

# CLEANING SYMBIOSIS AND DIEL BEHAVIOR OF GREEN TURTLES (*CHELONIA MYDAS*) AT PUAKO, HAWAII

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## Introduction:

Puako, on the west coast of the Island of Hawaii, is a 5 Km stretch of submerged lava platform bordered by coral reef. The platform has large shallow areas of “turf” algae providing substantial forage for green turtles (*Chelonia mydas*). This area has been a study site of ours since the 1980’s and over 300 juvenile and subadult green turtles have been tagged there (Davis et al. 1998).

Cleaning Symbiosis between fishes and turtles has been documented in many areas of the world. In some instances, the symbiotic relationship between fishes and turtles involves wrasses and the removal of ectoparasites (Losey et al. ,1994; Zamzow, 1998). More commonly, herbivorous fishes are observed cleaning the shells and skin of turtles (Limpus, 1978; Balazs, et al., 1987; Smith, 1988; Sazima et al. 2004). This cleaning behavior has been described and documented from various sites around the world, but there have been few attempts to quantify the diel time allotment to cleaning behavior by green turtles (*Chelonia mydas*).

The increasing population of Hawaiian green turtles (*Chelonia mydas*) has highlighted the occurrence of turtle cleaning stations in waters 10-20 M in depth at various locations along the west coast of the Island of Hawaii. Puako is a designated fisheries management area (FMA) and several cleaning stations have been identified. Our work centers on one station that has been in existence for at least 15 years (pers. Obs.) although it has expanded in size over the last three years. Our studies at this site clarify the fish/turtle cleaning behavior, time allotment by green turtles to this behavior, the number of green turtles frequenting the cleaning station and an estimate of the distances turtles travel to reach the cleaning station from their forage areas.

## Materials and Methods;

This study was conducted over a period of 6 months from August 2005 to February, 2006. The cleaning station is located in 10 meters of water off of a basalt reef shelf approximately 400 meters from shore (19.970<sup>0</sup> W, 155.846<sup>0</sup>) (Figure 1). The current site is larger in area and approximately 50 meters to the south of the original site although the old site is still in use on occasion. The substrate is largely healthy coral reef (*Porites lobata* and *Porites compressa* are the dominant corals), with substantial degradation in the area of the cleaning station resulting from constant use by juvenile and sub-adult green turtles.

Puako is a popular scuba dive site and many of the green turtles are quite comfortable in the presence of divers. The cleaning behavior of green turtles and fishes was documented while scuba diving using underwater digital video and still cameras to document complete cleaning episodes for later analysis in the laboratory. Whenever a

turtle swam into the area of the cleaning station and lingered for more than one minute, we logged it as a cleaning episode. A total of 23 hours was spent on scuba at the station. The presence of scuba divers appeared to have little or no impact on green turtle behavior. Thirty-Five complete cleaning episodes were recorded in this manner. Divers were careful to maintain at least a 3 meter distance from turtles although many of the turtles would swim right up to and around the videographers. Video tapes of the episodes were analyzed in the laboratory and behaviors were quantified at 10 second intervals. The number and kinds of fish and the behavior of the turtle were noted. Turtle behaviors were classified as swimming, posing, resting and shifting on substrate. Swimming behavior is defined as ????????

In order to document the number of turtles visiting the station over time and to further observe cleaning behavior, an underwater Pan-Tilt-Zoom digital video camera (Sony SNC-RZ30) was used in a custom built housing (Figure 3). Power and a wireless access point were contained in a surface buoy attached to the camera by an umbilical cord. The image from the camera was monitored and recorded on the research vessel some distance away from the site using a laptop computer. A total 23 hours of observations over a period of four days were recorded in this manner to determine times of maximum use at the cleaning station. In addition, counts of turtles at the cleaning station made during scuba dives were used to further clarify cleaning station usage at different times of the day. Three night dives were made to determine the presence of turtles at the cleaning station at night.

