Nesting and post-nesting studies of loggerhead turtles (*Caretta caretta*) at Omaezaki, Japan

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ABSTRACT
Nesting biology, measurement of body size and mitochondrial (mt) DNA haplotypes of loggerhead turtle, *Caretta caretta* at Omaezaki Beach, Japan were investigated by collecting data and samples during night observations from 6 July to 6 August 2004. In addition, seven post-nesting females, which nested during this observation period, were tracked by satellite telemetry. A total of 33 females were identified in this observation period. Seven females nested twice, with a mean inter-nesting interval of 18.0 days. Even though our observations did not cover the entire nesting beach and period, the frequency of nesting was estimated at three, using a calculation based on the total number of nests at this beach in this nesting season. The range of straight carapace length (SCL) was from 65.8 to 91.6 cm, and the mean (±SD) size was 81.5±5.83 cm. The SCL of females at Omaezaki Beach is significantly lower than at other nesting sites in Japan based on calculation of 90% confidence intervals for mean SCLs. Two haplotypes were detected among 33 females using mitochondrial (mt) DNA analysis. Composition of these two haplotypes of nesting females at Omaezaki Beach was similar to nesting females at other nesting beaches in Japan. Post-nesting feeding grounds of seven loggerhead turtles released from Omaezaki consist of two areas, the northwestern North Pacific and the East China Sea. It is confirmed that nesting females at Omaezaki Beach were from the two groups using the different post-nesting feeding grounds and these two groups can be distinguished by their body size criterion of 85 cm. If different factors impact females in each feeding ground, monitoring the number of females and the composition of body size can be useful in assessing the impact to females.

KEYWORDS: loggerhead turtle, nesting biology, morphometry, mtDNA analysis, satellite telemetry

INTRODUCTION

Omaezaki Beach (34º35'N, 138º14'E) is an important nesting site for loggerhead turtles (*Caretta caretta*) in Japan. This beach is about 5 km long, and nesting occurs between late May and mid August. Since 1973, conservation staff have recorded a number of nests during the nesting season. The number of observed nests has fluctuated greatly during the past 32 years. The number of nests ranged from 22 to 150 in the 1970s and early 1980s. Then it increased to over 200 in the mid-1980s and early 1990s. After these peaks, the number of nests decreased to around 50 in 1997, and then increased again to around 100 in recent years (Shiode, 2002). However, this fluctuation factor is not well known. So, it is necessary to investigate nesting biology in order to understand the reasons for this fluctuation, and whether this fluctuation reflects population size, changes in nesting characteristics, and the actual number of females. It is suggested that there are some factors for this fluctuation in the nesting beach and non-breeding habitat. It is important to investigate the habitat of females in non-breeding periods to examine how the influence of factors in the oceanographic conditions relate to their growth and foods. So, we have started night observations at Omaezaki Beach in 2002 to investigate nesting biology, including the number of females, inter-nesting intervals, morphometrics and analysis of mitochondrial (mt) DNA haplotypes. In addition, females were tracked using satellite telemetry in order to investigate their post-nesting feeding ground. This study presents the results of research in 2004 and describes preliminary results.

MATERIALS AND METHODS

Night observations were conducted from 6 July to 6 August 2004, the peak of nesting activity at this beach. The number of observed nests comprised about 40% of the nests in the nesting season at this beach. We chose the highest nest density area from the entire beach, and defined the night observation area. There, this area was divided into three sections and the length of each section was 500 m, 680 m and 1,350 m, respectively (Fig. 1). Night observations were conducted from 20:30 to 5:30, with each section

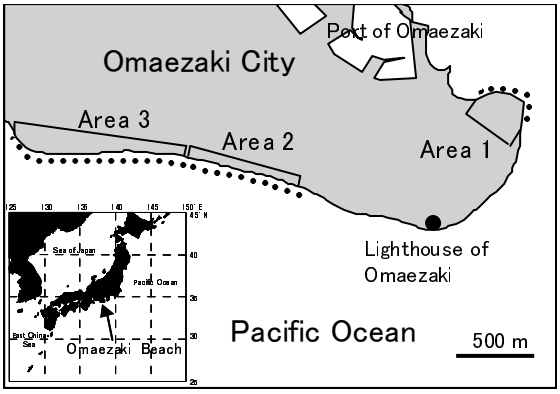

Fig. 1 Location of night observation areas at Omaezaki Beach, Japan. The dotted line shows the location of the three observation areas.

