2009 Report on Hawksbill Sea Turtle Foraging
&
Nest Monitoring Research

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2009 Maui Hawksbill Sea Turtle Activities

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, Moloka‘i 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. Hawai‘i Wildlife Fund organized a community-based effort to systematically monitor these occurrences 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, take biopsy samples for analysis, determine sizes of these females, the sites they use for nesting, the internesting intervals, 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 predators, human disturbance, coastal lighting, non-native vegetation, and vehicular traffic.

Little is known about the foraging ecology of critically endangered hawksbill sea turtles (*Eretmochelys imbricata*) in Hawai‘i. In 2007, HWF partnered with Shannon Graham in the Conservation Biology Masters Degree Program at the University of Hawai‘i Hilo to conduct foraging ecology research on the hawksbill turtle. The primary objectives of the foraging research are to identify foraging depth and preferred prey species of post-nesting females. Earlier tracking studies had shown that the majority of adult females migrate to the Hamakua Coast of Hawai‘i Island after nesting, however prey species of Hawai‘i hawksbills are only known from stomach contents of one dead animal as reported in Balazs (1978). From the latter study, only three sponges were specified but not identified to species.

Methods

Nesting Turtle and Nest Monitoring

Nesting season can begin as early as mid-May, with hatching events stretching into December. During these months, the Maui 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.

Transmitter Attachment

None in 2009

Procedures for tissue sampling from live hawksbill turtles

The skin sampling region was deadened with 2% lidocaine hydrochloride and cleaned with betadine prior to sampling. A few mg of tissue were removed with a 6 mm biopsy punch. Samples placed in a sealed cryotube were stored on ice in the field, and frozen at -20°C in the lab until subsequent analysis. Straight carapace length, width, and tag information, from each turtle were recorded. Activities were conducted by C.King on the islands of Maui and Hawai‘i (in collaboration with Hawai‘i Volcanoes National Park Hawksbill Monitoring Project).

Stable Isotope Analysis

Thawed tissue samples were rinsed in distilled water and desiccated at 60°C for 48 hours. Dried samples were granulated to fine powder with a scissor. Approximately 1.0 mg of dried homogenous tissue was placed in sterilized tin capsules. Samples were analyzed at the EPSCOR Analytical Lab by a DeltaV Isotopic Ratio Mass Spectrometer with a Costech Elemental Analyzer. Denoted as parts per thousand (‰), $\delta\ ^{13}C$ and $\delta\ ^{15}N$ values will be further investigated relative to the diet. These analyses were done by Shannon Graham. Samples were also sent to George Balazs (NMFS, Honolulu) for genetic analysis.

Results & Discussion

Tissue Sampling

A total of five tissue samples from nesters were collected by C.King in 2009 (3 on Hawai‘i Island, 2 on Maui). To date, analyses have not been completed on these five samples but S.Graham’s 2009 thesis is attached for the results of previous collections.

Kamehame, Hawai'i Island tissue samples (nesting females)

Date	Turtle	SCL (cm)	SCW	LFF	RFF	LRF	RRF
2009.08.21	1	81.3	61.5	2D85	2D84	2D89	2D90
2009.08.23	2	83.0	65.5	N404	N403	71M	2D86
2009.08.24	3	76.4	58.0	Y254	3D01	3D02	3D03

Kealia, Maui tissue samples (nesting females)

Date	Turtle	CCL (cm)	CCW	SCL	SCW	LFF	RFF
2009.08.25	Kolohe	85.4	78.5	81.2	60.9	H342	H340 & H341
2009.09.03	Kulu	83.5	76.5	80.6	60.4	H343	H344

