# Midway Atoll Marine Turtle Survey
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## Introduction

Midway Atoll (28$^0$ N, 177$^0$ W) measures approximately 9 km in diameter with 234,876 hectares of submerged reef and has three coral islands ( Eastern Island, Sand Island and Spit Island) totaling approximately 626 hectares. Work done by Balazs (Balazs, et al, 2005) between 1975 and 2001 showed that there was a significant population of green turtles (*Chelonia mydas*) living at Midway Atoll. The main population was congregated around Sand Island with the inner harbor and the cargo and fuel piers acting as sleeping locations for juvenile, sub-adult and adult turtles. In the 1970's and 1980's, most of the population was composed of juvenile turtles with a slow growth rate. By the late 1990's, the population had matured such that 40% of the animals were sub-adults or adults. (Balazs, et al, 2005). There were several cases of fibropapillomatosis observed in the 1990's, whereas no cases had been observed in the 1970's.

In April of 2010, I went to Midway Atoll with the Oceanic Society Expedition to conduct a survey of the green turtles that bask on "Turtle Beach," Sand Island and to observe related behaviors within the waters adjacent to Sand Island and Eastern Island.

## Methods

From April 17 to April 25, the basking beach (28.216$^0$ N, 177.366$^0$ W) on Sand Island was visited frequently (usually every hour on the hour) during the daylight hours and occasionally during the early night hours. All observations were conducted by me and a 3 person team from the Oceanic Society expedition group. Photographs of the beach were taken and telephoto shots of the turtle heads (mostly the right side because of the orientation of the turtles) were taken for future individual identification using head scale patterns. Observation of the turtles was limited to the northwest end of the beach because of concern about disturbing turtles, birds and monk seals. When possible, isolated individual basking turtles were unobtrusively approached from behind and scanned for PIT (passive integrated transponder) tags, and a straight carapace length (SCL) measurement was taken.

In between visits to the basking beach, we visited other sites on Sand Island where turtles had been seen in the past. The Inner Harbor and the cargo and fuel piers were the primary sites visited, but the entire island was visited at least once

except for an area called "rusty bucket" (28.215$^0$ N, 177.387$^0$ W) that was closed because of a monk seal (*Monachus schauinslandi*) birth. Observations of turtles and their behaviors were noted and collated relative to time and location.

Only one trip was made outside of Sand and Eastern Islands, but our earlier work in 1998-2004 (Balazs, et al, 2004) failed to find any significant numbers of turtles along the inner reef of the atoll and there were no reports to suggest that this had changed since then. It should be noted that Suzanne Canja, Cynthia Vanderlip Bruce Casler and Wayne Sentman have documented regular basking on the emergent reef during kayak patrols in the past (Wayne Sentman, pers. com.)

**Notes on observing basking turtles at Turtle Beach:**

Standing just back from the edge of the northwest end of the beach to observe basking turtles did not elicit any response from them. Turtles could be photographed and observed using binoculars from that vantage point as long as they were not in the process of coming out within about 10 meters of the ramp. The impact of human presence was significantly reduced by keeping a low profile (kneeling or laying down).

