What‘s on the Menu?

Unexpected Forage Plants in Green Turtle Diets on Hawaii Island

Kara Smith

Marine Science Department

University of Hawai‘i at Hilo

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Abstract

Green turtles, *Chelonia mydas*, were observed in the Wailoa Estuary in Hilo, HI. Herbaceous plants within reach of turtles were collected and analyzed for nutritional composition, including fatty acids.

Introduction

The green turtle (*Chelonia mydas* Linnaeus) is the most common sea turtle and the largest marine herbivore in the Hawaiian Islands (Balazs, 1980; Balazs and Chaloupka, 2004). The diet of the green turtle in Hawai‘i consists mainly of marine algae and sea grasses. However, other food items have been found in the green turtle digestive tract Balazs (1980). The scientific paper nonnative seashore paspalum, consumed by Hawaiian green sea turtles states that green turtles have been observed since 2008 foraging on terrestrial grass on the islands of Hawai‘i and Moloka‘i (G.H.B., unpubl. data; Ashley 2010). Green turtles have been observed grazing at high tide on partially submerged terrestrial grass, *Paspalum vaginatum*, ignoring their favored algal species (McDermid et al. 2001).

Methods

Site Description

The Wailoa Estuary is an estuarine environment located in downtown Hilo, of the Big Island of Hawai‘i. For this study, 14 stations were chosen for sampling estuary plants, GPS location, top and bottom water, pH, salinity, and temperature. All stations were located within the Wailoa Estuary State Recreation Park. The entire course of all stations traverses 2.8 kilometers by water and 1.6 kilometers accessible by land. Data were collected by kayak, Division of Aquatic Resources boat escort, or by walking the perimeter of the study site. Figure 1 represents all 14 different stations present at the Wailoa.

Sampling Strategy

Sampling was conducted within the Wailoa Estuary State Recreation Park from October 1, 2021 through March 31, 2022. Sampling included the collection of plants, water samples, and weekly turtle observations. The latitude and the longitude of all 14 stations were recorded using a handheld GPS. Stations where Green sea turtles were observed within the Wailoa Estuary were recorded, followed by photos of the turtle and notes of the turtles' presented behavior. With a particular focus on foraging within the Wailoa Estuary. Surface and bottom water data was collected from each station using a water quality YSI. Collecting data on the pH, salinity, and temperature. These data were compared to the Division of Aquatic Resources long running water quality study of the Wailoa Estuary. Stations that were accessible by land e.g., 1, 6, 8, 13, and 14 were collected more frequently compared to stations that were accessible by water e.g., 2, 3, 4, 5, 7, 9, 10, 11, and 12. Plants were collected under a special area permit through the

University of Hawaii at Hilo. A mass plant collection from all 14 different stations took place on December 27, 2021. The dominant three plants that were accessible by water were collected. After the mass plant collection was completed, they were brought back to the lab and dried on herbarium paper separated by station. The plants were left to dry over the course of a month. Samples were sent to the Bishop Museum to be identified. During this study, two turtles were observed actively grazing. The plant samples from these two different stations were collected. After they were collected, they were frozen until they could be further analyzed. Then they were separated and dried at 60°C for three days, removing all of the water weight from each individual plant sample. After the plant samples were completely dried, they were then finely ground up via a coffee grinder and separated into 30 gram portions. Once this process was completed, the dried plant samples were sent off for a plant composition analysis.

During this study, two turtles stranded, and were collected from the Wailoa Estuary by the UH Hilo Turtle Stranding Response Team and shipped to Maui for veterinary care. While the turtles were in Maui receiving treatment, their bowel movements were collected. These fecal matter samples were shipped to the University of Hawaii at Hilo where they were analyzed for their plant matter components. The plant samples were also sent to the Bishop Museum.

Results

Nineteen turtles were observed from October 2021 - March 2022. Figure 2 represents all stations where Green sea turtles were observed.

