

Review of Baird's Beaked Whale (*Berardius bairdii*) around Japan, exploitation, current knowledge and suggestions for future research

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ABSTRACT

In the western North Pacific, Baird's beaked whales inhabit the Sea of Japan, the Okhotsk Sea and the Pacific Ocean north of 34 degree north latitude, and contain at least two populations but probably more. Their seasonal migration is not well understood. In Japan commercial hunting of this species with hand harpoons existed in around 1600 and continued to around 1887. Norwegian-type whaling (small-type whaling) for this species started in 1907 in Chiba Prefecture and expanded to other regions. Vessel regulation started in 1920 in Chiba and expanded to entire Japan in 1947. Catch quota was first set in 1983, and now permit annual take of 66 individuals in the above mentioned regions. Catch statistics left for hand harpoon fishery suggest possible decline of the species migrating into the near shore whaling ground. Statistics for the small-type whaling are available since 1932, but they are thought to be contaminated with poached sperm whales, which is evidenced at least for Chiba area for 1959 to 1974. Abundance estimates exist since 1984, but the trend analysis has not been attempted. Life history of this species is characterized by absence of sexual dimorphism and greater longevity of males, thus resulting in male excess in the population. Biological significance of this character is not well understood. Females are apparently reproductive for their life.

KEYWORDS: WHALING - SMALL TYPE, MANAGEMENT PROCEDURE, HABITAT, PACIFIC OCEAN, ABUNDANCE ESTIMATE

1 INTRODUCTION

Baird's Beaked Whale (*Berardius bairdii*) has been hunted in Japan since around 1600 by hand harpoon fishery and Norwegian type whaling since 1907. We review currently available information relating to the management of the species (distribution, abundance, catch, regulation and life history) hitherto published for the species around Japan.

2 TAXONOMY AND NOMENCLATURE

Baird's beaked whale (*Berardius bairdii*), known in Japan as Tsuchi Kujira, Tsuchi, Tsuchinbo, Asobi Kujira. This species is Categorized as "Data Deficient" for species by IUCN Red List 2008, "Rare" for three populations off Japan by Japan Fisheries Agency, Mammalogical Society of Japan.

There have been reported several strandings of *Ziphiid* species in northern Japan, external feature of which is most similar to *B. Bairdii* but the body size is smaller than it (Personal Comm

of Yamada 2010 cited in Kasuya 2011, Asahi Newspaper 2010). Its taxonomy has not been fixed yet, and this review does not deal with them.

3 DISTRIBUTION, POPULATION STRUCTURE AND MOVEMENTS

East China Sea

One individual of this species was reported from the East China Sea (Wang 1999). This individual is considered to have been a straggler (Kasuya 2011)

Sea of Japan

Sighting surveys in June to October in the eastern part of the sea (Kasuya and Miyashita 1997), records of whaling operations on the continental slope in the eastern Sea of Japan (i.e. west coast of Japan) in June to August (Omura et al. 1955), and records of stranding in February, April, October and December indicate that this species occurs in the entire Sea of Japans. These records cover most of the months of the year, and suggest that this species is a year round inhabitant of the Sea of Japan (Kasuya and Miyashita 1997), but their seasonal movement in the sea is still unknown (Kasuya 2011).

Because information of the species in the central and western part of the Sea of Japan is scarce and sighting survey has been limited the eastern half, it is inconclusive if there are any distribution gaps, or any population structures within the Sea of Japan (Kasuya 2011).

Kishihiro (2007) found significant difference of external measurements between the species taken in the northern part of the eastern Sea of Japan (i.e. off the west coast of Hokkaido) and those taken off Chiba, Pacific coast of central Japan, and concluded that they represent different populations.

Kishihiro (2007) also showed that the Sea of Japan specimens are about two feet smaller than those from the Pacific (in both maximum and average body lengths). Kasuya (2011) considered that this observation agrees with the difference in modal body lengths of about 3-4 feet reported by Omura *et al.* (1955), and felt that the size difference between the two areas (northern Sea of Japan and Pacific coast of central Japan) will be real.

Okhotsk Sea

Availabe systematic ship board sighting surveys cover almost the entire part of the Okhotsk Sea and the months from May to October (Kasuya and Miyashita 1997). Baird's beaked whales have been recorded from each of these months, and they occurred south of 55 degree north latitude and on the continental slope of about 1,000m isobath. Opportunistic sightings and whaling operations recorded this species along the Hokkaido coast of the Okhotsk Sea including the Nemuro Strait (both in the southern part of the Okhotsk Sea).

