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ABUNDANCE DECLINE IN THE FINLESS PORPOISE POPULATION IN THE INLAND SEA OF JAPAN

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ABSTRACT. – From 5 March to 1 July, 1999 and 2000, we made six shipboard surveys for finless porpoises (*Neophocaena phocaenoides*) in the Inland Sea, which is believed to be inhabited by one local population of the species. Each survey lasted 2-24 days and covered nearly the entire extension of the sea. In principle, we followed the method of Kasuya and Kureha (1979) and attempted to revisit as many ferry tracks surveyed by them as possible, but we used a greater number of observers for some selected surveys and added some new tracks. Records of strandings and incidental mortality of the species were also analyzed. Comparison of the two sets of survey data, which were about 22 years apart, did not show establishment of new habitat in the Inland Sea, but confirmed disappearance of some habitat previously occupied by the species. All the 18 tracks surveyed by both studies showed various degrees of density decline, and the decline was statistically significant for 12 of them. The sighting rate (number of finless porpoises sighted per 100 km survey) declined in both nearshore and offshore strata. Using the 18 tracks and combining all strata, we estimated that the current density was about 4% that of the late 1970s in the middle and eastern Inland Sea, while it was about 70% in the western Inland Sea. From these results, we conclude that the finless porpoise population in the Inland Sea has dramatically declined. This decline was consistent with the trends of strandings and mortalities in fishing gear. Entanglement in fishing nets is the only documented human-caused mortality for the population. However, the decline was probably a result of compound effects of various types of environmental degradation, including destruction of coastal habitats due to construction, chemical pollution, red tide and vessel traffic.

KEY WORDS. – Finless porpoise, *Neophocaena phocaenoides*, pollutants, monitoring, incidental catches, pollutants, vessel survey, trends, Asia, Japan.

INTRODUCTION

Finless porpoises, *Neophocaena phocaenoides*, inhabit Japanese coastal waters from western Kyushu to the Noto Peninsula on the Sea of Japan coast, and to Sendai Bay on the Pacific coast (Fig. 1), with some distribution gaps within the range (Shirakihara et al., 1992). Although remains of the species have been identified in the stomach of a great white shark, *Carcharodon carcharias*, killed off Okinawa Island, distribution of finless porpoises in those waters has yet to be confirmed (Kasuya, 1999). Presence of a minimum of five discrete populations in Japanese waters has been postulated through three studies as described below (Fig. 1) (see Yoshida, 2002).

Calving peaks differed geographically (Shirakihara et al., 1993). Fetal records from the Inland Sea and Pacific coasts showed a single peak in April, while those from western Kyushu indicated a major peak in November/December and an indistinct smaller peak in March. This suggests the absence or limitation of intermingling between these regions. Skull morphology distinguished three geographical groups of finless porpoises, i.e. those from Ariake Sound/Tachibana Bay (shaded area 2 in Fig. 1), those from Ise and Mikawa Bays on the Pacific coast (shaded area 4), and those from the rest of Japanese waters (Yoshida et al., 1995). Among individuals of the last group covering various geographical areas, individuals from Omura Bay (shaded area 1) overlapped only partially with those from the Inland Sea (shaded area 3).

The third study on stock identity of Japanese finless porpoises used mitochondria DNA and reported differences in haplotypes or their frequencies among four regions (Yoshida et al., 2001). These are Ariake Sound/Tachibana Bay, Inland Sea including a part of the southwestern Sea of Japan opening to the Inland Sea, Ise and Mikawa Bays, and extended waters from Tokyo Bay to Sendai Bay (shaded area 5 in Fig. 1). Differences of haplotype frequencies were insignificant between Omura Bay and the Inland Sea. This may be

