A SURVEY OF GREEN TURTLES AT SELECT LOCATIONS IN THE HAWAIIAN ARCHIPELAGO

Duration

May-August 1977

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ABSTRACT

Between May-August 1977 an effort was made to examine the distribution and abundance of green turtles, *Chelonia mydas*, at three select locations within the major islands of the Hawaiian Archipelago. A total of 25 green turtles from wild populations was captured by using large mesh nets. The animals were measured, tagged with metal tags (Inconel) and returned to their natural environment. By sampling and tagging these animals, the data obtained from future recoveries will be helpful in answering the questions surrounding the migrations, growth, and longevity of this reptile in Hawaiian waters.

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INTRODUCTION

The green turtle, *Chelonia mydas*, is a reptile currently utilized for food and recreation by some residents of the State of Hawaii. Due primarily to over-exploitation, decreasing numbers of turtles have aroused public concern in recent years, thereby resulting in the initiation of regulations for the protection and perpetuation of this resource. Although regulation is an important component of resource management, scientific inquiry into the biology of the green turtle is also essential. Research conducted in the Leeward Hawaiian Islands has produced important data on the adult breeding colony which seasonally migrates to French Frigate Shoals. Laboratory and nutrition studies conducted at HIMB (1972-1974) and a MOP-supported project (summer, 1976) in the Ka'u district on the Island of Hawaii (with Mr. G. H. Balazs as project advisor) have also gathered valuable data on the green turtle in the Hawaiian Archipelago.

Having had the opportunity to work at the Hawaii Institute of Marine Biology on Coconut Island in Kaneohe Bay as a volunteer assistant since January 1976, and later as a student employee during the fall of 1976, I have come in contact with several individuals concerned with research and perpetuation of marine resources. My close association with Mr. Balazs has yielded a valuable introduction into the problems involved in managing resources without comprehensive information. His ongoing involvement in ecological studies of the Hawaiian green turtle has helped me to establish guidelines for making inquiries into the distribution and abundance of turtles at three select locations in the Hawaiian Archipelago.

The problems of conservation and utilization of valuable marine resources stem, in part, from inadequate biological data. In planning a comprehensive management program for perpetuating the green turtle for the benefit of future generations, information must be compiled on the present status of the resource. In examining three study areas, data were gathered on the distribution and abundance of green turtles within the major Hawaiian Islands.

STUDY SELECTION SELECTION

The Island of Hawaii was selected as one of the study areas because of the cooperation and green turtle fishing expertise of Mr. Arnold L. Howard, a resident of Punaluu. Mr. Howard was receptive and willing to share his knowledge of turtle habits he had acquired through the years. Under Mr. Howard's direction, the handling of large mesh nets permitted sampling to take place at Kaalualu and Punaluu on the southeastern coast of Hawaii during May 1977.

Bellows Air Force Station, Oahu was selected as the second study area because of personal communications between Mr. Balazs and Mr. Mel Tyau, a resident of Oahu. In the past Mr. Tyau had successfully caught turtles at Bellows using a baited hook and fishing rod. Mr. Tyau indicated that turtles could be frequently observed swimming along the shore. By obtaining a special entry permit from the military commander, Wayne H. W. Lee; Captain, USAF, access to the roads and coastal shores within the confines of Bellows Air Force Station was made possible. This permit allowed entry into a partially

restricted area thereby making it easier to carry out sampling techniques without interference from or to the public and military recreational usage of the beach area.

The Island of Kauai was selected as the third study area because it is the oldest of the Hawaiian Islands and possesses an extensive reef system with a variety of marine algae available to the feeding green turtle. The island was also chosen on the basis that it possessed a smaller rural human population, as compared to Oahu, and that turtles might appear in greater numbers because of lesser human interaction. Conversations with Mr. Herbert K. M. Kam, a resident of Kapaa, revealed a knowledgeable person acquainted with catching turtles. In the 1940's and 1950's Mr. Kam caught turtles as food and acquired an understanding of Kauai's coastal areas. It was through his wide range of acquaintances and introductions to various fishermen that encouraged study on Kauai.

HAWAII

Methods

On May 5-9, 1977 I accompanied Mr. Balazs to the Island of Hawaii to conduct a test of the feasibility of using large mesh nets to sample feeding aggregations of green turtles. With the help of Mr. Howard, field trials were conducted at Punaluu and Kaalualu (Figure 1).

