FIBROPAPILLOMAS IN GREEN SEA TURTLES OF OAHU, HAWAII

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INTRODUCTION

Neoplasms identified as fibropapillomas were first described in the green sea turtle, *Chelonia mydas,* approximately 50 years ago by Smith and Coates (Jacobson et al, 1989). Since that time, green sea turtle fibropapillomatosis (GTFP) has been reported in various parts of the world including Australia, the Bahamas, Barbados, Belize, Cayman Islands, Culebra Island, Curaco, Columbia, Dominican Republic, Florida, Hawaii, Mexico, Panama, Puerto Rico, St. Croix, St. Thomas, Venezuela, and the Virgin Islands (Aguirre, 1992). In recent years, the occurrence of these tumors in the green sea turtle population has reached epidemic proportions in areas of Florida, the Hawaiian Islands, and a few other locations (Balazs and Pooley, 1991).

The etiology of these tumors remains unknown. Possible etiologies include: 1) viral, 2) an immune response to trematode ova, 3) secretion of hirudin by marine leeches, 4) excessive solar radiation, 5) pollutants, 6) environmental factors (i.e. change in water temperature), 7) genetic predisposition to neoplasia, and 8) aberrant wound responses (Aguirre, 1992) (Balazs and Pooley, 1991).

Regardless of etiology, GTFP can result in reduced vision, disorientation, blindness, physical obstruction of normal swimming and feeding, and an apparent increase in susceptibility to parasitism by the marine leech *Ozobranchus branchiatus* (Balazs, 1991). Balazs (1991) has also observed in the Hawaiian population of green turtles that fibropapillomas can cause severe emaciation, increased predation by tiger sharks and humans, probably a reduced ability to migrate and breed successfully, and increased entanglement in fishing line and other gear. Thus, GTFP is a serious disease that potentially threatens the survival of this already protected species (Sundberg, 1991).

The purpose of this study was to investigate the occurrence of fibropapillomas in the population of green sea turtles of Oahu and to determine if certain physical factors such as body weight or carapace length can be associated with fibropapillomas. In particular, we attempted to identify the most common site of tumor development (eyes, mouth, flippers, etc.). In addition, the environmental and geographical features of the sample sites was considered in relation to tumor occurrence.

MATERIALS AND METHODS

SAMPLE SITES

Two sample sites were chosen for this study (Figure 1). Kaneohe Bay, which is located on the east coast of Oahu, is the largest sheltered body of water in the Hawaiian Islands, measuring 12.8 km long and 4.3 km wide (Smith et al, 1973). The bay is a substantial foraging and resting habitat for green sea turtles. The first confirmed case of GTFP in Hawaii was reported in Kaneohe Bay in 1958 (Aguirre, 1992).

Waikiki Beach is on the south shore of Oahu and extends a distance of about 3 km. Historically, this site has not been a haven for sea turtles. However, in the past 3 - 5 years the number of turtles in the Waikiki area has increased. Waikiki Beach differs from Kaneohe Bay in that it is not as enclosed and it has a large number of tourists which snorkel, swim, and surf in the waters off the beach (Miya and Balazs, 1993).

COLLECTION TECHNIQUES

At Kaneohe Bay a total of 30 turtles were collected from February 27 - March 18, 1993. Sixteen of these turtles were captured live by hand snorkel, thirteen by boat dive, and one turtle was captured after it stranded.

Since the population of turtles at Waikiki Beach was smaller than that at Kaneohe Bay, data collected from November 1990 - February 1993 was used for this study. A total of 49 turtles were sampled during this period. Twenty-two of these turtles were captured live by hand snorkel, nineteen by scuba diving, and eight by netting.

Captured turtles were taken to the boat for further data collection.

DATA COLLECTION

Calipers and a measuring tape were used to gather the following information on each turtle (in centimeters): straight carapace length (SCL), straight carapace width (SCW), curved carapace length (CCL), curved carapace width (CCW), head width (HW), tail length from plastron edge to tip of tail (TT), tail length from plastron edge to cloaca (TC), right front flipper width (RFFW), and plastron length (PL).

Turtles were weighed by cinching a rope around their body so that the carapace and not the flippers supported their weight when lifted (Balazs, 1992 in press) (Figure 2). Several hand-held scales were used. Dorsal and ventral barnacle counts were conducted on each turtle and the presence of any parasites such as marine leeches or leech eggs were also noted.