Maui Nesting Research

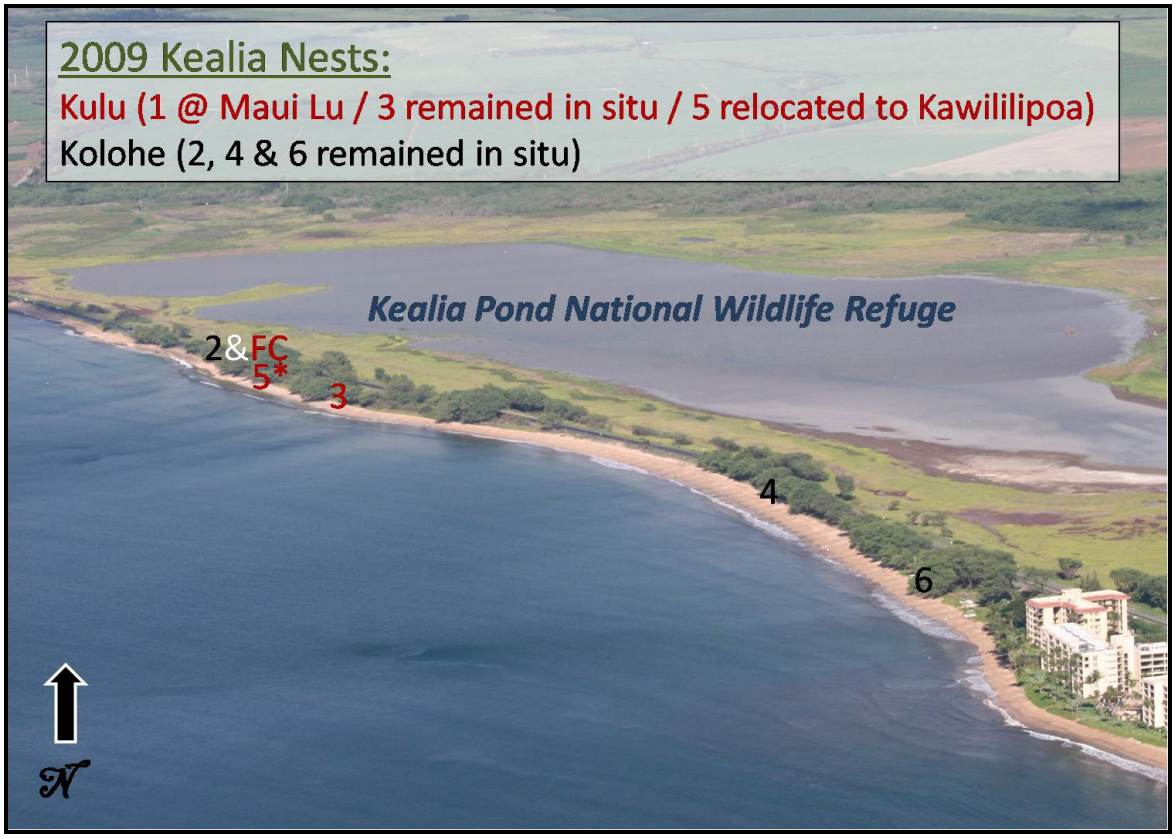
We documented six nests on Maui this season. For the first time since 1996, there were two nesting hawksbills at Kealia in the same season. One of the nesters was "Kolohe" (translated as mischievous, rascal), who laid one nest in 2002. The other female was a new nester so we tagged her making her the seventh known Maui nester since tagging began in 1997. We gave her the name "Kuluaumoe" (late at night) since we first found her after 3:00am, or "Kulu" for short because she first nested during the Hawaiian moon phase of Kulu. Kulu also translates as "to flow, as tears" symbolizing the salt tears that flow during nesting.

No nests were laid on the Dawn Patrolled Kawililipoa or Oneloa beaches this season. We will need to expand on our beach coverage though, as a hawksbill nest was laid across the street from the Maui Lu Resort, unkown to us. When the hatchlings emerged from the nest that was approximately five feet from the road, the hatchlings got disoriented by all of the lights and crawled onto the road. Tragically, eighty-eight dead hawksbill hatchlings were found. Counting back into the two turtles' nesting intervals (ranging from 16-23 days), this nest corresponds to what would've been Kulu's first nest. We later found out from a Maui Lu neighbor that they had to help an adult turtle who crossed the road get back to the ocean, likely meaning that Kulu had gotten disoriented after she nested. She's lucky to be alive!