The coastline of Hawaii is composed of recent basaltic lava flows and is highly irregular due to continuing volcanic action. The Kaalualu shoreline is a sharp rocky coast, rugged and marginally accessible to vehicles. It is an open area used by ranchers to graze cattle, with weathered boulders lining the beach. Punaluu consists of a steeply graded volcanic black sand beach that encloses a protected cove. The coastal waters along both of these areas is well mixed with freshwater producing a moderate thermocline change of one degree centigrade. A red alga commonly found growing on the nearshore margins of the reef was *Pterocladia* sp.

The test involved four sections of net. Two were made of cotton twine and two were made of nylon line. Each nylon net was 73 feet long and 12 feet high. The measurement of the mesh or "eye," or the distance between each knot when stretched was 18 inches. The other two nets were made of cotton twine, each 62 feet long and 14 feet high. Their mesh size stretched 26 inches. By joining different nets together, a variety of combinations could be selected to accommodate the varying bottom contours.

The nets were set by hand. This involved loading them into a large rubber innertube and then swimming perpendicular to the shore while releasing lengths of net. The nets were fastened to shore by a coral anchor placed

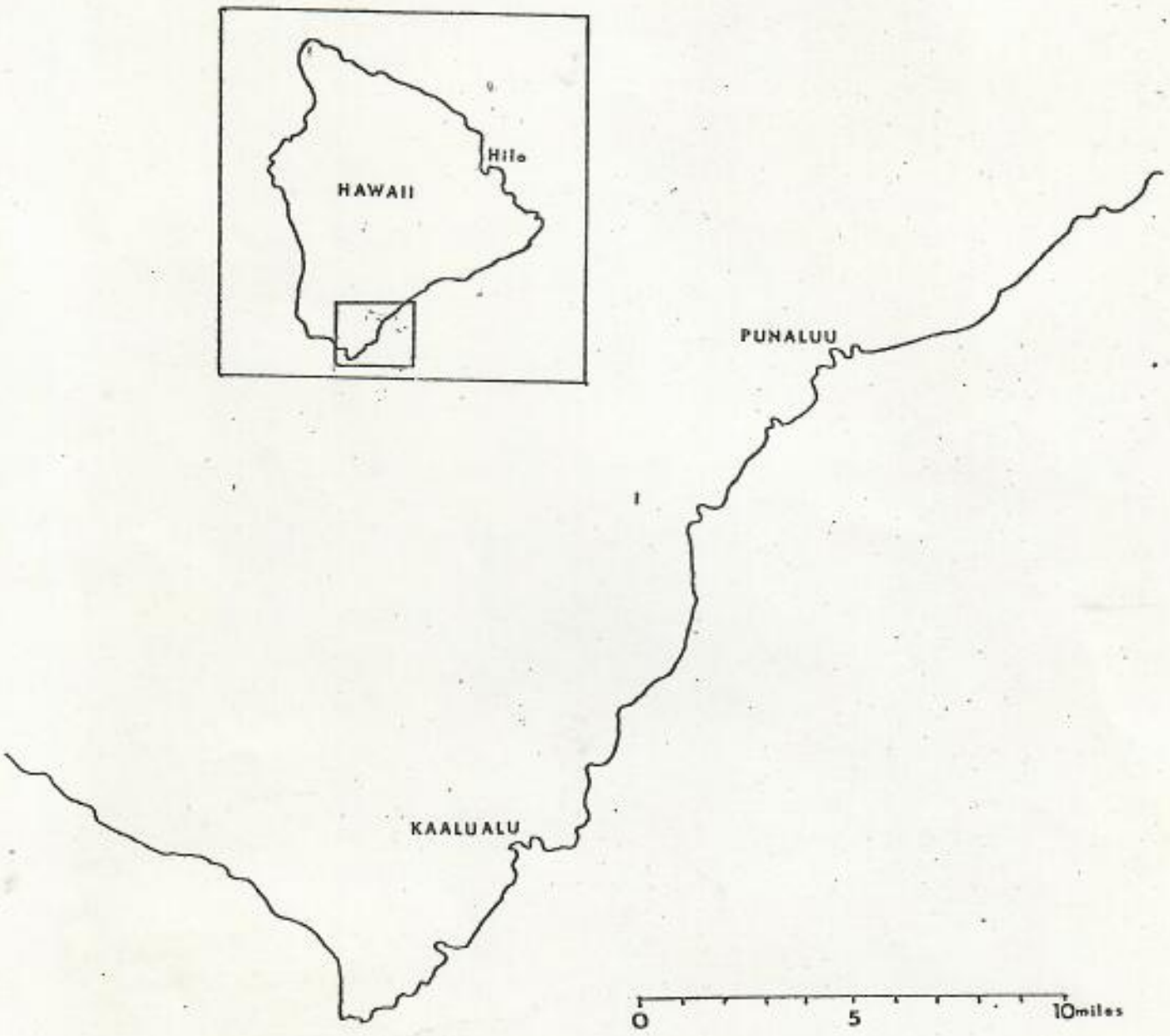

Figure 1. Coastline of the Island of Hawaii where field tests were conducted with large mesh nets.

within the rocks of the beach. This precaution prevented the nets from floating away due to strong shore currents, breaking waves or an entangled swimming turtle. By laying the sections of net perpendicular to the shore, an area could be sampled for any green turtles traveling along the coastline.