The carapace was inspected for any evidence of pink coralline algae. Open wounds, healing wounds, and scars were also recorded for each turtle.

Captured turtles were tagged for identification. Two or three tags made from a nickel cadmiun alloy were applied to each turtle depending on size. Tagging sites used were the trailing edges of the front and hind flippers (Miya and Balazs, 1993).

Oral exams were performed on each turtle using a vaginal speculum to detect the presence of tumors, injuries, foreign bodies such as fish hooks, parasites, and food material (Figure 3).

Each turtle was carefully examined for tumors. Location, number of tumors, and size of tumors were recorded. Tumor size categories are as follows: #1 = detectable patch to 1cm diameter

#2 = >1cm to 4cm
#3 = > 4cm to 10cm
#4 = > 10cm

Then an overall tumor score was assigned to each turtle. This score ranges from 0 - 4 with 0 being no tumors and 4 being the most severe cases. Number, size, and location determine the tumor score; however, turtles that had eye involvement were given a higher score, especially if the lesion obstructed vision (Balazs, 1993).

After all measurements, weights, tagging, and tumor evaluations were completed, turtles were released back into the wild. One turtle that stranded at Kaneohe Bay was severely tumored and was eventually euthanized and necropsied. No evidence of internal tumors was seen. Samples of liver, kidney, and spleen were submited for toxicological testing. The intestine was examined and found to have numerous fluke eggs present.

RESULTS

At Kaneohe Bay, twenty nontumored green turtles were captured with a weight range of 18-78lbs and a straight carapace length (SCL) range of 39.4-78.5cm (Table 1). Forty-three nontumored turtles sampled at the Waikiki Beach site had a weight range of17-180lbs and a SCL range of 37.6-80.8cm. Nine (30%) of the turtles captured from Kaneohe Bay had tumors, while only six (12%) of the sample

population from Waikiki had tumors (Figure 4 and 5). Of these tumored turtles, the range of SCL at Kaneohe Bay was 42.5-68.5cm and weight range was 24-120lbs. At Waikiki the SCL range was 52.6-73.7cm and weights for many of these turtles were not taken .

Tumors varied in appearance and color. Some were rough with papillae-like projections, while others were smooth and some were ulcerated, bloody and necrotic. Tumors were either white, pink, or darkly pigmented. Certain tumors were firm and appeared shrunken.

The total number of tumored turtles from both sample sites was fifteen. Thirteen (87%) of these turtles had tumors associated with the eyes, seven (47%) had oral tumors, nine (60%) had tumors in the neck region, thirteen (87%) had tumor involvement of the front flippers, ten (67%) had tumors of the hind flippers, and only three (20%) of the fifteen turtles had tumors in the cloaca/tail area . No tumors were associated with the seams or scutes.

It was seen that most tumors fell into the #2 size classification (>1cm-4cm) with #1 tumors being the next most frequent size seen. Only seven turtles had size #3 tumors and only one #4 tumor was noted (Table 2).

Several previously tagged turtles were recaptured during this study. At Kaneohe Bay, two of these turtles had tumors at present, but did not have them at the initial tagging. Turtle N585 was originally tagged in January 1991 and had no tumors at that time. In March 1993 this turtle was sampled again and had a total of eighteen tumors which were localized to the left eye, mouth, and front flippers. The overall tumor score was a 2. Turtle Y306 was tagged in May 1989. No tumors were noted at that time. This turtle was seen again in March 1993. It had seventeen tumors localized to the eyes and front flippers. The tumor score was 2.

Two other nontumored turtles were also recaptured in Kaneohe Bay in March 1993. One turtle was tagged in January of 1992 and another turtle was originally tagged in December 1990.

At Waikiki Beach, four turtles tagged in 1992 were all nontumored at the time of the initial tagging. These turtles were recaptured during the next 3 -12 months and no tumors had developed. A turtle at this site was tagged in December 1989. Since that time, it was recaptured in December 1990 and April of 1991. No tumors were noted. One turtle tagged in the area in May 1992 was given a tumor score of 3. Five months later, in October, it was sampled again and the severity of tumors had increased so the tumor score was raised to 4.