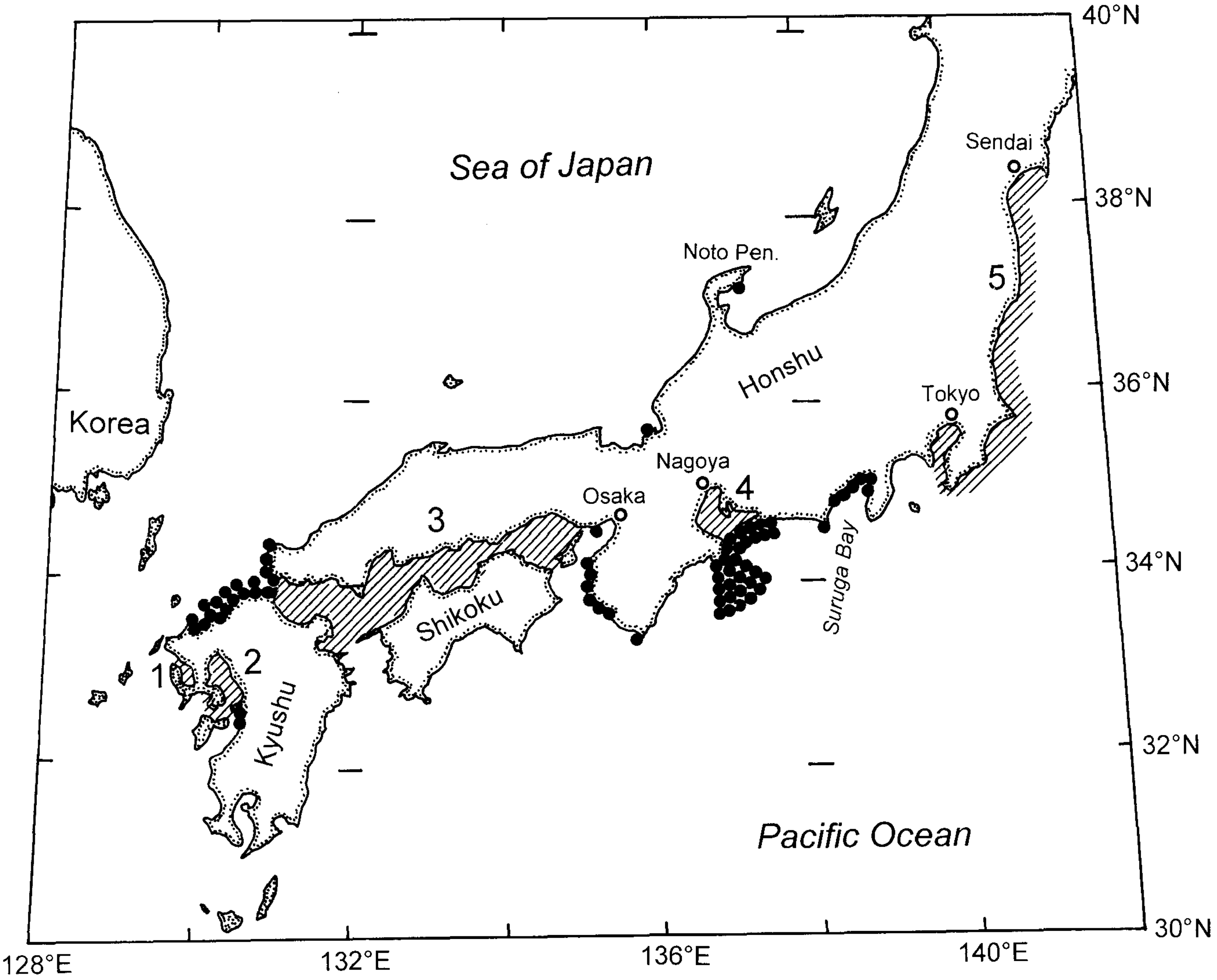

Fig. 1. Distribution of finless porpoises off Japan. Shaded areas represent the currently recognized five populations or range of abundance estimates. 1: Omura Bay; 2: Ariake Sound and Tachibana Bay; 3: Inland Sea; 4: Ise and Mikawa Bays; 5: Pacific coast from Tokyo Bay to Sendai Bay. Closed circles represent strandings or mortality incidental to fishing operations recorded outside of the above ranges. Each circle represents one individual, except for the southwest entrance of the Ise Bay, where each mark represents two individuals.

attributable to various factors, such as small sample size and limited genetic differentiation between the regions. In view of differences in the mating season, presence of weak cranial differences and a distribution gap between them, individuals of these two areas should be dealt with as separate populations for conservation purposes.

Some of the above five geographical regions cover a broad area (e.g., Tokyo Bay to the Sendai Bay), and the possibility of them containing more than one population can not be excluded. It also remains to be confirmed if some of the habitats not covered by the above studies contain additional populations (e.g. Suruga Bay on the Pacific coast, see Fig. 1). Presence of such isolated local populations and their habitat in coastal waters under influence of human activities require care for their conservation.

Abundance has been estimated for some areas inhabited by these populations (shaded areas 1 to 4 in Fig. 1), i.e. 187 individuals for Omura Bay in 1993-94 assuming g(0)=1 (Yoshida et al., 1998); 3,093 for Ariake Sound and Tachibana Bay in 1993-94 assuming g(0)=1 (Yoshida et al.,1997); 1,952 for Ise and Mikawa Bays in 1991-94 using g(0)=0.899 calculated from diving interval in an aquarium (Miyashita et al., 1994); and 4,900 for Inland Sea in 1976-78 using g(0)=0.5 (Kasuya & Kureha, 1979). These estimates used various methods and assumptions, and direct comparison may not be advisable. New aerial surveys for Japanese finless porpoises are underway in these habitats.

The abundance estimated by Kasuya and Kureha (1979) must be considered with caution, because it is based on surveys on commercial ferryboats, of which tracks were neither systematic nor random, while distribution of finless porpoises is affected by water depth or distance from shore, as identified by these authors. Parameters they adopted must wait further validation. However, their sighting records are still useful as historical records of relative abundance and the distribution pattern of finless porpoises in the Inland Sea. Using sighting records of finless porpoises in the Inland Sea in 1976-78 (Kasuya & Kureha, 1979) as a baseline, the present study examines historical changes in the abundance and distribution of the species in the past 22 years.