The nets were set in the late afternoon, usually during the beginning of a rising high tide. The nets remained in the water overnight, increasing the possibility of capturing a night swimming green turtle. Early the next morning before sunrise the nets would be checked and any entangled turtles promptly removed.

A floating net in the water would present an obstacle to a turtle. A swimming turtle would penetrate through the net and, because the lines were loose, further activity would gather the loose strands entangling the turtle's foreflippers. Bobbing floats and several floats found gathered close together or sections of floats pulled under water were indications of captured animals. Other identifying signs of capture were observations of dark masses and the characteristic raising of heads to breathe.

The turtles, immobilized by the confining strands of netting, were loaded into the innertube and brought to shore. Once on shore each animal was untangled and then measured. Every effort was made to treat the animal with great care, so as to prevent injury to the plastron, flippers or carapace. The first set of measurement taken was with a large caliper divided into one inch increments. This included the carapace length, which extended from the nuchal plate (located just behind the neck) longitudinally to the posterior marginals and the carapace width which was measured between the 6th marginal plates. The next measurement required a tape measure to

record curved data of carapace length and width, an indication of curvature or arch in the shell. The plastron was measured for straight length and the head measured at its widest point for straight width. The distance between the posterior end of the plastron and the tip of the tail recorded tail length. Each animal was then tagged, photographed, and released.

The tags were made of a nickel cadmium alloy (Inconel) possessing a high degree of resistance to saltwater corrosion. A set of four digit numbers appeared on each tag, as well as the imprinted message - "Write HIMB University Hawaii, 96744." The tags were fitted into a pair of application pliers and affixed to the trailing edge of the foreflippers. The tags were self-piercing and self-clinching. In this manner, the turtle was marked for identification and future reference.

Results and Discussion

On the Island of Hawaii, tests were successfully carried out to sample wild populations of green turtles by using large mesh nets. This technique showed that turtles could be captured and handled with minimum injury. The nets accounted for the capture of 15 turtles during a sampling period of four days. The animals ranged in size from 16-1/4 inches to 35-5/8 inches in straight carapace length (Table 1). The breakdown in size categories represented in these captures are as follows: juveniles (smaller than 19 inches in length) - 3; sub-adults (19 to 30 inches) - 8; and adults (greater than 31 inches in length) - 4.

In addition to the 15 animals that were captured, one turtle (Table 1, entry no. 12) was recaptured three days after its initial tagging at Kaalualu. Due to entangling within the nets, an original tag on the

Table 1. Length and Width Measurements of Green Turtles Caught on the Island of Hawaii

	Date	Area	Length		Width	
			Straight	Curved	Straight	Curved
	1977					
1.	May 5	Kaalualu	34-1/4	36	25-1/4	-
2.	May 5		29-7/8	32	24-1/2	31
3.	May 5		31-1/4	34	23-5/8	30-1/2
4.	May 6		23-1/2	25-1/4	18-7/8	22-7/8
5.	May 6		16-1/4	17-1/4	14	15-3/4
6.	May 6		20	21-1/2	16	20
7.	May 6		22-1/2	24-3/8	18-3/8	21-5/8
8.	May 6		27-7/8	29-1/4	22-5/8	28
9.	May 7	Punaluu	30	32	23-3/8	28-1/8
10.	May 7		32-3/4	34-3/4	25	31
11.	May 7		28	30-1/2	27	28-3/8
12.	May 8	Kaalualu	Recaptured turtle no. 3			
13.	May 8		18-1/8	19-3/8	13-5/8	16-1/4
14.	May 8		35-5/8	38-7/8	26-7/8	35-7/8
15.	May 8		28	30	22	27-3/8
16.	May 8		17	18	14-1/2	17-1/8

Mean Length: (straight) 26.3±6.36
(curved) 28.2±6.86

Mean Width: (straight) 21.0±4.77
(curved) 25.3±6.34

Range in Length: (straight) 16-1/4 - 35-5/8
(curved) 17-1/4 - 38-7/8

Range in Width: (straight) 14-27
(curved) 15-3/4 - 35-7/8

turtle's right flipper and one on its left flipper appeared to have been ripped off. New tags were applied and the animal again released into its environment.

