

Strandings of Sea Turtles on the Pacific Coast of the Boso Peninsula, Central Japan, in 2006 - 2008

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Abstract Beach strandings of sea turtles were investigated in the Pacific coast of the Boso Peninsula, from Choshi to Tateyama, during January 2006 to December 2008. The surveyed area represents the northernmost nesting site for loggerhead turtle in the northwestern Pacific. During the period, 292 individuals have been recorded. Out of these 292 individuals, 258 stranded individuals of which the specific identity and size measurements were recorded by local governments were reexamined in order to confirm identification of the individuals and to standardize the size. The most abundant was *Caretta caretta* (loggerhead) (157 individuals) and the second was *Chelonia mydas* (green) (115 individuals). Causes of death were estimated as possible. It was found that many stranded individuals ingested plastic debris. The high rate of subadults and juveniles among the stranded individuals may suggest that the region is the feeding ground for loggerhead and green sea turtles.

Key words : Boso Peninsula, loggerhead turtle, green turtle, stranding, subadult, juvenile, plastic ingestion.

It is generally considered that the stranded sea turtles are representatives of nearshore aggregations (e.g., Kopsida *et al.*, 2000; Hopkins-Murphy *et al.*, 2003; Maier *et al.*, 2004; Chaloupka *et al.*, 2008). Moriya (2009) reported strandings of sea turtles found in the Pacific coast of the Boso Peninsula (ranging from Choshi to Katsuura), central Japan, representing a northernmost nesting site of loggerhead turtle in the Northwestern Pacific in 2007. Twenty-four stranded individuals, most of them were identified with *Caretta caretta* (loggerhead), were recorded. He found that the rate of subadults and juveniles among the stranded individuals was very high, and suggested that the region might be a feeding ground for immature loggerheads. Nevertheless, biological information on sea turtles in this area is still very limited.

In this study, stranding data collected in the period of 2006 - 2008 along the coast of the Pacific coast of the Boso Peninsula (ranging from Choshi to Tateyama) are discussed. The species identifications of the stranded sea turtles have been reviewed.

Materials and Methods

The study area includes Choshi to Tateyama (about 170 km), involving a long sandy beach,

Kujyukuri-hama. The coastal area from Choshi to Isumi is characterized by the presence of a shallow shelf of 30 - 50 m deep, which extends up to 25 - 30 km offshore of the region. On the other hand, the southern part from Katsuura to Tateyama faces to a narrow neritic zone, extending to 10 - 15 km offshore at 200 m deep.

In collecting data of the stranded individuals, the author followed "stranding report format" proposed by Shaver and Teas (1999). Records on the stranded sea turtles were collected from the database accumulated by Chiba Prefecture. Three different indications of the size measurements were included; straight carapace length (SCL), curved carapace length (CCL), and total body length (TBL; measured from the top of the head to the posterior end of the carapace). The straight carapace length is used as a standard measurement in this study; values indicated by CCL were transformed to SCL based on the protocol by Bjorndal *et al.* (2000, 2001). The measurements indicated by TBL were erased from size comparison on loggerhead and green turtles so as to keep precision of statistical data on carapace size measurement. In addition, data provided by Ever Lasting Nature of Asia (2006, 2007, 2008) were also utilized.

Table 1. Summary of the numbers of stranded sea turtles according to major cities along the Pacific coast of the Boso Peninsula, recorded in the period of 2006-2008.