MATERIALS AND METHODS

We analyzed three sets of data. The first set of data is the records of sighting surveys made by Kasuya and Kureha (1979) in 1976-78. Only data of March-June were extracted for the present study, because the density was apparently highest in those months. Each ferry boat track was surveyed several times during the period. Sighting survey was conducted only during Beaufort sea state 0 to 2 and visibility over 1 km.

The second set of data is the recent sighting records obtained by us through 6 survey trips made from 5 March to 1 July, 1999 and 2000 (Table 1). Each survey trip lasted from two to 24 days, which varied due to weather condition and the availability of ships, but covered almost the entire range of the Inland Sea. We used the *Seisui-maru*, a 51 m research vessel of Mie University, and various commercial ferryboats for passengers and vehicles, which had various sizes and speeds (usually around 18.5 km/hr). High-speed ferry services for passengers were not used by us, nor by Kasuya and Kureha (1979). Survey tracks of the RV *Seisui-maru* were designed either to follow tracks identical to those observed by Kasuya and Kureha (1979) or to cover waters that had not been covered by them. While a single observer (Yamamoto) made sightings on ferryboats, RV *Seisui-maru* had 3-6 observers on the upper wheelhouse (7.6 m observer eye height) and 2-3 observers in the wheelhouse below it.

We compared, for each track, the number of finless porpoises sighted per trip (including records of RV *Seisui-maru*) against the corresponding figure of 1976-78 obtained by Kasuya and Kureha (1979). Both primary and secondary sightings were analyzed together, but secondary sightings were uncommon in our sample. We would expect the current surveys to have higher observed encounter rate because multiple observers were used in most surveys, while single observer was used in the 1976-78 surveys, with the exception of a very few cases. Thus only a reduction from historical encounter rate could be interpreted as a real change, which was found for all the tracks compared.

Kasuya and Kureha (1979) observed the highest density of finless porpoises in the nearshore stratum (<1.85 km, or one nautical mile), and the lowest density in the offshore stratum (>5.56 km, or three nautical miles). We followed this strata division and examined the historical change in distribution patterns and sighting rates calculated as the number of finless porpoises sighted per 100 km of survey.

The third set of data was the records of strandings and incidental mortality of finless porpoises in the Inland Sea. They were cited from published and unpublished sources, i.e. Ishikawa (1994), Anon. (1994a and b; 1995a, b and c; 1996a, b, c and d; 1997a, b and c; 1998a, b and c; 1999a and b), Oike and Komaba (1997), unpublished data of Mr. M. Furuta for Ise and Mikawa Bays and of Kasuya for the Inland Sea. These records cover the period from 16 November 1929 to 31 May 1999, but earlier records are limited, possibly due to low public concern on small cetaceans. These records were arranged by location, date, sex and body length, and possible duplications were eliminated. The total number of individuals thus identified was 428, representing 400 incidents.

Table 1. Sighting surveys conducted for the present study. All surveys were conducted from 5 March to 1 July, 1999-2000.

Survey no.	Vessel type	Survey period	Number of observers
1	RV *Seisui*	30-31 March 1999	multiple
2	Ferries	6-14 May 1999	single
3	RV *Seisui*	5-8 June 1999	multiple
4	Ferries	16 June-1 July 1999	single
5	Ferries	5-28 March 2000	single
6	RV *Seisui*	13-15 April 2000	multiple

RESULTS

Expansion or shift of the habitat. – Solid lines in Figs. 2 and 3 represent tracks surveyed by both Kasuya and Kureha (1979) and the present study, and dotted lines represent those surveyed only in the present study. Tracks surveyed by Kasuya and Kureha (1979), but not by the present study, were excluded from these text figures to avoid complication. Inclusion of these tracks would not contribute to showing historical changes in the distribution of finless porpoises. Sightings of finless porpoises were frequent in *Suwo-nada* region, i.e. approximately north of a line connecting positions 23 and 25 in Fig. 3, which has maximum water depth of only about 50 m. Kasuya and Kureha (1979) also identified this region to contain high density, but their survey effort there was insufficient, due to unavailability of ferry services. We were able to survey this area better using RV *Seisui-maru*.

Finless porpoises were scarce in the southern part of the western Inland Sea, i.e. *Iyo-nada* region (approximately south of a line connecting positions 19, 23 and 25 in Fig.3). This was identified by Kasuya and Kureha (1979) and interpreted as a reflection of deep (maximum of over 100 m) and relatively open water not preferred by the species.

No other new tracks resulted in significant sightings of finless porpoises. There were no tracks that recorded low density of finless porpoises in 1976-78 and recorded higher density in the present study. Thus we have no evidence that the finless porpoise population established new habitat in previously uninhabited regions within the Inland Sea.