Digital images were taken of the right and left sides of the head of individual turtles visiting the cleaning station using a Canon Eos Rebel XT digital camera in an Ikelite housing. These images were used to create a database of individuals using head scale patterns for unique identification (Keuper-Bennett et al., 2004; Quaintance et al., 2004). The head scale recognition catalog allowed us to log individual presence, estimate the number of turtles that utilize the cleaning station and calculate approximate individual diel time allotted to cleaning behavior.

During our normal shoreline capture and tagging work, we compared head scale patterns of captured turtles with our catalog of cleaning station turtles. Using GPS technology, we developed a rough estimate of the distances turtles traveled from their forage ground (capture and tagging site) to the cleaning station.

Results:

Cleaning Behavior:

At the beginning of a typical cleaning episode, a green turtle would swim into the area from the shallow reef platform (rarely did they enter the area from the open ocean side of the cleaning station). The turtle would swim in a “leisurely” manner into the cleaning area (Figure 1) and descend to 7-10 meters in depth. Herbivorous cleaner fish (cleaners) (Figure 2) would only service animals that were within 3-4 meters of the bottom. The predominant species of fishes involved in cleaning were the Yellow Tang (*Zebrasoma flavescens*) (present 81% of time) and the Golden Eye Surgeon Fish (*Ctenochaetus strigosus*) (present 88% of time) (Table 1). Occasionally, a parrot fish (*Scarus dubius*) (present <1% of time), Pink Tailed Triggerfish (*Melichthys vidua*)

(present <1% of time), and Black Triggerfish (*Melichthys niger*) (present <1% of time), were observed exhibiting cleaning behavior (Table 1). *C. strigosus* foraged almost exclusively on the turtles carapace with some foraging on the flat surfaces of the pectoral and hind flippers. *Z. Flavescens* forages on the rougher surfaces of the turtles skin in the neck and shoulder region. We believe that this is result of the different mouth structure of the two different species with *Z. Flavescens* morphologically adapted to feeding on rough, wrinkled surfaces and the broad mouth structure of *C. strigosus* better adapted to the flat surfaces of the turtles scales (Figures 3 &4).

Upon approach of a turtle, cleaners would ascend as a mixed school of *Zebbrasoma flavescens* and *Ctenochaetus strigosus* (Average 8 individuals) and begin foraging on the carapace and skin of the green turtle. Turtles in the area would begin posing as soon as they would see fish ascend toward them to begin cleaning behavior. Posing while swimming involved slow swimming strokes with the pectoral fins, extended hind flippers and an extended neck (Figure 4). The turtle, thus posing would swim back and forth within the confines of the cleaning area occasionally losing its cleaners and circling back to reacquire them. During 26% of the episodes the turtle would settle to the bottom and pose in a stationary position. Typical stationary posing involved elevating the body off the substrate by “standing” on the tips of the pectoral and hind flippers (Figure 5). This elevated position was often accompanied by extending the neck to facilitate access by the cleaners. Twenty-three percent (24%) of the time, turtles came to the cleaning station and assumed a typical resting behavior by swimming right into one of the recessed “beds” in the reef and remained quiescent (no overt posing observed) for up to 36 minutes. These animals were cleaned occasionally by one or more fish (Table 1) but were never serviced by larger schools of cleaners as posing turtles were. On several occasions (6% of the time), turtles would settle to the bottom and “scratch” their plastron on the hard coral substrate.

Juvenile and sub-adult green turtles were observed for a total of 35 complete cleaning episodes totaling 345 minutes. The mean length of time that was spent on station during an episode was 10 minutes (need the actual lengths for each episode) with a range of from 1 to 36 minutes. While turtles were on station, they were posing 41%, swimming 29%, resting 24% and shifting on rocks 6% of the time. Posing turtles were cleaned 73.5% of the time and there were an average of 9.3 (s.e.=???) cleaner fish present. Swimming behavior elicited cleaning behavior 42.9% of the time and garnered an average of 3.6 (s.e.=???) cleaner fish. Turtles resting within the area of the cleaning station had an average of .5 (s.e.=???) cleaners working and were cleaned 20% of the time while they were resting.