Observations made by surveying the area revealed increased feeding activity by turtles during the late afternoon. Because of this observation, which was supported by Mr. Howard's personal observations, the capture nets were prepared and set into the water in the afternoon. In this way, any turtle swimming and feeding along the coast between the time period of late afternoon and early morning might be captured.

Though the mesh of the nets was large, the activity of the turtles trying to penetrate through the net tended to gather the loose strands around the flippers and neck region. Increased motion only gathered more lines, further confining and trapping the animal. The rubbing of the lines over exposed portions of skin produced abrasive burns. The earlier or quicker the turtles were removed from the nets, the less chance of injury to the animal would exist. Thus, periodic surveilance was one way that provided protection for the turtle.

In some instances, there were distinct possibilities of danger from drowning for the turtle. If a turtle was caught near the bottom by the lead line, coral heads that snag the line would not leave enough slack for a turtle to rise to the surface. Larger turtles might be strong enough to pull the net to the surface, but smaller turtles lack the strength. It was through monitoring the line of nets that smaller turtles were protected from drowning.

BELLOWS AIR FORCE STATION, OAHU

Methods

The two areas sampled on Bellows Air Force Station were located at the mouths of the Koolau-Waimanalo drainage system (Figure 2). At these points of entry into the ocean the streams are flanked by rock groins. Area one is part of the southernmost perimeter that restricts Bellows Beach recreational area to military personnel and their dependents. Area two is located on the public access side of Bellows Beach, toward Waimanalo Beach, and is locally known as Sherwood Forest. The following marine algae were found growing on the rocks and scattered on the sandy bottom in Area one: *Halimeda* sp., *Caulerpa* sp., *Enteromorpha* sp., *Cladophoropsis* sp., *Dictyopteris* sp., *Sargassum* sp., *Desmia* sp., *Asparagopsis* sp., *Acanthophora* sp., *Hypnea* sp., *Grateloupia* sp., *Gracillaria* sp., *Codium* sp., and *Ulva* sp. *Ulva* sp. is the principal algal found on the rocks in Area two.

Bellows Beach extends for 2.1 miles, from Wailea Pt. to Area two. It is part of a longer stretch of coral sand beach extending 4.5 miles from Wailea Pt. to Waimanalo Beach Park and then to Kaiona Beach Park. A one mile sand beach separates Area one from Area two, and is accessible to the public only on weekends and holidays. The water is generally cloudy with suspended sand particles. Seasonal currents create many shallow sand bars that extend out into the surf zone.

Capture methods with nets took place after conducting observations of feeding and transiting turtles on six different occasions. Green turtles were observed to periodically surface within 30-100 feet of the rock groins. By using several sections of nets in combination, a suitable sampling distance could be achieved.