Reduction of range. – We confirmed the presence of finless porpoises at some survey tracks where Kasuya & Kureha (1979) also confirmed the species. However, even with repeated investigation we failed to find finless porpoises on some other tracks that once recorded numerous porpoises in 1976-78 (see Figs. 2 and 3). Such observation comes most

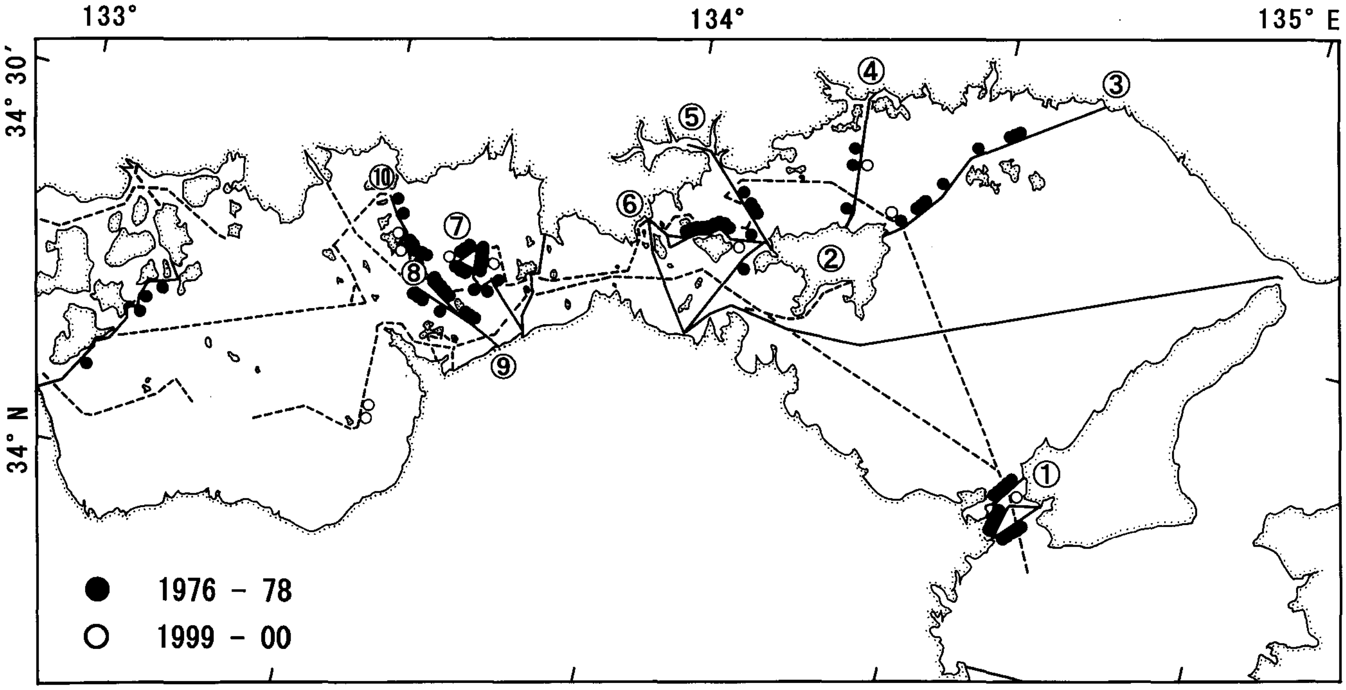

Fig. 2. Eastern Inland Sea, survey tracks and positions of finless porpoise sightings. Solid line: vessel tracks surveyed in 1976-78 and 1999-2000; dotted line: tracks surveyed only in 1999-2000; closed circle: position of finless porpoise sightings in 1976-78; open circle: position of finless porpoise sightings in 1999-2000. Sightings are under-represented in the concentrated area. Primary and secondary sightings included.