Nine turtles were seen in October, six turtles in November, one turtle was observed in December and in January, followed by no turtles in February and two turtles in March (Fig. 3). The majority, 12 out of 19, of the turtles observed within the Wailoa Estuary were seen during high tides (Table 1).

Out of the 14 different stations, green turtles were found at stations 2, 3, 5, and 8, with the majority (15 out of 19) of the turtles found at station 3 (Fig. 4). Out of the 19 turtles, two were juveniles based on size (Balazs 1980), 16 were subadults, and one was a mature male adult green turtle (Table 2).

Two turtles were observed feeding in the Wailoa Estuary. One turtle was observed on November 22, 2021 at the back of station 2 and the other turtle was observed on November 30, 2021 at station 3.

Table 3 lists all plants identified from the mass plant collection.

Nutritional composition of the plants at Station 2 and Station 3 (where turtles were observed grazing) shows varying amounts of crude fat, crude protein, crude fiber, moisture, and ash (Fig. 5). A full fatty acid profile is shown in Table 4.

Discussion

Over the course of this study green turtles frequented the Wailoa Estuary and individuals used the area for the purposes of basking and foraging. Foraging by turtles in the Wailoa Estuary may be occurring because of the accessibility or abundance a food source. Other aspects that could influence a sea turtle's food selection is the taste,

texture, or smell. The digestibility and nutritional quality may be factors. As the species' habitat and feeding grounds decrease and become more limited overtime because of increasing anthropogenic impacts and coastal development in East Hawaii, understanding the foraging ecology of green turtles will be important. This study demonstrates some of the unexpected food sources that the species can and actively chooses to eat instead of their more traditionally known diet. So, what's really on the menu?

Literature Cited

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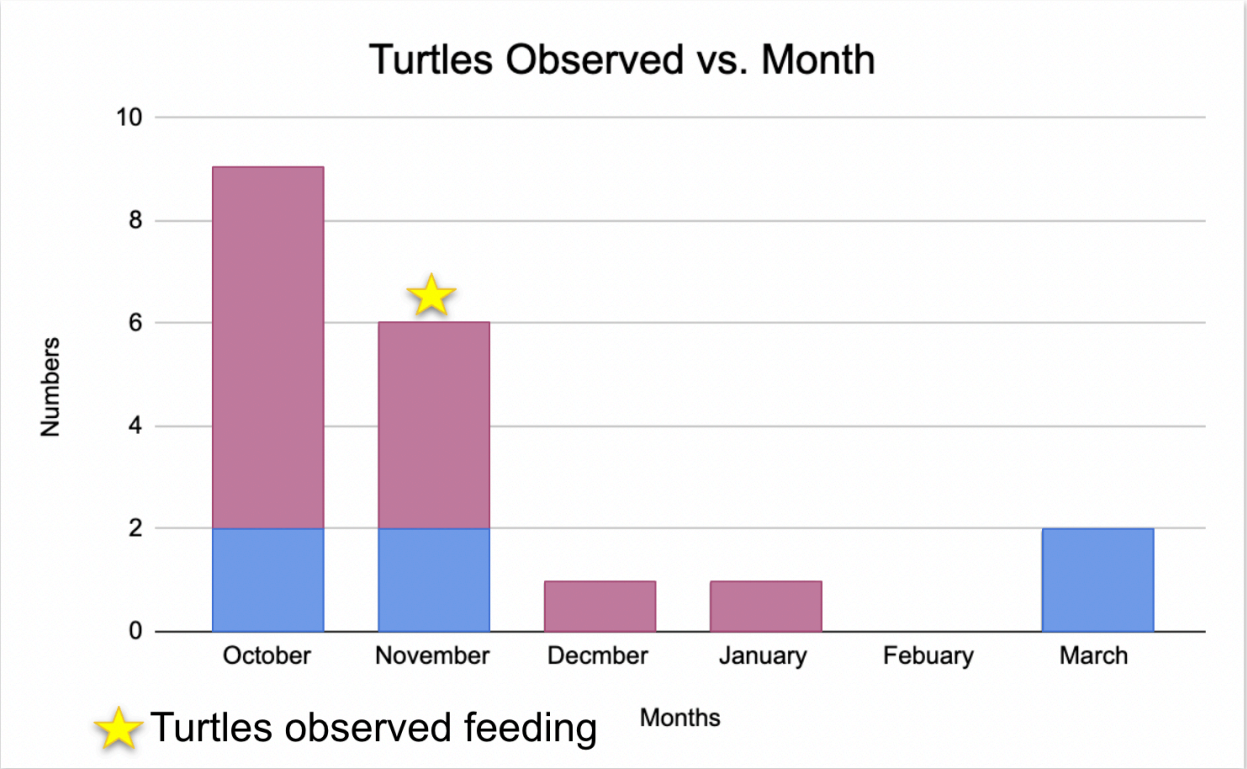
Fig. 1 Study Site Route of the Wailoa Estuary State Recreation Park