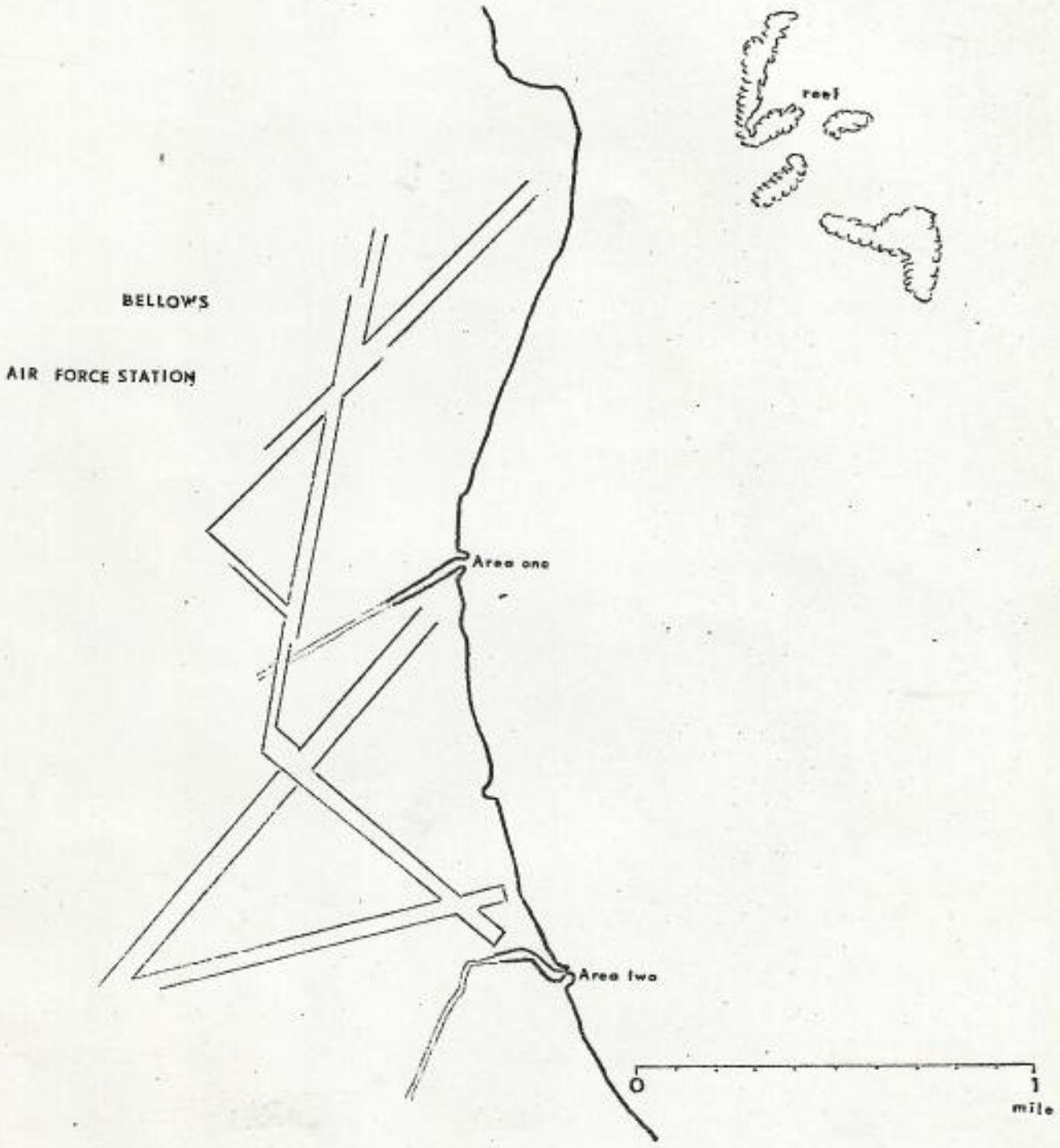

Figure 2. Bellows Air Force Station and adjacent waters.

Techniques that had been developed during the earlier experimentation on the Island of Hawaii were modified to fit the different topography at Bellows. The nets were set manually and again laid using a large innertube to float the gear beyond the breakers. A sand anchor (Danforth type) rather than a coral anchor, was set into the sandy bottom to secure the line of nets and prevent them from drifting into shore. This procedure of setting the nets took place in the afternoon. To maintain control over the project during the night, the nets were periodically monitored. By swimming alongside the nets and by beaming the light of a flashlight along the floats of the nets, any odd movement or downed floats indicative of captured turtles could be seen. If a turtle was caught, it would be promptly removed. At first light on the following day, turtles captured in the net were removed, brought to shore, measured, tagged, photographed and then released.

Between July-August 1977, sampling for green turtles with large mesh nets occurred on five separate visits to Bellows Beach. This involved camping near the nets to insure the security of the gear and to monitor turtle activity. At one or two hour intervals the nets would be checked with a powerful light. This would continue throughout the night until morning, when observation became more frequent.

Results and Discussion

Sampling with large mesh nets at Bellows Beach accounted for the tagging and release of ten green turtles. The sizes of these animals ranged from 15 inches to 24 inches, straight carapace length (Table 2). The breakdown in size categories represented in these captures are as follows: juveniles (smaller than 19 inches in length) - 4; and sub-adults (19 to 30 inches in length) - 6.

Table 2. Length and Width Measurements of Green Turtles Caught at Bellows Air Force Sation, Oahu

	Date	Area	Length		Width		Weight (lbs)
			Straight	Curved	Straight	Curved	
	1977						
1.	July 28	one	23-3/8	24-3/4	18-5/8	22-3/4	61
2.	August 1		18-3/8	19-1/8	15	17-3/4	30
3.	August 2		22-1/2	24	18-3/8	22-3/4	57
4.	August 3		20-1/8	21-3/8	16-7/8	20-1/8	42
5.	August 3		22-3/8	23-7/8	18	21-3/4	52
6.	August 3		17-3/8	18-5/8	14-1/4	17-1/8	25
7.	August 9	two	21-3/4	23-3/8	18-3/4	22-1/8	55
8.	August 10		24	25-1/4	19-1/8	23-1/8	70
9.	August 10		18-7/8	20	15-1/2	18-1/2	36
10.	August 10		15	15-5/8	12-3/8	14-3/4	16-1/2

Mean Length: (straight) 20.4±2.92
(curved) 21.6±3.17

Mean Width: (straight) 16.7±2.29
(curved) 20.1±2.90

Range in Length: (straight) 15-24
(curved) 15-5/8 - 25-1/4

Range in Width: (straight) 12-3/8 - 19-1/8
(curved) 14-3/4 - 23-1/8

Mean Weight: 44.4 lbs.