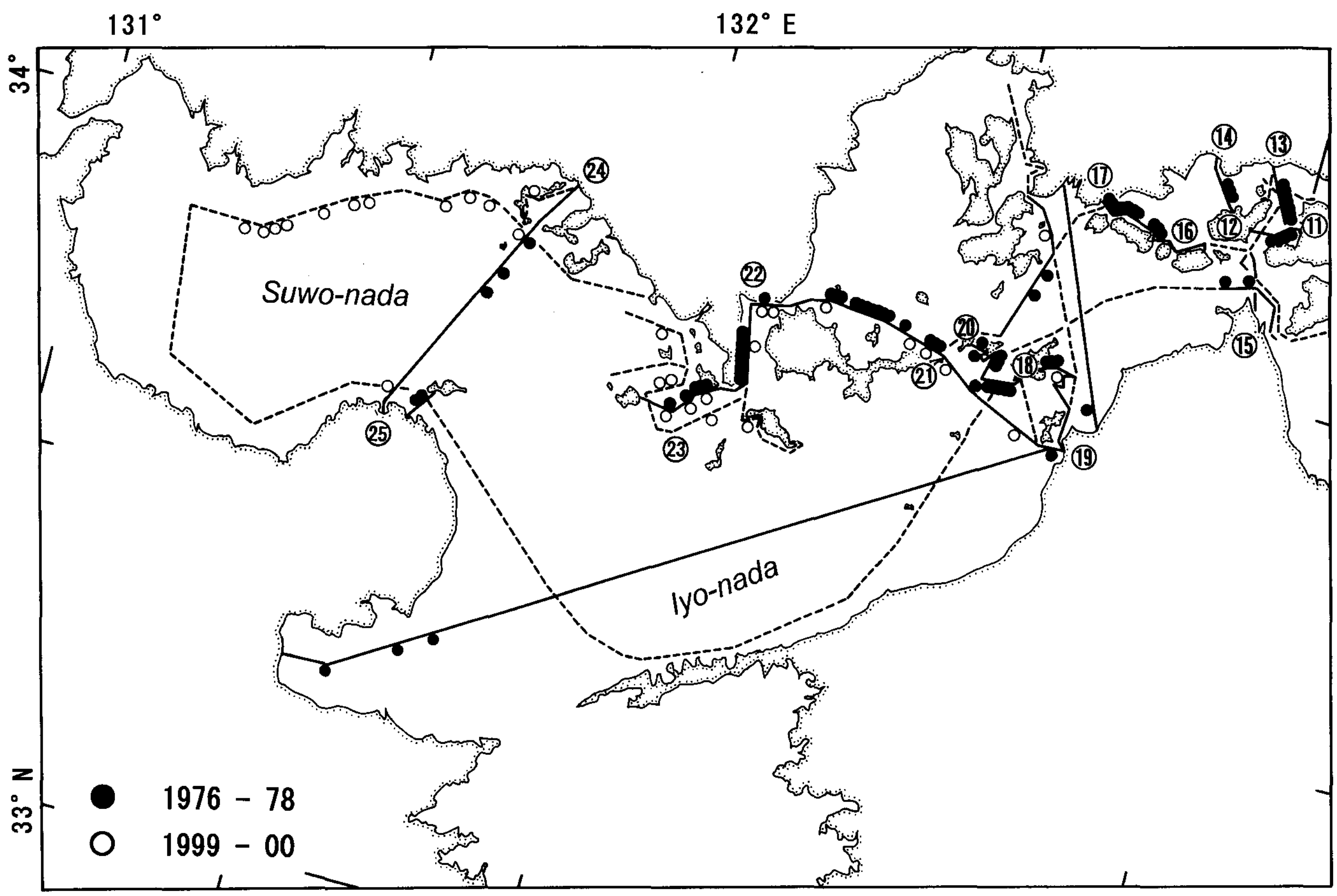

Fig. 3. Western Inland Sea, survey tracks and position of finless porpoise sightings. Position 13 represents town of Takehara. For other symbols, see Fig. 2.

typically from the middle part of the Inland Sea, which roughly corresponds to waters between positions 10 and 17 in Figs. 2 and 3. This is most probably an indication of local decline of finless porpoise density or reduction of distribution range of the species.

Density decline. – Some of the ferry tracks studied by Kasuya & Kureha (1979) were abolished following construction of bridges, but we revisited many of the remaining tracks. These are shown in Table 2. First we compared number of finless porpoises sighted at each ferry track between the two data sets, which were 22 years apart (nearshore, intermediate, and offshore strata were combined). The average number of finless porpoises per trip declined for all 18 ferry tracks analyzed, and the decline was statistically significant for 12 of the 18 (Mann-Whitney U-test, $p<0.05$, Table 2). Although the decline was not significant for the remaining six tracks, it could be because of low statistical power, due to small sample sizes, large variation between trips or minor degree of decline. This result indicates a historical decline in density of finless porpoises along the tracks surveyed.

Level of the decline (depletion level) was calculated for each of the above 18 tracks as the average number of finless porpoises per trip divided by corresponding figure of the past. The current figures for 16 tracks in the eastern and central parts of the Inland Sea (position numbers 1–22) were only 0-18% (3.8% in average) of 1976-78 values. However, two tracks in the western part of the Inland Sea (position numbers 22-25) gave figures 50-88% (71.5% in average) of the 1976-78 level.

This is in agreement with results of a questionnaire survey done in 1997 in the Inland Sea, where 48 of 49 (98%) fishery cooperative unions in the central and eastern Inland Sea thought that the abundance of finless porpoises declined while 24 of 39 (62%) in the western Inland Sea supported this (the remaining 38% believed that the number remained the same or increased) (Chiiki-koryu Center, 1998).

In order to analyze historical density change by strata, we calculated sighting rate of finless porpoises as the number of finless porpoises sighted per survey distance of 100 km. For this calculation we used both data representing the above mentioned 18 tracks and those representing other tracks surveyed in March-June (very few data of 1 July 1999 were also used). The relative density of finless porpoises declined in both inshore (<1.85 km) and intermediate (1.85-5.56 km) strata, where sample sizes were sufficient (Table 3), and the decline was statistically significant for all four strata/area segments analyzed in Table 3 (Chi-square test, $p<0.05$).

In the eastern and central part of the Inland Sea, the inshore stratum apparently showed greater density decline than the outer stratum. The degree of density decline and its inter-strata difference are apparently less in the western part of the Inland Sea. This suggests that destruction of inshore habitat has been greater in the central and eastern Inland Sea than in the western part, which is in agreement with our general understanding of the current status of the Inland Sea.