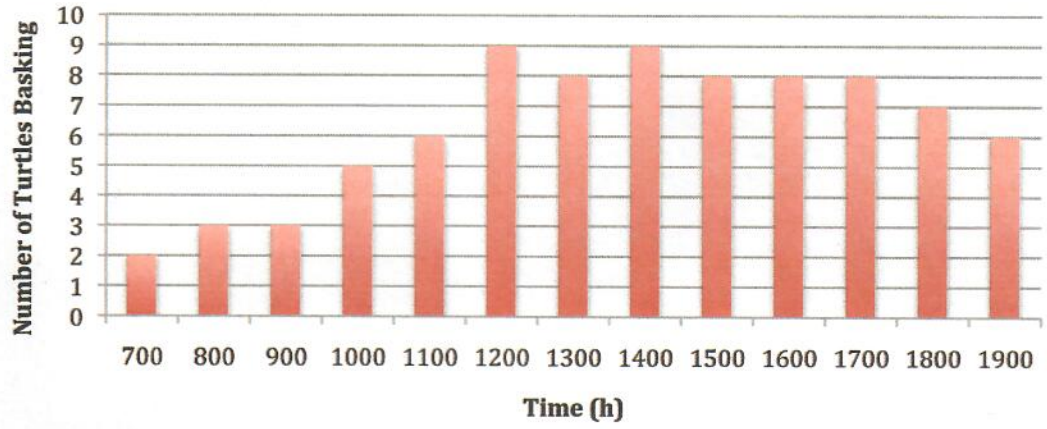
Once basking turtles were up as high on the beach as they were going to go, they settled into a quiescent state within approximately 15 minutes. In this state, they were not as alert and one could carefully, crouching as low as possible, walk up behind them and scan for a flipper tag and take an SCL measurement. It is only possible to do this if the turtles on the beach are all facing one direction, are in deep "sleep" and/or are alone on the beach.

A monk seal gave birth on Turtle Beach on April 25, 2010 in nearly the same location where one had given birth the previous year when there was no observation effort. This repeated use of a preferred pupping beach certainly indicates that our presence during the beach surveys was not disruptive to one of the most sensitive creatures on the island.

# Findings

The basking data for emergence times, numbers on the beach, identification of individuals, etc. gave a snapshot of the behavior during the 9 days of observation. Prior to 0700 h, there were usually very few turtles on the beach (Figure 1). The number of turtles basking increased through the morning reaching a peak between 1200 and 1400 h. The counts tapered off toward the evening hours. By 2100 h, there were very few turtles on the beach. On one occasion we were able to confirm that one turtle (PIT tag # 4A7E3F173E, Table 1) had remained out all night and into the next morning. The sex ratio of basking turtles was 31% males, 36% female and 33% sub-adults and unknown. The combined total percent adults (male and female) in the basking population is 67%.

**Figure 1. Mean number of turtles basking on Turtle Beach (4/18 to 4/26/10) during each one hour interval between 0700 and 1900 h.**




The number of basking turtles was influenced by tidal fluctuation, and whenever the tide was rising and near its high point many of the basking turtles would be washed over by the incoming waves and return to the water. Although it did not rain during this trip, observations made during our work from 1998 to 2001 found that basking turtles will return to the water if there is significant rainfall.

The largest number of basking turtles counted at any one time from 4/17 to 4/27/2010 was 17. Past counts have been higher. Wayne Sentman reported 20 basking turtles on May 9, 2010 with most coming out after 1100 AM when the sun came out following an entire morning of rain and 100% cloud cover (Wayne Sentman, pers. comm.). A picture taken on October 24, 2009 by George Balazs shows 35 turtles basking on Turtle Beach (Figure 2).

Opportunities to read tags on quiescent basking turtles were intermittent. The number of turtles on the beach had to be small, they needed to be facing in a direction that would prevent them from observing the approaching investigator and they needed to be quiescent with their eyes closed. This situation occurred 25 times during the 9 day observation period. Table 1 outlines the results of the 25 readings. The 8 re-sightings were very significant and are presented in Table 1 of the Appendix.

Table 1. The list of tag reading attempts made on green turtles basking at Turtle Beach, Midway Atoll between 4/17/2010 and 4/26/2010.

| | |
|---|---|
| Number of turtles scanned for PIT tags | 23 |
| Number of turtles with PIT tags: | 8 |
| Number of turtles without tags | 15 |
| Number of turtles with metal tags | 1* |

* Adult male observed with metal tag in right front flipper, but it was impossible to get close enough to read the tag and it was not counted in the total.

