKeown reached in 1977.

The exact role which commercial pressure has played in this decline is impossible to determine. Certainly, a percentage of those turtles whose shell was sold would have been killed anyway for food. There is no doubt, however, that the commercial incentive is what enticed non-meat eaters to hunt and increased significantly hunting pressure by others.

The commercial impact on cultural aspects is readily discerned. Commercial trade has been a deathblow to all artwork and artifacts which involve shell at village level. In the 21 villages I visited on Choiseul, I saw only one hawksbill shell being used as decoration. It belonged to an old man who complained that the two others had been taken by his sons to be sold. In Kia, only very small shells are kept, the rest are sold. In a few remote villages on Rendova, people still use tuna lures made from turtle shell and a Malaitan I met had only sold half of the shell and was going to use the rest for jewellery. With these few exceptions, it is fair to say that all shell is sold to a handful of traders and that shell which is worked here is priced too high for most Solomon Islanders to afford. No shell is left to serve old traditions or to enrich the ceremonial life of today's villagers. In a few years the practice of working the shell will also be forgotten and part of a rich and beautiful heritage lost forever.



OTHER MARKETS

Because most people lead subsistence level lives, there are very few organised markets. Each provincial headquarters has an open-air market and some of the larger villages have informal markets. Green turtles and turtle eggs are offered for sale on occasion. More are sold in Gizo than elsewhere, but even there, turtles are not on sale every week. A large turtle will bring up to $35; cooked, half pound parcels go for ten' to twenty cents.

Green turtles are occasionally shipped live from village to village. These are normally gifts or destined to be used in special religious celebrations and no money is involved.

On rare occasions, shell is on sale in the Honiara market. It is usually of sub-standard quality and sold at much lower prices than traders offer. Only a few scutes are offered and it mostly comes from Santa Cruz.

Japanese fishermen working on the Taiyo long line boats are known to cut open shark stomachs to look for turtle shell. What is found is taken back to Japan and sold there.

LAWS

The present law regarding sale of turtle shell is not specific, confusing, unenforceable and counter-productive as outlined below:

(a) the size limit of 75 cm does not define how the measurement should be taken;

(b) most people misinterpret the law and believe it applies to subsistence use as well;

(c) shells are always broken down to individual scutes to be sold and then measurements are difficult to make;

(d) the remote area where turtles are killed are impossible to police for violations;

(e) the easiest place to find a 75 cm turtle is on nesting beaches. Thus, people intent on observing the law will concentrate their efforts on beaches where they will harvest both the mother and the eggs. This is most detrimental to the population; "There can be no doubt that the practice of taking eggs and capturing turtles during the vulnerable nesting process has done far more harm to the stock than could possibly have been caused by heavy fishing alone". (Carr 1973).

(f) law enforcement has been lax and there is every indication that most traders deal in shell much smaller than 75 cm. Shell thickness is the important parameter for judging quality, not length,

and a small turtle can have good shell. Without enforcement, there is no incentive for traders to impose control on what hunters supply.

CITES

If the role of commercial hunting in the decline of Solomon Islands hawksbills is not yet obvious, it should be pointed out that commercial pressures have been directly implicated in the demise of several other populations of hawksbills and other species. As Rudloe points out, "but the rapid decline of the second most endangered sea turtle, the hawksbill, *(Eretmochelys imbricata)* is no mystery. Hawksbills are the source of tortoisehell jewellery which is made from carey (carapace scutes)". (Rudloe 1979). Perhaps the most dramatic declines are those of the green turtle in the Caribbean and the Atlantic ridley in Mexico, both of which have resulted in deprivations to subsistence level peoples. (From information presented in Noumea, SPC Conference on MarineTurtles).

In recognition that a large number of species of flora and fauna are actively endangered by international commercial trade, the International Union for the Conservation of Nature (IUCN) created the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES places the hawksbill turtle in Appendix 1, which includes those species currently threatened with extinction and which are influenced by trade. To date, 59 countries have signed CITES, including Pacific neighbours such as PNG and Australia.

