Habitat Use of Mixohaline Fish Ponds by Green Turtles at Kiholo Bay, Hawaii

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Kiholo Bay on the Kona Coast on the Island of Hawaii is located at 19°52'N, 155°55'W (Kay *et al*., 1977). This area has been studied regularly since 1987 and over 300 green turtles (*Chelonia mydas*) have been captured and tagged there (Balazs *et al.*, 2000). Kiholo Bay represents an important foraging and resting area for immature green and, to a lesser extent, hawksbill turtles. The primary resting area is Wainanali'i lagoon, but recent observations have shown that turtles are resting in mixohaline ponds that were previously little used. Turtles can now be seen entering and exiting these ancient Hawaiian fish ponds on a daily basis through a 50 m long channel (awai). Freshwater supplied by underground springs continually mixes with saltwater brought into the ponds with the tides through the awai and as tidal ground water. Nothing has been reported elsewhere about turtle behavior and ecology in similar brackish water environments (Lutz and Musick, 1996). The purpose of our study was to determine which turtles used the ponds, the times they entered and departed, their size distribution, and movements relative to tides and time of day. We additionally observed habitat usage and specific behaviors within the ponds.

Methods

A Sony TRV-10 Digital Video camera connected to a TV monitor and VCR was used to record turtles entering and exiting the mixohaline ponds through the awai. A total of 149 hour of observations were recorded between April 1999 and January 2000. Individual turtles were carefully hand captured using scoop nets. The turtles were measured, weighed, PIT tagged, and lightly inscribed on the left and right second lateral scute for visual identification (Balazs, 1995). The deep body temperature (Tb) was taken with a Cole-Parmer Digi-Sense thermister thermometer (model 8522-10). A lubricated, flexible probe was inserted at least 15 cm through the cloaca into the colon to reach the deep body regions. Time, identifying number, and behavior were recorded for any turtles observed in the ponds. Water temperature and salinity were taken at various locations within the ponds and awai. Water temperature was taken at the surface and at 1 m depth using a hand held thermometer. Salinity was measured with a refractometer. Current flow was measured by allowing a surface drogue to float a measured distance (10 m) and timing it. Algae samples were collected in feeding areas and stored in 10% formalin for identification.

Results and Discussion

A total of 42 turtles were captured. All of the turtles captured and tagged in the ponds were immature. Sventy-nine percent of the captured turtles had a curved carapace length between 40 cm and 60 cm. Eighty-two percent of the captured turtles weighed between 10 kg and 25 kg. Turtles in the ponds were generally observed to be resting, feeding, or basking out of the water. Turtles usually rested in the shallows (depth <0.5 m) near the edge of the pond. Larger turtles were also observed resting on the bottom within the deep sediment of the pond floor (1.5 m deep). Due to the warmer water at the bottom of the ponds, it is likely that resting in the sediment on the pond floor has thermal

benefits, but greater analysis of this behavior would have to be done. Individual turtles (as identified by their carapace numbers) were frequently observed resting in the same locations or home site. Turtles were also observed feeding on algae in and near the pond entrance. Analysis of algae samples taken revealed over 99% *Cladophora hemisphaerica*. Turtles were observed basking in four primary areas. The same turtles consistently basked at the same location. For example, #36 was observed basking on 11/2/99 at 1743 hours and then observed basking at the same site on 1/14/00 at 1455 hours. Many of the numbered pond turtles were observed outside the ponds as well, mainly in the lagoon. For example, on November 1, 1999, turtle 19 was recorded leaving the mixohaline ponds at 0611 hour and was then observed basking in the lagoon later that afternoon at 1457 hour. On 1/15/00, turtle 45 was seen basking in the lagoon and was captured the next day exiting the ponds at 0635 hours (Rice *et al.*, This volume). Tides appeared to be the determining factor for turtles entering the ponds. Numerous turtles were observed attempting to enter the ponds, but currents from the falling tides prevented them from doing so. Current flow measured in the awai during a falling tide was 0.6 m/second in the widest part of the awai and one meter per second in the narrowest part of the awai. Often turtles managed to swim part way up the awai before currents proved too strong and they were forced to abandon efforts to enter the ponds. No turtles entered the ponds when tides were below 0.2 m. However, turtles did not appear to be restricted by tides when exiting the ponds. Turtles left the ponds periodically, but 82% of the turtles observed exiting the ponds left between 0500 hours and 0900 hours, presumably to forage in the adjacent bay outside the ponds. Deep body temperatures (Tb) taken from turtles both entering and then exiting the ponds showed a decrease in temperature for pond residency. The average Tb of the eight turtles captured entering the ponds was 24.8°C. The average Tb for the ten turtles captured exiting the ponds was 21.9°C, an average drop in deep body temperature of 2.9°C. Water temperatures were taken in the ponds at both the top and bottom. The range of water temperatures in the ponds was 20°C to 23°C near the surface, while the bottom was much warmer with a range of 24°C to 26.5°C (depth = 1 m) Salinity measurements were taken at the same time. In pond one, surface readings gave a salinity of five parts per thousand (ppt) and the bottom was 33 ppt. In pond two, surface measurements showed a salinity of 0 ppt and a salinity of 21 ppt at the bottom. The slightly higher salinities in pond 1 are most likely due to the infusion of salt water brought into the ponds through the awai with the tides. The results of this study depict the ponds as an important resting habitat for the green turtles residing there. In the past, the ponds were not used at the current high level, but now turtles can be seen entering and exiting the ponds on a daily basis. Over fifty turtles were observed entering the ponds in a single 24-hour period. All of the turtles using the ponds were immature. The turtles usually left the ponds for at least a few hours each day, presumably to forage in the bay. Turtles were seen foraging and basking in the ponds, but the ponds appear to be principally a resting area. The ponds likely offer protection and safety from predators in the bay as well. Lower deep body temperatures observed in turtles exiting the ponds would lower their metabolism, perhaps resulting in an energy savings. The overall use of the ponds is primarily that of a resting habitat for immature turtles.

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