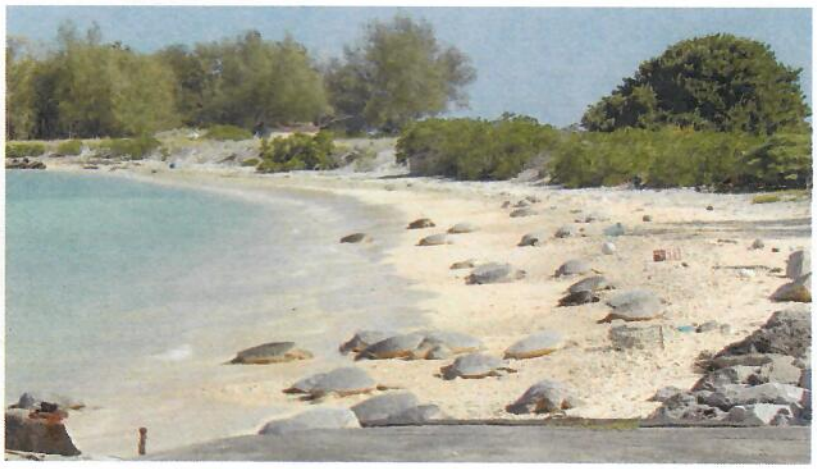


Figure 2. Digital image of 35 basking turtles on Turtle Beach, Sand Island, Midway Atoll taken by George Balazs on 10/24/2009 at approximately 1530 h.

# Island Locations

**Cargo Pier Area (28.72⁰ N, 177.37⁰ W):**

We observed the cargo pier area every day from 4/17 to 4/27/10 and noted turtle movement and behavior. The region around the cargo pier and Turtle Beach is very important for green turtles. There are turtles in the area almost continuously during the day. We observed turtles exhibiting mating behavior, transiting the area, coming in to bask on Turtle Beach and the adjacent launching ramp and foraging approximately 100 meters offshore in deeper water (~10 meters deep). As was the case 10 years ago, this area of the lagoon has the greatest concentration of juvenile, sub-adult and adult green turtles on the atoll.

We snorkeled the cargo pier three times (4/21/10, 4/25/10 and 4/26/10) during mid-afternoon. Each time there were approximately 6 juvenile green turtles present, sometimes resting on the submerged pier structure, but more often slowly swimming about under the pier (Figure 3). It is likely that on each of our snorkel surveys we saw some of the same animals repeatedly. No juvenile turtles were ever seen basking on Turtle Beach so we never observed juvenile green turtles except under the pier or in the inner harbor. Larger (sub-adult and adult) green turtles could occasionally be observed moving through under the cargo pier and, almost certainly, larger turtles use the cargo and fuel pier as resting sites at night (Rice & Balazs, 2000). On 4/25/10, we observed one set of turtle tracks on the sand immediately to the west of the cargo pier, indicating a basker that we did not see.

Figure 3. Juvenile green turtle (*C. mydas*) under the cargo pier with pilings in the background. (Photo by Wayne Sentman)

**Bulky Dump** (28.201$^0$ N, 177.374$^0$ W)

No turtles were observed or reported after 4 visits (4/18, 4/20, 4/25 and 4/26/2010) to the Bulky Dump area. All observations were made during the late morning and early afternoon.

**Rusty Bucket** - Off limits because of monk seal pup.

**Southwest Corner of Channel Entrance** (28.208$^0$ N, 177.360$^0$ W)

No turtles observed or reported after 3 visits (4/19, 4/22, 4/25/2010) of approximately 30 minutes each.

**West and South Beaches**

These beaches are off-limits, but while viewing from approved points we were unable to observe any green turtles.

**North Beach** (28.218$^0$ N, 117.378$^0$ W)

We observed one basking female on North Beach (28.217$^0$ N, 177.376$^0$ W) at 1700 h on 4/22/10. We haven't observed basking turtles on North Beach before although one additional basking green turtle was reported during the week of April

28 to May 4, 2010 (Wayne Sentman, per. com.). Limited observations of the waters off the beach failed to reveal any green turtles.