In a strikingly similar event, yet another surprise nest (which corresponds with Kolohe's first nest of the season) was found too late. Despite some being luckily rescued by a beach/road cleanup crew, over 100 hatchlings crawled onto North Kihei Road and were run over. This just goes to show the major influence that car headlights play when hatchlings are trying to find the ocean- they don't stand a chance of going the right way.

Kolohe was the smallest Maui hawksbill nester we've measured until Kulu. Although size is not necessarily an indication of age, we can hope that these two turtles have a long life of nesting on Maui ahead of them. Since 2002, Kolohe has only grown from 84.5 to 85.4cm curved carapace (shell) length and from 78.2 to 78.5 curved carapace width. Of all the Maui nesters, Kolohe and now Kulu are the only ones we have not used satellite telemetry to track them to their foraging grounds, so these areas remain a mystery.

We watched Kulu and Kolohe lay one nest each. The egg laying portion took ~30 minutes, and ended at 22:59 for Kulu and 21:19 for Kolohe so they were early nesters. The five nests laid at Kealia are labeled in succession below (starting with #2 since the first of the season was at the Maui Lu). Kulu made one "false crawl" at Kealia (labeled FC) in which she dug around but didn't find an adequate nest site. Ironically, this same spot was where the surprise nest #2 was. Since no live hatchlings have emerged from Kealia this century, we decided to relocate one nest from Kealia to Kawililipoa where we have had very high hatchling incubation/emergence. We did this with Kulu's last nest (#5), all 180 eggs. Kulu's nests are in maroon and Kolohe's are labeled in black.



Sand Temperature Analysis

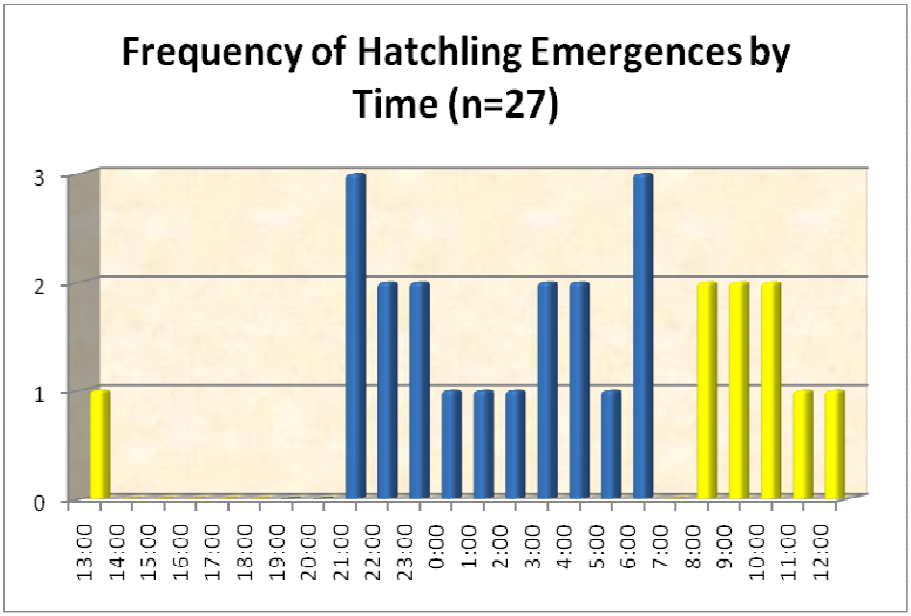
We buried small sand temperature loggers in one (Kawililipoa) and around the other three known nests, all at ~15-20" depth. Information obtained from these loggers during incubation coupled with dead hatchling necropsies can approximate the sex ratio of hatchlings produced. Sex-determination is temperature dependent so if the egg's temperature is over a certain degree the hatchling will be female, but if it's below it will develop to be male. 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 future population.