Fig. 2 Green sea turtles located within the Wailoa State Recreation Park

Fig. 3



October	
High Tide	Low TIde
7	2

Table 1

November	
High Tide	Low TIde
4	2

Decmber	
High Tide	Low Tide
1	0

January	
High Tide	Low Tide
0	1

Febuary	
High Tide	Low Tide
0	0

March	
High Tide	Low Tide
0	2

Fig. 4

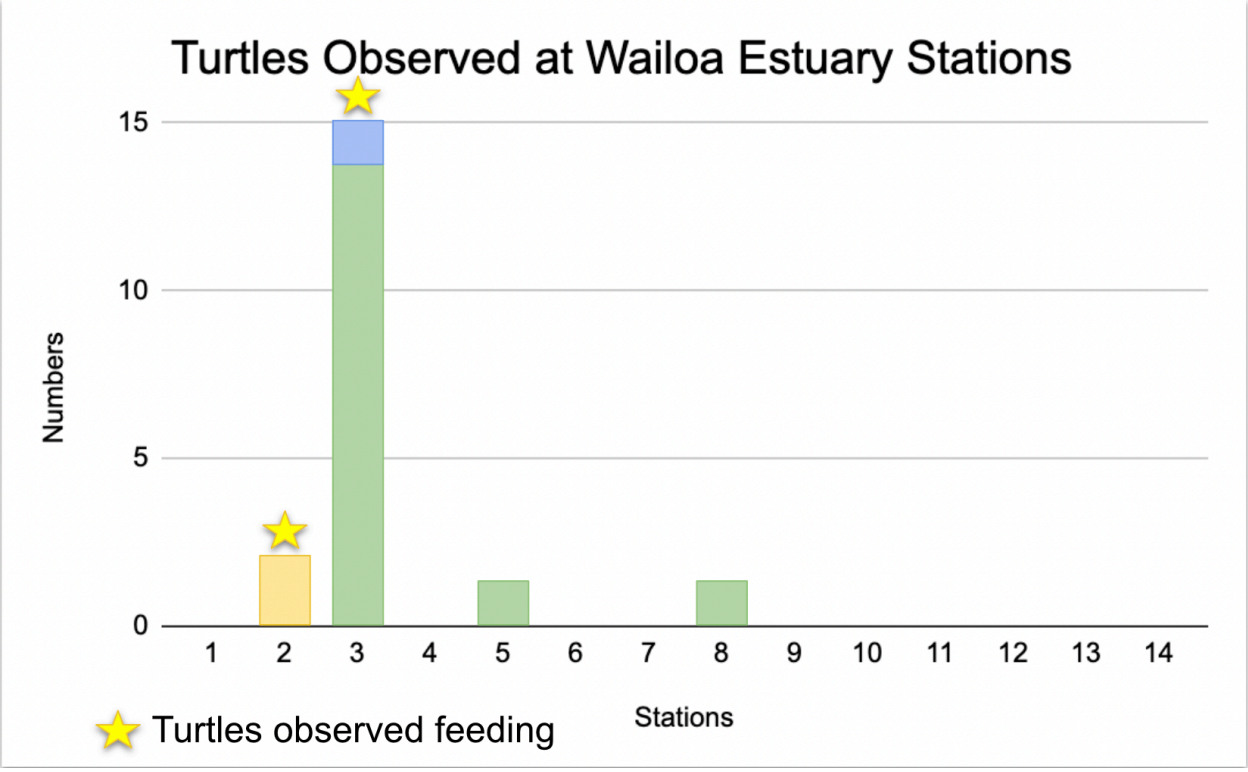


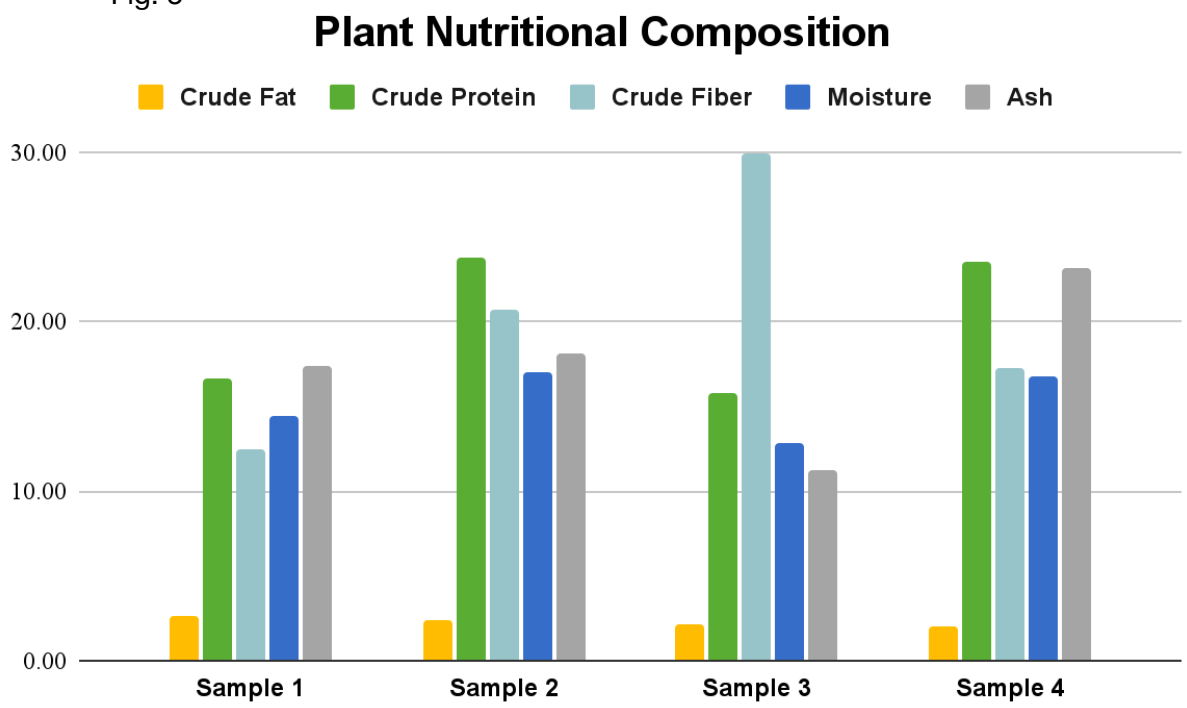
Table 2

Size Estimate		
Juvenile	Subadult	Adult
2	16	1

Table 3

Plant Species	Station #
Ageratum conyzoides	Station 14
Bacopa monnieri	Stations 5, 6, 7, 8, 9, 12, 14
Centella asiatica	Station 10
cf. Axonopus compressus	Station 14L
cf. Ludwigia octovalvis	Station 3L
Clusia rosea	Stations 7, 8, 9, 10
Commelina diffusa	Station 2
Cyperus polystachyos	Station 1
Echinochloa crusgalli	Station 11
Eleocharis cf. geniculata	Stations 9, 10
Ficus microcarpa	Station 13
indet. Grass	Stations 3, 4, 6
Mangifera indica	Station 3L
Microsorum grossum	Station 13
Myriophyllum aquaticum	Station 11
Paspalum urvillei	Station 5
Plantago cf. major	Station 14L