Table 2. Number of finless porpoises sighted at each track, compared between 1976-78 and 1999-2000 surveys (for tracks see Figs. 2 and 3).

Track number	Year	No. trips	Sighting rate (No. porpoises/trip) range	mean	Decline level (%)	p[1)] (%)
1	76-78	33	0-28	7.27		
	99-00	6	0-2	0.33	4.5	***1.1***
2-3	76-78	11	0-4	1.27		
	99-00	6	0	0	0	6.0
2-4	76-78	4	0-2	0.75		
	99-00	7	-1	0.14	18.7	18.5
2-5	76-78	4	0-10	4.00		
	99-00	9	0	0	0	***2.7***
2-6	76-78	5	0-27	8.20		
	99-00	8	0-1	0.13	1.6	***1.2***
7	76-78	9	0-13	7.00		
	99-00	10	0-3	0.70	10.0	***0.1***
8-9	76-78	7	0-3	0.86		
	99-00	6	0	0	0	8.2
8-10	76-78	6	6-22	13.00		
	99-00	6	0-5	0.83	6.4	***0.3***
11-13	76-78	6	1-16	7.67		
	99-00	8	0	0	0	***0.06***
11-12	76-78	7	0-9	4.57		
	99-00	2	0	0	0	7.3
12-14	76-78	6	0-7	2.83		
	99-00	2	0	0	0	8.8
12-15	76-78	8	0-8	2.25		
	99-00	10	0	0	0	***4.0***
16-17	76-78	5	3-11	7.20		
	99-00	7	0	0	0	***0.2***
18-19	76-78	5	0-9	2.60		
	99-00	8	0-2	0.38	14.6	37.1
18-20	76-78	5	4-18	10.80		
	99-00	7	0	0	0	***0.2***
21-22	76-78	7	1-51	15.00		
	99-00	9	0-2	0.67	4.5	***0.6***
22-23	76-78	7	2-16	7.29		
	99-00[2)]	11	0-56	6.45	88.5	***2.6***
	99-00[3)]	10	0-8	1.50	20.6	***0.6***
24-25	76-78	4	0-6	1.50		
	99-00	4	0-3	0.75	50.0	85.1
Mean	76-78 (18 tracks)			5.78		
	99-00[2)] (18 tracks)			0.58	10.0	
	99-00[3)] (18 tracks)			0.30	5.2	

1) Probability that two sets of sighting data represent identical populations (boldface italic type indicates presence of statistically significant difference). 2) All data included. 3) Excluding a trip that recorded an unusually large sighting of 56 finless porpoises.

We conclude from these analyses that the finless porpoise population in the middle and eastern parts of the Inland Sea has declined to an extremely low level in the past 22 years, but the decline in the western part of the sea is less severe. Because distribution of sighting effort is not proportional to

Table 3. Sighting rate of finless porpoises compared between 1976-78 (March-June) and 1999-2000 (5 March-1 July) surveys for each strata/region in the Inland Sea.

Strata	Year	Sea area (km^2)	Effort (km)	Individuals sighted	Sighting rate (/100 km)	Decline rate
Eastern and central Inland Sea						
I	76-78	2480	3272	595	18.2	
	99-00		2504	15	0.6	0.03
II	76-78	3920	1065	97	9.1	
	99-00		887	16	1.8	0.20
III	76-78	1327	117	3		
	99-00		274	0		
Western Inland Sea						
I	76-78	2329	670	131	19.6	
	99-00		767	86	11.2	0.57
II	76-78	1142	400	66	16.5	
	99-00		346	28	8.1	0.49
III	76-78	3070	393	2		
	99-00		159	1		

Notes. Eastern Inland Sea: positions 1-10; central Inland Sea: positions 11-20; western Inland Sea: positions 21-25 (see Figs. 2 and 3). Strata I: <1.85 km offshore; II: 1.85-5.56 km; III: >5.56 km. Sea areas are approximations cited from Kasuya and Kureha (1979).

sea surface area or size of habitat of finless porpoises, it is difficult to estimate the present level of the population relative to that of the late 1970s.

Reported mortalities. – Only a small, but unknown, fraction of finless porpoise strandings or mortalities incidental to fishing operations could have been recorded and thus became available to us, and existing records of such incidents could have been a function of both absolute frequency of such incidents and social concerns on finless porpoises.

The species was hunted for oil in the Inland Sea in the 1930s (Kaburagi, 1932), and extraction of oil from carcasses was practiced during the post-World War II period (Kasuya, unpublished). However, such practices had been abandoned long before the late 1970s, when Kasuya and Kureha (1979) surveyed the sea.

