THE HAWKSBILL TURTLE (ERYMOCHELYS IMBRICATA) IN WESTERN SAMOA

W. N. Wizell and Alan C. Banner

ABSTRACT

A small population of hawksbill turtles (Erymochelys imbricata) nested on six small islands off the eastern coast of Upolu Island, Western Samoa. The nesting season extended from September to July. Each nest averaged 149.1 eggs, of which 71.9% hatched. The average incubation period was 62 days. The resulting net production averaged a rise of 1.3°C over sea water. Natural predation on nests was seen, and only one instance of natural predation on adult turtles was seen. Human predation upon eggs and nesting females was extensive; the predation pressure being directly proportional to beach accessibility, and the major factor leading to the decline of the Samoa turtle population. Market surveys indicate a year-round occurrence of hawksbill. In view of protective legislation, the Fisheries Division of Western Samoa initiated a turtle conservation project to reduce the incidence of human predation on eggs.

There are no detailed published accounts on the biology and ecology of marine turtles in the central South Pacific. The Fisheries Division of the Government of Western Samoa sponsored a marine turtle research program (October 1970-May 1973) in an effort to study the life histories of the cheloniid species occurring in Samoan waters. The following is an account of the hawksbill turtle, Erymochelys imbricata.

Turtles have always played an important part in Samoan culture and were once widely used for food. Evidence from folklore, songs, and interviews with informants indicates that the Samoan turtle resource was once a sizable and an important food source for the small, isolated villages. However, the nesting turtles on Samoan beaches have almost been exterminated because of human population explosion. Turtle meat is presently eaten predominantly by village chiefs only on celebrated occasions.

MATERIALS AND METHODS

Fieldwork during the turtle survey was carried out using a 24 ft long powered by a 20hp outboard motor with 1.5hp auxiliary gas and fiberglass to a seaplane. Support was provided by the staff of the American Samoa National Park Administration. We attempted to visit all nesting beaches once a day, however, we made 19 overnight visits during calm weather in February 1972.

We anchored the boat outside the beach reef and swam to the beaches carrying a weighted net bag for removing eggs. We followed this procedure throughout the entire nesting season. Incipient dry turtle tracks found on the beaches was carried out and used for the sampling of the nests. Snaps stuck were pulled into the net to collect a clutch. The depths to the top and bottom of the egg mass were recorded in addition to the position of the nest on the beach. Fresh eggs were removed from the beach by further observations of the mainland hatchery. The oldest eggs string 2 days only. All older nests were counted and their positions on the beach recorded for future observations. Attempts were made to avoid cursing or leaving the eggs during the following and transplanting process. The eggs were removed in the hatchery; as soon as possible to avoid unnecessary embryonic deaths.

The hatchery, a small section of rainwater tank, was fenced off to keep out dogs, pets, and people. The eggs were incubated and a sample (1973) measured as they were removed. A few individuals with a clutch identification number, was then placed over the clutch in order to assure optimal of the emerging hatchlings.

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Nest temperatures were measured on a sample of transplanted nests using mercury indoor/outdoor thermometers with remote reading scales. These nest temperatures were recorded daily during incubation, simultaneously with the sand temperature at equal depths, air temperature, and general weather conditions.

Adult turtles were tagged midway along the posterior edge of the right front flipper with musel cow-calf tags. All turtle measurements are straight line measurements in centimeters and weights are in grams.

**Species Characteristics**

The hawksbill turtle (*Eretmochelys imbricata* Linnaeus, 1766), is readily distinguished from other turtles occurring in Western Samoa by the following combination of characteristics: four pairs of costal shields, anterior pair not touching the mufual shield; four inframarginal shields, without pores; two pairs of prefrontal scales on the head; two claws on each flipper; narrow beak. The costal shields are juxtaposed in hatchlings, imbricated in juveniles and adults, and juxtaposed again in extremely large turtles. The marginal shields are serrated in juveniles, becoming smooth in adults.

General color patterns of adult, juvenile, and neonate Samoan hawksbill turtles are presently described due to the ambiguities in the literature (Hughes, 1974) regarding the taxonomic status of the proposed Atlantic and Pacific hawksbill subspecies which are based, in part, on coloration.

The carapace in adult turtles is dark brown with faint yellow streaks and blotches (Fig. 1). The scales on the dorsal side of the flippers and head are dark brown to black with yellow margins. The ventral side of the flippers and the plastron are pale yellow, with scattered dark scales on the flippers (Figs. 1 and 2).