Baird's beaked whales have been recorded by Russian scientist to the north of the above records during the aerial sighting survey in April, May and December (Fedoseev 1985). They occurred in latitudes 54-59 degree north latitude in groups of 7-11 individuals swimming between ice floes. Fedoseev (1985) considers that these individuals are resident to the area for the whole year (i.e. not migrating from the south in particular season). The relationship of these individuals with those found in summer in the southern Okhotsk Sea needs to be investigated (perhaps also the taxonomic status, see above).

Kishiro's (2007) analysis of the external measurement showed that Baird's beaked whales taken off the southern Okhotsk Sea showed to be intermediate of those in the Sea of Japan and the Pacific specimens, and he reserved the conclusion.

Kasuya and Miyashita (1997), based on sighting and whaling records, suggested a possibility that there were more than one population of Baird's beaked whales in the Okhotsks Sea.

Pacific Coast of Japan

According to the results of whaling operation and sighting surveys along the Pacific coast of Japan, Baird's beaked whales are almost limited to the east of the Izu Peninsula (139 degree east longitude) and to north of 34 degree north latitude (Omura *et al.* 1955, Nishiwaki and Oguro 1971, Ohsumi 1983, Kasuya 1986, Kasuya and Miyashita 1997).

In summer most of these records occur on the continental slope between isobaths of 1,000m and 3,000m, and appears to be absent, or at least very scarce, in further offshore Pacific waters (Kasuya and Miyashita 1997).

Reported takes of the species since 1948 concentrated on the three grounds, i.e. Chiba (34-37 degree north latitude), Sanriku (37-40 degree north latitude) and Kushiro (41-43 degree north latitude). Recent operation (1973-1982) is almost limited to the Chiba ground, with the fishing season starting in July and almost ending by October, but the possible inclusion of poached sperm whales obscures the seasonality, particularly in the earlier years (Kasuya 2011). There appeared a trend of the fishing season to start earlier in the southern ground and move to the north, i.e. a peak in July in Chiba, August in Sanriku, and in September in Kushiro (Omura *et al.* 1955).

However, there has been obtained insufficient data if this seasonality is real (i.e. not an artefact related to availability of other species such as minke whales), or if it reflects south to north movement of the species, or if it only reflects inshore/offshore movement of the species (Kasuya and Miyashita 1997). The possibility of mixing of Baird's beaked whales in the southern Okhotsk Sea and the Kushiro ground through the Nemuro Strait and the Kuril Islands should also be investigated. Kishiro (2007) proposed, based on external morphology, that Baird's beaked whales taken off Chiba belong to different stocks with those taken in the Sea of Japan(see above).

Wintering ground of Baird's beaked whales that summer along the Pacific coast of Japan has not been confirmed. Subramanian *et al.* (1988) used PCB/DDE ratio for this purpose. They found that the ratios for Baird's beaked whales migrating to the Chiba ground in summer ranged 0.18-0.41 (mean=0.24, n=13), which was close to the values 0.37-0.41 (mean=0.39, n=3) for the dalli-type Dall's porpoise taken off Kushiro (which are believed to winter in the Sea of Japan), and concluded that Baird's beaked whales that summer off Chiba will winter on the continental shelf area (i.e. no offshore/inshore migration). Kasuya (2007), identifying that the *Berardius* data presented by Subramanian *et al.* (1988) are close also to northern form short-finned pilot whales (which are resident off Sanriku-Kushiro region), thought that even if the method is useful to reject some waters to narrow the possible candidates it will be risky as a method to determine certain area as the wintering ground.

4 LIFE HISTORY PARAMETERS

Following life history information has been obtained using carcasses taken in the Chiba ground and processed at the Wadaura station in 1975 and 1985-1987 summer seasons (Kasuya, Brownell and Balcomb 1997), and interpreted assuming annual deposition of growth layers in the tooth (Kasuya 1977).

Sexual maturity and longevity

Females experience their first ovulation at ages between 10-14 years at average body length of 9.8-10.6m and live to a maximum age of 54 years.

Males start spermatogenesis at ages 6-9 years (at single testis weight of 290-370g), and attain the full sexual maturity (which is a stage where all the tubules at the testicular center are spermatogenous) at ages 6-10 years (at testicular weight of 1.4-1.5kg, and body length 9.1-9.6m). If we assume that they become reproductive at this latter stage, male sexual maturity is 4-5 years earlier than that of females. Testicular tissue continues further increase till age of around 40 years (to reach a testicular weight of 4.8-5.9kg). The maximum longevity has been observed at 84 years which is 30 years greater than females.