The temperature loggers around Kealia nests 3, 4, and 6 (shaded locations) recorded temperatures ranging from ~26-28°C. The temperatures remained consistent at each nest site, varying only one degree or so. The control outside the Kawililipoa nest (in direct sunlight for the majority of the day) recorded consistent temperatures between ~29-31°C. In contrast, the logger inside the Kawililipoa egg chamber recorded temperatures from ~30-36.5°C, showing the effect of metabolic heating, as higher temperatures peaking from day 40-47 of incubation. The first hatchling emerged on day 54.

Nest Monitoring

Nest watch coverage was nearly 24/7 close to hatching time since we were worried that the hatchlings would crawl the wrong direction. They didn't have to crawl far at Kealia, and most took less than 15 minutes to reach the ocean. Kawililipoa's dune system has built up so we made a path over the dune and through the vegetation. These hatchlings understandably took up to 45 minutes to reach the ocean.

One of the most frequently asked questions is always, "When do the hatchlings crawl out of the nest?". Well, this is a sand temperature-dependent event which typically occurs at night, but we usually record daylight emergences as well. See graph below for how many times hatchlings emerged (27 total events) during each hour of the day this season. This does not cover the amount of hatchlings, just the hour that they emerged from the nest. Despite having low sample sizes, the important point is that we're documenting both night (blue bars) and daylight (yellow bars) emergences. The highest number of hatchlings that emerged at once was at 06:12 AM (~73 from nest #3), but as shown below they really can appear at any time. This year it was fairly evenly distributed except for the afternoon shifts, but the luckiest nest watchers had the 06:00 and the 21:00 shifts, as three different emergences happened between 06:00-06:59 and 21:00-21:59.



Nest Success

Despite repeated requests, all of the 2009 nest excavation summaries have not been completed/sent to us by S.Hau (DLNR DAR) and G.Nakai (USFWS) so these data cannot be included in this report. All nest excavation remains were sent to NOAA/NMFS for further analyses. Excavation dates and approximate success rates are as follows (keep in mind #1 and #2 were the unknown nests so the low success reflects the large number of hatchlings that got killed on the road):

Nest	Date Laid	Location	Turtle	INP #	Emergence	Excavation	Success
1	?	Maui Lu	Kulu	n/a	n/a	2009.09.13	24%
2	?	Kealia	Kolohe	n/a	n/a	2009.10.11	~30%
3	2009.08.08	Kealia	Kulu	n/a	67	2009.10.15	~81%
4	2009.08.16	Kealia	Kolohe	n/a	64.5	2009.10.21	~95%
FC	2009.08.25	Kealia	Kulu	19	n/a	n/a	n/a
5	2009.08.27	Kawililipoa	Kulu	21	54	2009.10.24	50%
6	2009.09.03	Kealia	Kolohe	21	68	2009.11.13	98%

Conservation Recommendations

HWF has now tagged seven nesting hawksbills since 1997. Orion (Oneloa 2001, 2004 and 2008) was the first, Lele (Kealia 2000 and 2005) was the second, Hōkūlele (Kawililipoa 1999 and 2006) was the third, and now Kolohe (Kealia 2002 and 2009) is the fourth known tagged hawksbill to return to Maui for another nesting cycle after being tagged. The survivorship of two tagged nesters, from 1997 (Hapa at Kealia) and 1998 (Sasha at Kawililipoa) is in question since they have not returned to nest that we know of. This could be partly due to the fact that there are barely enough people to reliably patrol the three known nesting beaches in the mornings, 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 seems to be the case for some 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. Kealia nesters consistently have the lowest nesting totals per season (1-3) compared to Kawililipoa (4-5) and Oneloa (4-5) nests. It could be that Kealia turtles have a larger nesting range and those other nests are going undetected if they aren't at Kealia. The south shore from Kihei to Makena should be prioritized for the expansion of patrols due to the proximity to the other nesting beaches: Kawililipoa and Oneloa.

Both tragic incidences that occurred this season in which the unknown nests' hatchlings crawled onto the road instead of towards the ocean shows the importance of intensive monitoring of each nest so that this can be prevented. Nest watching is also

needed when the hatchlings emerge during the day in which they are more susceptible to dehydration/sand burns and are more visible to predators or human disturbance.