surveyed in continuous one-hour circuits by two or three persons. When a loggerhead turtle was found, we observed its behavior by night vision equipment until egg-laying was finished. After laying eggs or before the turtle returned to the sea without nesting, micro-chip tags (passive integrated transponder tag; PIT, Trovan Ltd.) were inserted in both shoulders and metal tags were attached to both front flippers. We measured body size (straight carapace length: SCL, and curved carapace length: CCL) by caliper and tape measure. In addition, we collected blood samples from sinus venosus of the neck for mitochondrial (mt) DNA analysis. Subsequently, we extracted the

Table 1. Information on date of attachment of the transmitter, body size (SCL: Straight carapace length, CCL: Curved carapace length) of females and transmitter operating conditions as of 31 October 2004.

No.	PPT ID No.	Deployment Date	Body size (cm) SCL	CCL	Transmitter operating condition
4	46980	10 Jul.	76.9	85.0	Continuing
9	46982	12 Jul.	73.5	78.4	Continuing
10	46983	13 Jul.	86.8	93.0	Stopped 27, Aug.
12	46981	14 Jul.	87.2	91.8	Continuing
15	46984	15 Jul.	89.6	94.4	Continuing
19	46985	18 Jul.	89.1	94.0	Continuing
31	46986	2 Aug.	84.0	89.6	Continuing

DNA from the blood samples, and conducted polymerase chain reaction (PCR) amplification of the control region of the mtDNA, and restriction fragment length polymorphism (RFLP) analysis following protocols described in Hatase et al. (2002a). In addition, satellite transmitters (ST-20, Telonics Inc.) were attached to the carapace of seven loggerhead turtles after they nested, and they were released to the sea. Date of attachment, body size of females and the operating condition of the transmitter

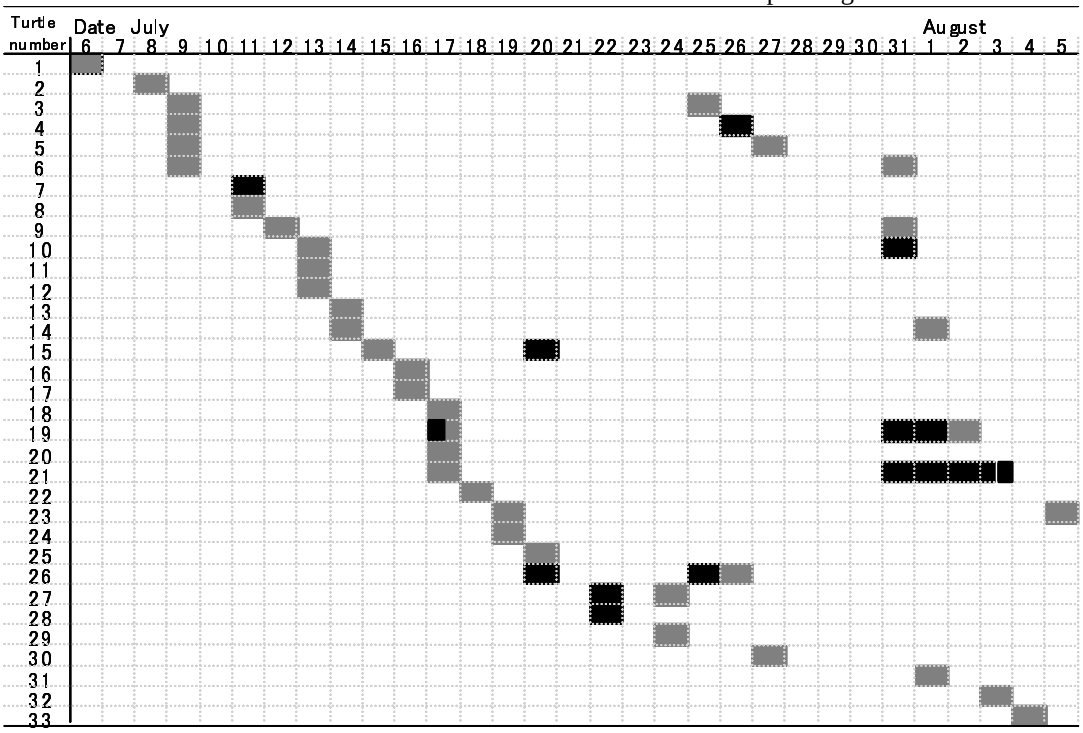

Fig. 2 Date of landing and nesting for each loggerhead turtle observed at Omaezaki Beach. The black square shows observations of landing only, while the gray square shows the date of nesting

up until 31 October 2004 are shown in Table 1.

