

Basking, foraging, and resting behavior of two sub-adult green turtles in Kiholo Bay Lagoon, Hawaii

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INTRODUCTION

The green turtle (*Chelonia mydas*) is the only marine turtle species reported basking on land. One notable place where basking occurs is the Northwestern Hawaiian Islands (Whittow and Balazs 1985). Terrestrial basking in the main islands has increased dramatically since 1994. By using a combination of a field remote-controlled video camera, time-depth recorders (TDRs), and sonic tags the diel behavior of two habitually basking sub-adult green turtles was studied. Behaviors monitored included basking, foraging, and resting.

Green turtles are known to have been basking in Kiholo Bay, Hawaii, located at 19 52'N, 155 55'W on the Kona/Kohala coast, since 1994. The lagoon where they are seen basking has a shoreline consisting primarily of basaltic rock and consolidated pahoehoe lava. The south shore, which separates the lagoon from the ocean, is made of large rounded basaltic rocks, with a small gravel beach called "Turtle Beach." The lagoon is marine with substantial subsurface fresh water influx. The surface water (< 0.5 m) has a temperature between 20-22 C and a salinity of 8-15 ppt. The subsurface water (>0.5 m) has a temperature of 24-26 C and a salinity of 28-30 ppt. Sea water outside of the lagoon is 28 to 36 ppt (Rice et al. 2002).

There are several possible reasons why turtles bask. It was found that metabolic rates during basking in captivity were lower than during active behavior, implying an energy conservation benefit (Swimmer and Balazs 2000). Adding to the energy conservation theory, it is thought that basking is preferred over resting on the bottom because of the energy used to swim to the surface to breathe. Basking also reduces exposure to marine predation (Green 1998). Thermoregulation is another possible benefit. Green turtles have been found to raise their body temperature while basking at the surface by as much as 5 C (Spotila and Standora 1985) and as much as 10 C more than ocean temperatures while basking on land (Whittow and Balazs 1985, Rice et al., in press). Body temperature is normally 1.0-2.5 C higher than the surrounding environment (Heath and McGinnis 1980). Basking behavior by Kiholo turtles is known to extend into the night most often until internal body temperature, T_b , drops to ~22 C at which point the turtles return to the water (Rice et al. 2000). However, for night baskers on Midway Atoll (Balazs et al., in press), energy conservation and safety might be primary factors since they most likely do not experience any warming affect at night. It is likely that basking behavior is exhibited for a combination of these and other unexplored benefits. For the Kiholo population, primary basking benefits most likely consist of thermoregulation and energy conservation.

In May 2000, two cameras were installed at Kiholo Bay lagoon. These cameras were used to observe turtle basking behavior for one month. Individual turtles were identified by their head scale patterns, as well as by moto-tool (MT) numbers lightly etched on their carapace to determine basking patterns (Quaintance et al., in press). More basking duration data has been collected for this study using one video camera. The camera was also used to correlate TDR data with observed basking behavior of the two TDR tagged sub-adult green turtles.

MATERIALS AND METHODS

On October 24, 2001, two sub-adult green turtles were hand captured while basking on Turtle Beach at Kiholo Bay lagoon. MT 53 and MT 94 were identified by their head scale patterns. These individuals were chosen because they met a predetermined set of criteria. They were 45 kg body weight, habitual

baskers, and had a long tag history of residence at Kiholo. The TDRs (Wildlife Computers Inc. MK7) and sonic tags (Sonotronics CH-87-L) were attached to the right of MT 94 and the left of MT 53 on the second lateral scute. The procedure of the attachment of the TDR to the carapace, as well as the use of the sonic tags, are described in Rice et al. (2000). The TDRs were programmed to collect depth every minute and temperature every three minutes. On January 18, 2002, all data were successfully downloaded from MT 53 using a Sony™ laptop. The MK7 unit was then redeployed. On February 1, 2002, MT 94 was recaptured and all data were recovered in similar fashion. It was also redeployed.

The remote camera was not functional until November 20, 2001, so the TDRs were out for about one month without the camera. The camera feed was monitored fairly consistently during the week, but not the weekends. All basking episodes were recorded and later entered in a File Maker Pro database. Pictures of the turtles, as well as full motion and time lapse video clips, were captured using BTV Pro and a VCR.

RESULTS

TDR carapace temperatures above 28 C were considered to represent basking (highest ocean temperature was 27 C). It was determined that small regular fluctuations in temperature indicated resting behavior and relatively constant temperature was foraging behavior (Fig. 1). Several of these episodes were confirmed with data collected using the remote video camera. MK7 temperature data were correlated with external carapace temperature using an IR temperature gun. Both readings were found to be within 1 °C of each other, which is within both instruments' error range.

From MT 53, a total of 85 days of data were recorded (10/26/01 to 1/17/02). For 60 of those days MT 53 came out to bask a total of 221h (11%) of the total time. The highest carapace temperature recorded while basking was 45 C for both turtles. The average time spent basking was 3.7h (S.E.=0.28) per basking episode with a range of 1.0-10.3h. MT 53 spent 728h (37%) of the time foraging, and 1040 h (52%) of the time resting.