**North Harbor Breakwall** (28.2140 N, 177.3600 W)

The inner harbor at Midway Atoll is a resting area for green turtles and sub-adults, and adults can be observed moving in and out of the harbor along the northern harbor wall. Most of them turned left at the end of the break-wall and followed the wall over toward the cargo pier area and Turtle Beach. A few were observed swimming straight into the deep water off of the harbor entrance. One female came back into the harbor by the north point and then crossed the harbor entrance to the south side of the harbor. The south side of the harbor is a known resting area also.

**South Harbor Breakwall** (28.209$^0$ N, 177.360$^0$ W)

We made 5 trips to the south harbor wall to look for green turtles (4/19, 4/21, 4/22, 4/23, 4/25/2010). During our previous work (1998-2001), we had captured a few juvenile turtles feeding on algae growing on the harbor wall. During this trip we only observed two juveniles feeding along the wall after 10 spot surveys made during the daytime (usually mid-morning and/or mid-afternoon). Grazing the wall does still occur, but turtles were definitely not lined up along the wall feeding.

We did find a sleeping "cave" at the northeastern terminus of the south breakwall. The large flat platform is hollow underneath, and a sand bottom area is accessible to turtles there. When we first observed it, there was one large female and one sub-adult resting in the cave. John Klavitter (FWS) mentioned that they have previously observed several turtles in the cave at one time. On two other occasions we checked the "cave" and found one sub-adult on each occasion (Figure 4). We don't know if it was the same turtle.

4a 4b

Figure 4. Photograph 4a shows a sub-adult turtle resting unharmed inside of an electrical outlet box that has fallen into the area under the pier surface. (photograph by Wayne Sentman). Photograph 4b is of a sub-adult resting on the sand "beach." (photograph by Marc Rice)

**Eastern Island**

We visited Eastern Island from 0830 until 1130 h on 4/21/10. No turtles were observed basking although basking in very small numbers regularly occurs on the beach near the pier (27.210$^0$ N, 177.335$^0$ W) (Wayne Sentman, per. com.). We crossed the island to the east side and spent about 20 minutes looking for turtles without success. Upon return to the west side of the island,one turtle was observed about 30 meters off of the pier at approximately 1115 h.

**Reef Hotel** (28.278$^0$ N, 177.367$^0$ W)

April 23, 2010, Fish and Wildlife personnel took us to the area known as Reef Hotel. The water was very calm, and visibility was excellent. The trip out of the harbor to the reef hotel took about 20 minutes each way. During the ride out and back we did not observe any turtles. We snorkeled the reef for about one hour at the Reef Hotel (1330 to 1430 h) and covered approximately 100 m along the inside of the outer reef platform but did not see any turtles. Small turtles are occasionally seen in that area (Wayne Sentman, per. com.), and we captured and tagged a couple of juveniles there during our earlier work (1998-2001).

**Spit Island (28.206⁰ N, 177.349⁰ W)**

On May 3, 2010 Wayne Sentman accompanied FWS personnel to Spit Island where the perimeter of the island was walked looking for invasive plant species and marine debris. No turtles were observed basking on the beaches. In the past a few turtles have been seen basking on Spit Island and swimming in the shallows off shore. (Wayne Sentman, per. com.)

# Discussion

The tag recoveries made during this trip were significant. The procedure for reading the tags was excellent because it was a passive operation and did not involve any impact on the turtles. Of the 8 tag recoveries, the most interesting was turtle number 4A7E3F173E (Table 1, Appendix). This animal was first captured on June 6, 1977 by a member of the Koral Kings Dive Club. At that time it was already 90.1 cm SCL and probably a mature female. Assuming that it was 20+ years old at that time, it would now be somewhere in the vicinity of 55 years of age. She was recorded nesting at French Frigate Shoals in 2009. It was not possible to get an accurate SCL measurement, but a fairly accurate estimate was made and, based on that estimate and her size in 1977, she had a growth rate of ~0.3 cm/year.