Age and body length and age at physical maturity

Females attained physical maturity at ages around 14-15 years when they are 10.45m in average, and males at ages 9-15 years and at 10.10m in the average. These ages are only slightly higher than the ages at sexual maturity.

Apparently, males mature at younger age, at slightly smaller body size, and live longer. No sexual dimorphism exists on this species.

Body length at birth and length of gestation

Omura *et al.* (1955) estimated body length at birth at 15 feet (4.85m) using limited data. This figure is slightly greater than the corresponding figures for sperm whales cited in Best *et al.* (1984), but considered to be reasonable because female Baird's beaked whales mature at greater body length than sperm whales off Japan (9.4-9.9m reported by Ohsumi and Satake 1977).

There are no data to allow direct estimation of gestation period. The above body length at birth and interspecies relationship suggest the gestation length of Baird's beaked whales at 517 days or 17.0 months (Kasuya 1977).

Reproductive cycle and its age dependent change

Insufficient data are available to estimate reproductive cycle. Pregnant females off Chiba had fetuses of 4-9 feet, suggesting conception and parturition seasons sometime in Autumn to Spring or outside of the fishing season.

27 sexually mature females were represented by 8 pregnant, 12 lactating and 7 resting females, which gives an apparent pregnancy rate of 29.6%. Assuming, without firm evidence, that weaning would occur before the fishing season and using these data. Kasuya (2011) suggested the average calving cycle could be 3.4 years.

Regression of corpora counts on age gave annual ovulation rate of 0.47 (Kasuya *et al.* 1997), which is not inconsistent with the above estimate of average calving cycle.

No age dependent decline in fecundity has been confirmed on the female Baird's beaked whale.

Mortality

Natural or fishing mortality rates have not been estimated.

Sex ratio

Sex ratio seems to be even or females may slightly exceed males at younger ages, but after age of sexual maturity female proportion start to decline, i.e. 13 males: 16 female (<10 years), 17: 16 (10-19 years), 33:15 (20-54 years), and 22: 0 (>54 years).

Similar imbalance in sex ratio has been recorded in broader geographical range (but no age information), and segregation between sexes is excluded as the possible cause of biased sex ratio. And such biased sex ratio is considered to be due to the higher natural mortality rate of females, although selective benefit of such biased sex ratio has not been explained (Kasuya 2011).

5 abundance and trends

5.1 Abundance

There are available Five abundance estimates for Baird's beaked whale around Japan, These estimates are given in Table 1, and brief explanation is given below.

1. Miyashita (1986). As a part of $g(0)$ correction he added 19% to compensate whales missed by observers because they were below surface when sighting vessel passed over. This figure was created using observation of dive/surface time in Kasuya (1987), and vessel speed. This figure was reviewed by the Scientific Committee in 1985.

2. This figure appeared in the Progress Report of Japan in 1989 (Anon. 1990).

3. Miyashita (1990). This estimate was submitted to SC in 1990, and cited in IWC (1991). Correction for underwater individuals was done in the same way as above 1.
4. Miyashita and Kato (1993). Reviewed by SC (IWC 1994). There are minor difference in the confidence limits between Miyashita and Kato (1993) and IWC (1994).
5. Okamura *et al.* (2011). This analysis was apparently based on the same idea as Miyashita (1986) to correct for whales passed by sighting vessels while stayed underwater, but used different dive profile which was obtained from animals attached with a data logger of Minamikawa *et al.*

5.2 Trends

There has been published no analysis of trend of abundance based on estimates cited above.

6 Direct removals

6.1 Directed takes

Kasuya (2011) reviewed published information of Baird's beaked whale fishery in Chiba Prefecture. The oldest record of the fishery is known from around 1600. This fishery started in the entrance of the Tokyo Bay near Takeoka (c. 35 degree 14 minutes north latitude) where submerged canyon extends from the south. This fishery, operated using hand harpoons and rowing/sailing boats in June to August, almost ceased the operation by around 1887.

Kasuya (2011) observed a declining trend in this fishery during 1815 to 1869. The annual catch of this fishery fluctuated between zero and 25 whales, but the ratio of [good year (catches >14 whales)] : [bad year (catches <6 whales)] changed during the period, i.e it was 7 years :8 years during the earlier 27 seasons of 1815-1841, but it was 2 years: 11 years during the subsequent 18 seasons of 1842-1869. Kasuya (2011) interpreted the decline in the proportion of good years as an evidence of decrease of Baird's beaked whales migrating close to the inshore fishing ground (this may not necessarily represent correct trend of the population).