Data from MT 94 showed similar percentages. During a 99-day period (10/25/01 to 1/31/02) it spent 41 days basking for a total of 239 h or 10% of the total time. MT 94 spent 975.5 h (41%) of the time foraging, 1,160.4 h (49%) of the time resting. MT 94 spent an average of 4.6 h (S.E.=0.57) basking per basking episode with a range of 0.3 h to 16.4 h. Both turtles most often came out to bask in the late morning and early afternoon with peaks at 1100 h and 1300 h. This is similar to previously observed behavior. MT 94 did not bask as often as MT 53, but on average it stayed out longer.

Some interesting behaviors were observed with the camera while turtles basked. They were often seen yawning and, less frequently, some aggressive biting and snapping was observed. Camera observations also showed that, for all turtles, basking was most often initiated in the late morning and early afternoon similar to MT 94 and MT 53.

Most commonly, turtles were observed basking in groups and sometimes they would climb over one another or bask on top of each other. The question asked to prove group basking was whether green turtles initiate basking closer to existing baskers or to a fixed point (A) on the beach. The null hypothesis was that turtles emerged at random locations on Turtle Beach. Data were gathered by estimating distances of emerging turtles from Point A and from the nearest currently basking turtle for 7 days of basking (N=81). A single factor ANOVA test was run on

the data giving a P-value of $<.001$. The null hypothesis was rejected and it is assumed that the turtles were choosing emergence points closer to other basking turtles. The reasons for this possible aggregating behavior are not known but turtles may simply be choosing better basking areas and, therefore, ending up close together. As is the case with pinnipeds that bask, there may be a group protective factor involved in green turtles choosing to come out near other basking green turtles. In all likelihood, the aggregating behavior shown by the basking turtles at Kiholo results from a combination of the two factors mentioned above.

CONCLUSION

Habitually basking sub-adult green turtles basked an average of 3.7 to 4.6h per episode and stayed out as long as 16h. They spent an average 10% of their day basking, 39% foraging, and 51% resting. Basking turtles tend to initiate basking close to other basking turtles, which may offer added protection from terrestrial disturbance. Basking at Kiholo Bay is only initiated during daylight hours but extends into the night. Internal body temperatures of basking turtles are significantly above environmental temperatures up to 10 C, and slowly drop as external environmental temperature drops. Basking turtles return to the water at night when their internal temperature decreases to 22-24 C. Basking is most likely a way for turtles to conserve energy, decrease the probability of predation, and raise internal body temperature thereby increasing the rate of metabolism.

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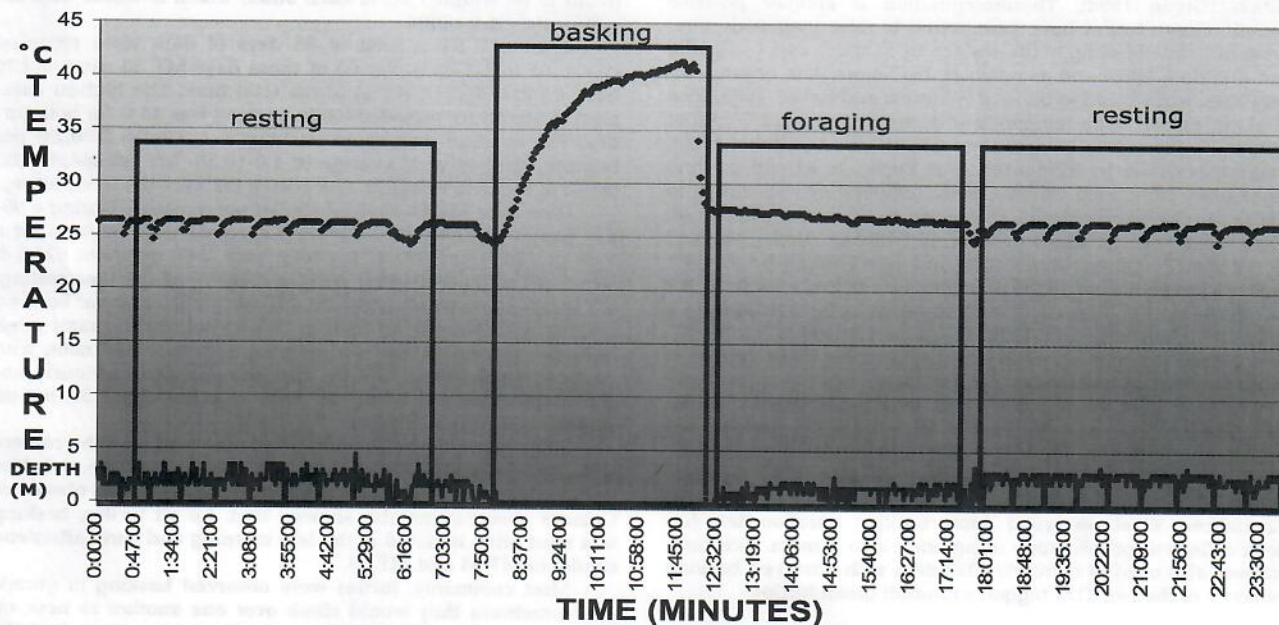


Fig. 1. MT 94 temperature data from 11-20-2001. Resting, basking, and foraging behaviors are indicated.



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