Hawai‘i Hawksbill Recovery Project

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Report on 2004 Permit Activities- Permit TE-89250-3

Introduction

In the Pacific, little is known about the abundance and distribution of critically endangered hawksbill sea turtles (*Eretmochelys imbricata*). Within the Hawaiian Archipelago, hawksbills predominately nest on Hawai‘i Island. Lower numbers are also known to nest on the islands of Maui, Molokai and O‘ahu, with a statewide estimate thought to be at least fifty reproductive females with only 6-20 of these nesting each year. Hawksbill nesting activities were first documented on Maui in 1991 at Kealia. An organized community-based effort to systematically monitor these occurrences began in 1996 after a passing car killed a second gravid female when she wandered onto North Kihei Road, either seeking suitable nesting habitat or disoriented by headlights.

The primary objectives of this research are to identify individual nesting hawksbill turtles, determine sizes of these females, the sites they use for nesting, the internesting interval, the number of nests laid in a season by each female, to relocate nests that may be threatened by tidal flooding, and to attach transmitters to post-nesting females to track them to their long-term foraging/resting areas. During the course of this research, nesting females, nests and hatchlings are protected against dangers caused by human disturbance, coastal lighting, non-native vegetation, predators, and vehicular collisions.

Methods

Nesting season can begin as early as mid-May, with hatching events stretching into December. During these months, the Dawn Patrol, a community group of approximately 30 volunteers, walks Maui’s three known nesting beaches (Kealia, Kawililipoa and Oneloa) early each morning looking for evidence of nesting. Once this has been discovered, a phone tree is activated to advise the Department of Land and Natural Resources Division of Aquatic Resources (DLNR DAR), the United States Fish and Wildlife Service (USFWS), and the Hawai‘i Wildlife Fund (HWF). Each subsequent nesting and hatching event is intensely monitored by HWF. This typically entails all-night vigils waiting for the females to nest successfully, and guarding the nests during the course of hatching to ensure each hatchling reaches the ocean safely. Three days after the first major emergence of each nest, the nest is excavated to release any trapped hatchlings and to determine overall nest success.

Activities under this permit in 2004 were conducted only on the island of Maui, where a single turtle was taken. Prior to taking by PIT tagging and radio/satellite transmitter application, she had nested twice at Oneloa (also known as Makena Beach and Big Beach). After the completion of this second nest, she was positively identified by an injury to the rear of her carapace, which can be seen from a distance (due to our renewed State permit not being ready, we were unable to approach her). Cheryl King, who had monitored this same turtle's nesting activities in 2001 at Oneloa, was aware of her shell irregularity and immediately recognized her as "Orion".

She was taken for VHF radio/satellite transmitter attachment after the completion of her third nest's nesting activities (suspected egg deposition and then throwing sand to cover the nest) on the evening of July 27th. We restrained her in a 4-walled plywood/carpeted "corral" and confirmed her to be Orion (tagged H334 & H335 in 2001). Carapace measurements were taken, one radio and one satellite transmitter (supplied by George Balazs, NOAA, NMFS Honolulu) were attached to her carapace, and we applied one PIT tag to her left hind flipper (#424E384555 supplied by George Balazs). These operations were conducted by Cheryl King, assisted by Mary Grady, Hannah Bernard and Alastair Hebard, and supervised by William Gilmartin. The turtle incurred no injuries as a result of restraint.

Results & Discussion

This is the first hawksbill known to return to Maui in a subsequent year to nest since the establishment of Hawai'i Wildlife Fund's Hawksbill Recovery Project and the associated tagging that began in 1997. Since no other nester has been documented at Oneloa, it is suspected that Orion also laid the clutch that was found there in 1997. This would equate to a four-year remigration interval in 2001 and a three-year interval from then until this 2004 season. Orion's shell irregularity doesn't allow for reliable carapace length growth measurements, but her curved carapace width (CCW) measurements showed an increase of 0.6 cm from 2001 (84.5 to 85.1). Her metal flipper tags were secure and in good condition. As in 2001, she laid 5 nests, with 3 "false crawls" (Table 1). Using the VHF radio tracking equipment, we recorded four surface durations between five and eleven minutes long, which we suspect were brief false crawls. She probably did not make it past the high tide line before she aborted the attempt, as tracks were not found.

In 2001, efforts to locate her internesting locations were thwarted by a faulty VHF radio transmitter; therefore we were grateful for another chance this season. But, the effort to locate her internesting location after this third nesting was hindered by misleading interference signals and the rough terrain of East Maui's lava fields. With the help of the satellite data her internesting location was finally identified. She was found to frequent the waters out to Nakaohu Pt., approximately 16 miles (~24 km) southeast of Oneloa, towards Nu'u Bay (Fig. 1). This distance significantly surpassed both of the other three previously tracked hawksbills' internesting locations on Maui, which were found to be only a few miles away from their nesting sites at Kealia and Kawililipoa (1997, 1998 & 1999).

Upon comparing the benthic compositions of the nearshore areas between Oneloa and Nakaohu Pt using NOAA's ArcView habitat maps, it is unclear why she traveled such a distance (http://biogeo.nos.noaa.gov/products/hawaii_cd/htm/mauimaps.htm). Nakaohu Pt consists of "Uncolonized and colonized volcanic rock/boulder habitat: Solid volcanic rock that has coverage of macroalgae, hard coral, zooanthids, and other sessile invertebrates that begins to obscure the underlying surface". These same habitat types can be found near Oneloa, but Oneloa also has "sand, uncolonized pavement and coral head/aggregated" habitats.

HWF researchers were able to monitor her near Nakaohu Pt for 24 continuous hours and 29 continuous hours before she departed for her fifth nest. It can be inferred by her long, similar submergence durations that she was simply resting during this period, day and night (Fig. 2). Every dive lasted longer than one hour, with the longest dives of closer to two hours occurring at night (Fig. 3). If she were foraging, mating or traveling, her dives would have been shorter and less predictable. Her dive durations during the day and night averaged 1:29:45 and 1:46:12, and her maximum dive was 1:56:17 (recorded at night). She remained at the surface to breathe for an average of 0:01:37 during the day and 0:01:24 at night, and her maximum surface interval was 0:02:49 (recorded during the day). This information on behavioral parameters will be particularly useful for future radio tracking projects.

Her behaviors before the fourth and fifth nesting attempts were monitored using VHF radio tracking gear, and nearly continuous dive interval data were recorded when she was found to be near the nesting area (51 hours for nest #4 and 69 hours for nest #5). This data collection revealed that she returned to Oneloa by at least day 18 of her internesting cycle. Unlike at Nakaohu Pt, she exhibited highly irregular diving activities offshore of Oneloa (Figs. 4 and 5). This indicated that she was not simply resting in one location all day.

From all of our 2004 tracking work, her maximum submergence duration was recorded here: 2:12:42 (7:56:27-10:09:09 on day 19 before her 4th nest). The second longest duration of 2:05:02 (15:36:47-17:41:49 on day 18 before her 5th nest) was also recorded offshore of Oneloa. But, these over two hour lapses of signal reception might not have been actual dives. We have one unconfirmed report from a commercial dive boat captain that Orion was briefly seen at the surface in the area of some offshore pinnacles. This location is around the northern corner of Pu‘u O‘lai, out of the reception range from the tracking site at Oneloa. This happened to correspond to the time of her 2:12:42 "disappearance", but the exact date of the captain's observation cannot be verified. Since the length of her surface intervals did not always seem to coincide with her dive durations, this data cannot be reliably used to help determine if she were resting for that long or traveling from around the corner. Closer examination of the satellite locations for the Oneloa area may solve this question, allowing us to comprehensively analyze her submergence patterns and overall habitat usage.