CONCLUSION

Marine turtles play an important role in the cultural and nutritional lives of modern, subsistence level, coastal peoples. It is these people who have used turtles for hundreds of years and who should have top priority for their use today. It is these people who would be most adversely affected by a decline or loss of the turtle resource.

A wide range of complex, socio-economic factors in the post-war years have caused declines in turtle populations. In the case of the hawksbill turtle, the decrease has been precipitous. This decline is attributed to very heavy human predation on nests over many years and has been greatly aggravated by recent commercial pressure exerted by the tortoiseshell trade.

Green and leatherback turtles have suffered less dramatic declines. This is attributed to the lack of commercial demand. Additionally, leatherbacks are only eaten by some peoples and can only be hunted when they beach. The possibility exists that the majority of greens nest elsewhere where their eggs may not be subject to high human predation.

Both present laws are inadequate and ineffective. Reforms are needed which will clearly give full priority to turtle stocks to subsistence users.

Certain areas have been identified as being important nesting areas; a few account for very high proportions of total nesting. The protection of these areas by the creation of sanctuaries would be a major step towards the ultimate goal of stabilised turtle populations which are large enough and resilient enough to support subsistence hunting by local people.

RECOMMENDATIONS

In view of the information and conclusions presented in this report, the following recommendations are put forward for consideration by Fisheries Division and the Ministry of Natural Resources

LAW

(1) All export of turtle shell and other turtle products should be banned immediately. *

(2) A very restrictive permit system, similar to that outlined in the section on leatherbacks, should be instituted for the hunting of leatherback turtles.

(3) Legislation should be enacted to prevent local trade in turtle meat. Fisheries should not encourage the selling of turtle meat in local fish markets.

(4) Sophisticated or modern methods of capture should be restricted. The use of guns and outboard engines to capture turtles should be outlawed.

SANCTUARIES

National Wildlife Sanctuary

(1) Tetepare Island, Western Province. All species.

Provincial Sanctuary or Local Agreement with Landowners

(1) Arnavon Islands, Santa Ysabel. (Follow-up work). Hawksbills.

(2) Litoghahira, Santa Ysabel. Leatherbacks.

(3) Ramos Island, Santa Ysabel. Hawksbills.

(4) Malaulalo and Malaupaina Islands, (Three Sisters Group), Makira. Hawksbills.

(5) Vacho Rivermouth, Choiseul. Leatherbacks.

(6) Haycock (or neighbouring islands), Choiseul. Hawksbills.

(7) Ausilala (Autarara), Shortlands. Greens.

(8) Bagora and Obeani Islands, Shortlands. Greens and Hawksbills.

(9) Mariu and Kulokulo Islands (Helebar Group), New Georgia, Hawksbills.

ARNAVON SANCTUARY

(1) Management of Arnavon Islands should be placed under

the control of a Solomon Islander (Andrew Age).

(2) Wardens should maintain a constant presence on the islands to prevent poaching.

(3) Complete nesting records should be maintained for Kerehikapa only

(4) Rat trapping should continue on Sikopo.

(5) Headstarting should be carried out at the discretion of the head warden.

(6) Tagging of immature greens should continue for growth studies.

(7) Intensive tagging of nesting hawksbills should be done during the months of June and July, less intensive tagging during other months (at Kerehikapa).

OTHER

(1) Solomon Islands should request aid from IUCN to determine which of the species listed in the CITES appendices occur in Solomon Islands and which are presently being traded in. Subsequent to this investigation, Solomon Islands should consider becoming party to CITES.

(2) Overseas funding should be sought to finance the Arnavon Sanctuary and to complete the investigations of the marine turtle resource.

(3) When funding is secured, a volunteer should be recruited to:

(a) complete the survey of Makira, Guadalcanal, Malaita, and Eastern Outer Islands;

(b) help implement the recommended policy changes;

(c) work out sanctuary negotiations with Provincial Assemblies and village leaders;

(d) correlate data collected at Arnavon Islands.

(4) a division of Parks & Wildlife should be created within the MNR. Control of the turtle project should be transferred to this division, as should licensing and enforcement duties.

(5) The proposed study of shark stomach contents caught by Taiyo longliners should be undertaken to quantify shark predation on turtles.

