

Evaluating Spatial and Temporal Patterns of Green Turtle Distribution at a Foraging Hotspot in Kailua, O'ahu



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Rationale

Coastal foraging sites are important developmental habitats for juvenile green turtles (*Chelonia mydas*). Understanding how turtles use these areas is essential to assess impacts from current human activities (e.g. entanglement in monofilament fishing line) and future environmental change (e.g. marsh restoration).

Objectives

This study describes the abundance, distribution and movements of juvenile green sea turtles (straight carapace length: 40-60 cm) at a foraging site, using three approaches: (1) capture-mark-recapture (CMR) population estimates, (2) visual surveys of turtle distributions, and (3) acoustic tracking of individual turtles.

Study Site and Sampling

- The Kaimalino study site is a sheltered cove at the northern end of Kailua Bay, O'ahu (Figure 1). Juvenile green turtles forage in the cove and rest in the adjacent canal, which leads to Kawainui Marsh. The NOAA Marine Turtle Research Program (MTRP) has sampled turtles at this site since 2000. This study was initiated in June 2008 and will continue through August 2009.
- Turtles were captured by the NOAA MTRP personnel using large scoop nets or by hand while snorkeling. Each turtle was tagged or identified by existing tags (PIT or Inconel flipper tags), measured, and marked for visual identification (Balazs 1992; Figure 2a).
- Six turtles were also equipped with acoustic transmitters in November 2009 (Balazs et al. 1995; Figure 2b).

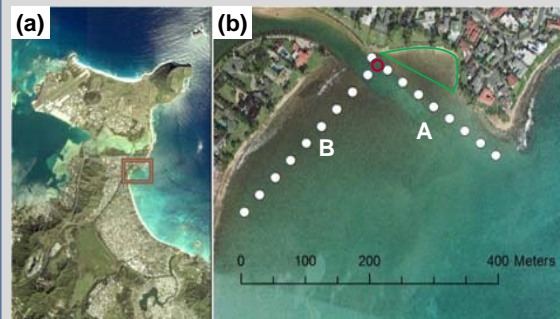


Figure 1. (a) Kaimalino study area at the north end of Kailua Bay, adjacent to Mokapu peninsula. (b) Visual surveys are conducted along two transects (A & B) consisting of nine stations, spanning a depth range of 0.9 – 2.1 m. Foraging cove is indicated by green polygon. Stationary receiver for acoustic tracking is indicated by red circle.

Specific Goals

- Compare seasonal CMR estimates of turtle population size using the Lincoln - Petersen estimator (Krebs 1989): fall (November), winter (February), spring (May).
- Estimate the number of turtles that have utilized the area over the entire study period, (November – May) using the Schnabel CMR estimator (Krebs 1989).
- Describe the abundance and distribution of turtles by conducting standardized visual surveys. Surveys occurred within 24 days after turtle markings and consisted of two replicates of six different time - tide combinations, conducted over two seasons (Fall, Winter) (Table 1).
- Assess movement patterns of six turtles tracked during Fall and Winter survey periods.



Figure 2. (a) Thirty-five turtles were marked with unique identification numbers (Balazs 1992). (b) Six turtles were also equipped with acoustic transmitters (VEMCO V16, 120 second repetition rate) (Balazs et al. 1995). (c) Stationary receiver (VEMCO VR2) records date and time of signal reception of unique transmitter codes (maximum detection range: 115 m).

Table 1. Visual survey design and effort.

Number of sampling days in fall (November) and winter (February). Sampling effort covered 2 tidal phases and 3 time periods of the day.

	Rising Tide	Falling Tide
Morning (6 - 10)	2 / 2	2 / 2
Midday (10 - 14)	2 / 2	2 / 2
Afternoon (14 - 18)	2 / 2	2 / 2

Visual Surveys - One observer (BA) swam and another observer kayaked along the two survey transects (Figure 1b) and recorded sea turtles (marked and unmarked). Sightings of marked turtles provided the recapture data for estimating three seasonal population sizes (Figure 3). Turtle counts were evaluated as a function of four variables (transect, season, time, tide) and three covariates (depth, distance from cove, algae cover). While the time variable alone was marginally significant ($p=0.077$), it was highly significant in combination with season (Figure 4). The 'distance from cove' had a negative effect ($p=0.002$, not shown).

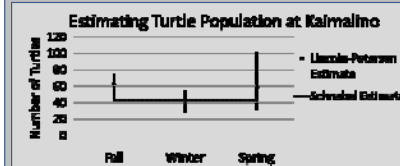


Figure 3. Seasonal population estimates (box plots, mean +/- 95% confidence intervals) and cumulative estimate (dashed line) calculated using data from all marking days.

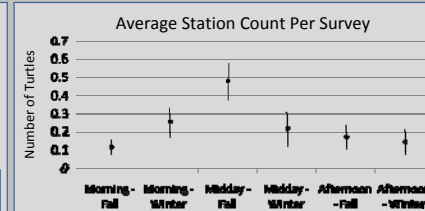


Figure 4. Turtle counts (mean +/- S.E.) vary significantly (season x time interaction; $p=0.014$).

Acoustic Tracking - Detections at the stationary receiver indicate turtle visits to the cove (Figure 1b). Individuals vary in the consistency of their visits, residency and movement patterns (Table 2, Figure 5).

Table 2. Summary of turtle visitations during four-hour time intervals in fall and winter (total time intervals = 306).

	Turtle					
	aa	bb	cc	dd	ee	ff
% Total Time Intervals Detected	17.32	22.55	64.38	39.87	76.80	40.85
Total # Detections	226	376	10998	2688	7821	1411
Max. Detections in Time Interval	35	37	126	89	93	85

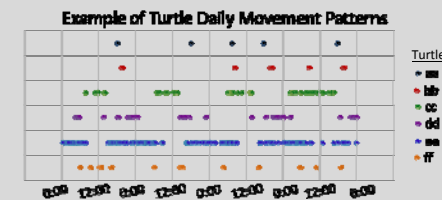


Figure 5. Detections of six tagged individuals by receiver over a four-day span (November 24 - 27).

Conclusions

- Highest seasonal population estimate at Kaimalino in fall CMR (November; 62 turtles).
- Observed 35% decline in population estimate during winter (February; 40 turtles).
- The spring CMR showed return to the original estimate (May; 59 turtles).
- A multi-season CMR estimate yielded an overall population size of 43 turtles.
- Turtle counts from visual surveys were influenced by interaction of season and time of day. Counts were also marginally influenced by time of day. Distance to cove was a significant covariate.
- Individuals demonstrate unique movements, with distinct residency and movement patterns.

Future Plans

- Completed fourth CMR in summer (August) will yield a final seasonal population estimate.
- Expand analysis to include four additional receivers (one in canal and three 80 m offshore of Transect A).
- Analyze six additional transmitters deployed in February. Fully assess individual movement differences.

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