Following some attempts to use bomb-lance-gun from rowing boats started in 1887, use of small calibre whaling cannon mounted on powered vessel (i.e. Norwegian-type whaling, and we call it small-type whaling) for Baird's beaked whales started in 1907 at Tateyama (c. 35 degree north latitude). The land station later moved to further off the bay to reach at Wadoura, which faces the current whaling ground off Chiba. Such shift of the whaling station from bay to outer shore could have been to approach better fishing ground.

Recent statistics of Baird's beaked whale fishery by small-type whaling are shown in Table 2. It recorded a great expansion in the 1950. However a suspicion was expressed by Kasuya (2011) on the

accuracy of the statistics of this period due to the possible inclusion of poached sperm whales, although such evidence is limited to the operation off Wadoura, Chiba Prefecture (Balcomb and Goebel 1977), where poaching of sperm whales continued from 1959 to 1974 (Kasuya 2011).

Number of catcher boats operating for this species off Chiba was regulated by Chiba Prefecture Government since 1920. Japanese Government introduced license system to the small-type whaling in 1947 to control the total number of catcher boats operating off Japan (Ohsumi 1975, Kasuya 2011), and then it introduced quota system for this species in 1983 as a voluntary regulation. The quota was 40 at the beginning, and now increased to 66 (Table 3)

Scientific Committee's Sub-committee on small cetaceans noted that this catch was about 1% of the population estimate---- The subcommittee noted that in the absence of an estimate of gross reproductive rate, it did not know whether or not the population could sustain the present level of catch. To investigate this question further it was agreed that studies on school structure would be desirable (IWC 1986). Since then, Government of Japan increased the quota several times and expanded the operation to the Sea of Japan (Table 3).

6.2 Incidental takes

Marine Mammals Stranding Database by National Museum of Nature and Science, Tokyo (<http://svrsh2.kahaku.go.jp/drift/e/>) have 67 cases of strandings, washed ashore or sightings, from 1941 to 2010. Among those, 5 cases were categorized as incidental takes. Two by small type "set nest" (a kind of fixed trap net), one by salmon set net, one by scallop farming, and one by drift net (Table 4). These records must be considered with caution because most of the Baird's beaked whales killed incidentally in the offshore gillnet fisheries could have been discarded in the sea and left unreported. Such gillnet fishery existed in the Sea of Japan, Okhotsk Sea and northern North Pacific.

7 Other actual and potential threats

Actual/ Potential Threat	Anthropogenic activity/ies	Evidence ¹	Possible impact ²
<i>Serious injury/death (not direct take or bycatch)</i>	Unknown	-	-
<i>Prey depletion</i>	Unknown		
<i>Acoustic pollution/harassment</i>	Unknown		
<i>Chemical pollution</i>	High concentration of mercury, HDBPs and or PCBs were found in this species. Concern raised since Fukushima No1 nuclear power plants accidents and release of radioactive materials into ocean. No evidence yet.	Endo <i>et al.</i> (2003), Endo <i>et al.</i> (2005), Haraguchi <i>et al.</i> (2006)	Unknown

8 status

Status of the populations of this species off Japan has not been assessed.

9 Recommendations

It is most important to clarify population structure of the species off Japan, if hunting of Baird's beaked whales continues there.

Abundance estimates need to be improved for each population thus identified, and trend in abundance should be examined.

Quota should be maintained at a safe level, because it is unlikely that we can estimate abundance and life history parameters with sufficient precision for calculation of quota.

Status of exploitation of this species by range countries should be collected.