City/Species	<i>Caretta caretta</i>				<i>Chelonia mydas</i>				<i>Eretmochelys imbricata</i>	<i>Demochelys coriacea</i>	Hybrid (*1)	Unidentified	Total
	2006	2007	2008	Total	2006	2007	2008	Total					
Choshi	3	1	1	5	0	0	0	0	0	0	0	0	5
Asahi	2	3	4	9	1	0	0	1	0	0	0	0	10
Sosa	1	2	0	3	0	0	0	0	1(*2)	0	0	0	4
Yokoshibahikari	2	1	0	3	0	0	0	0	0	0	0	0	3
Kujyukuri	3	0	0	3	0	0	1	1	0	0	0	0	4
Oamisirasato	2	4	0	6	0	1	0	1	0	0	0	0	7
Shirako	4	3	2	9	1	0	0	1	1(*2)	0	0	1(*3)	12
Ichinomiya	2	0	1	3	0	1	0	1	0	0	0	0	4
Isumi	0	5	4	9	0	2	0	2	0	0	0	0	11
Onjyuku	0	0	1	1	0	0	0	0	0	0	0	1(*2)	2
Katsuura	6	7	0	13	0	1	1	2	1(*3)	0	0	0	16
Kamogawa	4	16	4	24	5	2	6	13	0	0	0	0	37
Minamiboso	8	3	7	18	2	7	10	19	0	0	1(*2)	6(*6)	44
Tateyama	17	15	19	51	29	17	28	74	2(*4)	3(*5)	1(*2)	2(*7)	133
Total	54	60	43	157	38	31	46	115	5	3	2	10	292

- Remarks :
- *1 Hybrid between *Caretta caretta* and *Eretmochelys imbricata*
 - *2 Record in 2008
 - *3 Record in 2007
 - *4 Records in 2007
 - *5 One individual recorded in 2006 and two in 2008
 - *6 One individual recorded in 2006, one in 2007 and four in 2008
 - *7 One individual recorded in 2006 and one in 2007

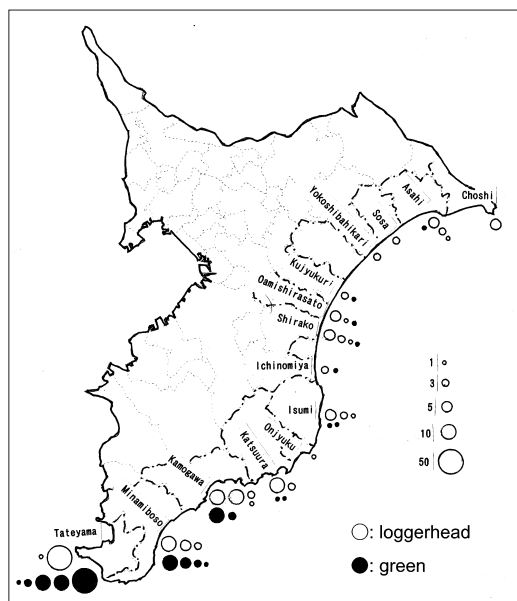


Fig. 1. Map showing localities and numbers of the stranded individuals of *Caretta caretta* (loggerhead) and *Chelonia mydas* (green) in the Boso Peninsula, recorded in the period of 2006-2008.

It was expected that the records of the stranded sea turtles accumulated by the staff of the local governments might contain misidentification, because identification of juvenile or subadult specimens is sometimes difficult. Therefore, the species identification of some stranded individuals were reexamined using photographs, with the kind help of Drs. Y. Matsuzawa and J. A. Seminoff, when possible.

The stranded individuals were directly examined by the local government staff and photographed for subsequent examination in order to estimate the causes of mortality or emaciation.

Results

Strandings of sea turtles from Choshi to Tateyama

Two hundred ninety two stranded individuals were recorded along the coast from Choshi to Tateyama during the period of 2006-2008. Reexamination of the species identity has revealed that the stranded individuals contain 157 loggerhead (*Caretta caretta*), 115 green (*Chelonia mydas*), five hawksbill (*Eretmochelys imbricata*), three leatherback (*Demochelys coriacea*), two possible hybrid (loggerhead x hawksbill) turtles and ten unidentified individuals. The records of the overall stranded sea turtles according to the location and year are summarized in Table 1. It is obvious that loggerhead is the most abundant, and the

second is green.