(6) Further trawl net studies should be done from MV Walo to test the hypothesis that young turtles are concentrated in debris lines.

* A proposal has been submitted to the MNR outlining a wide range of policy options. This is the most highly recommended option.

APPENDIX 1

NESTING AREAS WITH TEN OR MORE NESTS PER YEAR

Map No:	Name	Species	Sand	Use	Annual Estimate
SANTA YSABEL					
1.	Arnavon Islands	H & G	White	None	600
2.	Golara Is.	H & G	white	Low	15-20
3.	Hakelake Is.	H & G	White	High	10
4.	Helihavo Is.	H & G	White	Mod.	5-10
5.	Hetaheta Is.	H	White	High	5-10
6.	Kale Is.	H	White	High	5-10
7.	Kiaba Is.	H	White	High	5-10
8.	Nanuhana Is.	H	White	High	10
9.	Nohabuna Is.	H	White	Law	5-10
10.	Ramos Is.	H & G	White	Mod.	50-100
11.	Sorusitana Is.	H	White		5-10
12.	Suki Is.	H	White	Low	10
13.	Fagho Is.	H	White		5-10
14.	Barrier Is.	H	White		5-10
15.	Garanga	L	Black	High	5-10
16.	Kaipito	L	Black	High	5-10
17.	Kokota	L	Gray	High	5-10
18.	Lilika	L	Black	Mod.	20-30
19.	Litigohire	L	Black	Mod.	50-100
20.	Sasakola	L G	Black	Mod.	50 20
21.	Katova	L	Black	High	30
TOTALS:	Hawksbill	38 beaches)	800 to 950 nests per year		
	Green	10 beaches)			
	Leatherback	20 beaches	150 to 250 nests per year		
CHOISEUL					
22.	Haycock Is. & vicinity	H & G	White	High	200-400
23.	Komboro Point	H	White	Low	15-20
24.	Kolombangara	L	Black		15-20
25.	Vacho River	L	Black	High	50-100
26.	Siruka Bay	L	Ref/white	Low	5-10
27.	Sisikama	L	Black	High	10-15
28.	Kamangga	L	Black		10-15
29.	Mangoo	L	Black		

TOTALS:	Hawksbill	38 beaches)	230 to 450 nests per year
	Green	11 beaches)	
	Leatherback	27 beaches	110 to 220 nests per year

NEW GEORGIA

Map No:	Name	Species	Sand	Use	Annual Estimate
30.	Cross (G)	H & G	White	High	10
31.	Mbimbilusi(G)	H & G	White	High	15
32.	Nakaza(VL)	H	White	Low	5-15
33.	Mariu & Kulokulo (Hele Bar)	H	White	Low	50
34.	Marovo Lagoon(M)	H	White	High	10-20
35.	Ngatokae(M)	H	White	High	10-20
36.	Mbaniata(R)	L	Black	High	10-30
37.	Tetepare(R)	L	Black	Low	50-100

TOTALS:	Hawksbill	17 beaches)	120 to 175 nests per year
	Green	4 beaches)	
	Leatherback	13 beaches	60 to 150 nests per year

SHORTLANDS

38.	Balaka Is.	H & G	White	Mod.	50-100
39.	Ausilala Is.	G	White	Low	100
40.	Maifu Is.	H & G	White	Mod.	100
41.	Mamalohu Is.	H & G	White	Low	30
42.	Tuluve Is.	H & G	White	Low	25-30
43.	New, Samarai,etc.	H & G	White	Mod.	200-250

TOTALS:	Hawksbill	25 beaches)	500 to 600 nests per year
	Green	21 beaches)	
	Leatherback	1 beach	0 to 1 nest per year

MAKIRA

44.	Three Sisters Is.	H & G	White	High	35-50

(Cont.)