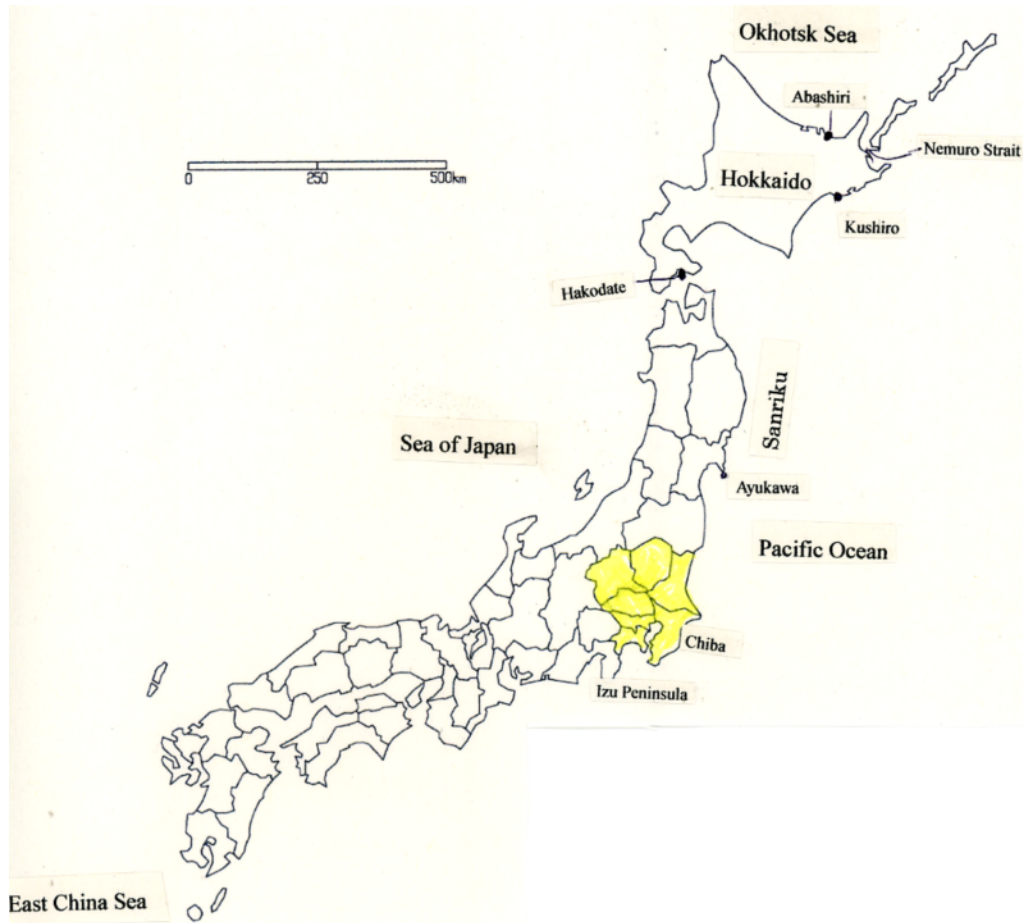
Currently available information is limited, however, information available to present suggests a peculiar life history and social structure of this species. Although we do not know if it is common among *Ziphiidae* or limited to the Baird's beaked whale, further information will improve our biological science of toothed whales and will, in the long term, facilitate the conservation of the species.

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Map of Japan



Map of Kanto Region



Table 1. Abundance Estimates of Baird's Beaked Whales around Japan

	Survey year	Pacific side	East side of Sea of Japan	Southern Okhotsk Sea	Source
1	May to September, 1984	4,200 (0.295) ^{*1}			Miyashita 1986
2		2,500	1,000		Anon. 1990
3	August. 1983-1989	3,948 (0.276) ^{*1}			Miyashita 1990, IWC 1991
	May to October, 1983-1989		1,468 (0.390)	664 (0.270)	
4	August to September, 1991-1992	5,029 (1,801-14,085)			Miyashita and Kato 1993
					IWC 1994
5 ²	2008	10,190			Okamura <i>et al.</i> 2011
	2009	7,307			Okamura <i>et al.</i> 2011

Inside of parentheses are coefficient of variance or 95% CL by original authors, except 2 which is from SC Report (IWC 1994).

*1: when calculate 95% CL from these coefficient of variances with assumption of proper distribution, 50% or more on both side.

*2: Added from 2 (2008) and 3(2009) areas estimates, as no total estimate were in Okamura et al. (2011). 1,515 (0.702), 8,675 (0.584), -- for 2008, 560(1.244), 6,135 (0.504), 612 (0.668) for 2009

Table 2. Official statistics of Baird's beaked whales take by small-type whaling in Japan (from Kasuya 2011, and JFA 2012 for 2009 and 2010). Statistics for 1943-1946 are not available.