Her fifth nesting cycle coincided with Labor Day Weekend, an especially busy time at Oneloa with night campers, fishermen, and partiers shining lights up and down the beach. Even though Makena State Park is closed after 9:00pm, these human activities persisted throughout the weekend, quite possibly deterring her emergence. She "false crawled" at 2:27am on the night of 9/4/04 (day 19 of the internesting period) near the northern parking lot. We heard her VHF signal constantly, which significantly that she was on the beach. We were stationed at her second nest waiting for hatchlings to emerge, so by the time we got to the other end of the beach where she was, all we saw were her tracks. She had crawled up, past the high tide line and halfway up the beach, where she reached a cardboard box filled with ice and beers, then retreated back to the ocean. No one was around when we got there, but upon further inspection of the area, we found that three of the portable toilets, directly up the beach from her tracks, had been recently knocked over. So, the combination of these factors certainly could have scared her back into the water. She did not come ashore again that night.

She continued to remain offshore of Oneloa all day and into the next evening (9/5/04) but she didn't crawl ashore again. Into the next day, she was extremely active and as the day progressed her VHF signal became weaker until it was lost by that afternoon. We continued to search for her through the night by listening to the receiver and walking the beach. The next morning, 9/7/04, Cheryl King walked Little Beach, Black Sand beach and the other small pocket beaches North of Puʻu Oʻlai searching for tracks. After climbing Puʻu Oʻlai and not getting a signal from up there either, we weren't sure what had happened. On 9/8/04 we found out through Denise Parker of NOAA that Orion had in fact left the Oneloa area, and she and George Balazs sent us the first satellite map of Orion's travels on 9/14/04 (Fig. 6). When we were informed that she had made a full circle and appeared to be back in Makena, HWF researchers immediately went back to Oneloa and tracked from the beach and atop Puʻu Oʻlai, but did not locate her signal. After spending the night listening and still not hearing her or seeing any signs of tracks at Oneloa, we determined that she had already left the area. We were at least one day too late.

We can only speculate why Orion left Oneloa, went to the island of Kahoʻolawe, swam back to Maui towards Lahaina, through Maʻalaea Bay, then back to Makena (Fig. 6). Was she searching for better nesting habitat? Had she given up trying to lay a fifth nest and was trying to swim back to her foraging grounds but got disoriented? Even after her fifth nest was discovered on Little Beach (someone reported seeing hatchlings), this remains a mystery because it isn't clear when she laid this nest. Was it before or after her ~6 day, ~67 mile (107 km) journey around the waters of Maui Nui? The future analysis of the satellite data we may obtain from Denise Parker and George Balazs might help solve this question.

Piecing together what we do know about her behaviors from the VHF monitoring still does not solve the question of when this fifth nest was laid. Due to our continuous listening from September 3-6, the only chances that she possibly had to have swum around the corner to Little Beach and nested were between 02:35:09 & 03:40:00 and 04:04:20 & 05:26:15 on the morning of September 6. During these 1:04:51 and 1:21:55 periods we did not hear her signal, and at the time we assumed she was resting. But if she did swim around the corner to Little Beach, we would also not have heard her signal because the receiver only operates line-of-sight. It would have been a rather quick nest (< 1 hr 21 min), but she didn't have the expanse of beach to crawl, as Little Beach is much narrower than Oneloa. Her other nesting times for nest #2, 3 and 4 have been 2 hrs 3 min, >2 hrs, and 1 hr 31 min. Upon closer examination of the data, she had actually only made 4 additional >60 min dives during the other 4½ nights we monitored her, and these all occurred on day 18 before her fourth nest. A total of 11 (mean of 2 per night) >50 min but <60 min dives were recorded for all 5½ nights of monitoring her fourth and fifth nesting activities. She had made one of these dives on the night of the possible nesting as well.

Her surfacing behaviors were compared before and after her fourth nest, her false crawl before her fifth nest, and the possible fifth nesting explained above to potentially find a pattern that could reveal whether she nested or not (Fig. 7). The nocturnal activity levels before each event are similar in that she was very active. But we do not have enough data to analyze her behaviors afterwards, as we did not continue monitoring her through the day after her fourth nest. Even though we assume that she would have left the area fairly soon after nesting, we don't know if there was a period of resting prior to the departure. Also, the times of each event are not similar, so daylight versus nighttime may have had just as much of an influence on her activity levels as whether she actually nested or not.

After the three hatchlings were found on Little Beach, HWF researchers camped out for two nights to watch for hatchlings until the excavation. Only eight hatchlings emerged on the first night, zero on the second. At the excavation, 55 live hatchlings were released, Skippy Hau held 14 extremely weak ones (12 died overnight and 2 died by the afternoon) and 49 dead hatchlings were found, with a clutch total of 165 eggs (Table 2 data are considered preliminary until George Balazs can confirm all remains). Since 129 hatchlings were accounted for and there were 156 empty shells, 27 hatchlings must have emerged on their own sometime before the first 3 were found. They most likely emerged at night because they would have been noticed (although possibly not reported) on this popular beach during the day. The rescued hatchlings at the excavation were very weak, which could have been caused by human compaction (the top of the nest was 12 in deep, under a popular drum circle gathering spot). Since we have narrowed down the date of her nest to three possibilities, the date of the excavation would have been either day 76, 69 or 68. The nest remains were not decomposed, but we don't know how quickly these eggs actually developed especially since Little Beach faces a different sun angle, changing the amount of sun exposure on the nest compared to the Oneloa nests.

HWF permittees and volunteers conducted nightly vigils at each of her nests from day ~57 (except #5 which was monitored upon discovery) until the excavations, and organized daytime volunteer watches due to the high occurrence of daylight emergences. Ninety percent (335) of the hatchlings that emerged this season did so not under the cover of darkness, but during daylight hours (Table 1). This was not just a factor of nest location, as it occurred with every nest, except #3, which no hatchlings emerged from naturally. At Oneloa, the morning sun is blocked by the tree line so it didn't reach nest #3 and #4 until mid-morning. Her first and second nests were subject to additional shade because they were located under large kiawe trees, therefore not receiving direct sunlight until the afternoon. The resulting cooler temperatures could have delayed development time as hatchlings didn't emerge until day 69 and 64.

Three of Orion's 2001 nests were laid in similar shade-influenced locations to this season's first and second nest, but the 2001 nests' first emergences all occurred on day 61. Her fifth nest in 2001 and her second nest in 2004 were laid in almost the exact place, and the first emergences differed by 3 days. Although data on temperature and the depth of these nests are not available, it is suspected that weather played a role in these yearly differences. Although impossible to measure now, lesser compaction could have even been a factor. In 2001, a total of only 14 hatchlings from two nests emerged during daylight hours, 8 of which were triggered by rainfall. Not including nest #3, the mean number of eggs laid per nest this season increased from 169.6 to 178.3. Mean nest success (defined as the number of live hatchlings per number of eggs) for these two seasons improved from 68.7% to 81.1%. Only 19 eggs (3%) from 4 nests did not hatch in 2004 compared to 224 eggs (26%) in 2001.