Four other recoveries were of animals tagged during our work at Midway Atoll from 1998 to 2001 (Balazs, et al, 2004). Three recoveries were turtles that were originally tagged at French Frigate Shoals during the nesting season. Growth rates for mature animals is very low and, as expected, the data on growth rates of mature animals recaptured during this trip ranged from 0 to 0.58 cm/yr. The growth rate of two recaptures that were originally tagged as sub-adults was 2.29 and 2.62 cm/year (mean = 2.45 cm/year).

The percentage of adult turtles in the Turtle Beach basking population was 67%. While it cannot be assumed that the basking turtles are representative of the population as a whole, it is interesting to consider the possibility that the number of adult turtles in the population may have increased from approximately 24% in the late 1990s (Balazs, et al, 2004) to 67% in 2010.

Based on overall observations and the relative number of tagged and untagged turtles found on Turtle Beach, I speculate that Midway has a population of between 200-600 turtles. It is evident that basking behavior has "caught on" at turtle beach, and the basking rate is definitely higher than it was a decade earlier. Unless there are new areas where turtles are gathering or there are feeding areas that we don't know about, the numbers of turtles is probably similar to what it was in 2001. The size-class distribution has apparently shifted over the intervening 10 years as the juvenile and sub-adults of the 1970s and 1980s have matured. The turtles that come out to bask appear to be very well fed with an obvious rotund appearance and rolls of fat showing in the area of the hind flippers.

The juveniles we observed under the cargo pier also appeared to be 'nicely rounded' and healthy. They were wary but not overly concerned about our presence.

There were no fibropapilloma tumors observed on any of the basking turtles or on the small turtles we observed while snorkeling. This was particularly good news because of the presence of tumored animals discovered during our work from

1998 - 2001 (Balazs, et al, 2004). It appears that the disease may have run a course similar to that in the population in Pala'au, Molokai, Hawaii where the disease has gone from a high of nearly 60% incidence rate in 1996 to approximately 11% in 2010 (Chaloupka et al, 2009).

Turtles were regularly observed on Turtle Beach basking in or near marine debris that they could potentially become entangled in. It might be prudent to organize some marine debris collection effort at the beach during times of low basking numbers (during rain storms, early morning or late evening).

## Thoughts about the future:

1. New tagging and recapture work would be useful to:
    a. gain further insight into the size of the population
    b. gather growth data on immature turtles
    c. assess the health of the population through weight measurement and or body mass calculations
    d. determine food preferences
    e. determine if the "old haunts" are still being used or if there are new areas where turtles are aggregating
    f. continue to obtain data from previously tagged individuals is very enlightening and useful to:
        1. get an idea of how many of the adult females are using FFS as their nesting site.
        2. clarify the length of the internesting period of females at Midway Atoll
        3. get an understanding of the growth rates of various size classes
    g. assess the occurrence of fibropapillomatosis
        1. incidence of the disease appears to have declined since 2001
    h. assess recent nesting activity observed for the first time at Midway Atoll.
        1. An increased monitoring effort may allow FWS to assess the significance of these events

2. Placing a PTZ (pan, tilt, zoom) camera out at the launch ramp to observe would be very useful
    a. scheduled photographs of the beach would allow analysis of basking behavior
    b. the ability to PTZ from "headquarters" would allow staff to observe what was happening out at the cargo pier
    c. individual head shots could be taken with the camera to begin to develop a catalog of habitual baskers
    d. developing a catalog of habitual baskers would help to ascertain how many individuals we are dealing with

3. The PTZ camera and direct observations might allow the cooperative project between HPA/NOAA/OS/FWS to continue.

4. If the cost of transportation to and from Midway ever gets to be reasonable, it would be productive to plan an HPA/NOAA trip using student assistants as we did in 1998-2001. It may also be possible to obtain support for such a project that would ameliorate the overall cost so that participant cost was reasonable.
    1. this would fit into the FWS stated goal of "providing visitors opportunities to learn about the animals, the history and the environment." "Hands-on learning opportunities may also be available through participatory research projects, including seabird and spinner dolphin monitoring.... projects." No reason the same can't be provided for turtles!