Juvenile coloration (Fig. 3 left) is often variable, particularly the carapace, which ranges from light brown to black with varying amounts of distinct yellow streaks and blotches. The head and dorsal flipper scapulation is black with whitish margins and the plastron is whitish with many brown blotches; the ventral side of the flippers have scattered black scales.

Neonate coloration (Fig. 3 right) is uniform, variations are generally noticed when the turtles are about 5 months old. The carapace and the top of the head and neck are tan; the side and bottom of the head and neck, including the beak, are dark grey; the dorsal and ventral sides of the fore flippers are grey with a whitish fringe around the posterior edge; the dorsal and ventral sides of the hind flippers and plastron are dark grey with two whitish ridges posteriorly on the plastron.

**Results**

Nesting Islands and Beaches

The hawksbill turtle was the only species of marine turtle found nesting in Western Samoa. The nesting beaches are located off the eastern end of Upolu Island on three small offshore islands: Namu’u, Nu’utele, and Nu’ula (Fig. 4).

Namu’u is approximately 800 m long, 300 m wide, and 76 m above sea level. A nesting beach 175 m long is situated on the eastern side of the island. From the low water mark to the beach vegetation there is a steep 7 m slope, with another 9 m moderate uphill slope to the jungle. The approach to the beach is clear of obstacles; a few scattered rocks in the water at the center of the beach should not hinder a nesting turtle or emerging hatchlings. The reef begins immediately in front of the beach and extends seaward for 30 m before dropping off into deep water. The entire length of the beach has a layer of beach rock 2 m wide at the low water mark; this rock is low in profile and does not obstruct nesting turtles.
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or emerging hatchlings. The sand is medium coarse broken shells and corals,
extending inland as far as the jungle where it blends into packed soil and root
masses. Most nests were 1–2 m inside the beach vegetation at the north end of
the beach.
Figure 2. Adult male hawkfish head illustrating pigmentation, squamation, and morphology of lateral (upper) and dorsal (lower) surfaces.
The largest nesting island is Nu'ulele, approximately 1,650 m long, 850 m wide, and 300 m above sea level. There are two nesting beaches, Nu'ulele and Vini. Nu'ulele beach, located on the eastern side of the island, is 350 m long and 12 m wide from the low water mark to the vegetation. The beach slopes uphill gently to the edge of the vegetation where there is a steep 0.75 m high sand bank that hinders access to the vegetation. The reef extends from the beach to 40 m offshore before dropping off into deep water. There is no beach rock and the sand is medium coarse broken shells and corals. Most nests were 2-3 m inside the beach vegetation, and no section of the beach was preferably nested upon. Vini beach, on the northeastern side of Nu'ulele Island, is 600 m long, with an excellent passage through the reef and has no obstructions or beach rock. Privately owned property inhibited the collecting of detailed turtle information during the nesting season.

Nu'ulua Island is approximately 700 m long on each side and 108 m above sea level. The nesting beach on the eastern side is 350 m long with 50 m sections of rock rubble at both ends. There is a uniformly steep 6 m slope from the low water mark to the vegetation line and 20 m of level vegetation to the jungle. The approaches to the beach are blocked, in sections, by large rocks and by the shallow 30 m wide reef. The entire length of the beach has a 2-3 m wide layer of beach rock at the low water mark and forms an obstacle to the nesting turtles and a formidable barrier to hatchlings. The beach is composed of coarse broken shells, corals, and rocks. Most turtles nested 2-4 m inside the vegetation on a 20 m section in the middle of the beach.

Nesting Season

The nesting season extends from September to July, with January and February being the peak months. Figure 3 depicts the estimated total number of turtle tracks found on the four beaches during the 1971-72 nesting season. The beaches had large differences in numbers of nesting turtles as well as different nesting season periods. The smaller the total number of nests on a beach, the shorter was
the nesting season. These differences resulted from varying amounts of human predation pressure upon nesting females and eggs, predation being proportional to the ease of beach accessibility. Beach accessibility is defined in terms of distance from the mainland reef and ease of passage through the beach reef. The beaches were ranked from the smallest to the largest (percentage of total nests, shortest nesting season, and earliest beach access): Nuu‘u A (46%, January–February), Vini (79%, December–March), Ne‘u‘ugle (11%, November–April), Nu‘u‘uia (78%, September–July).

Climatological data (Fig. 5) from the Apia Weather Observatory is summarized for 1953–73, showing increasing air temperature and rainfall and decreasing wind speed during the nesting season.