Locations and numbers of stranded individuals of loggerhead and green turtles are indicated in Fig. 1. Loggerhead turtles occurred throughout the area from Choshi to Tateyama, whereas most of the stranded individuals of green turtles were found in the southern part of the peninsula between Kamogawa and Tateyama. The numbers of individuals summarized according to the major cities include 51 at Tateyama (32.5%), 24 at Kamogawa (15.3%), 18 at Minamiboso (11.5%), 13 at Katsuura (8.3%), and nine (5.7%) at Asahi, Shirako and Isumi, respectively. The subtotal number for these seven cities was 133, which comprised 84.7% of the total loggerhead turtles in the Boso Peninsula for 2006-2008.

Green turtles were recorded mainly at the southern part of the Boso Peninsula, from Kamogawa to Tateyama. The number of the recorded individuals according to the major cities was 74 at Tateyama (64.3%), 19 at Minamiboso (16.5%) and 13 at Kamogawa (11.3%). The subtotal number for these three cities was 106, which comprised 92.2% of the total records of the stranded green turtles in the Boso Peninsula for 2006-2008.

Two examples of stranding of the hawksbill turtle were recorded at Tateyama, and one at Sosa, Shirako and Katsuura, respectively. Three records of the leatherback turtles were available at Tateyama.

The identified individuals with measurements, included 141 loggerhead, 109 green, five hawksbill and three leatherback turtles, resulting in the total number of 258. The possibly hybrid individuals (loggerhead x hawksbill) were recorded at Minamiboso (one) and Tateyama (one). Ten individuals could not be identified because most of them were destroyed before making positive identification.

The location where the most abundant sea turtle strandings were recorded is Heisaura beach, Tateyama, located near the southernmost tip of the Boso Peninsula. The number of the stranded individuals at this location was 45, which constitutes 15.4% of overall stranding records during the period of 2006-2008. Species composition at Heisaura includes 19 loggerheads (nine in 2006, three in 2007 and seven in 2008), 25 greens (12 in 2006, six in 2007 and seven in 2008) and one hawksbill in 2007. The ratio of the two major stranded sea turtle species at Heisaura against the total of the Boso Peninsula for 2006-2008 was 12.1 % for loggerhead and 21.7% for green turtle.

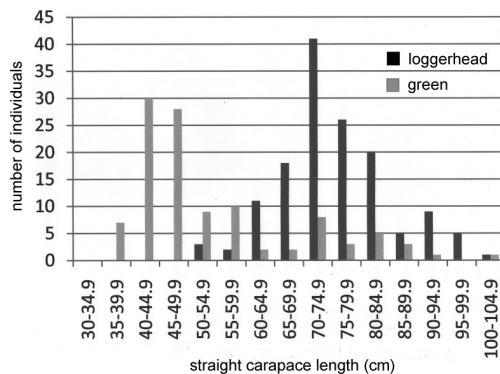


Fig. 2. Size-frequency of the stranded individuals of *Caretta caretta* (loggerhead) and *Chelonia mydas* (green) in the Boso Peninsula recorded in the period of 2006-2008.

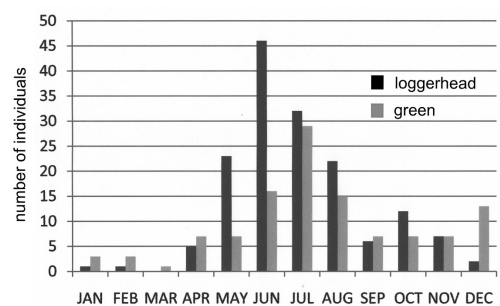


Fig. 3. Numbers of stranded individuals of *Caretta caretta* (loggerhead) and *Chelonia mydas* (green) by month in the Boso Peninsula in the period of 2006-2008.

Table 2. Causes of death for sea turtle strandings in the Boso Peninsula, recorded in the period of 2006-2008.