Again, the urgent and critical priority for the upcoming nesting season must be the completion of the Kealia fence replacement or repair to keep nesting hawksbills from being run over by passing vehicles on North Kihei Road. One night, Kulu dug in over three different spots before pushing her way through the old wire fence trying to find better habitat. Luckily, we were there to veer her back onto the beach and away from the road. Half of the recycled plastic fence was installed in 2008 and funding for the rest of the fence was secured through the County of Maui but hasn't been implemented. Sections of the new fence are inadequate at stopping the turtles (they can crawl under it) so until the special posts are pounded in and the rest of the fence is ordered, HWF will have to continue to fix nearly the whole dilapidated fenceline. Not only does it need to be fully replaced with the recycled plastic fence material, 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 as much as possible on this highly eroded beach. Unfortunately, this is Alexander and Baldwin land, and we presume the negotiations by USFWS Kealia Pond National Wildlife Refuge continue. The idea of rerouting the road around the Kealia Refuge, obviously the best solution, should be proposed again.

Getting the report of the Maui Lu neighbors having to redirect Kulu back across the road to the beach after she got disoriented was very disturbing. Unfortunately, there are many well-lit roads that run very close to much of Maui's coastline, so if hawksbills (or any other turtle species) choose these areas to nest there is a real concern for their safety as well as passing motorists. Erecting turtle fences around every beach is impractical, and it's impossible to darken vehicle headlights, so solutions to these problems on a case by case basis should be considered before another valuable nesting turtle is killed.

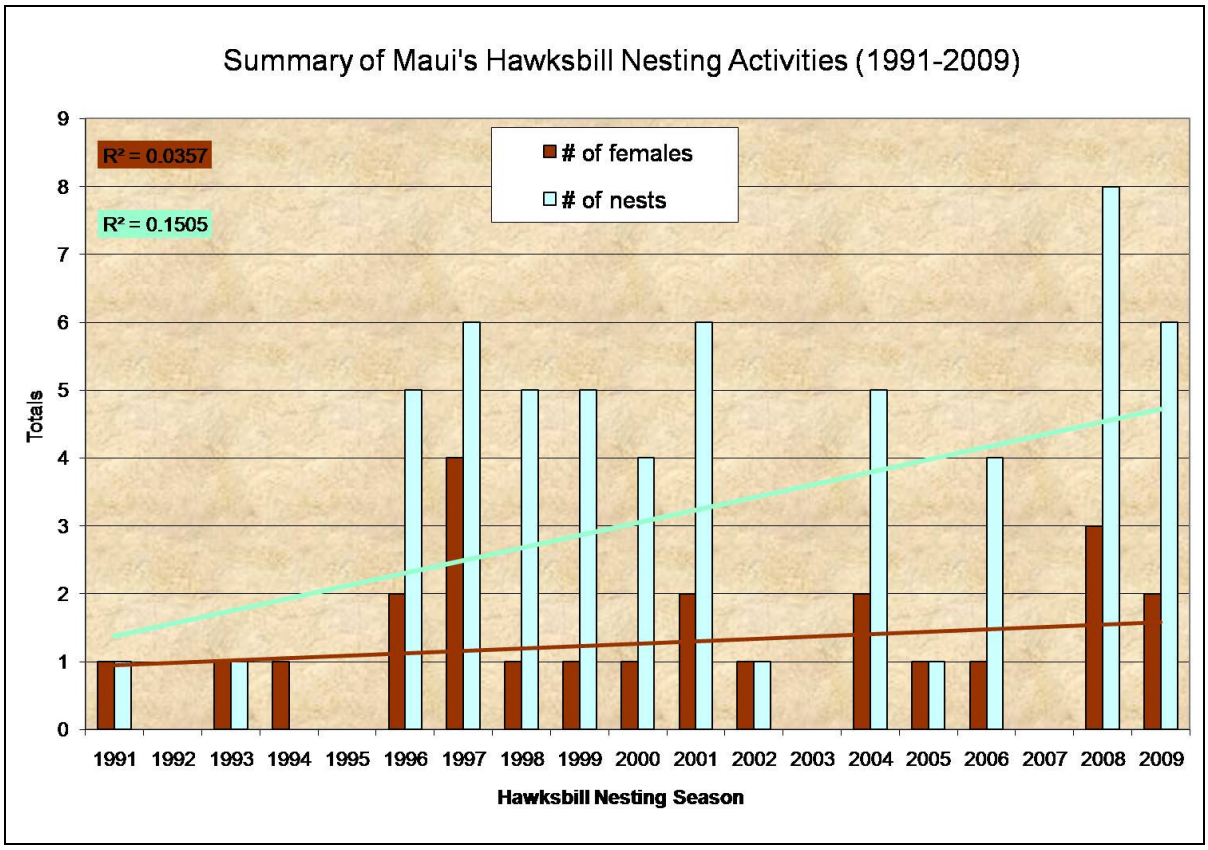
The high success of the Kealia nests this season was a welcome surprise. Why this was the case after a total failure of all nests this century is a mystery. None of Kolohe's 2002 eggs developed, but it's undeterminable if they were fertilized or died very early in development. The only obvious difference between these 2009 successful nests and the unfruitful ones of the past are their general location. This season's nests were laid east of all the other unproductive ones. Nest 6 was laid close to where the 1996 nester was killed on the road (pre-fence). Also that year and very near nest 6, dead hatchlings were found on the road so it had been a good incubation environment back then. Two of the four 2009 nests (#2 and #4) were laid in a dirt/sand/kiawe mix, resembling the substrate of unsuccessful Kealia nests from the past. This didn't seem to affect development as was suspected; as these nests had remarkable incubation results similar to the other two laid in predominately sand (#3 and #6). The location of nest #3 allowed some direct sunlight, but the other three were laid in extremely shady locations. This noticeably slowed nest incubation, but we have no way of knowing how it affected incubation. Most past Kealia nests have been laid in direct sunlight, so coupling the heat

