

Satellite tracking of immature loggerhead turtles in the Northwestern Pacific

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ABSTRACT

Five subadult loggerhead turtles (*Caretta caretta*) captured in the northwestern Pacific in 2002 and 2003 were tracked by satellite telemetry. Two juvenile loggerheads in age of 1+ and 2+ hatched and kept in an Aquarium were also tracked by satellite telemetry in the northwestern Pacific. Five subadult turtles moved at the average speeds of 1.1 to 2.1 km/h with the total distance ranged from approximately 2,200 to 8,800 km during total tracking of 132 to 186 days. The average speeds of 2 juvenile turtles were 2.1 and 1.0 km/h with the total distance of approximately 4,300 and 3,800 km during total tracking of 85 and 156 days, respectively. All subadult turtles moved rapidly the long distance along the Kuroshio Current and its extension and stayed in warm water mass for a long time. The warm water mass might be important feeding grounds of subadult loggerhead turtles. On the other hand, juvenile turtles migrated to higher latitudes than subadult turtles. The difference between subadult and juvenile turtles might result from the difference of feeding grounds by growth stage, body size, ability to swim, or individual career history of turtles.

KEYWORDS: loggerhead sea turtle, satellite tracking, migration, subadult, immature

INTRODUCTION

Sea turtles are widely distributed in tropical and subtropical waters in the world. Recently, incidental take of sea turtles by longline fisheries was noticed (Brogan, 2002). The Fisheries Research Agency of Japan attempts to develop mitigation measures for incidental take of sea turtles in tuna longline fisheries through research activities. In addition to management of incidental take of sea turtles, we have also worked on conservation of sea turtles on the nesting beach and studied ecology, nesting behavior, oceanic distribution and feeding ecology, of sea turtles, particularly loggerhead turtles (*Caretta caretta*). It is very important to make clear the oceanic distribution and migration route of loggerhead turtles for the conservation and management. Although many studies have been conducted on the movements of post-nesting female loggerheads (Japan Fisheries Resource Conservation Association, 1999; Hatase *et al.*, 2002), there is little information on the movements of immature turtles in the ocean. In this study, subadult loggerhead turtles captured in the northwestern Pacific and juvenile loggerheads hatched and kept in an aquarium were tracked by satellite telemetry.

MATERIALS AND METHODS

Two subadult loggerhead turtles (SCL: 62 and 65 cm) captured in the northwestern Pacific on May to June in 2002 and 3 subadult turtles (SCL: 64, 64 and 70 cm) in the same period and same area in 2003 were captured through longline operations by research vessels, Taikeimaru No. 2 and Kurosaki. These turtles were tracked by satellite telemetry in the northwestern Pacific. Two juvenile loggerheads in age of 1+ and 2+ (SCL: 40 and 53 cm) hatched and kept in the Port of Nagoya Public Aquarium were also tracked by satellite telemetry in the northwestern Pacific to compare with the behavior of subadult turtles. The satellite transmitters, Teronics model ST-6, ST-18 or Wildlife model SDR-T16, were attached to all turtles. Total distances, average daily distances and average speeds of all turtles were estimated by their movements between the average daily positions. The relationship between movements of turtles and two measures of oceanic conditions, oceanic flow and sea surface temperature which are data from the Japan Meteorological Agency and the Naval Research Laboratory, US Navy were examined. The frequency distribution of time spent in depth classes recorded by transmitters of 2 subadult

and 1 juvenile loggerheads in 2002 were also examined.

RESULTS AND DISCUSSION

The results of satellite tracking of 5 subadult and 2 juvenile turtles are shown in Table 1. The results of 2 subadults are *May to the end of October 2003*, but we keep tracking them at the time of writing. During total tracking of 132 to 186 days, 5 subadult turtles moved at average speeds of 1.1 to 2.1 km/h (Table 1). The total distance ranged from approximately 2,200 to 8,800 km (Table 1). On the other hand, the average speeds of 2 juvenile turtles were 2.1 and 1.0 km/h with the total distance of approximately 4,300 and 3,800 km during total tracking of 85 and 156 days, respectively (Table 1). Therefore, average daily speeds of juvenile turtles were similar to that of subadults.

