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# Movement and dive behavior determined by satellite telemetry for male and female olive ridley turtles in the Eastern Tropical Pacific

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Olive ridleys have a worldwide distribution in mainly tropical areas. Nesting occurs along continental margins in all oceans. The largest nesting areas in the Eastern Pacific are along the coasts of Mexico and Costa Rica. Many studies have been done on nesting populations and movement from the nesting grounds, but few studies have been done on the movement of olive ridleys in the open ocean (Plotkin et al. 1994, Beavers and Cassano 1996). This paper summarizes the movement and dive behavior of male and female olive ridleys tracked during 1999-2000.

Satellite-linked Time-Depth Recorders (SDRs, Wildlife Computers) were deployed on eight olive ridley turtles, four adult females, three adult males, and one juvenile, during the 1999 *Stenella* Abundance Research Survey (STAR) in the Eastern Tropical Pacific. Turtles were spotted from NOAA ships traveling set course lines. Small boats were deployed to capture turtles rodeo style by hand, and turtles were brought back to the ship for measurements and satellite attachment. The SDRs were attached using fiberglass cloth and polyester resin based on the methods by Balazs et al. (1996). Dive data from the SDRs were compiled using Wildlife Computers SatPak30 and duration of dives and time-at depth were examined. The time-at-depth bins recorded the amount of time spent at each preset depth. Three of initial SDRs were programmed with parameters starting at 1-meter (m) depth (depth histogram bins: 1, 5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100, 150, 150+ meters). However, since an objective for this on-going study was to be able to link the dive data with visual surveys, the parameters were changed. The final five SDRs were programmed to include a bin that specifically counted time on surface (depth histogram bins: 0, 1, 5, 10, 15, 20, 30, 40, 50, 60, 80, 100, 150, 150+ meters). However, for purposes of analysis in this presentation, the 0 and 1 meter depth bins were combined for these five SDRs so the data could be compared to the previous three. T-test analyses were done to determine significant differences in dive behaviors between male and female turtles.

The movements of all of the olive ridleys are seen in Fig. 1. The three mated female olive ridleys moved directly to or offshore of a major nesting area. The two males captured mating with two of the females were seen to continue to move along the coast. The non-mating female and male both stayed offshore. While all of the turtles recorded a high percentage of short dives, 60% of the dives were 2 min or less in duration, table 1 shows the maximum dive duration for each turtle. The average of the longest dive time for females was 120-180 minutes, 75 minutes for males, and 45-60 minutes for the one juvenile. There were no significant difference between male and females for any of the dive duration bins.

Visual observations of olive ridleys at sea have indicated that they may spend a large amount of their time on the surface. Average time-at-surface calculated for the five SDRs that recorded 0-m data indicated surface times of 10-22%, and even with depths to 1-m included, times near the surface were still low, 19-44%. However, daily, diurnal and variations between turtles were seen. Daily time-near surface averages ranged between 10 and 50%, and this varied between turtles. A diurnal dive behavior was seen where most turtles spent more time near the surface during daylight hours, which were between 9am-2 pm, between 22-56% (mean of 37%) of the total dive time was spent near the surface during this 6-hour period. There was no difference seen for time spent near the surface between male and female turtles.

There were no significant differences in time-at-depth and dive duration between turtles that had mated and not mated. Although all turtles had the opportunity to make deep dives, the mated females and males did not make dives greater than 150m, even while over open ocean. The non-mated, pelagic male and female both made dives greater than150m with a number of dives over 200m, some which registered at the limit that the SDR could record (250m). On the other hand, a mated female that had moved inshore and possibly nested spent 6 months off the coast of Nicaragua. During that time, it stayed in waters that were less than 150m in depth and made regular dives to depths that would have reached the bottom - possibly either resting or foraging on the bottom.

Fig. 2 shows the average time-at-depth profiles for female and male olive ridley turtles. Females spent significantly more time at 40 and 80m depths than did males. It has been shown by Donguy and Meyers (1987) and also Fiedler (1992), that within the Eastern Tropical Pacific there is a permanent thermocline between 20 and 100m (around the 20° C isotherm). All of our adult turtles spent significant amounts of time, at least 25% of total dive time, in the area of the thermocline.

An SDR transmitter put on only one juvenile turtle unfortunately had a very short track, only 5 days in length. The juvenile stayed near shore in waters that were between 100 - 200m in depth. During the track, the daily and diurnal differences in time spent near surface were similar to that of the adult turtles, but there were visual differences between the juvenile and adult dive profiles. The juvenile made no dives greater than 80m even though it was in water where deeper dives could be made, and 75% of its time was spent within 10m of the surface.

In conclusion, the low average times that the turtles spent near the surface were a combination of diurnal and daily difference in dive behavior. Female olive ridleys in this study spent significantly more time at 40 and 80 meters than did the males, and the thermocline is an important foraging area for the olive ridley as both male and female turtles spent a significant amount of time in the region of the thermocline - between 20-100m. The significance of these findings are that the data obtained for time at surface when taking into account the diurnal variability will be able to be combined with observers visual counts to gain a better estimate of pelagic numbers of olive ridleys in the Eastern Tropical Pacific. Also the information on dive depths and behavior can be also be used as a tool to help mitigate and reduce bycatch in fisheries.