Range in Weight: 16-1/2 lbs - 70 lbs.

No adult size turtles (greater than 31 inches in length) were captured. The captured turtles' weights ranged from 16-1/2 lbs. to 70 lbs.

Most of the captured specimens appeared healthy, with several turtles having unusual physical characteristics. One turtle (represented by entry no. 2) had parts of its left front flipper missing and also a portion of its left hind flipper missing. A turtle (represented by entry no. 5) was missing its entire left front flipper, severed at the humerus. The injury was most likely from a shark attack. The wound had completely healed and the turtle compensated for its loss of a limb by vigorous use of its right front flipper. When released, the turtle appeared to move about without undue difficulty. Another turtle (represented by entry no. 6) had the misfortune of sticking its head through the threaded plastic lip of a container. The body portion to the container was gone, therefore the turtle had on its neck a confining plastic ring. The ring may have restricted the turtle's feeding and perhaps any further growth. This particular turtle was taken to HIMB facilities and the plastic ring removed by a hacksaw. That same day, the turtle was taken back to Bellows Beach and returned to the ocean.

Efforts were made to obtain samples of the foods the captured turtles utilized. A flexible grasping tool obtained from a hardware store, used to pick up small objects in hard to reach areas, was used as a stomach sampler. Its grasping end had previously been sanded and rounded to reduce any sharp edges. The grasping end was coated with a thin layer of salad-vegetable oil that aided its manipulation down the turtle's esophagus. The mouth of the turtle was gently forced open and a coiled tape measure placed between the upper and lower jars at the side of the mouth. The softness of the

tape measure did not harm the mouth and its position propped the mouth open. By following the tongue to the back of the mouth, the esophagus was found. It was essential that the probe went down the proper opening, for the opening to the trachea (respiratory system) also begins in the mouth. The oil-coated stomach sampler was gently inserted down the esophagus. Because the esophagus of the turtle is not straight, but bends and turns, flexibility of the sampler was essential. When the sampler could go no further, a spring was depressed which opened the grasping end. Upon release of the spring, the grasping end closed, usually with a sample of the stomach contents. The sampler was then removed and the stomach contents preserved in a dilute formalin solution. With care, the turtles appeared to suffer a minimum of discomfort. The marine algae *Codium* sp. and *Ulva* sp. made up most of the material recovered. In several instances no samples of stomach contents could be obtained.

KAUAI

Methods

Between August 17-24, 1977 investigations of green turtle aggregations on Kauai were carried out by visiting sites that were identified in interviews. These sites were compiled from information that was gathered from various people that were introduced to me through Mr. Herbert Kam. Some of these people had caught and eaten green turtles in the past, but presently no longer exploit this resource. A fireman from the Hanalei Fire Station (Mr. M. Mundon), a dive shop owner (Mr. L. Kaipaka), an owner of a sporting goods store (Mr. P. Yamagata), and a fisherman from Hanalei (Mr. M. Miyamoto) along with Mr. H. Kam were helpful in identifying coastal areas where turtles aggregated.

Observations at each site involved an ocular survey of the reef system. The length of time spent at individual sites ranged between 30 minutes to 1 hour. Sites that produced repeated observations of feeding and swimming turtles were revisited. Usually the observations were made from high points of land (bluffs and cliffs) or from the beach. With the aid of binoculars, turtles could be located and studied.

Results and Discussion

Interviews with various residents of Kauai identified areas that green turtles visited. The areas listed are as follows (see Figure 3):

1. Mililii
2. Nualolo
3. Haena (end of the road)
4. Haena Park Pavilion
5. Hanalei Bay (below Hanalei Bay Villas)
6. Hanalei Bay - Princeville (Pepe Street)
7. Hanalei Bay - Princeville (Punahele Street)
8. Anini (Blue Pond)
9. Anini Pavilion
10. Pilaa
11. Kaakaaniu
12. Moloaa Bay
13. Kealia
14. Kapaa
15. Wailua
16. Koloa Landing
17. Port Allen
18. Makaweli to Pakala