GREEN TURTLE TAG RETURNS

	First Seen					Second Seen					Third Seen					Fourth Seen				
#	CL	CW	PL	Wt	Inter	CL	CW	PL	Wt	Inter	CL	CW	PL	Wt	Inter	CL	CW	PL	Wt	Cl.Incr
394	47.5	45.0	38.8	?	6/29	47.5	45.0	39.0	?	-	-	-	-	-	-	-	-	-	-	0/-/-
530	45.0	41.3	35.0	?	6/12	45.0	41.3	35.0	10.0	9/1	46.0	41.5	36.5	10.0	-	-	-	-	-	0/1.1/-
586	50.8	45.0	42.0	?	2/ 7	50.8	45.0	42.0	?	10/0	51.0	47.5	42.5	15.0	-	-	-	-	-	0/0.2/-
586	45.0	42.0	36.8	?	14/ 9	45.0	42.0	36.8	10.0	2/5	45.0	42.5	36.8	10.0	-	-	-	-	-	0/0/-
538	45.0	42.5	36.3	?	11/14	46.5	42.5	37.0	10.5	-	-	-	-	-	-	-	-	-	-	1.3/-/-
047	50.0	46.3	38.8	?	3/ 1	50.2	47.0	39.5	13.0	-	-	-	-	-	-	-	-	-	-	0.7/-/-
016	45.0	42.5	35.0	?	0/24	45.0	42.5	35.0	10.6	2/8	46.0	43.0	36.0	10.0	-	-	-	-	-	0/4.4/-
019	45.0	42.0	38.0	10.0	9/ 3	45.5	42.0	38.0	10.5	0/22	45.5	42.0	38.0	10.5	1/17	46.0	42.0	38.8	10.5	.56/0/1.
022	49.0	46.0	38.0	13.0	4/14	49.0	46.0	39.0	13.0	-	-	-	-	-	-	-	-	-	-	0/-/-
024	49.0	45.0	38.5	12.5	4/25	49.0	45.0	38.5	11.5	-	-	-	-	-	-	-	-	-	-	0/-/-
61	47.0	43.0	39.0	11.6	1/18	47.0	43.0	39.5	11.6	8/6	48.0	43.5	40.0	11.5	-	-	-	-	-	0/1.2/-
043	46.0	44.0	36.0	10.0	0/26	46.0	44.0	36.0	10.5	0/20	46.5	44.2	36.0	10.4	6/19	46.5	45.0	36.5	10.6	0/5/0
047	54.5	50.0	43.0	18.5	9/ 9	56.2	51.0	44.2	20.0	-	-	-	-	-	-	-	-	-	-	1.8/-/-
082	49.0	47.5	40.0	14.0	2/ 4	49.5	48.0	40.0	14.0	1/11	50.0	48.0	40.0	13.5	-	-	-	-	-	2.2/3.3/
084	52.0	47.0	41.0	15.0	?	52.5	47.0	41.0	16.0	-	-	-	-	-	-	-	-	-	-	?/-/-
	55.5	49.0	45.0	19.5	1/28	57.0	49.0	45.0	19.8	-	-	-	-	-	-	-	-	-	-	7.5/-/-
24	47.5	42.5	40.0	?	3/14	48.8	45.0	40.0	?	5/12	51.0	46.0	41.0	14.9	-	-	-	-	-	3.7/2.2/
	45.0	42.5	35.0	?	12/18	46.0	44.0	37.0	10.5	-	-	-	-	-	-	-	-	-	-	0.8/-/-
61	47.5	45.0	40.0	?	0/27	47.5	45.0	40.0	?	-	-	-	-	-	-	-	-	-	-	0/-/-
66	52.5	50.0	40.0	?	6/ 6	53.0	50.0	40.5	15.4	-	-	-	-	-	-	-	-	-	-	0.8/-/-
69	45.0	45.0	37.5	?	0/27	45.0	45.0	37.5	?	0/29	46.2	46.2	38.8	?	-	-	-	-	-	0/12/-
52	48.5	45.0	37.0	13.5	0/ 1	48.5	45.0	37.0	13.5	-	-	-	-	-	-	-	-	-	-	0/-/-
60	47.0	45.0	37.0	10.5	12/16	47.5	45.0	37.0	11.0	-	-	-	-	-	-	-	-	-	-	0.4/-/-
62	49.0	45.0	39.0	14.0	0/ 5	49.0	45.0	39.0	14.0	-	-	-	-	-	-	-	-	-	-	0/-/-
68	48.0	46.5	38.0	12.0	2/22	48.0	47.0	38.0	12.8	-	-	-	-	-	-	-	-	-	-	0/-/-
97	43.5	44.0	35.5	9.5	1/15	43.5	44.5	35.5	9.5	-	-	-	-	-	-	-	-	-	-	0/-/-