RESULTS AND DISCUSSION

1. Nesting Biology

The females observed nesting, and the females observed without nesting were 38 and 16 respectively, which included females observed more than once. However, we could not find 6 nests in our observation period because the females nested at the same time and in the same section. After identifying these 54 females, it is confirmed that 33 females nested in this beach. 7 females nested twice, 24 females nested once, and 2 females did not nest. The date of landing and nesting for each loggerhead turtle is shown in Fig. 2. From 28 to 30 July, there was no nesting habitat available for loggerhead turtles within the observation areas due to high water levels and wave action caused by the approach of a typhoon. Inter-nesting intervals of 7 females ranged from 16 to 22 days. The mean inter-nesting interval of these females was 18.0 days. Nesting occurred between 26 May and 18 August for 85 days in this nesting season (Omaezaki city, unpubl. data). If the observed 33 females nested at 18-day intervals during these 85 days, the number of nests was calculated as 155.8. However, the total number of nests at Omaezaki Beach was 95 for the 2004 nesting season as recorded by the conservation staff (Omaezaki City, unpubl. data). The frequency of nesting for loggerhead turtles in a nesting season has been reported to range from one to five times in Yakushima, Japan (Nishimura and Omuta, 1993). Even though our observation did not cover the entire nesting beach and period, if we assume that each female nested three times, we would expect to find 99 nests which is very close to the actual number of nests we found. Females 4, 10, 15 and 21 were nesting and then returning to this beach 5 to 18 days later but did not nest a second time. These females might have nested outside our study area.

2. Morphometry

Fig. 3 shows the straight carapace length frequency distribution of 33 females. The range of straight carapace length (SCL) was from 65.8 to 91.6 cm, and the mean (±SD) size was 81.5±5.83 cm. The mean

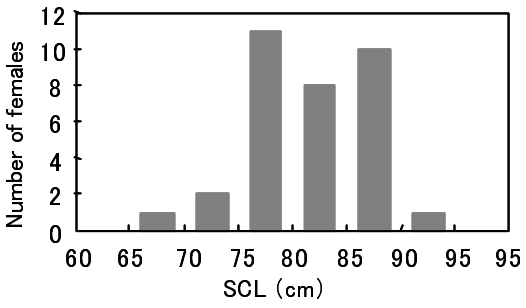

Fig. 3 The straight carapace length (SCL) frequency distribution of loggerhead turtles (n = 33) at Omaezaki Beach.

SCLs of females at Omaezaki Beach in 2002 and 2003 were 81.5 cm (n=9) and 81.1 cm (n=22), respectively. The mean (±SD) SCL of 64 females at Omaezaki Beach between 2002 and 2004 was 81.3± 5.21 cm. The mean (±SD) SCL of females at other nesting sites at Yakushima, Miyazaki and Minabe Japan from 1992 to 1994 have been reported at 85.6 ±4.68 cm (n=690), 84.5±5.64 cm (n=183) and 83.2 ±5.25 cm (n=281), respectively (Kamezaki et al. 1995). Calculation of 90% confidence intervals for mean SCLs at Yakushima, Miyazaki, Minabe and Omaezaki Beach, 85.6±0.29 cm, 84.5±0.69 cm, 83.2±0.52 cm and 81.3±1.09 cm, respectively, shows that the SCL of females at Omaezaki Beach is significantly lower than at other nesting sites in Japan.

3. Analysis of mtDNA haplotypes

Loggerhead turtles in the Pacific Ocean have been reported as having three haplotypes, referred to as A, B and C (Bowen et al. 1995). Haplotype A is the group in Australian nesting sites, whereas haplotypes B and C are groups in Japanese nesting sites. Haplotypes B and C were detected among 33 females, in our study based on RFLP analysis. Haplotype B and C accounted for 87.9% and 12.1% of the individuals, respectively. Loggerhead turtles at the four nesting sites in Japan, Yakushima, Fukiagehama, Miyazaki and Minabe, were comprised mainly of haplotype B, with only a small number of haplotype C (Hatase et al. 2002a). Nesting females at Omaezaki Beach were also predominantly of haplotype B.