No nests were relocated under this permit in 2004, although nest #3 should have been moved due to two factors: its location on the heavily trekked path to Little Beach and the mixture of cinder in the sand surrounding the nest chamber. Since our permit does not address this type of situation for relocating, we had to leave it *in situ*. Skippy Hau erected bamboo stakes a few days after the nest was laid, but someone took them down almost right away. We experimented with placing a rock near the nest to subtly veer people around it, but it didn't last long there either. We finally had to encircle the nest with five metal t-posts that could not be dug out easily. We marked them with red flagging tape to keep people out of the area and from hurting themselves on the posts. We started with a small sign identifying it as a turtle nest, and as interest and attention grew we made more signage explaining all aspects of the nesting process, the Hawksbill Recovery Project and Orion herself. These visuals helped the naturalist stationed at the nest educate and enrich the experience for the passersby.

Foot traffic and the resulting compaction is not as much of a threat to the eggs themselves as it is a problem when the hatchlings make their way up towards the surface of the nest. We were especially concerned about this timeframe, and since Orion's first two nests did not show any signs of emergence until day 64 and 69, we permanently blocked off the area in the manner explained above on day 55. The secondary reason why we waited before publicizing the nest was so that we could have volunteer naturalists present around the clock. Attracting attention to the nest for a period of over two months would have invited the possibility of human/predator disturbance, and it wasn't feasible to have it monitored for the whole duration, night and day.

Blocking it off as soon as it was laid for the duration of the incubation could have potentially helped the nest's success by eliminating compaction. None of the hatchlings emerged on their own, and the 40 that were alive when we excavated on day 71 were lethargic. The nest remains were a mixture of smashed, decomposing hatchlings and eggs and were not quantified by the excavators. We must wait until they are sorted out by George Balazs for further developmental clues and clutch totals. The depth of the bottom of this nest was 16.5 inches, shallower than her other 4 nests (21, 20, 20, and 18 inches for nest 1, 2, 4, and 5 respectively). Orion likely found it difficult to dig through this pathway, hence the shallowness. The top of the nest was only 11.5 inches from the surface of the sand; therefore it became more influenced by the foot traffic.

Theoretically, since this clutch was laid closer to the surface than the other nests, the eggs were more prone to diurnal temperature fluctuations, and with higher daily temperatures they could have developed faster. The decaying remains of the nest add evidence to this possibility. We do not know the effect the cinder had on the developing eggs or the hatched hatchlings as far as gas exchange. But the several large pieces (~5x3 inches) certainly hindered the hatchlings' emergence efforts by trapping them or by causing them to waste their energy digging around them. In conclusion, the unexpected short incubation time combined with the effects of foot traffic and the cinder mixture sealed the outcome of this nest.

This nest illustrates the need for us to have the option of relocating future nests if such situations arise again, therefore we will be pursuing an amendment to our permit. Presently, our permit states allowance to relocate only nests that are in danger of tidal flooding or the second nest per female in a season at Kealia. As Maui's beaches become even more populated, compaction and human disturbance will likely become more common issues in the future.

At Kealia, the Dawn Patrol found tracks from a hawksbill on the morning of September 24th, which is very late in the season for a turtle's first nest. It was determined by Glynnis Nakai of USFWS to be a "false crawl". HWF wanted to identify this nesting female, but the real concern was that the turtle would crawl onto North Kihei Road. The dune fence that is supposed to keep turtles off the road was not completely replaced as it desperately needed to be, and the newest areas already had large missing pieces in which a turtle could easily have crawled through and reached the road. The only action that HWF could take was to try to repair it as much as we could, station volunteers at these large gaps and to patrol the beach in attempt to locate her to make sure she didn't approach the road. We took these actions through 3 nights after the tracks were found and 18 through 23 days later, which would have been within her nesting interval. No further sign of her or hatchlings from other possibly missed nests were ever witnessed. It was confirmed that the turtle that made these tracks was not Orion, as she was already on her open ocean journey north of Moloka‘i back to her foraging grounds on O‘ahu (Fig. 6).

Orion traveled from Oneloa to O‘ahu, the area north of Lā‘ie Point (~189 miles, 300 km), in approximately 16 days. It is unknown if she swam continuously, and the following numbers are estimations. Her (constant) swimming speed during the 6-day, 67-mile nearshore route around East Maui would be calculated at 0.46 miles/hr (11 miles/day). Her 122-mile open-ocean route from Maui to O‘ahu took 10 days, with a constant swimming speed of 0.51 miles/hr (12 miles/day). Without analyzing the effects of ocean currents, these similar travel speeds indicate that her pace was similar regardless whether she was near shore or in the open ocean.

Although the satellite information on her return route is limited, it seems that she did not utilize the nearshore waters of northwest Maui nor northern Moloka‘i for her migration, but swam in an open-ocean route to her destination. Orion is the first monitored Hawaiian hawksbill that has had to “skip over” an island to get to her foraging grounds, as the other 7 hawksbills that have been tracked by satellites were found to forage and nest on bordering islands or the other side of the same island. She took the longer route (by at least 65 miles and another 6 days) by swimming around East Maui instead of going directly through Maui Nui from Oneloa. NMFS Coastwatch maps for September indicate she was swimming with the geostrophic currents around East Maui, then against them once in the open ocean (Http://coastwatch.nmfs.hawaii.edu/ocean_height/tmp/aviso/monthly/AV200409_ssh_Hawaii.jpg).

The location of her foraging grounds on the northwesterly portion of O‘ahu is consistent with the other 7 tracked hawksbills that reside on the same windward facing shores of Hawai‘i and Moloka‘i. Reliable satellite fixes have pinpointed her at different depths within an approximately 5-mile region. This area appears to have a wide range of habitats, as it is a high-energy area with numerous offshore islets. HWF researchers have monitored Orion’s activity with the VHF tracking gear on two separate occasions, for 39 and 51 nearly continuous hours (Figs. 8 and 9). She appears to rest (symbolized by long submergence durations) mostly at night and travels/forages (short, irregular submergence durations) during daylight hours. We are hoping to return for more data collection opportunities before the transmitter battery is exhausted. Our main objectives are to determine her home range and whether she has a recognizable diurnal “routine” of foraging, resting and traveling, then extrapolating how much time/effort is devoted to each activity (Fig. 10). This information can be inferred with the VHF data with the help of similar studies that have determined which dive profiles are associated with certain behaviors. Also, the amount of time she spends at the surface can be used to determine correction factors for aerial survey studies.

Conclusions & Future Conservation Recommendations

Orion has been the first known tagged hawksbill to return to Maui for another nesting cycle since 1997 when tagging began. This lack of recaptures could be partly due to the fact that we only have enough people to patrol the three known nesting beaches, and nests are going undetected and/or unreported on other beaches. Hawksbills have been known to nest in sporadic locations elsewhere in the world, which may be the case for Hawaiian hawksbills as well. Larry Katahira of the National Park Service has reported that a handful of Big Island hawksbills have switched nesting beaches within and among seasons, to beaches that are sometimes 11 miles apart. Orion switched to a totally new nesting beach for her fifth nest this past season and no one reported seeing her tracks. This illustrates the need for an increase in the number of patrolled beaches coupled with more public education. Although Kealia’s characteristics (highly eroded, prone to high winds and tides) often make it difficult to detect evidence of nests, it is also a possibility that the hawksbill that false crawled at Kealia this season chose another beach to utilize instead. The south shore from Kihei to Makena should be prioritized for the expansion of the patrol due to the close proximity to Kealia, Kawililipoa and Oneloa.

The biggest priority for the upcoming nesting season should be the completion of the Kealia fence repair to keep nesting hawksbills from being run over on North Kihei Road. Not only does it need to be replaced with the recycled plastic fence, it ideally should be relocated *mauka* of the existing location of the sand fence, which is too close to the high tide line in many areas. This will increase the available nesting habitat on this highly eroded beach. The idea of rerouting the road around Kealia National Wildlife Refuge, obviously the best solution, should be proposed again.