The movements of 5 subadult turtles released in 2002 and 2003 are shown in Figures 1 and 2. These turtles stayed in small areas for a long time and moved rapidly a long distance to the north or east (Figs. 1, 2). On the other hand, the movements of 2 juveniles hatched and kept in the aquarium are shown in Figure 3. These juvenile turtles moved to the east and north and rarely stayed in a small area for a long time (Fig. 3). In the northwestern Pacific, the Kuroshio Current and its extension flow to the east and in some areas, there are warm water mass associated with the Kuroshio extension. Our results suggest that the 5 subadult turtles moved rapidly over long distances along the oceanic flow and stayed in the warm water mass for a long time (Fig. 4). Turtles remained in waters between about 17 to 23 degrees of sea surface temperature. Two juvenile turtles moved to the east and north as the sea surface temperature increased. This suggests that the movements of juvenile turtles were related to sea surface temperature rather than the flow of sea water. Juvenile turtles moved at lower temperature than subadults.

Subadult turtles stayed on warm water mass for a long time and moved to east around 35°N, while juvenile turtles migrated at higher latitudes, around 38 and 42°N, than subadult turtles (Figs. 2 and 3). The frequency distributions of depth recorded by transmitters in 2002 are shown in Figure 5 for 2 subadults and 1 juvenile. Although subadult turtles dived frequently over 26 m, juvenile stayed near the sea surface (Fig. 5). These results suggest that behavior of juvenile turtles was affected by sea surface temperature and there were differences in feeding habits between subadult and juvenile turtles.

CONCLUSION

The subadult turtles moved eastward along the flow of the Kuroshio extension and remained on warm water masses for a long time, and dived deep. In contrast, juvenile turtles moved to north and east depending on sea surface temperature and stayed at the sea surface. Our results suggest that the warm water mass which is an area of high productivity is a feeding ground for subadult loggerhead turtles. The difference between subadult and juvenile turtles might result from the difference of feeding grounds by growth stage, body size, ability to swim, or individual career history (wild or captive).

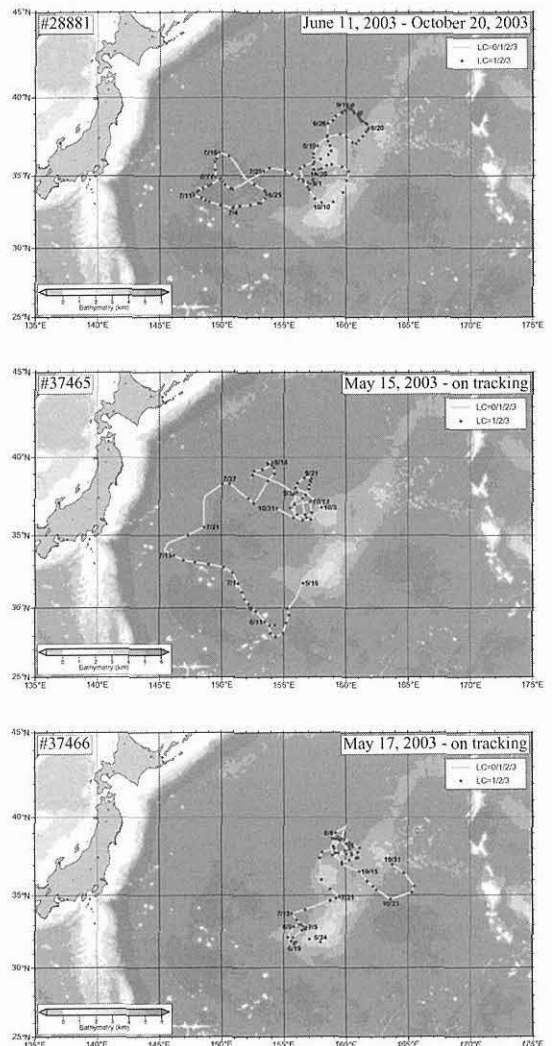


Fig. 1. Satellite tracking of 3 subadult loggerhead turtles (ID: 28881, 37465 and 37466) in 2003 (Estimated accuracy in latitude and longitude; Line: > 1 km, Dot: < 1 km).