Eggs and Incubation

A sample of eggs from 25 transplanted nests from the 1971–72 nesting season was analyzed by laying through hatching (Tables 1–3). Few parameters involving excessively large numbers of measurements per nest; a sample of 10% of the eggs was used.

Nest characteristics (Table 1), with the exceptions of egg diameter and weight, are highly variable. This variability was seen through the nesting season and could be attributed to the wide size range of nesting turtles. Although we were only able to tag and measure the carapace length of seven comparatively small nesting turtles, larger turtles were seen captured by the Samoan fishermen. Also,
Table 1. Salmo harrisi nest characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (m)</td>
<td>26.86</td>
<td>11.3-36.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>34.40</td>
<td>23.9-35.9</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>3.47</td>
<td>3.4-3.6</td>
</tr>
</tbody>
</table>

**Note:** Values are in millimeters.

The eggs are spherical and white. Although abnormal shaped eggs were rarely seen, three clutches contained 1-3 yolkless lips, all spherical and averaging 1.3 cm in diameter.

Incubation and hatching parameters for the 23 clutches are also highly variable (Table 2). The mean number of transplanted eggs is smaller than the mean number of eggs per nest (from Table 1) because several eggs per clutch were broken when locating the nest with sharp sticks. The day after emergence each clutch was excavated and all unhatched eggs opened to determine the percentage of undeveloped eggs and percentage of dead embryos. These incubation and hatching figures correspond closely with those nests left undisturbed on the nesting beaches.

Most hatchlings (77.2%) emerged in the late afternoon when sand temperatures fell below 30°C. The shadow caused by the high rock cliffs on the western side of each nesting beach accounted for this daylight hatch (full darkness begins around 2000 h).

Nest temperatures were measured at the nearest of the egg mass and averaged a maximum increase of 2.6°C (range 1.7-5.0°C) over the sand temperature at equal depth. Nest temperatures were affected by clutch size and the prevailing weather conditions; the larger the clutch, the higher the rise in temperature, and the less fluctuation from adverse weather. Periods of heavy rain lowered the nest temperature by 8.5°-12°C, and lengthened the incubation period 4-6 days over clutches of equal size free from rain.

Nestate harrissi were very uniform in size (Table 2). They were healthy and no abnormal hatchlings were seen, very few died after emergence during the first weeks of captivity before release.

Table 2. Incubation and hatching of transplanted Salmo harrissi

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of transplanted eggs</td>
<td>14.70</td>
<td>4.96</td>
<td>7.0-21.0</td>
</tr>
<tr>
<td>Percent eggs incubated</td>
<td>22.45</td>
<td>17.17</td>
<td>3.6-36.8</td>
</tr>
<tr>
<td>Percent eggs hatched</td>
<td>6.40</td>
<td>5.67</td>
<td>2.65-10.5</td>
</tr>
<tr>
<td>Number of incubation days</td>
<td>62.90</td>
<td>5.58</td>
<td>59.0-70.0</td>
</tr>
<tr>
<td>Time of day hatch*</td>
<td>10:25</td>
<td>0:12</td>
<td>10:00-12:00</td>
</tr>
</tbody>
</table>

* For single hatch only; 72.3% of all clutches hatched in single.
Table 1. Measurements of mature Samoan hawskbill turtles

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carapace length (cm)</td>
<td>1.96</td>
<td>0.08</td>
<td>1.88</td>
<td>2.1</td>
</tr>
<tr>
<td>Carapace width (cm)</td>
<td>1.48</td>
<td>0.08</td>
<td>1.38</td>
<td>1.55</td>
</tr>
<tr>
<td>Plastron length (cm)</td>
<td>1.59</td>
<td>0.06</td>
<td>1.53</td>
<td>1.65</td>
</tr>
<tr>
<td>Head length (cm)</td>
<td>1.38</td>
<td>0.04</td>
<td>1.3</td>
<td>1.44</td>
</tr>
<tr>
<td>Eye width (cm)</td>
<td>0.46</td>
<td>0.03</td>
<td>0.43</td>
<td>0.5</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>12.55</td>
<td>6.11</td>
<td>12.1</td>
<td>13.2</td>
</tr>
</tbody>
</table>

* SD's of carapace width measured.