DISCUSSION

In comparing the two sample sites, the turtle population at Waikiki Beach weighed more and were longer than those at Kaneohe Bay. There was a greater percentage of tumored turtles in the Kaneohe Bay population (30%) as compared to Waikiki (12%). However, this difference may be even more significant when one considers that the data from Kaneohe Bay was collected within a 4-week period and the data from Waikiki was generated over 2.5 years. Therefore, if the two sites were sampled over the same time period, it would appear that Kaneohe Bay would have a very high occurrence of GTFP as compared to Waikiki. Kaneohe Bay is more enclosed than Waikiki. Perhaps this higher percentage of tumors reflects the geographical influence at the site. Furthermore, only forty-nine turtles were sampled in the Waikiki area over 2.5 years, while thirty turtles were collected in Kaneohe Bay in just four weeks. Thus, it might be reasoned that the population density of Kaneohe Bay is much greater than at Waikiki. This may lead to a greater chance of tumor development, especially if the cause is infectious.

At both sample sites, tumored turtles had a greater average straight carapace length than nontumored turtles. This is consistent with Aguirre's (1993) findings that demonstrated a relationship between carapace length and the presence of fibropapillomas in green turtles. Data from this study must be further analyzed to determine if body condition, based on a weight to length relationship, differs between tumored and nontumored turtles.

The variation in appearance of the tumors is not well documented. There is some speculation that the firm, shrunken tumors might be fibropapillomas which are actually regressing (Balazs, 1993). However, at this time no turtle which has been documented with having tumors has been recaptured and found to no longer have tumors. These differing tumors must be examined histologically to determine if any differences do in fact exist and to determine if a regression phase might occur.

Based on the data, it appears that tumors occur most frequently on the eyes and front flippers. Eye tumors tend to obstruct vision and may decrease the ability to find food and navigate properly. Tumors associated with the flippers can often interfere with normal swimming if they are large or numerous. The cloaca/tail region had the lowest percentage of tumors.

The growth rates of fibropapillomas was documented by Balazs (1991b) in two Hawaiian green turtles. One turtle, a nesting female with no signs of neoplasia when first tagged, was seen three years

later in an emaciated state with a large (10 x 20cm) fibropapilloma along the base of the tail. Another adult male which was free of tumors when originally tagged had numerous growths, including a 10cm diameter mass in the axilla when seen again just two years later. In this study, one apparently "clean" turtle had developed eighteen tumors within two years of the original tagging. Another turtle was found to have seventeen tumors four years after it was tagged initially. Since relatively small turtles in Hawaii have been seen infested with fibropapillomas, this indicates that growth of these tumors can occur rapidly under certain conditions (Balazs, 1991b).

In other areas of the Hawaiian Islands, GTFP has increased drastically over several years. Since May 1982 turtles were captured, tagged, and released along the island of Molokai. During this time, 397 turtles were examined and no GTFP was seen. Then in October of 1985 on e individual turtle was identified with GTFP. In June 1987 a second turtle with the disease was captured. By 1988, GTFP was seen in 5% of the 125 turtles sampled. In 1989 and 1990, the percentage of turtles affected increased to 10% and 25% respectively of the 320 turtles captured (Balazs,1991a). Since February of 1989 in Kaneohe Bay the rate of GTFP has increased from 49 - 92% in 121 turtles captured live by hand at four discrete habitat sites (Balazs, 1991a). Based on this information, the area of Waikiki is being closely monitored to see if this sort of drastic increase in GTFP will occur as it has in other sites.

Currently the etiology of GTFP is unknown. Various attempts at virus isolation have been unsuccessful. Numerous turtles are afflicted and the eventual outcome is death. Cryosurgery has been used to treat the tumors with some degree of success; however, with the increasing number of turtles affected and the high tumor numbers that are often found on each individual, this procedure may not be practical. This mysterious disease threatens the survival of the green turtles and may, in time, begin to afflict other species of sea turtles.