Sphagneticola trilobata	Stations 1, 5, 6, 7, 8, 11, 12, 14
undetermined	Station 3
Urochloa mutica	Station 2
Not found	Station 12

Fig. 5



Plant sample 1 is *Sphagneticola trilobata*, plant sample 2 is *Paspalum urvillei*, plant sample 3 is *Urochloa mutica* and plant sample 4 is *Bacopa monnieri*.

Table 4

Description: Terrestrial; Grass				
ESCL #	**5668**	**5669**	**5670**	**5671**
U of HI ID	Sample 1	Sample 2	Sample 3	Sample 4
Plant species name	Sphagneticola trilobata	Paspalum urvillei	Urochloa mutica	Bacopa monnieri
Fatty Acid Profile ***(Expressed as Percent of Total Fat)***				
C14:0	0.23	0.14	0.28	1.18
Myristoleic (9c-14:1)	0.02	0.13	0.01	0.03
C15:0	0.08	0.17	0.14	0.03
C15:1n5	0.01	0.00	0.00	0.00
Palmitic (16:0)	19.63	24.54	21.50	21.11
Palmitoleic (9c-16:1)	0.88	1.35	1.37	1.13
Margaric (17:0)	0.46	0.54	0.47	2.90
10c-17:1	0.05	0.10	0.03	0.06
Stearic (18:0)	2.63	3.34	2.01	2.58
Elaidic (9t-18:1)	0.00	0.00	0.05	0.05
Oleic (9c-18:1)	5.85	6.78	5.77	4.60
Vaccenic (11c-18:1)	0.86	1.06	0.38	0.69
Linoelaidic (18:2t)	0.08	0.24	0.08	0.24