Table 1. Movements of subadult and juvenile loggerhead turtles by satellite telemetry.

ID No.	Growth Stage	SCL (cm)	Body Weight (kg)	Tracking Date	Tracking Period (day)	Total Distance (km)	Ave. Daily Dis. (means±S.D. km)	Ave. Speed (means±S.D./km)
ID 07829	Subadult (wild)	62	43	29 May 02 - 30 Nov.	186	6536.3	35.3±25.9	1.5 ± 1.1
ID 07811	Subadult (wild)	65	41	14 Jun. 02 - 8 Dec.	178	8790.6	49.7±30.1	2.1 ± 1.3
ID 28881	Subadult (wild)	70	57.5	11 Jun. 03 - 20 Oct.	132	4920.7	37.6±25.6	1.6 ± 1.1
ID 37465	Subadult (wild)	64	46.5	16 May 03 - 31 Oct. (Continue)	169	2752.5	32.8±20.8	1.4 ± 0.9
ID 37466	Subadult (wild)	64	43.5	18 May 03 - 30 Nov. (Continue)	167	2177.0	26.2±18.5	1.1 ± 0.8
ID 07800	Juvenile (1+) (Captive)	39.7	8.7	29 May 02 - 21 Aug.	85	4275.3	50.9±36.8	2.1 ± 1.5
ID 27975	Juvenile (2+) (Captive)	53	19.8	8 Jun. 02 - 10 Nov.	156	3830.9	24.7±22.6	1.0 ± 0.9

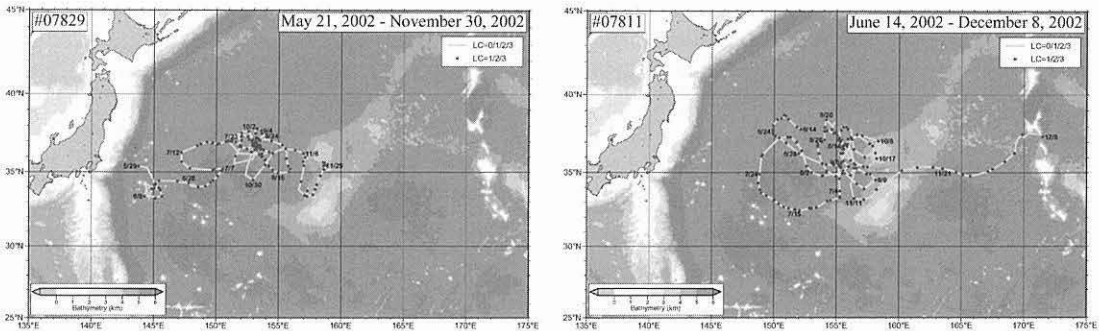


Fig. 2. Satellite tracking of 2 subadult loggerhead turtles (ID: 07829 and 07811) in 2002 (Estimated accuracy in latitude and longitude; Line: > 1 km, Dot: < 1 km).

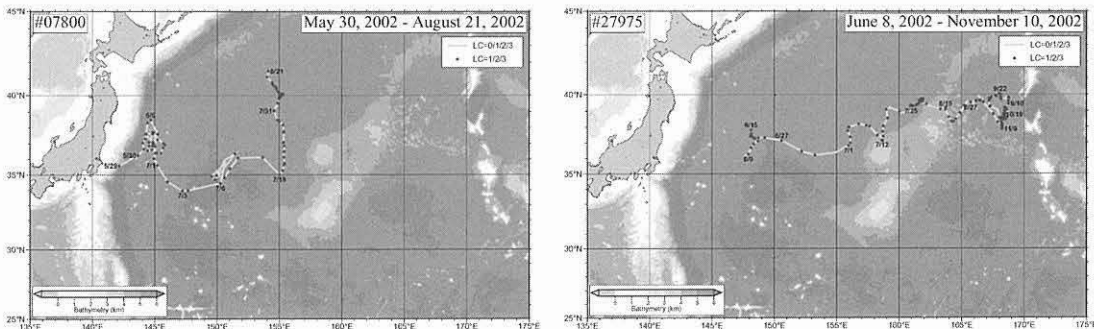


Fig. 3. Satellite tracking of 2 juvenile loggerhead turtles (ID: 07800 and 27975) in 2002 (Estimated accuracy in latitude and longitude; > 1 km, Dot: < 1 km).