4. Post-nesting feeding ground

Post-nesting feeding grounds of seven loggerhead turtles released from Omaezaki were divided into two areas, the northwestern North Pacific and the East China Sea (Fig. 4). The body size of the three loggerhead turtles moving to the northwestern North Pacific was under 85 cm, whereas body size was greater than 85 cm for the four loggerhead turtles moving to the East China Sea. In 2002 and 2003, two post-nesting loggerhead turtles which nested at Omaezaki Beach were tracked by satellite telemetry (Nobetsu et al. 2004). These turtles migrated to the northwestern North Pacific after they were released, and their body sizes were 75 cm and 82 cm, respectively. It is confirmed that nesting females at Omaezaki Beach comprise of two groups, which use different post-nesting feeding grounds and these two groups can be distinguished by comparing their body size against the criterion of 85 cm. It is suggesting that post-nesting females did not change the feeding ground with their growth because the mean (±SD) growth rate of adult female was 2.5±4.0 mm^{-1} on Senri Beach in Minabe, Japan (Hatase et al. 2004).

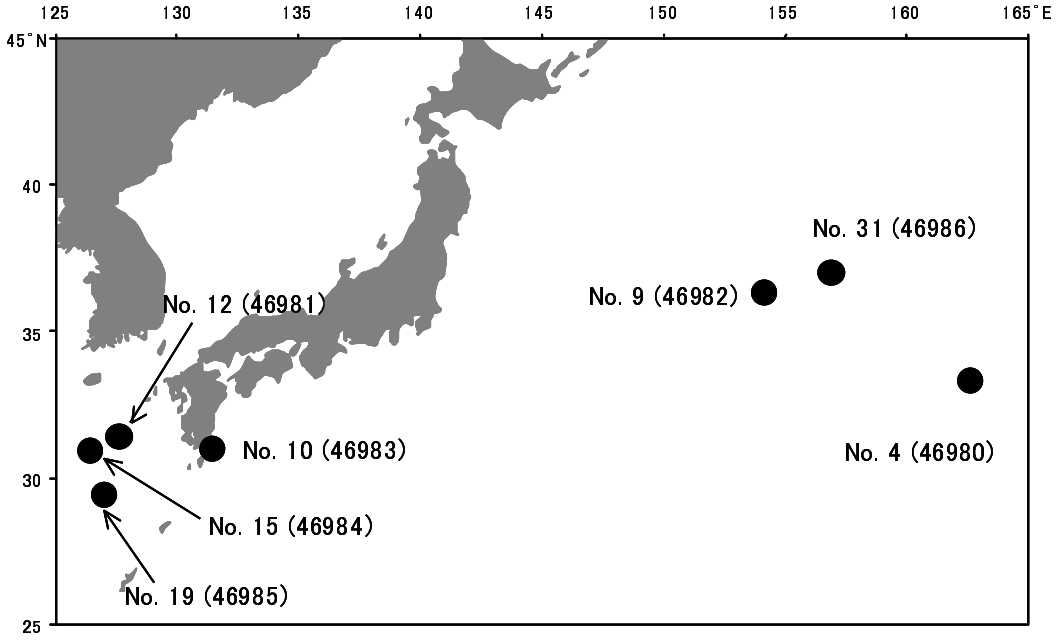

Fig. 4. Location of 6 loggerhead turtles on 31 October, 2004 after release from Omaezaki Beach. Tracking of Turtle No 10 finished on 27 August 2004.

at nesting sites in Japan (Kamezaki et al. 1995 and this study) may represent a difference in the proportion of females at each nesting site using different post-nesting feeding grounds. Hatase et al. (2002b) has shown using stable isotope analysis and satellite telemetry that larger females come from the East China Sea to the nesting beaches in Japan, and smaller females come from the North Pacific, and then each returns to their respective feeding grounds from the nesting beaches. If different factors impact females in each feeding ground, monitoring the number of females and the composition of body size can be useful in assessing the impact to females. Furthermore, by continuing our investigations, we hope to provide other useful links with biological characteristics, thereby allowing these data to contribute to effective conservation and management of the species.

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