Foraging trends of hawksbill turtles on Hawai`i Island: A study utilizing stable isotopes and satellite tracking

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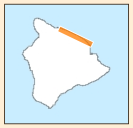
Introduction



◆The Hāmākua Coast of Hawai`i Island has been found to be an important foraging habitat for post-nesting Hawaiian hawksbills (Parker et al. 2009).

◆While prey preferences for the Hawaiian population are unknown, their diet was assumed to consist of sponges like other populations (Carr & Stancyk 1975, Meylan 1988, Alvarez 1998).

◆To date, the only collated foraging information on hawksbills in Hawai`i comes from turtles observed in Maui waters feeding on marine invertebrates and algae at wide depth ranges (Cheryl King unpublished data), and findings of three sponge specimens from a deceased turtle (Balazs 1978).

◆Hāmākua Coast's relatively low hawksbill population density, limited access, and rough ocean conditions hinder traditional foraging research such as stomach content analysis and in-water observations.

Purpose

The purpose of the study was to investigate foraging dive behaviors and utilize stable isotope analytical methods to determine the dominant prey species of Hāmākua Coast foragers by sampling post-nesting females. The study was guided by the following research questions.

1) What are the foraging dive patterns of post-nesting females?
2) What are the dominant prey species of Hāmākua Coast females?
3) What are the isotopic patterns among Hawai`i hawksbill females?

Acknowledgements

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◆National Park Service Hawksbill Turtle Recovery Program

MAHALO!

Methods

◆Data Collection/Analysis: 2007 - 2010

◆Materials:

Argos satellite-linked transmitters with pressure sensor capabilities (Telonics model ST-20 A-1025)

Transmitters programmed to record percentage of time spent within 10m depth increments and accumulate dive count over two-12 hour periods.

◆Procedures:

Three Hawai`i Island post-nesting females were outfitted with satellite transmitters (Fig. 1). Differences between dive count by periods and percentages of time spent underwater by depth bins were compared.

Potential prey organisms were collected from sites along the Hāmākua Coast (Fig. 2).

Epidermal tissues from 4 post-nesting females (3 with satellite transmitters) from Hawai`i Island and Maui were collected with a 6mm biopsy punch.

Tissues of marine organisms and adult tissues were dried to mass and run through a mass spectrometer for isotope signatures.

Carbon ($\delta^{13}C$) and Nitrogen ($\delta^{15}N$) values were entered in a two-source mixing model to determine contribution of prey resources in hawksbill diets.

Fig. 1. Satellite transmitter position on post-nesting female at Kamehame

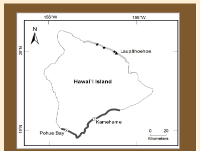

Fig. 2. Study sites
★ = potential prey species collection site (Kuka`iau, Honoka`a, Laupāhoehoe)
⦿ = attachment of satellite transmitters at nesting sites (Pōhue Bay, Kamehame)

Results

One instrumented hawksbill traveled to Maui (1D79/M) and one to the Hāmākua Coast on Hawai`i Island (1D58/HC). The third hawksbill's (1D51/JA) foraging site was unconfirmed due to loss of battery life. From her last transmission, she was located at 645 km southwest of Johnston Atoll and moving west. Pressure gauge on the Maui forager was corrupted. Analysis of dive behavior is limited to the Hāmākua Coast forager.

Results, cont.

◆Question 1: Foraging dive patterns

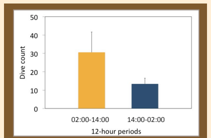

Fig. 3. Dive count within two 12-hour periods

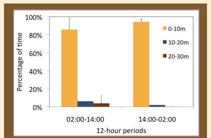

Fig. 4. Percentages of time spent within three depth bins

The Hāmākua Coast female spent more than 85% of her total dives foraging between 0 to 10m throughout 24 hours. Dive counts ranged from 1.5 to 2.4 dives per hour. Differences of count by period was significant ($p<.05$). Increased activity occurred as deep as 30m during morning to afternoon hours with lower dive count in shallower waters (<20m) occurring in the evening/night.

◆Question 2: Dominant prey organisms

Table 1. Three sponge species with highest carbon contribution to the Hāmākua Coast forager's diet

SPONGE	*M*	*SD*
Meandering sponge (*Chondrosia* sp.)	0.86	0.12
One unknown sponge species	0.82	0.15
Vagabond boring sponge (*Spirastrella cf. vegabunda*)	0.43	0.06

Fireworms, mussels, sea cucumbers, brittle stars, zoanthids, urchins, 3 algal spp., and 3 sponge spp. were collected. Potential food sources, according to proximity of $\delta^{13}C$ to adult signatures, included sponges, fireworms, mussels, sea cucumbers, algae (*A. glomerata*), and green algae (*C. taxifolia).* All three sponge species constituted the highest carbon contribution to the Hāmākua Coast forager's diet.

◆Question 3: Stable isotope patterns

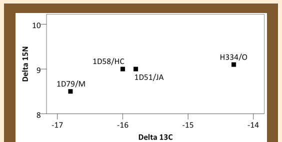

Fig. 5. Delta ^{13}C and $\delta^{15}N$ values of females from different foraging sites (O`ahu, Maui, Hawai`i Island)

Tissues from the foragers on Maui (1D79/M: -16.8‰) and O`ahu (H334/O: -14.4‰) varied slightly in $\delta^{13}C$, with no variation between the other 2 females. All 4 females had similar $\delta^{15}N$ signatures.

Discussion/Implications

◆More than 85% of the Hāmākua Coast forager's dives took place between 0 to 10m and there was a biphasic trend with slow activity at night from 0 to 20m and increased activity at daylight from 0 to 30m. Not surprisingly, it is projected that feeding occurs during the daytime.

◆Of the sampling items, sponges had the highest carbon contribution to the Hāmākua Coast female's diet. Other organisms from the sampling pool with comparable $\delta^{13}C$ values included fireworms, mussels, sea cucumbers, red algae (*A. glomerata),* and green algae *(C. taxifolia*); however, carbon sources from these organisms were low. Regardless of the low sources of carbon in the female's diet, these organisms should be considered for further foraging studies.

◆Isotopic signatures of two females (1D58/HC and 1D51/JA) did not vary in $\delta^{13}C$ or $\delta^{15}N$; however, there was a slight variation of $\delta^{13}C$ among two females that forage on Maui (1D79/M) and O`ahu (H334/O). The small variability may be explained by the differences in prey species or interisland disparity of carbon signatures among similar prey organisms.

◆It is essential to understand forage locations, species and behaviors. Stable isotope analysis allows for alternative approaches to difficult in-the-field species confirmation. Despite this study's small sample size, these novel research methodologies yielded informative results, contributing significantly to previously limited knowledge of Hawaiian hawksbill foraging ecology. The expansion of this study is recommended, with findings applied to the conservation and management of this critically endangered species.

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