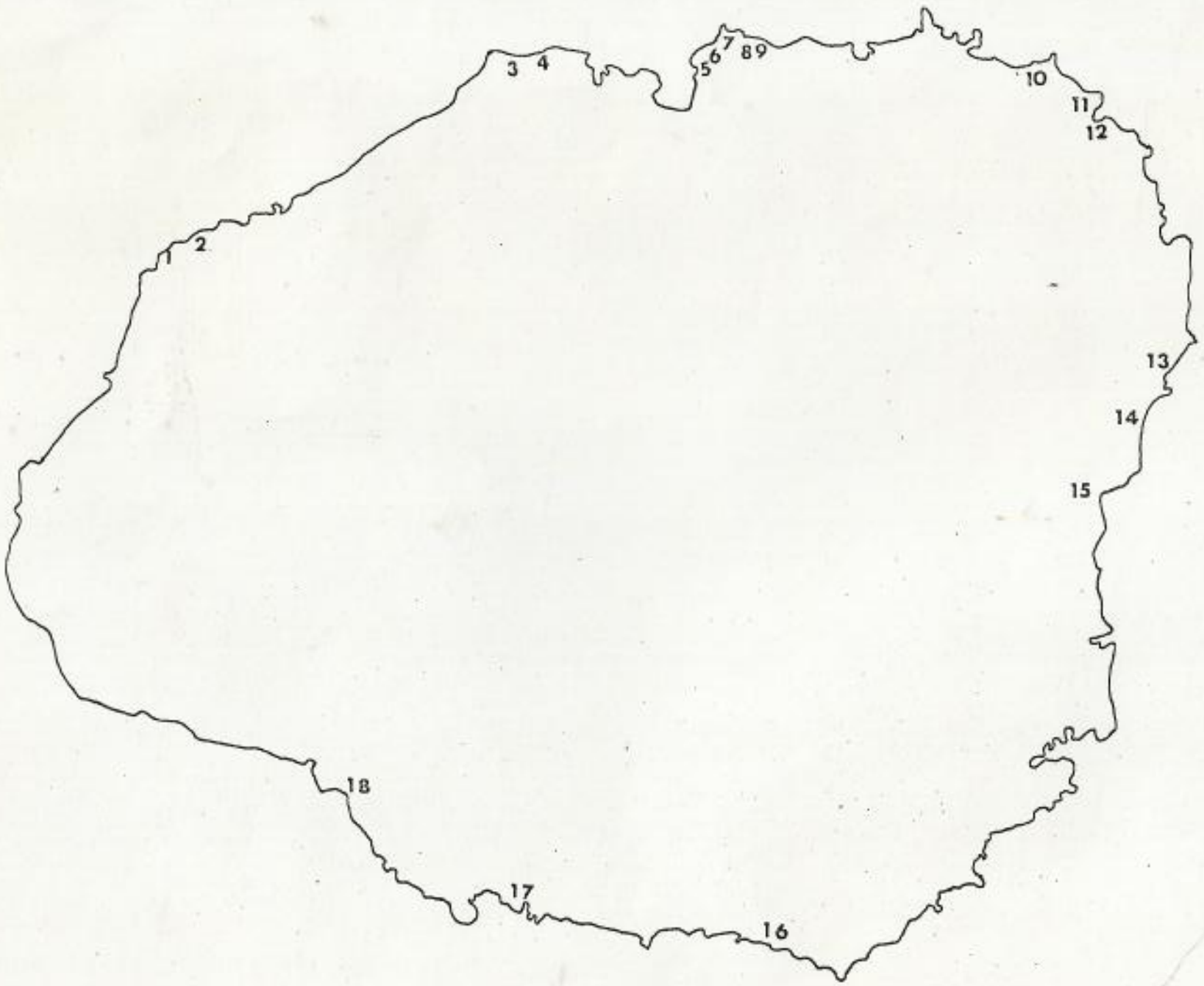

Figure 3. Island of Kauai. Numbers refer to areas listed on page 16.

Due to the inaccessbility to the valleys and shorelines of Milolii and Nualolo, the often-called "home of the sea turtle" on the Na Pali coast was not visited. Mr. Mundon believed that from these two valleys, Kauai turtles would travel to Princeville and then to Moloaa Bay. Between Milolii to Moloaa Bay turtles could reportedly always be found. Mr. Kam and Mr. Miyamoto expressed similar ideas of the abundance of turtles at Milolii and Nualolo, saying that if someone laid nets at those areas, a lot of turtles could be caught.