The recipe for nest success for the 2004 season could be measured by Orion's fourth nest's characteristics. It was laid deeper than the other nests, probably due to the relatively non-compacted sand, so the hatchlings weren't affected upon emergence by foot traffic as much as at the more shallow nests. The seemingly lighter foot traffic flow and lack of cinder within the nest likely contributed to the ability of the 180 hatchlings to have all strongly emerged together at one time. This happened on day 59, 5 and 8 days earlier than the other two known nests' first emergences. This seemingly reflects the non-compacted state of this site. The location away from the tree line and not directly laid under a tree (just around some fallen logs and stumps) allowed it to get more sun exposure, likely decreasing the incubation interval. And like all of her other nests, there were no entangling roots/vegetation to hinder the hatchlings' emergence.

Keeping these characteristics in mind, nest success could potentially be maximized by relocating nests that are laid in unsuitable locations, namely in high-traffic areas, not just ones that are in danger of tidal inundation as our permit now states. Cordoning off and marking nests on a case-by-case basis, at the risk of drawing negative attention, is another protocol that needs to be discussed. This action would solve the problem of compaction from foot traffic and potentially save the nest from other threats like someone building a campfire on top of the nest, digging it up accidentally, or driving an umbrella or stake for a volleyball net or tent through the nest. The puncture of even one egg can be fatal to the rest of the eggs due to the decomposition process, resulting in unwanted bacteria, gases and insects. Marking nests with appropriate signage to explain to passersby what to do/who to call if they witness someone tampering with the nest or see a daytime emergence would also be beneficial since it is difficult to have enough volunteers constantly watching the nest, day and night. For instance, it is important to allow the hatchlings to crawl and swim into the ocean themselves for orientation purposes, but certain things can be done to prevent dehydration, which can be explained on the signs.

Daytime emerging hatchlings are more prone to dehydration and being stepped on or "harassed" by people or dogs while they make their way to the ocean. And they can receive fatal burns to their flippers if the sand temperature is too hot. Once in the ocean, since hawksbill hatchlings are not counter-shaded, they are more visible to their predators as they actively swim over the reef out to deeper water. They will also be visible to avian predators. Quantifying both diurnal and nocturnal mortality rates here in Hawai‘i are significant factors to consider for long-term population studies, and should be planned for in the future. This knowledge also affects the decision of whether or not to hold the hatchlings that emerge during the day to be released the following night. If the predator threat is actually found to be higher during the day than at night, then the biggest concern is that the hatchlings would waste their energy of the “frenzy” period while being held. But if they can be placed in a dark, quiet, cool environment (something as simple as a black bucket of moist sand with a towel over it), they should return to a quiescent state until they can be released safely at night. This is a procedure adopted by many mainland nesting projects, especially those with hatcheries in which emergences are easily witnessed. If the turtles emerge in the daylight, they are kept in shaded buckets until nightfall to improve their survival.

It has been practiced to schedule each nest excavation on the third day after the first emergence. This has given the hatchlings two additional nights to emerge naturally and is the protocol for South Carolina and Florida nesting projects. But after witnessing the poor physical conditions of many hatchlings during the excavations in 2001 and 2004, HWF recommends that the excavation be scheduled one day earlier (on the second night after the first emergence). Since their weak state likely stems from their struggling to crawl out of the nest, our assistance will hopefully save the hatchlings valuable energy while still allowing them time to emerge naturally. For these same reasons, each nest should be excavated by day 70 if no emergence is detected. Our permit already states that we are able to do this, but it has been our decision to wait until day 72, another protocol for South Carolina and Florida nesting projects (of which the majority of their turtles are loggerheads, *Caretta caretta*).

Each nest excavation was scheduled for either 5:30pm or 6:00pm. We believe that this is too early in the day, because the hatchlings ended up being held for at least 20 minutes before they were released, at sunset. During this time some are measured and weighed by USFWS and DLNR DAR, a methodology with unclear goals. Besides wasting valuable energy, there may be other harmful effects involving the imprinting process that are not well understood. Sunset gave us enough light to make sure the hatchlings reached the ocean, and the onlookers got a worthwhile view. Unfortunately, dusk is commonly referred to as “feeding time” for apex predators, and could be the most dangerous time for these hatchlings to be swimming out over the reef. The in-water mortality rate needs to be assessed to determine if the timing of release has an impact on survivorship. Until then, they should be released well after dark, a protocol that South Carolina and Florida projects follow, which means that the excavations should begin much later in the evening. The negative impacts of this change would be that community volunteers and other passersby might not get the same experience as they do during the daylight. But infrared video equipment could be used to watch the event, while recording everything for later. Our primary goal is to increase hatchling survival; therefore we need to think beyond the beach and especially beyond what is simply convenient for our schedules.

Another concern with the excavations is the tools used. If the nest isn't found almost immediately, the excavator used a small metal trowel to sift through the sand. Once a pile was made, a bigger shovel was sometimes used to remove this pile (especially with green turtle excavations which tend to be deeper and more difficult to find). Our obvious anxiety about this procedure is that it can be quite easy for a hatchling(s) to be harmed by this type of digging. Just as an example, the whole state of Florida forbids workers to use any tools of any kind when redigging nest cavities for relocated nests for fear that they might dig into an unknown nest. So they would never even consider allowing a shovel to be used in an area where there is a known turtle nest! We should adopt this no tool policy for excavations as well.

Excavations this season were extremely popular, with over 50 people at each one. This was a mixture of volunteers from the project, friends and family of the volunteers, and random beachgoers. Crowd control was a real problem for the first excavation, as many hatchlings that got washed back up the beach by waves nearly got stepped on by onlookers who didn't adhere to instructions and walked too close to the water. For this reason, we had to put up caution tape around the "hatchling runway" (an approximately 15x30 ft stretch of sand leading to the water) for the next nests. Depending on where the hatchlings would crawl, we realized that some people might not get an up-close look at the hatchlings. So, before the hatchlings were released, we walked closer to the crowd with a few hatchlings to make sure everyone got a satisfactory look. Certain excavators were allowing people to touch and hold the hatchlings, which we are concerned about and disagree with mainly because of the possibility of disease transmission to the turtles. Also, Glynnis Nakai actually got bit by one of the hatchlings while handling them. And at least one hatchling was dropped by a child, so there are real health and safety concerns for both turtles and humans involved with this practice.

Determining the sand incubation temperature of each nest laid on Maui would be an important project to undertake. Placing a number of small temperature data loggers into the sand surrounding each nest can accomplish this. Information obtained from these loggers throughout the duration of incubation coupled with genetic analysis can determine the sex ratio, which is temperature-dependent, of hatchlings produced. This pivotal temperature has not been determined for Hawaiian hawksbills. Predicting whether the majority of hatchlings are males or females would provide insight into the reproductive potential for the population.

The issue of what to do with weak hatchlings has been ongoing for several years now, and is still not resolved. On Maui, the Maui Ocean Center has agreed to work with HWF on ways to help rehabilitate these hatchlings. This would only be a temporary situation until they can be released, and they would not be on public display. Many details need to be ironed out for this to happen- everything from what to feed them to where they should be released. Disease transmission is the biggest concern. Solid protocols must be researched thoroughly.