Species /cause	Boat strike	Shark attack	Plastic ingestion	Total
Loggerhead	3	1	39	43
Green	0	1	29	30
Leatherback	0	0	1	1
Hybrid*	0	0	2	2
Total	3	2	71	76

* Hybrid between loggerhead and hawksbill

Size frequency distribution and seasonal trend of stranded loggerhead and green turtles

The size frequency distribution of the measured individuals ($n=141$ for loggerheads and $n=109$ for greens) is shown in Fig. 2. In loggerhead turtles, SCL ranges from 53.3 cm to 100.0 cm (mean 73.7 cm, $n=141$); individuals of SCL 70.0-74.9 cm were most abundant (41 individuals). In green turtles, SCL ranges from 35.0 to 100.0 cm (mean 47.9 cm, $n=109$);

Table 3. Conditions of stranded individuals of sea turtles, recorded along the Boso Peninsula in the period of 2006 - 2008.

Conditions/Species	Loggerhead	Green	Hawksbill	Leatherback	Total
Fresh dead	65	57	3	0	125
Moderately decomposed	21	34	2	2	59
Severely decomposed	1	2	0	0	3
Total	87	93	5	2	187

individuals of SCL 40.0-44.9 cm were most abundant (30 individuals). The number of immature individuals was 75 loggerhead (SCL ranges 53.3-74.9 cm) and 104 green (SCL ranges 35.0-84.9cm); the ratio of immature individuals is 53.2% for loggerhead and 95.4% for green.

Seasonal change of the number of stranded individuals is obvious, as summarized in Fig. 3. For loggerhead turtle, five or more individuals were recorded every month from April to November, and the subtotal number of stranded individuals in the four summer months (May to August, with peak at June) was 123 (78.3% of the total stranded loggerheads). With regard to green turtle, seven or more individuals were found every month from April to December (an average number for one month is nine), and the subtotal number of stranded individuals four summer months (May to August, peak at July) was 67 (58.3% of the total stranded greens).

Causes of sea turtle strandings

The causes of the sea turtle strandings are summarized in Table 2. They were estimated for 76 of 258 stranded individuals (29.5%). It was found that 68 of these 76 individuals of loggerhead and green turtles (89.5%) ingested plastic debris, although the amount was rather variable. Items of the ingested non-digestible material include: small pieces of plastic bag (the most abundant), small blocks of polyurethane (the second most abundant), small pieces of fishing line, rubber sheet, nylon thread, vinyl thread, toy balloon, tar block, and transparent packing tape.

Three individuals were heavily injured on their carapaces, possibly caused by strikes of boat propellers. Trauma of shark attack was also recorded for two individuals for one subadult loggerhead (damaged at the neck) and one subadult green (damaged at the periphery of the carapace).

Condition of stranded sea turtles

Condition of the stranded individuals was estimated following the categories proposed by Shaver and Teas (1999): (1) fresh dead: individuals without apparent damage; (2) moderately decomposed:

individuals of a little damage, showing a partial scale loss, a partially rotten head and flippers, and a swollen body with gas; (3) severely decomposed: individuals with heavy damage, missing head and/or flippers and missing more than half of scutes on the carapace. The condition of the stranded individuals is summarized in Table 3. The number of individuals for which the condition was estimated were 187 (72.5% of the size-identified stranded individuals). Of 187 individuals, 125 was referred to "fresh dead" (66.8%), 59 to "moderately decomposed" (31.6%) and three to "severely decomposed" (1.6%). Furthermore, with regard to loggerheads, 65 individuals (74.7%) were referred to "fresh dead" and 21 (24.1%) to "moderately decomposed." On the other hand, with regard to greens, 57 individuals (61.3%) were referred to "fresh dead" and 34 (36.6%) to "moderately decomposed."

Discussion

During this study, previous identifications of the stranded sea turtles have been reexamined. This resulted in the substantial increase of the records of green turtles. The misidentification was mainly due to the difficulty of the identification of young individuals. Because the accurate identification is fundamental for evaluating the mortality through stranding records, it is strongly recommended that photographs of the stranded sea turtles are taken. These photographs can be used to re-examine the species if necessary. With the advancement in digital photography and inexpensive digital media, storage of high-quality photographs should not be an issue.