Individual Time Allotted to Cleaning Behavior and the number of turtles that visit the cleaning station---

Head scale identification allowed us to identify 104 individual turtles that were observed utilizing the cleaning station on one or more occasions. Some individuals were frequently seen at the station. Our sampling dives were hampered by rough weather and, consequently, we were unable to make repetitive dives over consecutive days.

Nonetheless, we feel that we can gain some insight into the amount of time allotted to cleaning behavior. Forty Two of the 104 turtles were observed on one of 19 dives, 26 on two out of 19 and 22 were seen on three or more occasions out of 19 dives (dives made during the peak times from 0900 to 1400 hours (Figure ???). Two turtles were observed at the cleaning station on 7 of the 19 dives. One turtle was seen on 8 of the those 19 dives. It appears that time allotted to cleaning behavior varies greatly between turtles with some visiting every two or three days while others may only visiting once or twice every couple of weeks. It would also appear that cleaning behavior is not evenly distributed over time but clumped into several consecutive days followed by extended absence from the cleaning station, similar to what we see in basking behavior (Rice, et al., 2000).

#### Time of Day Turtles visit cleaning station-

Counts of green turtles visiting the cleaning station were made over a period of 26 days of sampling from August, 2005 to Jan, 2006. Counts of turtles present within the area of the cleaning station were taken every 10 minutes and an hourly mean number present was calculated. Figure 6 shows the distribution of turtle presence. The numbers varied significantly, but there is a clear preference of cleaning station use during the morning hours with very little visitation occurring in the late afternoon. During a series of three night dives between the hours of 2000 and 2300 hours, no turtles were observed in the area of the cleaning station. It would be expected that no turtles would come to the station during the night as all cleaners are diurnal but it was interesting to note that none of the daytime resting locations were used during the night. We have not observed any turtles during the early morning pre-dawn hours.

#### Number of turtles frequenting the station and the distance they travel from their forage grounds..

There are a number of cleaning stations that have been discovered along the leeward coast of the Big Island and many of them are well know to SCUBA divers as they are popular dive sites. We know of two major cleaning stations along the Puako FMA coastline and they are approximately 3 Km apart. Turtles visiting the cleaning stations, it is assumed, come from some distance north of south of the station and we have observed turtles that visit the station foraging directly inshore from the station. We also documented cleaning station turtles foraging .5 Km north of the cleaning station. Further identification work will most likely show that turtles may travel from as far away as 1 Km to the north and south of the station.



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FIGURES AND TABLES-

Table 1 . Effectiveness of 4 green turtle behaviors in attracting cleaner fish in the vicinity of the Puako cleaning station.

YT=*Zebrasoma flavescens*; GRS =*C. strigosus*); PF= *S. dubius*; PT= (*M. vidua*); *M. niger*.

Behavior	Cleaner Fish Present	% of Time Behavior Exhibited	Percent of Time Behavior Elicits Cleaning	Average Number of Cleaners	Relative Index of Effectiveness of Behavior
swimming	YT, GRS, PR, PT, BT	29	43	3.6	.45
Posing	YT, GRS, PR, PT, BT	41	73.5	9.3	2.8
Resting	YT, GRS	26	20	.5	.03
Shifting on Substrate	YT, GRS	6	3.1	4.5	.01

Figure 1. Location of the cleaning station just off of the western edge of the basalt reef platform (19.970<sup>0</sup> W, 155.846<sup>0</sup>) at Puako, Hawaii.



Figure 3. Sony PTZ camera (SNC-RZ30) shown in the background as surface personnel use it to observe cleaning behavior.



Figure 4. Juvenile green turtle exhibiting posing behavior while swimming.



Figure 5. Resting pose with body elevated on tips of hind and pectoral flippers as well as significant neck extension.



Figure 6. Average count of turtles visiting the Puako cleaning station per hour using a 10 minute sampling interval.