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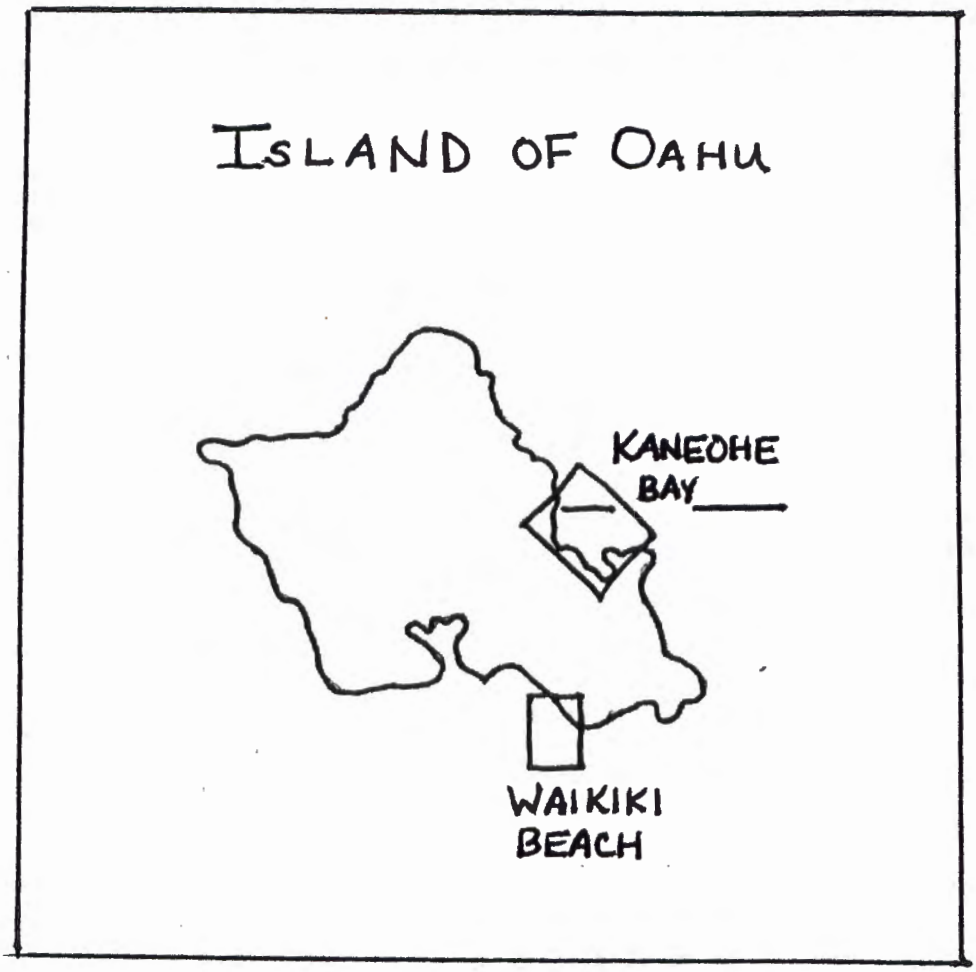


Figure 1: Sample sites for Hawaiian green sea turtle fibropapilloma study.