In 1930, the Ministry of Education started legal protection of this species as a natural monument in a small area of 1.5 km radius centered at 34°18.3'N, 132°57.1'E, about 5 km southeast of Takehara (Takehara corresponds to position 13 in Fig.3) (Kaburagi, 1932). Although the Japanese hand harpoon fishery for small cetaceans did not target this species at the time, harpooning this species was prohibited sometime around 1989 by local bodies that are responsible for the fishery, i.e. prefecture governors or Regional Fishery Coordination Committees. In March 1991, hunting of this species was prohibited by order of the director of Division of Fishery Promotion, Fisheries Agency. In April 1993, Minister of Agriculture, Forestry and Fisheries took action to protect this species with the Fishery Resources Protection Act. Although none of the above protection measures aimed to stop or decrease incidental mortality of this species in fishing gear, the action of 1993 required fishermen to report fishing mortalities of the species.

Seventy-six finless porpoises have been reported from the Inland Sea as stranded or killed in fishing operations during the 28 years from 1970 to 1998. Both stranding and mortality in fishing gear were common prior to 1989, but only strandings were recorded since 1990 (Fig. 4). This date agreed with the time when above mentioned protection measures started in 1989 or reporting of incidental kill became obligatory in 1993. We do not believe that mortality in fishing gear ceased since these dates, but do consider that fishermen disliked the trouble of reporting incidental kills and discarded carcasses without recording (some of them would subsequently be stranded). If we arbitrarily divide the Inland Sea into two parts bounded at 133°25'E, 61 individuals or 80.3% of the mortalities reported from the Inland Sea were from the eastern half and only 15 (19.7%) were from the western half.

Examination of historical trends of such mortality in the eastern area, where records were relatively abundant, revealed that 54 individuals or 88.5% of the total of the area occurred in the first 16 years (1970-1985), and only 7 in the subsequent 13 years (Fig. 4). The sudden decrease of reported mortality of finless porpoises in around 1985 is not coincident with any of the social or legal changes mentioned above. One plausible explanation for it is a crash in the abundance of finless porpoises.

In the past 2 or 3 years public concern for finless porpoises has increased, partly due to political controversy about construction of an atomic reactor in the western Inland Sea and partly to increased public attention to cetaceans. These changes could have resulted in the high reported mortalities in 1998.

DISCUSSION

The Inland Sea is a marine area of 14,300 km^2, connected to outer seas by four narrow channels; it contains about 3,000 islands, and has an average water depth of 31 m. Such an environment created a suitable habitat for finless porpoises, which were mostly found within about 6 km of the coast or at depths less than 40 m. This area was believed to support the largest population of finless porpoises in Japan (Kasuya & Kureha, 1979).

Protection of this species off Takehara started in 1930 (see above) to conserve an area of high finless porpoise density, where they were believed to assist hook and line fishermen (Kasuya, 1999). Although that particular fishing method had already disappeared, finless porpoises were still considered to be abundant when Kasuya & Kureha (1979) surveyed the region in 1976-78. However, our repeated visits to the region during the present study failed to find any finless porpoises.

This single fact is sufficient to cast doubt about the above optimism.

The results of our study indicate that finless porpoises are almost absent in the central part of the Inland Sea that surrounds the above-mentioned waters off Takehara. This is in stark contrast to the study of Kasuya & Kureha (1979), who found finless porpoise density slightly higher in the central portion of the Inland Sea in spring and early summer. The current density of finless porpoises is only about 4% that of the late 1970s in the eastern and central parts of the Inland Sea (east of position 22 in Fig. 3), while it is about 70% in the western part of the sea.

We do not know if finless porpoises in the Inland Sea constitute a single population, or if the abundance decline was accompanied by a population shift to the western Inland Sea. However, in view of the current distribution pattern of the species in the Inland Sea, it is possible that individuals remaining in the eastern and western parts of the sea have less opportunity for mixing than in the past.

We do not know what demographic changes were the major causes of the decline of finless porpoises in the Inland Sea. Shirakihara et al. (1993) recorded 84 finless porpoises killed by fisheries off western Kyushu and in the western part of the Inland Sea in 1985-92. Bottom gillnets killed 69% of them, surface gillnets 20%, trap nets 8%, and trawl nets and drifting discarded fishing nets each killed one individual. During the present study we identified all of these fisheries operating in the Inland Sea. Thus it is certain that entanglement in these fishing gears made at least some contribution to the observed population decline. We confirmed during the shipboard survey and fishing port hearing an intensive bottom gillnet fishery in the *Suwo-nada*, northern part of the western Inland Sea. Thus, it is reasonable to conclude that threats to the finless porpoise still continue in the last "refuge" of the species in the Inland Sea.

Annual capture fish production (excluding fish culture) in the Inland Sea recorded a peak of about 338,000 metric tons in 1985 and then declined to 209,000 metric tons in 1994, which was still slightly above the level of 1965 (Anon., 1996e). This change accompanied alteration of fish species, but the evaluation of the effect is difficult, because finless porpoises are known, as opportunistic feeders, to use numerous kinds of available food items (Kasuya, 1999).