All returns of longer than one month interval, Mean CL Increase = 1.82 mm/month

CL = Carapace Length (curved cm) Wt = Weight (Kgs)

CW = Carapace Width (curved cm) Inter = Interval between captures (months/days)

PL = Plastron Length (curved cm) CL INCR= Carapace Length Increase (mm/month)

APPENDIX 2

APPENDIX 3

GLOSSARY

BEACH TERMS

Fore-beach: That area which slopes forward towards the sea and is usually innundated by tides and waves.

Mid-beach: That are behind the fore-beach which is usually flat or has a slight backward slope. Only innundated by highest tides.

Back-beach: That area behind the mid-beach which is usually flat and has vegetation. Often separated from mid-beach by a steep, short cliff face.

FALSE CRAWL

When a turtle emerges on a beach, but does not lay eggs, even though it often goes through the motions.

HEADSTARTING

The practice of keeping hatchling turtles until they have attained a size which might allow them a better chance of survival in the wild. Stocking process.

MEASUREMENTS

Curved measurements are taken with a flexible tape and follow the contour of the shell.

Straight measurements are taken with calipers and measure the straight-line distance.

TURTLE SIZES (Adopted from Balazs 1979a)

Hatchling: Umbilical scar still present.

Juvenile: Post hatchling to 65 cm.

Sub-adult: 65 cm to 81 cm (Green turtles)
65 cm to 72 cm (Hawksbill turtles)

Immature: Juvenile and sub-adult.

Adult: Greater than sub-adult size.

APPENDIX 4

SAND COMPOSITION OF TEN NESTING BEACHES

(1) RAMOS ISLAND, SANTA YSABEL

Hawksbill and green nesting. White, highly calcareous, shelly, medium-coarse grained sand; almost entirely composed of abraded foraminifer and other shell fragments. Very rare dark grains of rock, probably basalt.

(2) KEREHIKAKA, ARNAVON ISLANDS, SANTA YSABEL

Hawksbill and green nesting. White, medium grained, highly calcareous sand composed almost entirely of rounded-subrounded shell fragments. Very rare dark mineral grains of pyrocene (iron magnesium aluminium silicate) and olivine (iron magnesium silicate) probably derived from basaltic lavas.

(3) MBANIATA, RENDOVA, WESTERN PROVINCE

Leatherback nesting. Coarse black basaltic sand. Composed mainly of very fine crystaline basalt fragments. Quite a high proportion of basalt glass shards.

(4) KABILABA, SAN JORGE, SANTA YSABEL

Leatherback nesting. Dark fine to medium calcareous sand composed of olivine, feldspar and black lustrous, magnetic oxide, magnetic chromite. The magnetic oxides compose about 25% of the sand.

(5) SAUVANA, SANTA YSABEL

Dark gray, medium-coarse grained sand. Slightly calcareous with rare shell fragments. Mainly composed of lithic grains of sandstone together with the following mineral grains: feldspar, olivine, pyrocene and about 15-20% magnetic iron oxide. Trace of quartz.

(6) RAJA, SANTA YSABEL

Leatherback nesting. Coarse grained, dark gray calcareous sand with some shell fragments. Composed mostly of lithic grains, including sandstone and basalt. Mineral grains include: much feldspar, some quartz and pyrocene. Small proportion of fine magnetic oxide, about 5%.

(7) KILOKAKA, SANTA YSABEL

Leatherback nesting. Coarse, dark gray-black sand. Non-calcareous, mainly composed of lithic grains, including sandstone and basalt. Mineral grains include feldspar, pyrocene and olivine. 10-15% magnetite.

APPENDIX 4(Con.)

(8) LITHOGHAHIRA, SANTA YSABEL

Leatherback nesting. Dark gray-black sand, non-calcareous. Mainly composed of lithic fragments and feldspar with approximately 20% magnetite.