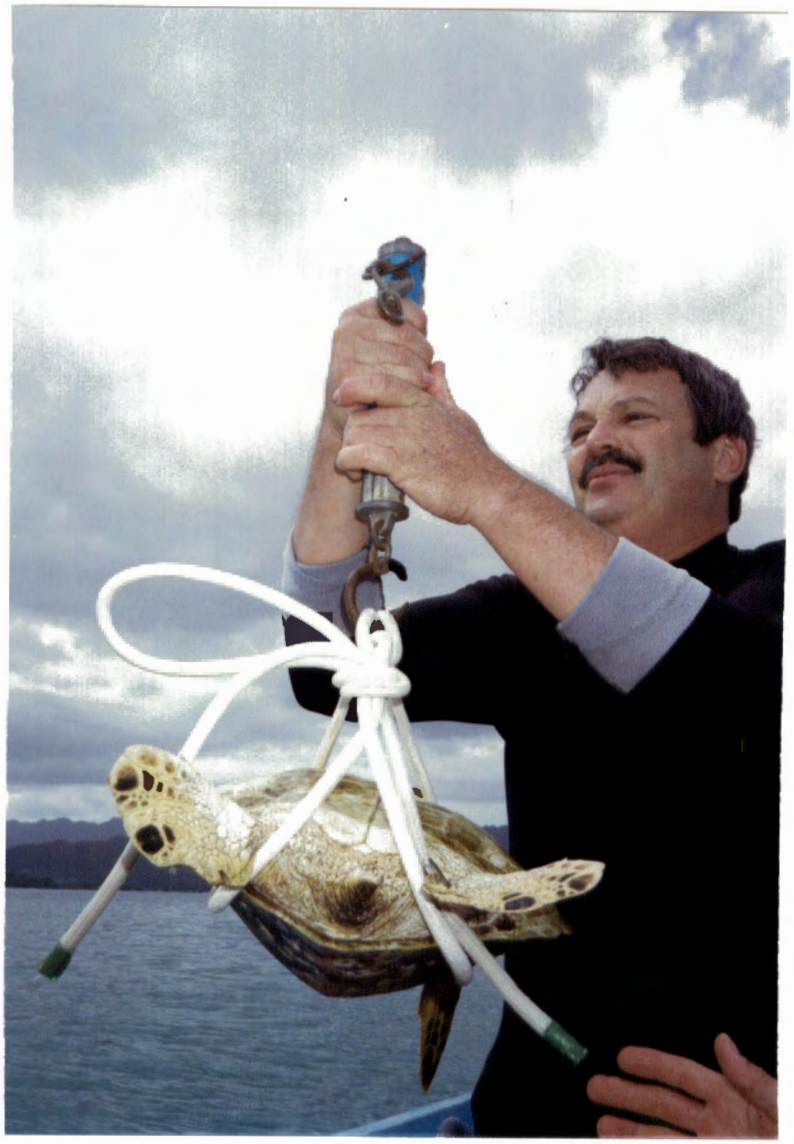


Figure 2: Method used for weighing green turtles during sampling.

Figure 3: Use of vaginal speculum for oral examination in green turtles.