Prediction on Eggs and Hatchlings

The nesting islands and surrounding waters abound with potential predators of eggs and hatchlings. Polynesian rats (Rattus exulans) are the only mammals found in abundance upon the nesting beaches, though traces of wild pigs were found on Niutao and Vini beaches. The ghost crab (Ocypode sp.) exists in great numbers on all of the beaches near the high water mark. The hatchlings, which must traverse the open beach upon emergence, are surrounded with potential predators. The belt of ghost crab holes must first be passed, then the section of beach rock. The rock itself is a formidable barrier, and upon this rock lives a large population of gray-tailed crabs averaging 6-10 cm carapace width.

The nesting islands support large populations of sea birds throughout the year. They consist of different species of boobies, terns, tropicbird, frigatebirds, petrels, and shearwaters.

Potential reef predators are numerous in both numbers and species: needlefish, barracudas, jacks, groupers, and sharks. Pelagic predators include: bonito, skipjacks, tunas, dolphins, and sharks. The pelagic predators with the exception of sharks are often seen in schools within 2.5 km of the beaches.

Natural predation upon Samoan hawksbill eggs and emerging hatchlings seems to be a relatively unimportant factor contributing to the apparent decline of the turtle population. All of the species of rats, hogs, and crabs have been termed "potential" since we did not see any evidence of egg or hatchling predation during our observations on the beaches, though the mortality rate from turtles, dolphins, and sharks is undoubtedly high. We witnessed one instance of a 1.5 m black-tipped reef shark (Carcharhinus spallanzani) attacking a group of freshly released turtles 1.5 km east of the nesting islands. Daytime hatching may relieve some predation pressure because the turtles swim across the reef before nocturnal feeders—such as groupers and sharks—become active; the hatchlings reach deep water in darkness when bony, skipjack, and tuna cease surface feeding. Human predation on hawksbill eggs and nesting turtles, however, is severe; almost all nests not removed or concealed by the Fisheries Division are collected by Samoan fishermen.

Conclusions

Hawksbill Ecology and Status in Western Samoa

A segment of the hatching and juvenile hawksbill population stays near Samoan reefs year-round. We observed that small hawksbills (4-10 cm) frequently foraged off Samoan reefs; a 3-year fish-market survey in the capital city of Apia also supported these observations. We noted the eighth left marginal shield on 1,720 hatchlings before releasing them; we had six sets returned, all within 12
months. The much remained perceptible for 14 months on turtles reared in captivity. Possibly the most important factors explaining the low return rate (0.4%) are poor identification by the local fishermen, high mortality by pelagic fishes, and passive migration away from Samoa by oceanic currents.

Mature hawksbill turtles were also sighted by us throughout the year, but they were seen in abundance only during the nesting season. Samoan fishermen are not equipped to capture large turtles from the ocean, thereby explaining the absence of mature turtles in the marketplace. It is not known whether most of the adult hawksbill population migrates and, if so, how far or in what direction. Recaptured turtle marked with Western Samoan tags have not been reported.

The Western Samoan hawksbill turtle resource is a small remnant of the former nesting population. Extensive human predation upon eggs and nesting females has extirpated all turtles reported to have once nested on the excellent mainland beaches. The three small islands off the eastern coast of Upolu Island now support only sporadic nesting activities, and only one beach, Nu'ualou, holds any promise of continued nesting. Relative inaccessibility to this beach is undoubtedly the principal reason for the survival of this lingering nesting population.

The Western Samoan Government has not passed protective legislation or set aside nesting islands as wildlife refuges. There is little chance of either of these protective measures becoming law in the near future. The Fisheries Division, however, followed up the turtle survey with a conservation program of its own, in which 50-75% of all clutches found are collected, hatched on the mainland, raised in captivity for 3-4 weeks, and then released at sea near the nesting beaches. Uncollected nests are concealed and observed (Wittliff 1972:1974).

There is no indication of an increase in the nesting population at this time, though there is an increase in juveniles reported in the market, and the imminent extinction of the Samoan hawksbill is likely to occur if the hatchery program fails to substantially increase the numbers of nesting turtles and if the eggs and nesting females continue to be taken by Samoan fishermen.

ACKNOWLEDGEMENTS

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LITERATURE CITED


Wittliff, W. N. 1972. To live or not to live. Int. Turtle Tournament Soc. 8: 3-35.


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ACKNOWLEDGMENTS: W. N. Wittliff, Fisheries Division, Western Samoa; Present Address: National Marine Fisheries Service, Southwest Fisheries Center, 75 Virginia Beach Drive, Miami, FL 33149; (A. C.B.) Life of the Fisheries Division, Western Samoa. Reused by Nu‘ualou Island during the spring survey.