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 is assumed to consist of sponges like other populations (Carr & Stanichyk 1975, Meylan 1988, Alvaro 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comes from turtles observed in Maui waters feeding on marine invertebrates and algae at wide depth ranges (Cheryl King unpublished data), and findings of three sponge specimens from a deceased turtle (Balazs 1978).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 foragers?
3) What are the isotopic patterns among Hawai`i hawksbill females?

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 Hawaii`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 (δ13C) and Nitrogen (δ15N) values were entered in a two-source mixing model to determine contribution of prey resources in hawksbill diets.

Results, cont.

• Question 1: Foraging dive patterns

The Hāmākua Coast female spent more than 85% of her total dives feeding between 0 to 10m throughout 24 hours. Dive counts ranged from 1.5 to 2.4 dives per hour. Differences of (pre-dawn) period was significant (p<0.05).

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

<table>
<thead>
<tr>
<th>SPONGE</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meandering sponge (Chondrilla sp.)</td>
<td>0.86</td>
<td>0.12</td>
</tr>
<tr>
<td>One unknown sponge species</td>
<td>0.82</td>
<td>0.15</td>
</tr>
<tr>
<td>Vagabond boring sponge (Sparastrella cf. vagothoula)</td>
<td>0.43</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Fireworms, mussels, sea cucumbers, brittle stars, zoanthids, echinoids, and sponges were collected. Potential food sources, according to proximity of δ13C 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

Tissues from the foragers on Maui (1D79/M: -16.8‰) and O`ahu (H334/O: -14.4‰) varied slightly in δ13C, with no variation between the other 2 females. All 4 females had similar δ15N 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 δ13C values included fireworms, mussels, sea cucumbers, red algae (A. glomerata), and green algae (C. taxifolia).

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/A) did not vary in δ13C or δ15N; however, there was a slight variation of δ15N 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 interspecific 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.

Literature Cited


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