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Table 1. Maximum dive duration recorded for four female, three male, and one juvenile olive ridley turtles. Data were received from satellite time-depth recorders attached to each turtle before release during the 1999 Stenella Research Cruise in the Eastern Tropical Pacific.

| Turtle ID | Sex | Maximum Dive Duration |
|---|---|---|
| 21128 | Female | 60 - 75 minutes |
| 21130 | Female | 120 - 180 minutes |
| 21136 | Female | 180 - 240 minutes * |
| 24645 | Female | 120 - 180 minutes |
| 21129 | Male | 75 – 90 minutes * |
| 21138 | Male | 60 - 75 minutes |
| 21143 | Male | 60 - 75 minutes |
| 24644 | Juvenile | 45 – 60 minutes |

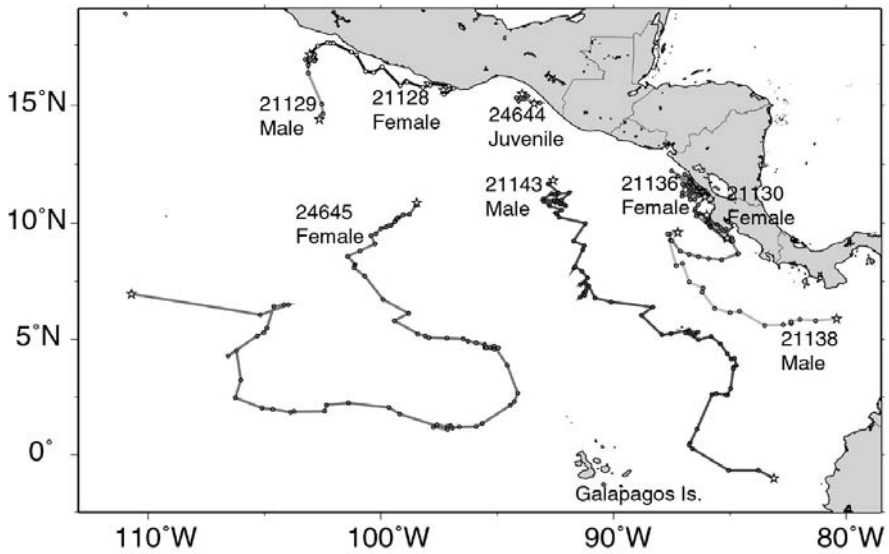


Fig. 1. Map of the movement of eight olive ridley turtles (four female, three male, and one juvenile) that were released with satellite time-depth recorders during the 1999 Stenella Research Cruise in the Eastern Tropical Pacific.

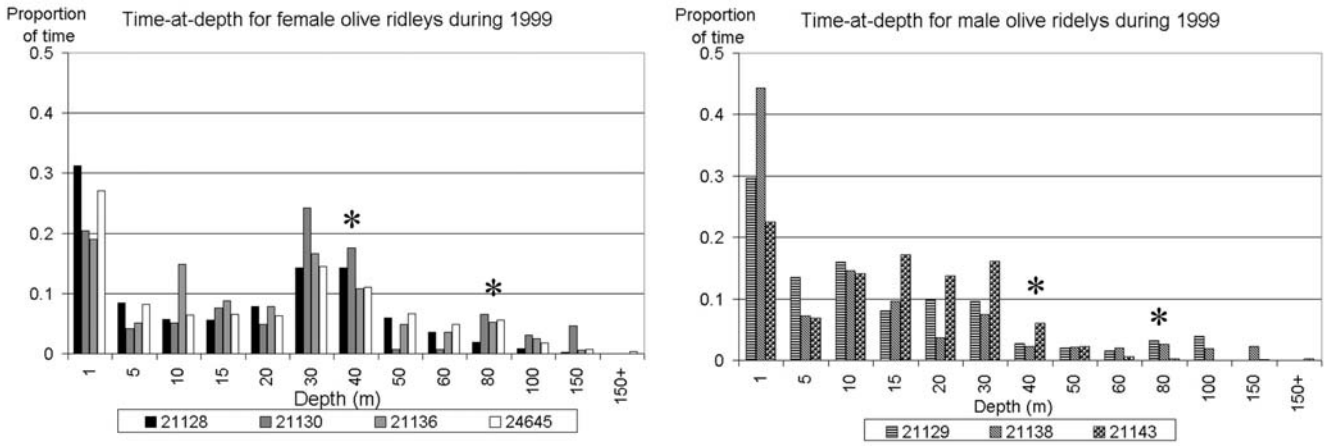


Fig. 2. Average time-at-depth dive profiles for four female (left) and three male (right) olive ridleys during 1999-2000. Time-at-depth was averaged for each depth bin over the complete track of an individual turtle (one bar indicates one turtle). Significant differences ($p<0.05$) were found between male and female turtle's time-at-depth for the 40 and 80-m depth bins shown by an asterisk.

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