The other areas were visited with no actual confirmed sitings, except at Kaakaaniu. In the past (1975-1976) when I had visited Kauai for recreation, a favorite surfing spot on the southern coast hosted many turtles. This was Pakala, or "Infinities," an area of land that was owned by the Robinson family. While in the muddy water surfing, it was not uncommon to be surprised by the sudden appearance of a turtle. On this particular visit in August, no turtles were observed. At Port Allen, while walking along the breakwater I thought I saw the shape of a diving turtle. Surveillance of the area produced no turtle.

Some of the areas noted for green turtles were on coasts that were restricted from the public, due to private land ownership by cattle ranchers. The cattle rancher may be approached for entry onto his property if given a satisfactory reason, and a pledge not to injure the livestock. Pilaa and Moloaa Bay were two areas that required hiking along the coast to reach. By following trails made by fishermen study of these spots was achieved.

An area that I found to be visited by turtles was Kaakaaniu, a portion of reef that borders the coast from Kepuhi Pt. to Moloaa Bay. It is in an area that was once used for cattle grazing, but now shows signs of urban

development. Plots for two new houses have been cleared and a road leading down to the beach is being built. From a pine-tree covered bluff overlooking a 1,500 ft. strip of reef, green turtles could be seen engaged in feeding and swimming. On my first visit, August 18, I observed 7 turtles and upon subsequent visits, turtles numbering up to 4 were seen. By walking to the edge of the reef over a 2-3 foot deep reef flat, 100 yards from shore, I was able to approach unobserved to within 15-20 feet of a feeding turtle. The turtle would at regular intervals lift its head out of the water, take a breath of air and then dive. Through the clean water, the turtle could be observed up-ended, apparently feeding upon the algae which matted the reef. On the outer reef along the edges of the channels created by breaking waves was the red alga, *Pterocladia* sp. Also in abundance could be found *Acanthophora* sp. and limu kohu, or *Asparagopsis* sp.

While on Kauai I was able to witness an event that I had never experienced during my work with green turtles. The event involved the hunting and killing of a sea turtle at Kaakaaniu on August 19, 1977. At 5:00 p.m. on that date I was making observations on four turtles in the water at Kaakaaniu. The weather was clear and the water quite calm, with the wind 5-10 mph from the Northwest. The tide was low exposing the reef flat. Small one to two foot waves were breaking upon the outer edges of the reef. Two men were walking along the shallow reef sometimes stopping and peering at the open ocean. One of the men carried a long pole while the other carried a coil of rope. At one particular spot, instead of standing upright, the two men crouched low to the reef. In the surge zone, parallel to the men were several turtles feeding quite unaware of the danger. As a turtle approached the shallower edges of the reef, the fisherman carrying the pole; in fact a harpoon,

steadily moved closer to the turtle. Apparently the low profile of the hunter is unseen when the turtle is approached at the same level. After the turtle took a breath and resumed its underwater feeding, the fisherman quickly walked closer to the edge where the turtle was anticipated to surface. As the turtle surfaced to exhale a breath, the fisherman cast his harpoon. The turtle was speared and held fast by the rope attached to the harpoon. The two men then proceeded to drag the struggling turtle onto the reef flat and turn the turtle upon its back. This position rendered the turtle helpless and with this extra time the fishermen gathered their gear. By dragging and guiding the speared turtle from tide pool to reef flat, the two men managed to get the turtle pointed in the right direction. Soon the fishermen were out of my field of vision, lost behind a hill further up the beach. I wanted to see what they were going to do with the turtle, but first I had to find a way down to the beach. I retraced the path of my travel and remembered an unimproved dirt road that led to the beach further up the coast. By following that road I was able to drive to the beach a little before sunset (7:00 p.m.). I followed the beach from the end of the road back towards Kaakaaniu. I found the butchered carcass buried in the sand about 5 feet from the waters edge. I uncovered the remains to see what parts had been taken by the fishermen. The two men had removed both front flippers with the shoulder region and the pelvic and hind flippers. What remained in the sand was the carapace, plastron, head, tail, stomach and intestines. The extremely long tail identified this animal as a mature male. The following measurements were recorded from the reamins:

carapace length	(straight)	32-1/8 inches
	(curved)	34 inches
carapace width	(straight)	25-7/8 inches
	(curved)	31-1/2 inches
plastron length	(straight)	24-1/4 inches

Because the intestines were intact, I was able to obtain a fresh sample of the alga this particular turtle was eating. The sample was identified as *Pterocladia* sp., one of the dominant algal species found on the reef edge at Kaakaaniu. The stomach contents were preserved in formalin and the head and tail frozen to be studied at a later date.

ACKNOWLEDGEMENT

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