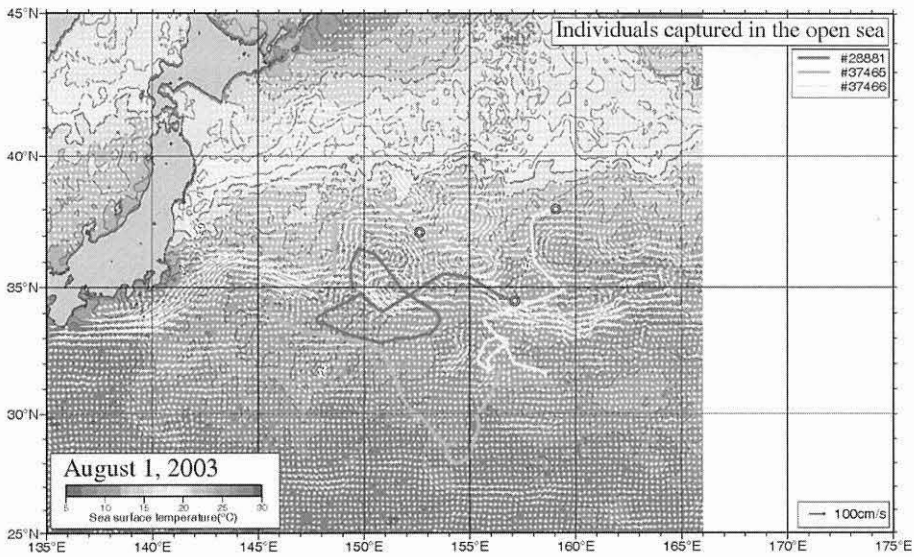


Fig. 4. Relationship between movements of 3 subadult turtles (ID: 28881, 37465 and 37466) and two measures of oceanic conditions, oceanic flow and sea surface temperature on August 1, 2003. Data of oceanic conditions were presented from the Japan Meteorological Agency.

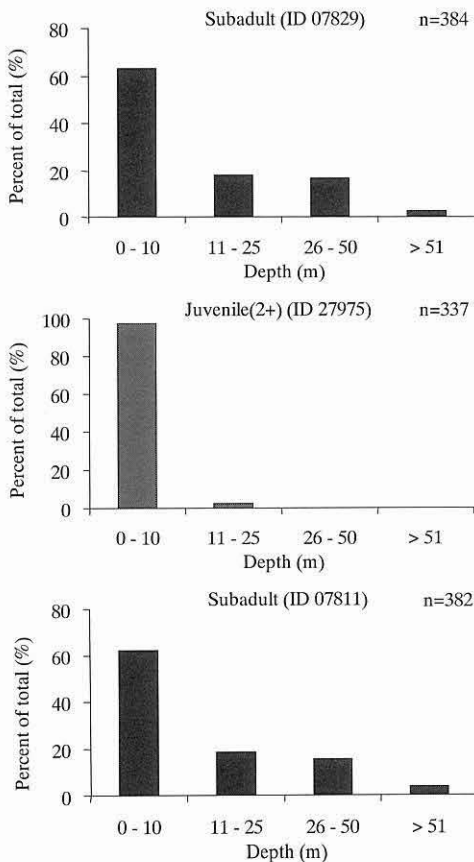


Fig. 5. Frequency distributions of depth for 2 subadult (ID: 07829 and 07811) and 1 juvenile (ID: 27975) loggerhead turtles in 2002.

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