Another factor that could have affected the finless porpoise population is deterioration of habitat of this extremely coastal species. Filling the shallow coastal waters to create land (reclamation) started in 1898 and about 440 km^2 of land was created in the Inland Sea (including Osaka Bay) by 1994, about 48% of which occurred during 1965-87 (Anon., 1996e). Reclamation often accompanies dredging the nearby bottom for the material, and destroys the coastal habitat in multiple ways. Sand has also been taken from the Inland Sea for industrial use. These activities presumably had adverse effects on the finless porpoise population, but the effect cannot be measured at present.

Discharge of organic material into the Inland Sea has been controlled, but various parameters of water quality, including total phosphorus and nitrogen in the seawater have not improved since 1978. The frequency of red tides recorded a peak of 299/year in 1975, and then dropped to around 100 in 1987 and remained at about that level thereafter (Anon., 1996e). No mass mortalities have been recorded in the Inland Sea for finless porpoises, but the effect of red tides on their survival remains to be investigated.

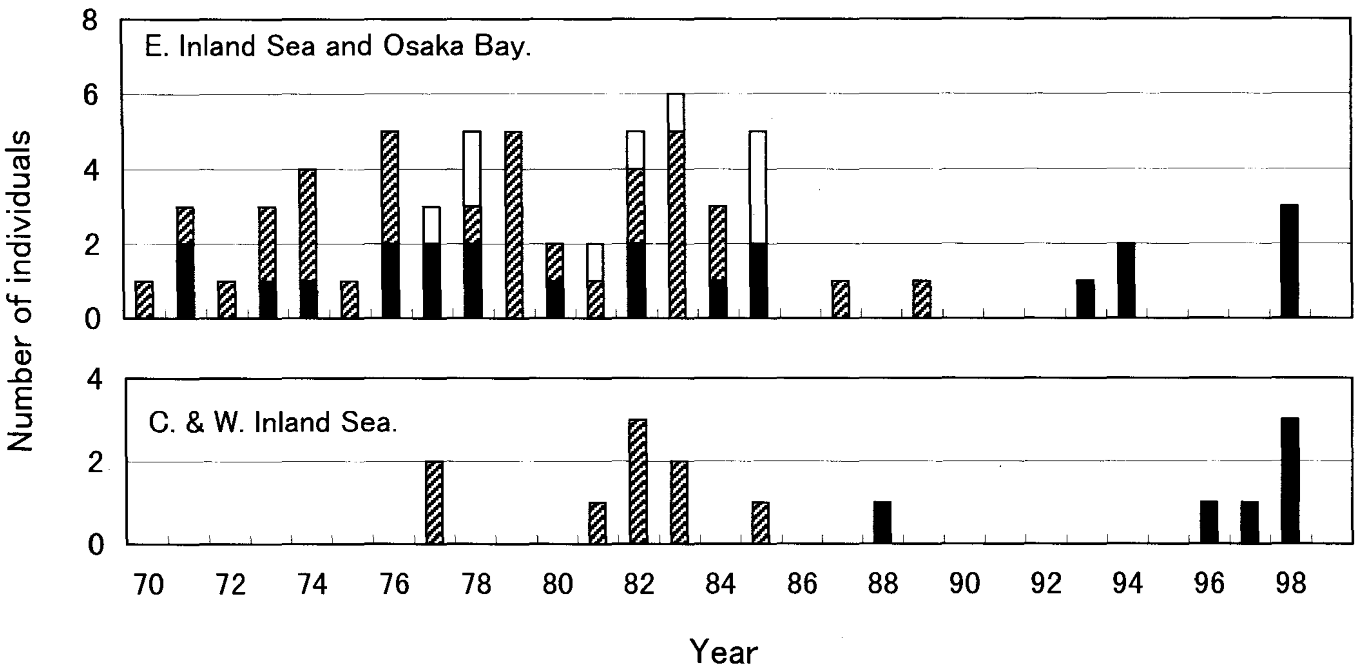

Fig. 4. Finless porpoise strandings and mortalities in fishing gear reported from the Inland Sea. Black squares: strandings; shaded squares: incidental mortalities; white squares: no information. For area divisions see footnote to Table 3. One record from Osaka Bay is also included (see Fig. 1).

Persistent ocean contaminants are a concern for marine mammals, because of their suspected adverse effects on survival and reproduction (O'Shea et al., 1999). Finless porpoises in the Inland Sea are known to accumulate high levels of such pollutants, e.g. total DDTs of up to 132 ppm in blubber (O'Shea et al., 1980), total PCBs of up to 320 ppm in blubber (O'Shea et al., 1980; Kannan et al., 1989) and total butyltins of 10 ppm in liver (Tanabe et al., 1998). Cargo boats using ports in the Inland Sea in 1994 increased to 126% of the 1973 level (1.56 million gross tons), and operation of high speed passenger boats seems to be increasing. When encountering a vessel, finless porpoises often dive in front of it (Kasuya & Kureha, 1979). Vessel collisions are likely to increase their mortality rate to some degree.

It is likely that many factors have caused the observed decline of the finless porpoise population in the Inland Sea. If we do not successfully reduce such adverse factors, finless porpoises in the Inland Sea will probably continue to decline to extirpation.

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