Tracking the adult females during their internesting and post-nesting migrations continues to provide useful insight into their lives that wouldn't be possible without this technology, especially since this equipment continues to be perfected. Additional information could be gleaned by including time/depth recorders (TDRs) along with the VHF/satellite transmitters. This will give us dive depth profiles, something we can only estimate now by overlaying the habitat contours with each turtles' approximate positions. And eventually the Crittercam© will become small enough to use. This device can be applied to the turtle early in the nesting season to hopefully show mating interactions with other hawksbills. Being able to see what they are seeing when deciding to come ashore to nest would be very insightful and helpful to conservation efforts. We could also learn what species they are choosing to forage on, as well as the quantity, which are both completely unknown for adult Hawaiian hawksbills at this time.

A tremendous effort is ongoing to understand and protect Maui's few nesting hawksbills, and without it the survivorship of these turtles would certainly be jeopardized further. This project has saved adults and hatchlings from a gauntlet of threats. The intensified monitoring of each nesting and hatching event has also greatly improved the dataset for these occurrences. But, the actual numbers of nesting hawksbills on Maui are not increasing (Fig. 11). And the annual mean hatching success for Maui's nesting beaches remains low with a range of 0% to 72.3% (Fig. 12). With a Critically Endangered species at such risk, more resources need to be funneled in this direction. And innovative research methodologies should be explored to further our knowledge of all aspects of this specie's life history so it can be protected.

We certify that the information in this survey report and attached exhibits fully and accurately represent our work.

William Gilmartin	Date
Cheryl King	Date

HAWAI'I WILDLIFE FUND

List of Tables and Figures

Table 1. 2004 nesting and emerging summary.

Nest #	Date laid (night)	Beach	Location	Internesting Interval	1st Emergence	Night Emergence	Daylight Emergence
1	17-Jun	Oneloa	N. of 1st P.lot	^	68.5 days	22 (27%)	60 (73%)
2	6-Jul	Oneloa	N. of 2nd P.lot	19 days	64.5 days	5 (5%)	92 (95%)
3	27-Jul	Oneloa	path to Little B.	21 days	none	0	0
4	16-Aug	Oneloa	S. of 2nd P.lot	20 days	59.5 days	2 (1%)	180 (99%)
5	5,12or13-Sep	Little	2/3 down bch.	20, 27, 28 ?	74, 67, 66 ?	8 (73%)	3 (27%)
F.C.	23-Sep	Kealia	mile marker 2	^	^	^	^
Total	{"Orion" laid nests 1-5}					**37**	**335**
Mean	{unknown *'ea* false crawled only}			****20 days**	*****64.2**	***9.3 (10%)**	***83.8 (90%)**

*Without Nest # 3 (remains were not quantified)
**Without Nest # 5 (nesting date unknown)

Table 2. 2004 nest excavation summary.

Nest #	Date of Excavation	# of eggs	Empty Shells	Live Hatchlings	Released at Excavation	Held at Excavation	Dead at Excavation
1	28-Aug	178	177 (99%)	165 (93%)	14	0	12
2	11-Sep	180	175 (97%)	134 (74%)	36	0	41
3	6-Oct	?	?	40 (?%)	40	0	>28
4	17-Oct	190	186 (98%)	186 (98%)	3	0	0
5	20-Nov	165	156 (95%)	93 (56%)	55	14 (died)	63
Total		***713**	***694**	**618**	**148**	**14**	**>144**
Mean		***178.3**	***173.5 (*97%)**	**123.6 (*81.1%)**	**29.6**	**2.8**	**>28.8**

All excavation #s are preliminary until nest remains can be confirmed by NOAA.

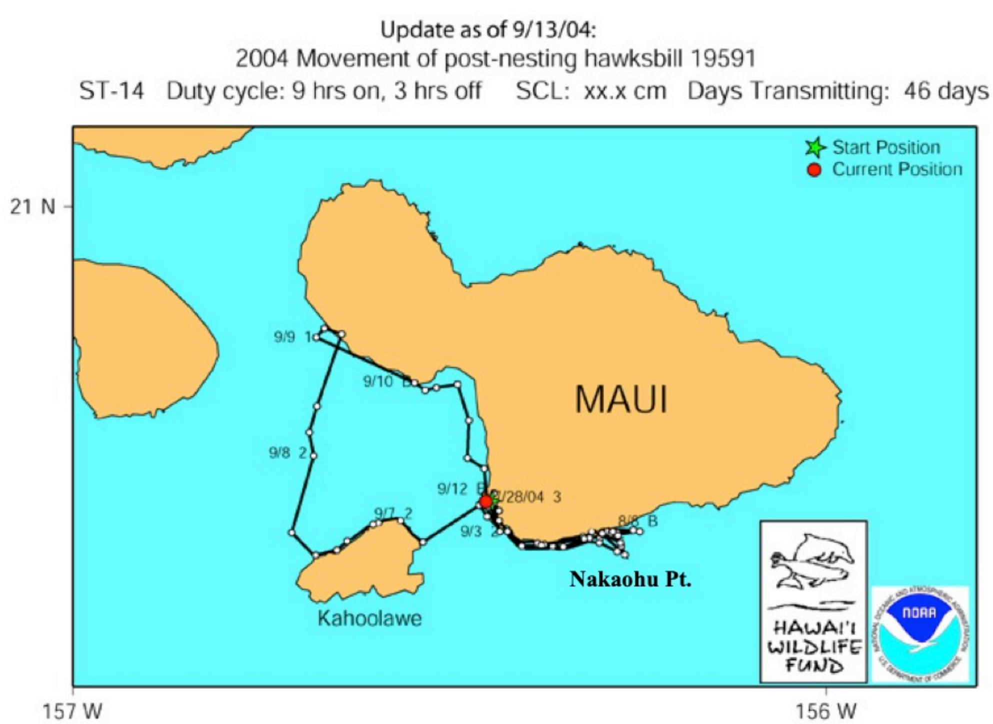
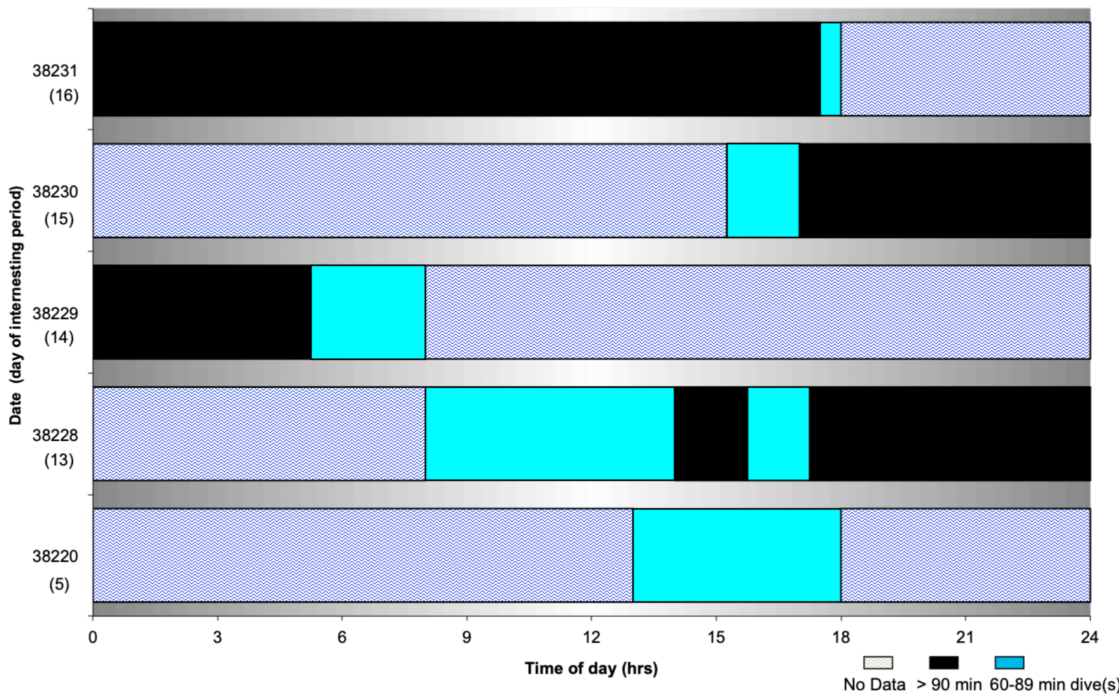


Fig. 1. Internesting movements determined by satellite telemetry.