Year	Chiba	Sanriku	Kushiro	Abashiri	Sea of Japan	Country Total
1932	31	-	-	-	-	-
1933	31	-	-	-	-	-
1934	34	-	-	-	-	-
1935	35	-	-	-	-	-
1936	33	-	-	-	-	-
1937	50	-	-	-	-	-
1938	34	-	-	-	-	-
1939	50	-	-	-	-	-
1940	25	-	-	-	-	-
1941	23	-	-	-	-	-
1942	36	-	-	-	-	-
1947	60					
1948	43	0	2	24	4	76
1949	48	0	0	30	14	95
1950	122	18	1	19	26	197
1951	108	102	11	18	13	242
1952	72	202	26	11	10	322
1953	83	-	-	-	-	270
1954	76	-	-	-	-	230
1955	52	-	-	-	-	258
1956	53	-	-	-	-	297
1957	73	-	-	-	-	186
1958	82	-	-	-	-	229
1959	73	-	-	-	-	186
1960	79	-	-	-	-	147
1961	72	-	-	-	-	133
1962	64	-	-	-	-	145

Cont.

Cont.

1963	81	-	-	-	-	160
1964	68	-	-	-	-	189
1965	68	60	19	25	0	172
1966	85	54	17	15	0	171
1967	58	27	14	8	0	107
1968	80	27	9	1	0	117
1969	91	32	4	7	0	138
1970	54	-	-	-	-	113
1971	68	-	-	-	-	118
1972	79	-	-	-	-	86
1973	30	-	-	-	-	32
1974	32	-	-	-	-	32
1975	39	-	-	-	-	46
1976	11	-	-	-	-	13
1977	28	-	-	-	-	44
1978	33	-	-	-	-	36
1979	28	-	-	-	-	28
1980	31	-	-	-	-	31
1981	36	-	-	-	-	39
1982	57	0	0	3	0	60
1983	33	0	0	4	0	37
1984	35	0	0	3	0	38
1985	36	0	0	4	0	40
1986	35	0	0	5	0	40
1987	35	0	0	5	0	40
1988	22	13	0	22	0	57
1989	27	22	0	5	0	54
1990	27	25	0	2	0	54
1991	27	25	0	2	0	54

Cont.

Cont.

1992	27	25	0	2	0	54
1993	27	25	0	2	0	54
1994	27	25	0	2	0	54
1995	27	25	0	2	0	54
1996	27	25	0	2	0	54
1997	27	26	0	1	0	54
1998	26	26	0	2	0	54
1999	26	26	0	2	8	62
2000	26	26	0	2	8	62
2001	26	26	0	2	8	62
2002	26	26	0	2	8	62
2003	26	26	0	2	8	62
2004	26	26	0	2	8	62
2005	26	26	0	4	10	66
2006	26	26	0	4	10	65
2007	26	27	0	4	10	67
2008	26	25	0	3	10	65
	Pacific			Okhotsk Sea	Sea of Japan	
2009	53			4	10	67
2010	52			4	10	66

Table 3. Annual quota of Baird's beaked whales given for the operation of small-type whaling off Japan (Kasuya 2011).

Period	Total	Wadaura, Chiba	Ayukawa, Miyagi	Abashiri, Hokkaido	Hakodate (Sea of Japan)	Remarks
1983 - 1987	40	35	0	5	0	Start of voluntary regulation
1988	57	22	13	22	0	Temporary increase ^{*1}
1989	54	27	22	5	0	Quota decreased with reduction of whaling boat
1990 - 1998	54	26	26	2	0	
1999 - 2004	62	26	26	2	8	Stated as special quota for Sea of Japan ^{*2}
2005 - 2010	66	26	26	4	10	Statement of special quota disappears

*1, With suspension of minke whaling, Baird's beaked whale quota was distributed to all the small-type whaling company. Quota once increased as temporary measure changed permanent.

*2, Also called as Special quota or Special Measure.

Table 4. Record of incidental mortality of Baird's beaked whales off Japan.

Date/Month/Year	Male	Female	Unknown	Place	Area	Fishing gear	Dead/Alive	Remarks
30, April 1988			1	Hokkaido Matsumae-gun Matsumae-Cho	Sea of Japan	Drift net	D	About 2 days after death
?, August 1988			1	Hokkaido Tokoro-gun Saroma-Cho	Okhotsk Sea	Scallop farming		
29, August 2002		1		Hokkaido Shibetsu-gun Shibetsu-Cho	Pacific Ocean/Okhotsk Sea	Salmon set net	A then D	
20, June 2003		1		Hokkaido Nemuro-shi	Pacific Ocean	Small Type set net	A then D	
20, July 2004			1	Hokkaido Menashi-gun Rausu-Cho	Okhotsk Sea/Pacific Ocean	Small Type set net	D	Probably calf