(9) HAEVO, SANTA YSABEL

Leatherback nesting. Lithic sand, dark gray, slightly calcareous with feldspar and some shell fragments.

(10) KATOVA, SANTA YSABEL

Fine dark gray-black sand, mainly composed of lithic fragments, together with feldspar and some pyrocene and olivine. Approximately 5% magnetite.

All samples analysed by Peter Dunkley of the Geology Division, Ministry of Natural Resources, Honiara.

APPENDIX 5

VERNACULAR NAMES FOR TURTLES

(expanded from McKeown, 1977)

Language	Turtle	Green	Hawksbill	Leatherback	Loggerhead
SANTA YSABEL					
Zabana	Tege	T. mogaha	T. ngapo T. cuare	Babaru	Kakapodoko
Laghu	Fotogigiro				
Mbugotu	Vonu	V. mogaha	V. ngapo	Khulano	
Maringe	Thege	T. mogaha	T. ngapo		
Kokota	Vonu	V. mogaha	V. ngapo V. cuare	Babaru	Kodoko
Gau	Seru	mogaha S. venu S. kuta	S. ngapo	Kulano	Natosi
CHOISEUL					
Gilbertese	Teon	Teon T.-n-Kiribati	T. tapakea T.-n-Toromon		
Vaghua, Varisi & Tepazaka	Tengge	T. basoi Mumoco	T. tango	Mokolo	
Mbambatana	Vunu	V. moga	V. suri	Galo	
Avaso	Tenge	T. mogaga	T. suri	Alo	
Tamberato	Tenge	T. bose	T. tango	Galo	
NEW GEORGIA					
Marovo	Vonu	V. ihana	V. pende	Karatolu	Kakapodoko
Roviana	Vonu	V. igana	K. kapa	Tavatolu	Kakapodoko
Ndighore	Vonu	V. igana	V. ngapo	Tavatolu	
Mbaniata	Gonu	G. foforo G. soreke	G. safi	Oihare	
Moila	Vonu	V. mogasa	V. sori	Tavatolu	
Ranonga	Vonu	V. igana	V. Kapu		
Mbilua	Vo vognu	Vo gnugnu vognu	Vo sori vognu	Vo tavatolu vognu	
Simbo	Modoko				
SHORTLANDS					
Alu	Palusu	Koburu = small	Nahisi = small	Raurau	Karale
		Baolo = mid	Soleke = mid	Darau	Kukupata
		Muko = big	Palususai = nesting		
Mono	Palusu	P.vasivavare P. muko	P. Sa-e Purai = small	Raurau	

APPENDIX 5 (Con)

Language	Turtle	Green	Hawksbill	Leatherback	Loggerhead
GUADALCANAL					
Tolo & Birau	Vonu		Avonu	Raro Tarunga	
Talise	Vonu	V. maliku	V. ngaehi	Raro	
Rennell & Bellona	Honu				
MAKIRA & EASTERN OUTER ISLANDS					
Arosi	Aroha'i	A.menamena	A. una	Orobiu	
Santa Ana	Gharofai	N. noo	N. daling N. taleni	Tapoako	
Waihira Bay			G. garohagi	Iora	
Santa Catalina		Garo fae	Auna	Wonu iora	
Uki Is.				Honu iora	
Utupua	Gningig-navo	Ramarau	Navete	La'ata	Tekea
Vanikoro		Tukteleu	Anairo		Tekea
Tikopia	Te fonu		Koroa		
Duff Is.	Te fonu	Te vai vai	Te fonu knaga		Tekea
Reef Is.	Toponu	T. aumalu	T. nembe		T. sekea
MALAITA					
Sa'a	Honu	H. ie	H. hapa H. rama	Kulune Guleongo	
Lau, Kwaio, & Mgaenggnu	Fonu	F. ia	F. bala	Ghulano Bulanga	
Langa Langa	Folu	F. ia	F. baba	Kwailuile	
Tobaita	Fonu	F. ia	F. rurumu		
Are Are	Honu	H. para	H. hapa	Oropi	
Sikiana	Honu	Honu	H. masana		
Ontong Java	Nanumea	Tehongu	Kimasanga	Susulu	
		Kengumea Keroumea Keunamea		Keioho	

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