Linoleic (18:2n6)	27.03	15.58	22.76	17.04
Linolenic (18:3n3)	**23.60**	**12.98**	**28.57**	**23.04**
g-Linolenic [C18:3n6]	0.02	0.00	0.03	0.13
Stearidonic (18:4n3)	**0.00**	**0.00**	**0.00**	**0.00**
Arachidic (20:0)	0.56	1.14	0.74	0.86
Gonodic (20:1n9)	0.15	0.39	0.27	0.25
C20:2	0.06	0.05	0.07	0.13
Homo-g-linolenic [C20:3n6]	0.00	0.00	0.07	0.50
Homo-a-linolenic(20:3n3)	**0.05**	**0.00**	**0.08**	**0.08**
Arachidonic [20:4n6]	0.41	0.00	0.06	0.53
3n-Arachidonic (20:4n3)	**0.00**	**0.00**	**0.00**	**0.00**
EPA (20:5n3)	**0.13**	**0.16**	**0.08**	**0.97**
C21:0	0.24	0.73	0.12	0.24
Behenoic (22:0)	1.00	1.93	0.94	0.98
Erucic [22:1n9]	0.07	0.08	0.08	0.12
C22:2n6	0.00	0.00	0.00	0.05
Adrenic [C22:4n6]	0.24	1.98	0.29	0.67
Clupanodonic (22:5n3)	**0.01**	**0.00**	**0.00**	**0.04**
DHA (22:6n3)	**0.05**	**0.00**	**0.00**	**0.11**
C23:0	0.90	1.86	0.52	0.62
Lignoceric (24:0)	1.20	3.24	1.57	1.47
Nervonic (24:1n9)	0.06	0.00	0.10	0.02
*W/W%= grams per 100 grams of sample. *Omega-3 fatty acids are in bold type; UNK, unknown.*				