Fig. 2. Internesting diel dive patterns determined by VHF radio telemetry.



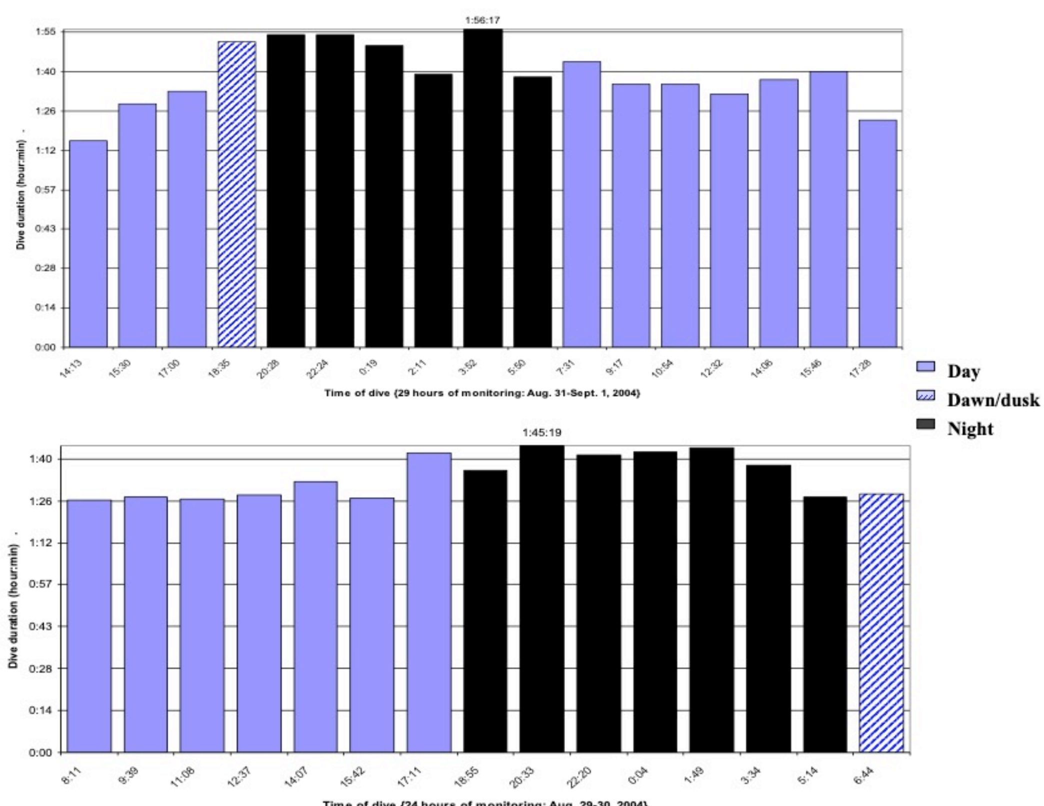


Fig. 3. Internesting dive durations.

Fig. 4. Surfacing patterns for nest #4 activities.

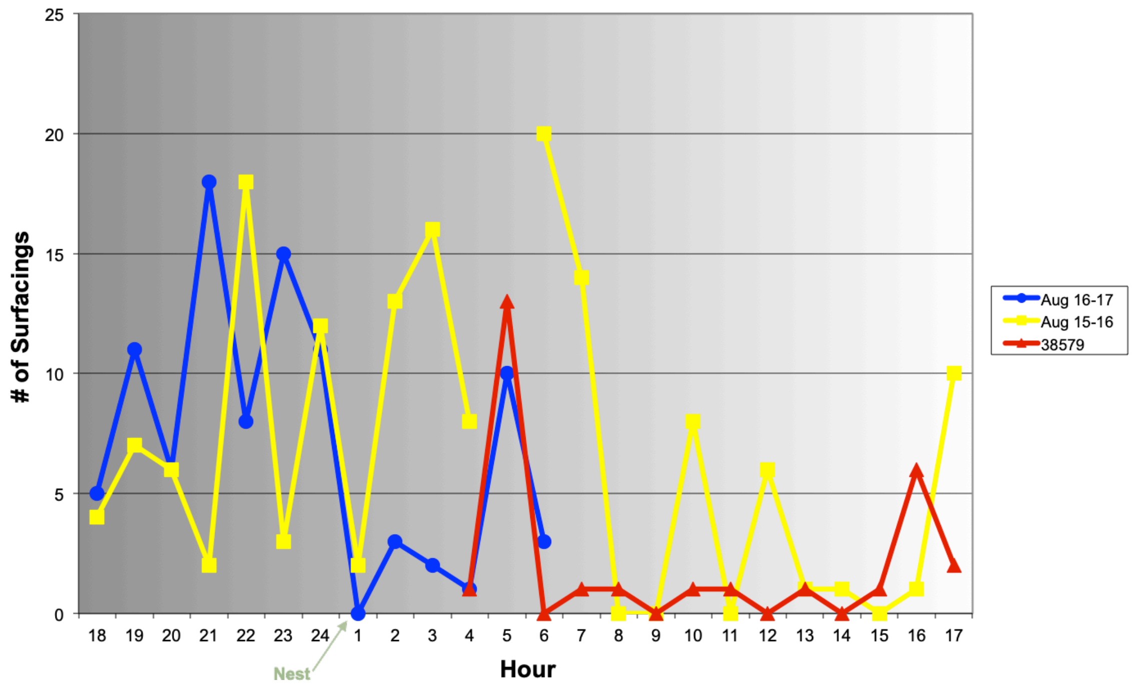
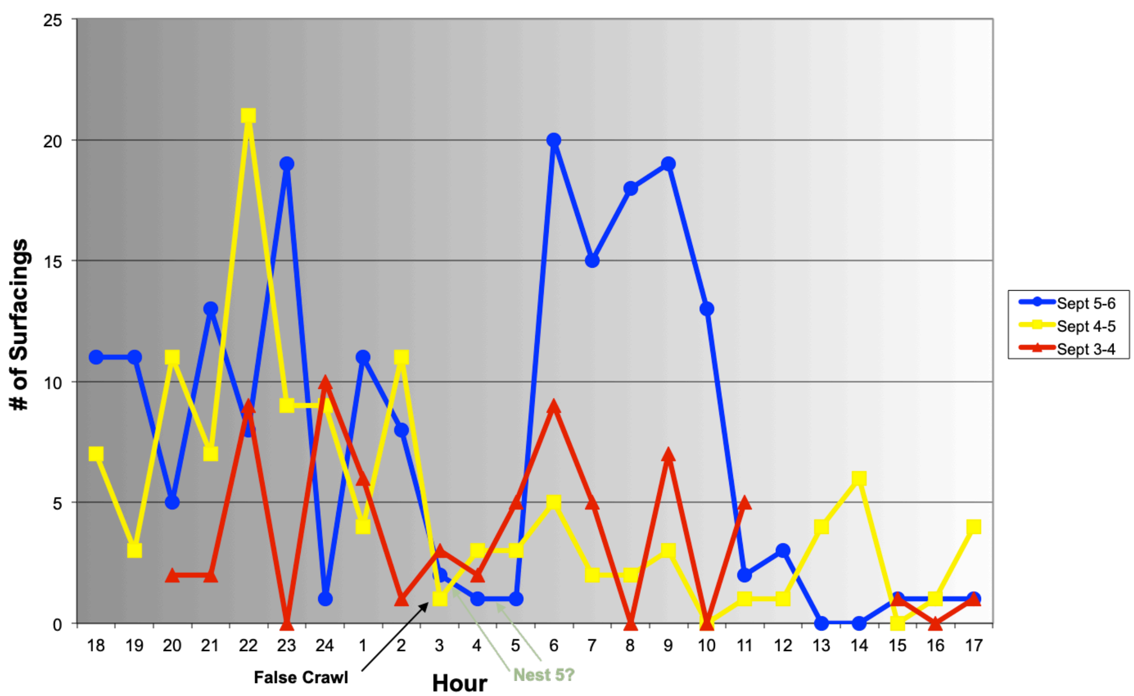


Fig. 5. Surfacing patterns for nest #5 activities.