with the lack of moisture in the sand may have negatively affected hatchling development.

The future relocation of nests from Kealia, a highly degraded habitat, warrants further discussion. At this point, our recommendations are that if nests are laid at Kealia where egg development has been unsuccessful (all western sites) then they should be relocated to these 2009 eastern, successful Kealia nest spots. One consideration with this is that these 2009 nests were laid in very shaded locations, and with what we know about temperature-linked sex ratios (more research is needed) this likely contributed more males to the population than females. In contrast, Kawililipoa's habitat is much warmer in direct sunlight (which would conceptually produce more females), but the higher temperatures may have contributed to hatchling mortality. At this time, causes of nest mortality cannot be confirmed, only speculated. Thinking long-term, Kawililipoa seems to be the better nesting habitat, but Kawililipoa has degraded due to the invasive dune vegetation so it may not be as conducive to hatchling survivorship until that habitat is restored.

Please see S.Graham's thesis (attached) for her foraging study results. The five samples that were collected this season will be analyzed and compared to her thesis samples. One particularly noteworthy application to our future research: the preliminary findings from S.Graham's analyses suggests that tissue from fresh dead hatchlings recovered at nest excavations could be used in stable isotope analyses as a substitute tissue to obtain foraging data on the adult female. If this is substantiated in further study, the method will allow long term monitoring of adult female foraging preferences without sampling the female.

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 community-based 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. As of yet, the actual numbers of nesting hawksbills on Maui are not increasing significantly (see graph below). 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 species' life history to aid in its protection.


Summary of Maui's Hawksbill Nesting Activities (1991-2009)
R² = 0.0357
R² = 0.1505
# of females
# of nests
Totals
0
1
2
3
4
5
6
7
8
9
1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Hawksbill Nesting Season

We certify that the information in this report and attached exhibits fully and accurately represent our work. Excavation nest numbers still must be verified by NOAA/NMFS, so the ones used here are unofficial.

William Gilmartin — 1/30/10 Date

Cheryl King — 1/30/10 Date

HAWAI'I WILDLIFE FUND

HAWKSBILL RECOVERY PROJECT