It has been found that the stranded individuals are fewer in the areas where breeding activities of loggerhead turtles is high, i.e., Isumi, Shirako, and Yokoshibahikari (Moriya, 2009). As mentioned above, it is remarkable that the strandings of green turtles were more abundant than previously expected, although the surveyed area is not the breeding ground for the species.

Sixty-eight of the 75 stranded individuals of loggerhead and green turtles (89.5%), for which the causes of death could be estimated, were found to ingest

plastic debris. It cannot be denied a possibility that ingestion of plastic debris brought harmful influence to the health of these stranded individuals, since even small amounts of plastic debris can cause death or emaciation by obstructing the digestive organs (Balazs, 1985; Bjorndal *et al.*, 1994; Mrosovskye *et al.*, 2009). It was very difficult for other individuals to identify causes of stranding. A fibropapillomatosis was found at a rear flipper of one subadult green turtle; however, this could not be fatal (Benett and Keuper-Benett, 2008).

This study shows that immature individuals are dominant among the stranded individuals of loggerhead and green turtles in Boso Peninsula, although the size range of the recorded specimens is wide, including those attaining maturity. In particular, those of green turtle were almost all juveniles or subadults (SCL 35-84.9 cm). In fact, nestings of green turtles are very rare in the Japanese mainland, although this species breeds in the rookery of the Ogasawara Islands, located at about 1,000 km to the south of the Boso Peninsula. There have been no records of nesting of the species in the Boso Peninsula. As mentioned above, the stranded individuals were fresh dead or moderately decomposed, suggesting the presence of near shore aggregations of these two species, mainly consisting of young individuals. This observation circumstantially supports the trans-Pacific migration of loggerhead turtles that has been documented (Bowen *et al.*, 1995; Resendiz *et al.*, 1998; Nichols *et al.*, 2000; Haplin, 2000; Polovina *et al.*, 2004; Parker *et al.*, 2005; Peckham *et al.*, 2008; Peckham *et al.*, 2009), although it is still possible that non-migrating population could exist in local waters. The coastline along the Boso Peninsula, which represents the major fishing ground in local waters, seems to provide good feeding ground for young sea turtles.

As mentioned above, many stranded individuals were found with plastic debris in their digestive organs. Reduction of dumping of plastic debris to the sea is essential for conservation of the sea turtles, as well as other marine organisms.

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2006～2008年の房総半島における ウミガメ類の漂着

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2006～2008年の3年間に観察された房総半島東海岸(銚子～館山間約170km)におけるウミガメ類の漂着個体について調査し、その結果をまとめた。漂着個体の写真などの資料が残されている個体については再同定を行った。その結果、アオウミガメの漂着がこれまで報告されていたよりも多いことが判明した。アカウミガメは157個体、アオウミガメは115個体漂着したが、そのうち甲長測定が行われたアカウミガメ141個体、アオウミガメ109個体についてサイズ分布の分析を試みた。アカウミガメについては直甲長75cm未満の亜成体と幼体が53.2%を占めることが明らかとなった。アオウミガメについては、直甲長90cm未満の亜成体と幼体が98.2%を占めた。また、館山市、南房総市、鴨川市の3市における漂着死骸の報告例は92.2%に及んだ。アカウミガメについては、房総半島沿岸における産卵が知られているが、アオウミガメについては、日本本土における産卵例は稀であり、房総半島では記録がない。種とサイズが特定された258個体のうち76個体(29.5%)について漂着原因を推定したが、残りの個体については原因の推定が非常に困難であった。原因を推定した個体のうち、68個体(89.5%)はプラスチック類を摂取していることが判明した。本研究の観察結果は、亜成体段階のウミガメ類が房総半島沿岸で摂餌・生育していることを示唆するものと考えられる。アカウミガメにおいては成長に伴い太平洋を横断する大規模な回遊が知られているが、本研究の結果はこのことをよく支持するものとなっている。