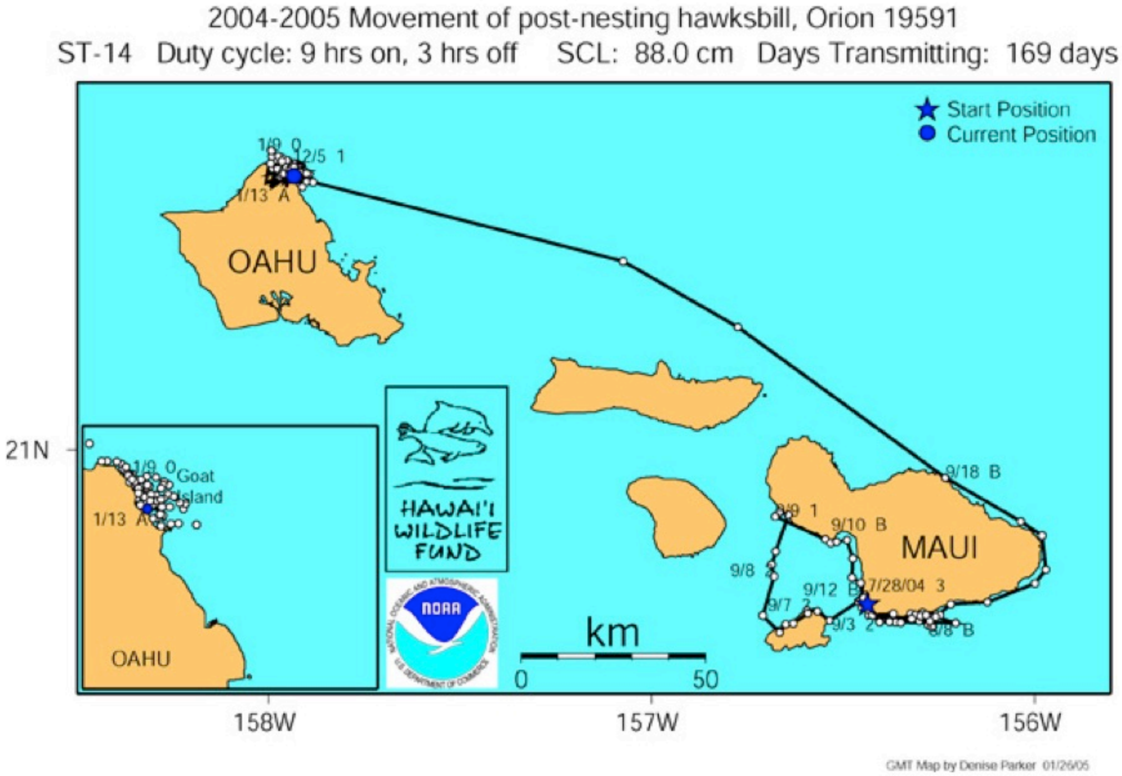


Fig. 6. Internesting and postnesting movements determined by satellite telemetry.

Fig. 7. Surfacing patterns for 2004 nesting activities.

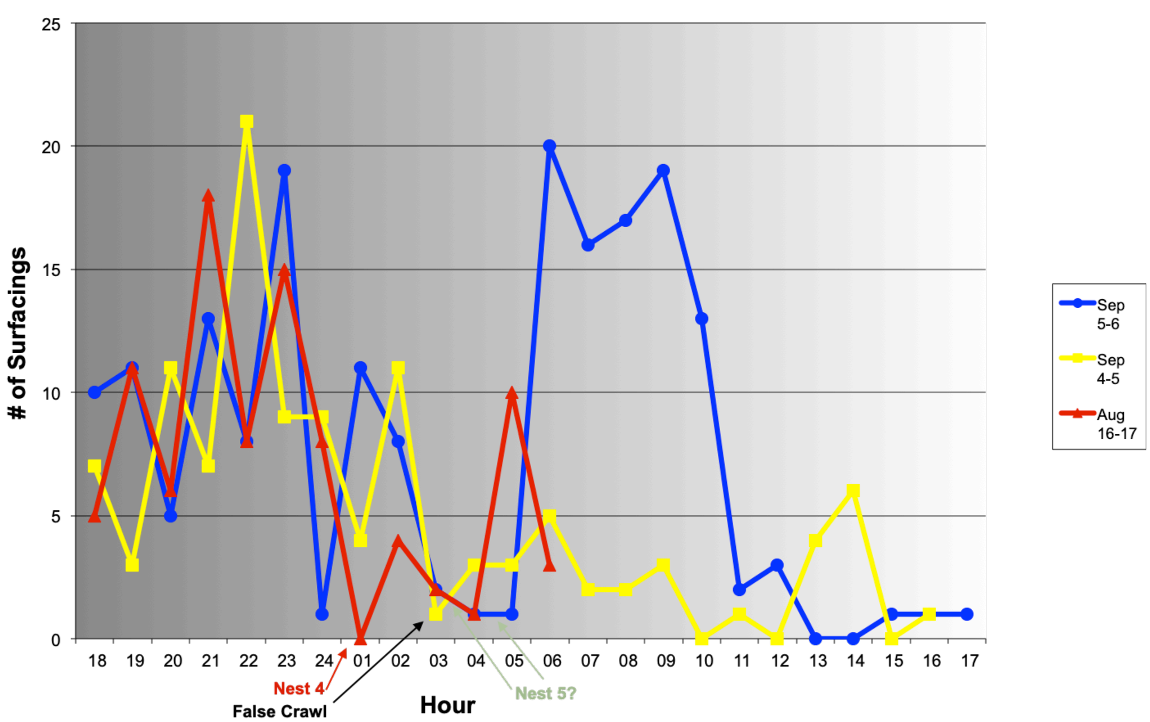


Fig. 8. Postnesting dive durations Nov. 6-7, 2004.