Figure 4: Turtles examined at Kaneohe Bay

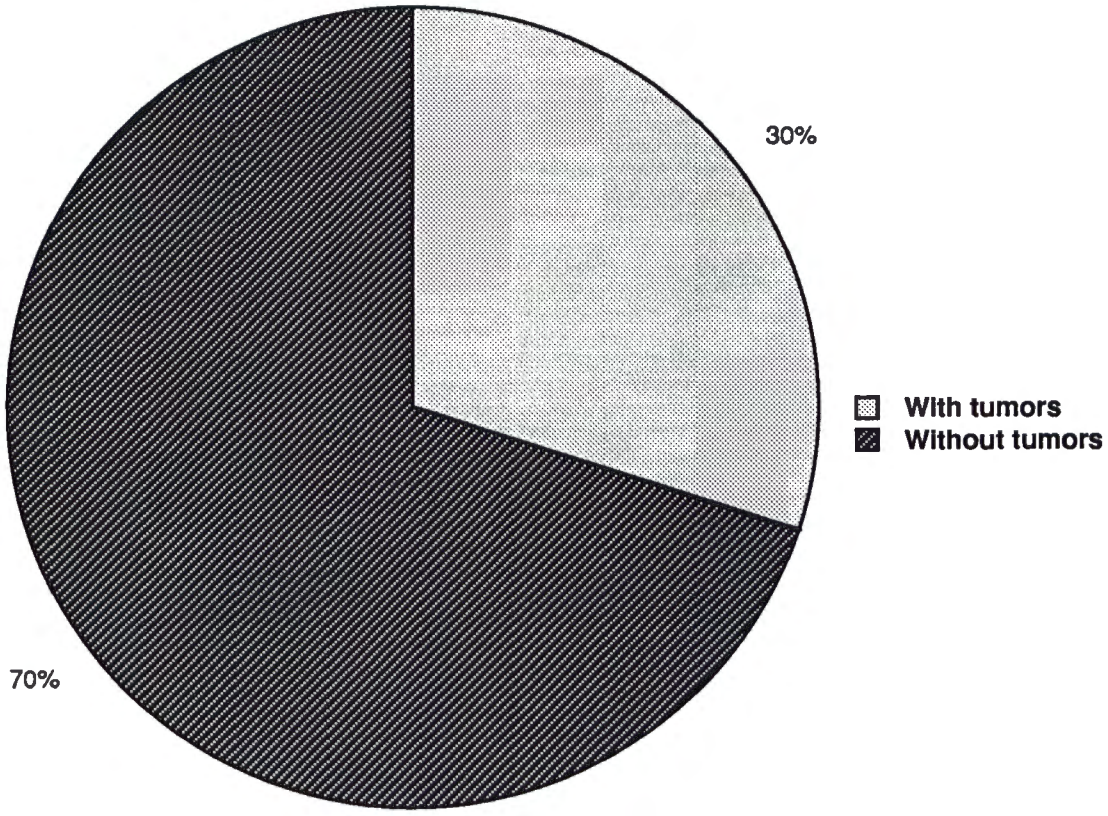
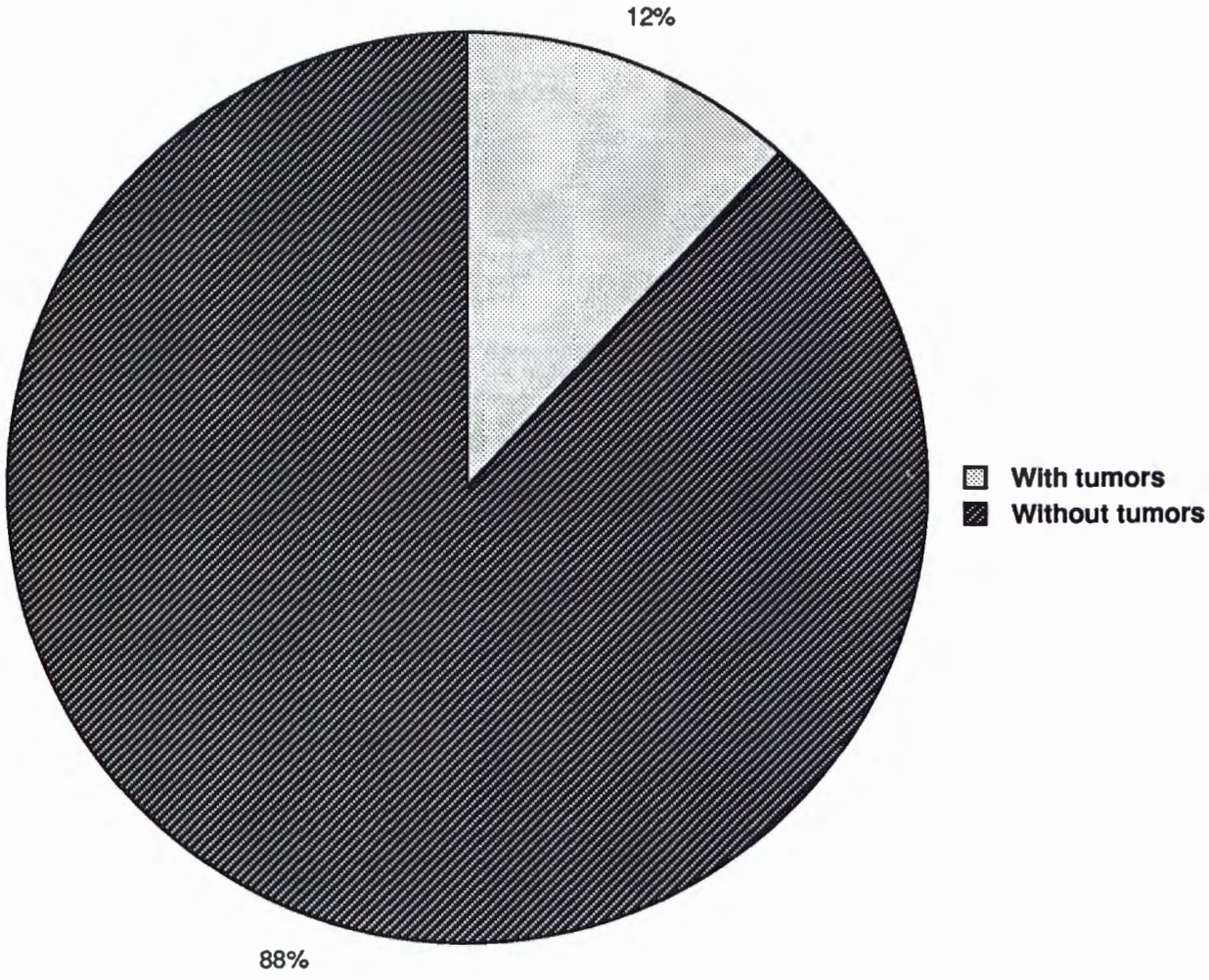


Figure 5: Turtles examined at Waikiki



	KANEOHE BAY				WAIKIKI BEACH			
NONTUMORED TURTLES								
	Mean	Median	25%	75%	Mean	Median	25%	75 %
SCL(cm)	45.3	41.5	40.1	45.0	56.8	57.1	45.6	66.9
Wt(lbs)	27.7	23.0	20.0	27.0	56.8	46.0	30.7	72.5
TUMORED TURTLES								
	Mean	Median	25%	75%	Mean	Median	25%	75%
SCL(cm)	51.7	48.9	43.5	60.5	67.9	69.8	64.6	72.9
Wt(lbs)	51.6	42.0	26.0	75.0	-	-	-	-

Table 1: Summary of straight carapace lengths and weights from nontumored and tumored turtles in Kaneohe Bay and Waikiki Beach.