**Acknowledgements:**

This project could not have been completed without the help of many people and organizations. Special thanks to Dan Aeberli and Doris Aeberli for their dedication and hard work in monitoring Turtle Beach, taking pictures and recording data, Oceanic Society for sponsoring the trip and promoting interest in Midway Atoll sea turtles, to Oceanic Society biologist Wayne Sentman for his expertise, experience and support, to John Klavitter and the Fish and Wildlife Service personnel for their outstanding help and support and to George Balazs (NOAA Pacific Islands Fisheries Science Center) for reviewing this manuscript and making significant contributions to its content. He was originally scheduled to participate in this survey, but was unable to because of circumstances beyond his control.

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# Appendix

**Table 1. Eight tag recoveries made at Turtle Beach, Midway Atoll. Tags were read by unobtrusively sneaking up behind basking turtles and reading the PIT tag and taking a straight carapace length measurement (SCL).**

| Tags | Date Read | Location | SCL (CM) | Date First Capture | Location | SCL (CM) | Growth cm/year | Remarks |
|---|---|---|---|---|---|---|---|---|
| 4A7E3F173E, 413611786C | 4/18/10 | Midway, Turtle Beach | ~100 | 6/3/77 | Inner Harbor, Midway | 90.1 | ~.3 | Tagged by G. Balazs & Koral Kings diver Chris Baireuther in Inner Harbor. Clean, gold/brown shell. Large barnacles in skin, no copulation scars seen. Last nested East Island, FFS 2009. |
| 41363F315B, 413E2D6650 | 4/18/10 | Midway, Turtle Beach | 88.7 | 13-Nov-01 | INNER HARBOR, MIDWAY | 83.1 | .58 | Captured using scoop net from breakwater by HPA/NOAA team |
| 50191B4D63, 500E1B000C | 4/19/10 | Midway, Turtle Beach | 80.4 | 11/13/01 | Basking, East Island | 58.4 | 2.29 | Captured by hand by HPA/NOAA team |
| 4135704F6D, 4136356E27 | 4/19/10 | Midway, Turtle Beach | 92.2 | 6/14/94 | East Island FFS | 90 | .14 | East Island, FFS, nesting. |
| 470B4D5E22, 470D087522 | 4/19/10 | Midway, Turtle Beach | 89.2 | 6/20/08 | East Island FFS | 89.2 | 0.0 | Originally tagged on 6-20-08 nesting at East Island, FFS (SCL=89.2cm) |
| 4144330940 | 4/21/10 | Midway, Turtle Beach | 84.9 | 10/19/98 | Sand Island, cargo pier | 83.5 | .11 | Posterior shell damaged and healed. Short measurement reflects this injury. Likely shark scratch in carapace. Long thick tail. Tail 30cm beyond carapace. 5 laterals on right. Released in inner harbor |
| 4135747E3F 4136012807 | 4/23/10 | Midway, Turtle Beach | 89.4 | 11/15/00 | Tug Pier | 61.9 | 2.62 | PPS. Mototool #52. Axial: 24cm, Lateral: 23.6cm. 3.6cc IM Liquamycin. Eye and ventral photos taken. VB-1 (2.8cm). |
| 413B1B0E44 | 4/23/10 | Midway, Turtle Beach | 91.7 | 5/16/99 | East Island | 91.1 | .05 | Originally tagged while nesting at Tern Island, FFS on 5-16-99 (SCL=91.1cm) |