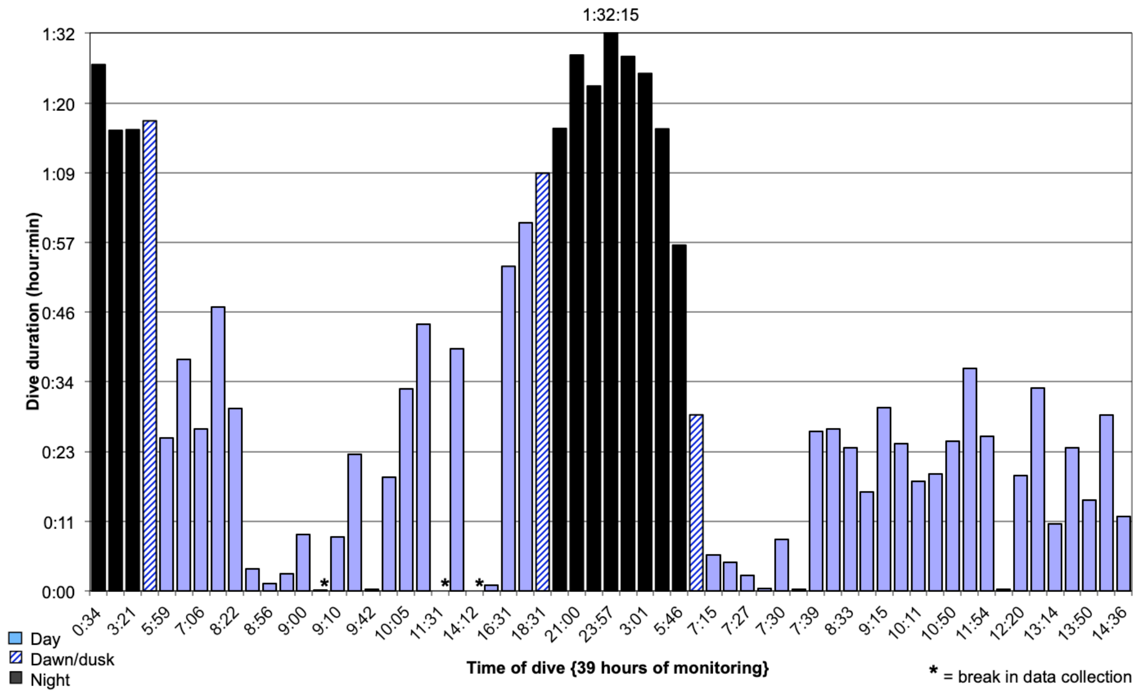


Fig. 9. Postnesting dive durations Nov. 23-25, 2004.

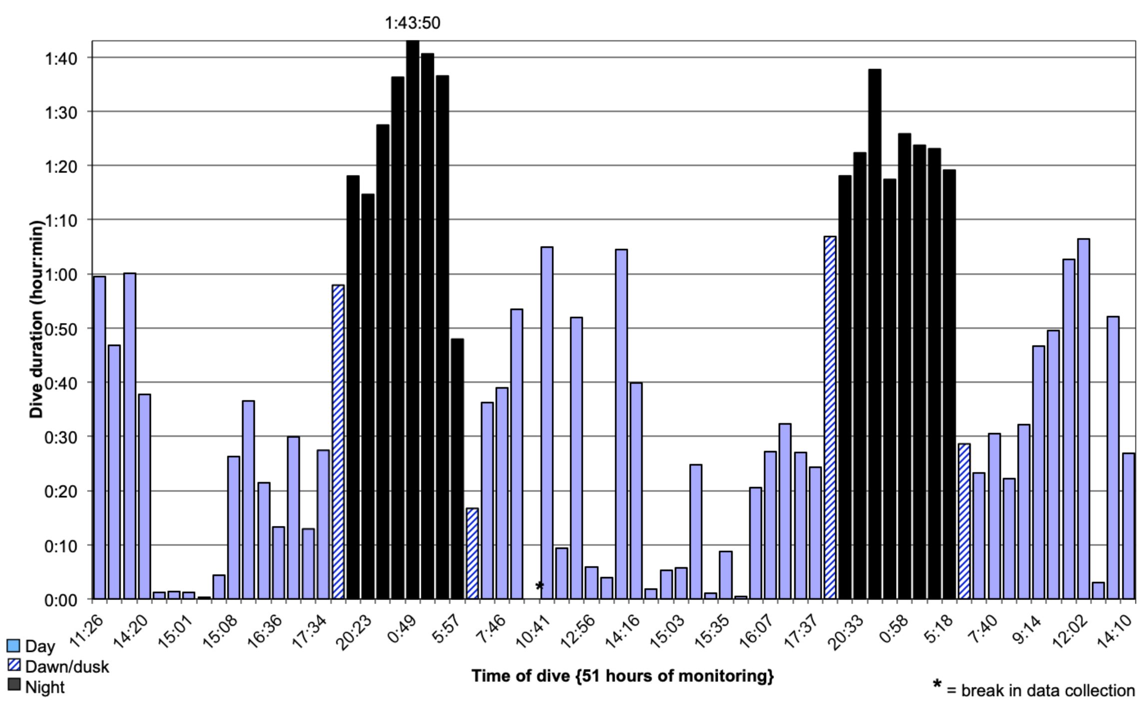


Fig. 10. Postnesting diel dive patterns determined by VHF radio telemetry.

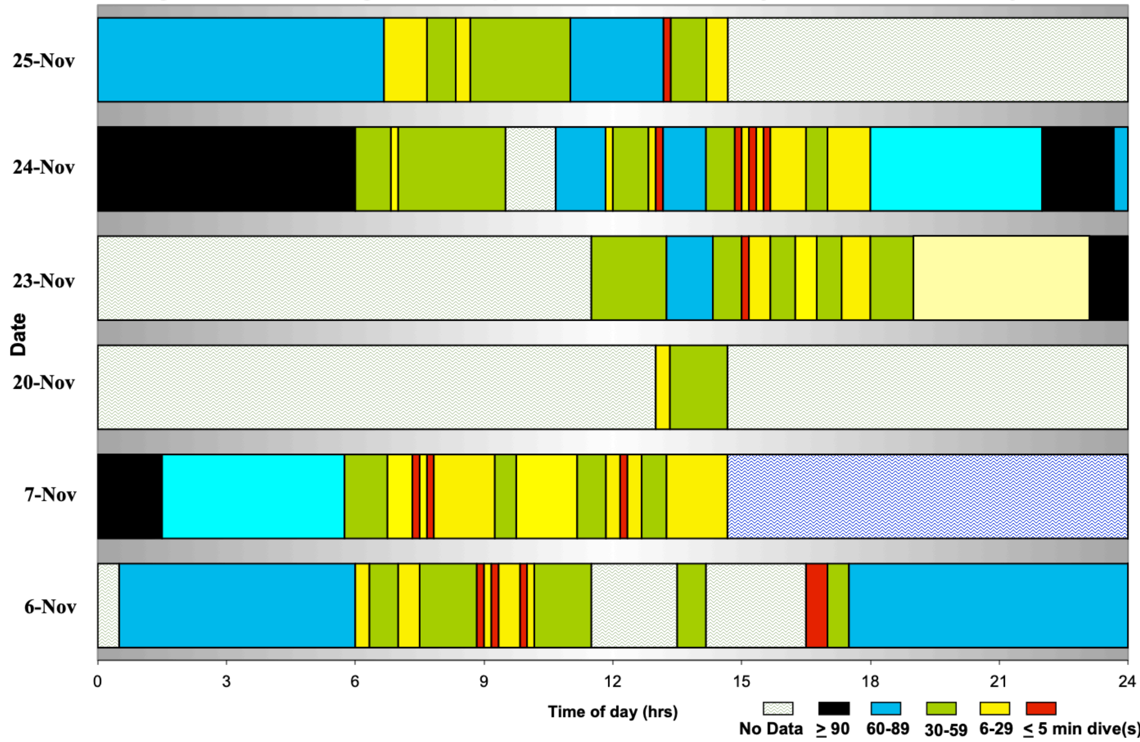


Fig. 11. Summary of Maui's hawksbill nesting activities (1991-2004).