Sightablity of the North Pacific loggerhead sea turtle at the Baja California Sur foraging hotspot

FINAL REPORT

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I. Objective
To assess the sightability of juvenile loggerheads off the Pacific coast of Baja California Sur in order to calibrate relative abundance estimates generated by NMFS aerial surveys and to help elucidate foraging ecology and dive behavior of juvenile loggerheads in order to inform bycatch mItigation initiatives.

II. Deliverables
A. Deployment of crittercam VDTRs on loggerhead turtles at BCS Mexico.
B. Generate an aggregated sample size of dive profiles adequate for estimating daytime sightability of loggerheads.
C. Produce DVD featuring video highlights of turtle behavior and crittercam deployments to demonstrate the innovation of efficacy of NOAA funded research.

III. Background
Five species of sea turtle inhabit the eastern Pacific Ocean; each is endangered or threatened under the Endangered Species Act. Sea turtle mortality is occurring due to direct take by poachers who sell turtle meat and eggs on the black market and also by incidental capture by fishing nets, trawls, and longlines (Koch et al. 2006). Along the Baja California peninsula, where intense fishing overlaps with sea turtles' critical nursery habitat, extraordinarily high bycatch occurs, resulting in among the greatest documented threats to the endangered North Pacific loggerhead (Peckham et al. 2008). Although wide-ranging during their lifetimes, many Japanese-born loggerheads apparently spend the majority of their time in a foraging "hotspot" that lies within coastal fishing grounds off the Baja California peninsula (Peckham et al. 2007).

Aerial surveys were conducted off Baja California, Mexico by the SWFSC during September/October of 2005, 2006 and 2007 (Seminoff et al. 2006). Animal-borne video time depth recorders can help elucidate dive behavior, foraging strategies, and sightability of turtles in order to recalibrate relative abundance estimates generated by aerial surveys. A pilot study conducted by ProCaguama/TOF in 2009, in partnership with National Geographic, yielded four deployments producing full dive profiles. The pilot study also revealed consumption of jellyfish by the instrumented loggerheads, a behavior that had not been documented in the region to date.

NMFS' Southwest Regional Office (NMFS-SWR), Protected Resources Division (PRD), along with the Southwest Fisheries Science Center and the Pacific Islands Regional Office, have a need to assess the sightability of juvenile loggerheads off the Pacific coast of Baja California Sur in order to calibrate relative abundance estimates generated by NMFS' aerial surveys.

IV. Methods
Opportunistic surveys were conducted from two vessels with support from an ultralight aircraft to encounter loggerhead turtles at the foraging hotspot. Upon detection, turtles were hand-captured. Using proven, benign National Geographic methodology, crittercam animal-borne imaging and data-logging systems were attached to the turtles (Gen 5.7 in 2009 and Gen 6.0 in 2011). Each turtle was released within 45 mins of capture. Once crittercams were recovered using VHF radio tracking system, TDR data were extracted and analyzed.

Data were manually truncated to exclude pre-deployment period. Raw depth data were processed in MatLab and zero-offset-corrected using dive analysis code (IKNOS toolbox, Y. Tremblay, unpub. data). To determine the proportion of time spent within sightable depths, data from each turtle were used to create cumulative density distributions and then averaged together to plot inter-individual variation in sightability.

Due to unseasonably strong winds in July 2011 that resulted in few workable sea days, fewer Crittercam deployments were made than planned. To overcome the lack of VTDR data we aggregated dive profiles from previously deployed satellite dive recorders. Six turtles were hand-captured and instrumented with Wildlife Computers satellite transmitters (model SDR-T16, Redmond, WA, USA). Binned dive data were received along with location data via ARGOS. These data were extracted using proprietary software (Wildlife computers DAP processor). We used the binned data to assess sightability as a function of time-of-day. We identified the proportion of time spent in each of the two shallowest depth bins (surface and <5m). Data were grouped into 6 hour blocks (2 day and 2 night).

V. Results

Nine Crittercam deployments were made on loggerheads, four in July, 2009 and five in July-August of 2011. 22.3 hrs of dive profiles and video were collected from the nine deployments, with a mean deployment time of 2.5 ± 1.1 hr. Turtles instrumented were juvenile loggerheads with a mean CCL of 63.7 ± 6.7 cm (Tables 1-2). The instrumented turtles spent 13.9 ± 10.5% of time at the surface, and 39 ± 18.4% of time within 2m of the surface (Figure 1).

Satellite dive recorder (SDR) deployments were made on six loggerheads (68.8 ± 8.0cm; mean ± SD) with mean deployment times of 169 ± 103 days. 1,141 6-hr histograms from these records were analyzed. The instrumented turtles spent 11.7 ± 14.0% of time at the surface, and 40.2 ± 28.6% of time within 5m of the surface (Figure 1). There was no diel variation in the time turtles spent at the surface, but turtles spent considerably more time within 5m of the surface during daylight hours (from 0600-1200 and 1200 to 1800; Fig. 2).

Deployment date	CCL (cm)	Deployment time (hr)
22-Jul-09	65	1.4
23-Jul-09	65	2.2
25-Jul-09	55	3.3
25-Jul-09	79	1.8
27-Jul-11	58	0.9
31-Jul-11	64	3.8
31-Jul-11	61	1.8
1-Aug-11	63	3.9
1-Aug-11	63	3.2

Table 1. Crittercam deployment time and size of instrumented turtles.

Deployment date	CCL (cm)	Deployment time (days)
18-Jul-02	65	96
3-Aug-02	60	140
17-Aug-02	61	143
26-Aug-02	72	108
9-Aug-03	79	157
10-Aug-03	79	397
13-Jul-04	66	143

Table 2. SDR deployment time and size of instrumented turtles.

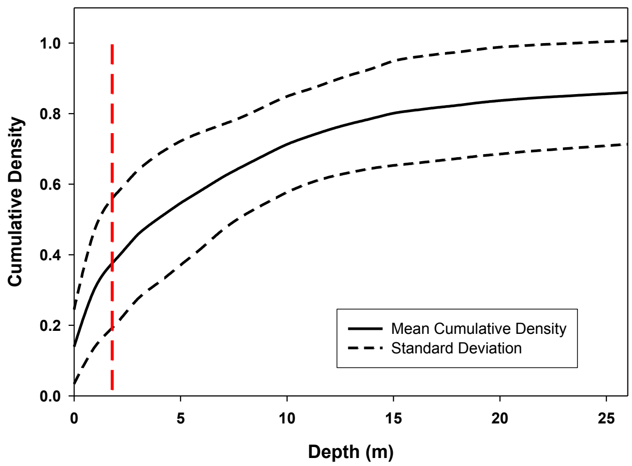

Figure 1. Cumulative density of diving data from full time-series records from Crittercam deployments (N = 8).

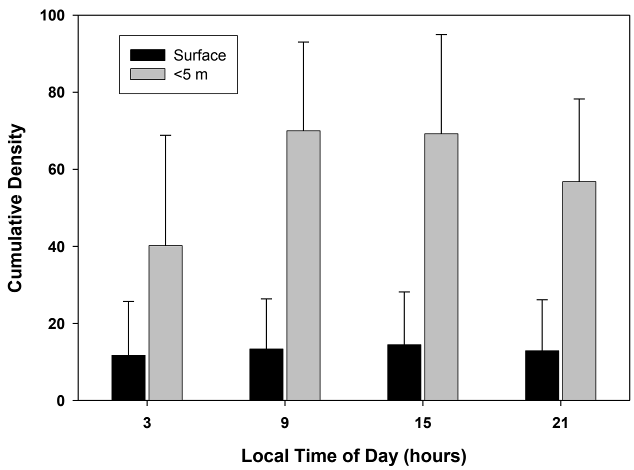

Figure 2. Diel variation in depth zone occupied by turtles in two depth bins, surface and 5m, recorded with SDRs (N=1141 6-hour histograms).

V. Discussion

While assessing the dive behavior of sea turtles can be helpful for avoiding bycatch interactions (Polovina et al. 2003; Howell et al. 2010), for the estimation of sea turtle abundance using aerial surveys, quantifying surfacing behavior or sightability is crucial (Byles 1988; Mansfield 2006). For instance, to estimate population abundance of sea turtles in Virginia, Mansfield (2006) conducted satellite and radio telemetry to determine surfacing behavior and found that mean percent time spent at the surface ranged from 9.9% to 30.0% with significant differences between individuals. Incorporating these sightability data enabled correction of previous abundance estimates (Mansfield 2006).

Oceanic juvenile loggerheads have been found to spend considerable time at the surface, with two studies concluding that approximately 35% of time was spent at the surface (Dellinger et al. 2000; Cardona et al. 2005). A study conducted more recently on slightly larger North Pacific juvenile loggerheads found that they spend 20% of their time within 1m of the surface (Howell et al. 2010). In addition there is a clear relationship between size and habitat and surfacing time. Smaller turtles (eg Dellinger et al 2000; Cardona et al 2005) spend more time at the surface than larger turtles (eg Mansfield 2006; Braun-MacNeil et al 2010). Our results showing loggerheads spending 12-15% of their time at the surface are consistent with those reported for large juvenile and/or neritic loggerheads {Braun-McNeill, 2010 #982;Mansfield, 2006 #627}.

To use the data presented here to correct for aerial surveys conducted at Golfo de Ulloa, BCS (Seminoff et al. 2006), it will be important to include only surface sightings and to exclude subsurface sightings. We provided two datasets for estimating time at surface, but these do not include time at sightable depths, for instance at one or two m depth. Due to the binned nature of our satellite dive recorder data, we cannot calculate percent time at sightable depth.

Further deployments of TDRs and VTDRs are recommended for both loggerhead and olive ridley turtles to a) identify diet items, b) elucidate foraging behavior, c) determine sightability of olive ridley turtles and to in turn derive abundance estimates following Seminoff et al 2006 for oilive ridley turtles, and d) to reveal why loggerhead turtles suffer much higher bycatch rates then olive ridleys despite the species being sympatric and at apparently similar abundance in the Gulf of Ulloa.

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