The results of long-term monitoring and first evidence of stable social associations in Baird's beaked whales (*Berardius bairdii*) in the waters of the Commander Islands, Russian Far East

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ABSTRACT

The waters off western Bering Island provide a convenient place for the detection and observation of Baird's beaked whales because a deep-water trench lies close to shore. During 2007-2011, we observed 85 groups (a total of 597 animals) of Baird's beaked whales from shore with a mean group size of 7.1±5.01 animals. During our boat-based work, we encountered 21 groups (188 individuals). The mean size of groups encountered at sea was 9.0±5.55 animals. Baird's beaked whales were observed much more frequently in April-June and August-November, than in mid-summer. We analyzed the photo-ID data from 20 encounters with Baird's beaked whales during four field seasons (2008-2011). We identified 78 individual animals. We found 48 matches of individual animals within and between field seasons. We found several long-term social associations numbering two to five animals. The time between the re-sightings of these associations within a field season was 4 to 130 days, and between seasons 245 to 778 days. One stable alliance numbering two animals was registered four times, and the maximum time between the re-sightings of this association was 1194 days (more than 3 years). Analyzing the shape of the scars on the animals' back and flanks, we found 20 animals with scars from killer whale (*Orcinus orca*) teeth, 36 animals with scars probably from drift and other nets and three animals with other anthropogenic scars. All adult animals had scars from cookie-cutter shark bites suggesting travel and time spent in warmer waters. Over the past 130+ years, there were only nine known strandings of Baird's beaked whales on the Commander Islands, though the species appears to be common (though perhaps not numerous) in the area.

INTRODUCTION

Little is known about the ecology and social structure of Baird's beaked whales. Few detailed life history and behavioural studies have been conducted to date; some information about the species comes from the whaling industry in Japan (Kasuya and Ohsumi 1984, Kasuya 1986, Balcomb 1989; among others). In the 1930s, information about this species in the Russian Far East seas was collected by Soviet whalers, but this whale was described as *Hyperoodon ampullatus)* (Tomilin 1937) or *Hyperoodon rostratus* (Tomilin 1938) instead of Baird's beaked whale. Tomilin (1937, 1938) published some information about morphology, behaviour, distribution and migration patterns of Baird's beaked whales along the Kamchatka coast.

In both the eastern and western North Pacific and adjacent seas, the overall pattern of migration for Baird's beaked whales has been described as moving towards continental slopes and sea floor escarpments in spring through autumn, when water temperatures are highest, and away from them in winter (Tomilin 1967, Dohl et al. 1983, Kasuya 1986, Balcomb 1989).

The waters off the western shore of Bering Island, in the Commander Islands, provide a convenient place for the detection and observation of Baird's beaked whales because a deep-water trench lies close to shore. The main prey of these whales in Bering Sea waters are thought to be deep-sea squids living along the deep slope relatively close to shore. Balcomb (1989) cited various authors in compiling a prey list of benthic and epibenthic species including squid (*Gonatus* sp., *Onychoteuthis* sp., *Moroteuthis* sp.), skates (*Raja* sp.), rat tails (*Coryphenoides* sp.), rockfish (Scorpaenidae), octopus (*Octopus* sp., *Tremoctopus* sp.), mackerel (Scombridae), sardine (*Sardinops* sp.) and saury (*Cololabis* sp.).

Baird's beaked whales, especially older individuals, are known to be heavily scarred with scratches, pock-marks and irregular white gouges (Balcomb 1989). Baird's beaked whale teeth are apparently used "pugnaciously" (McCann 1974). Both sexes are thought to participate in pugnacious behaviour of body scratching one another, with scars appearing around the time of sexual maturity and accumulating thereafter. As Balcomb (1989) writes, this behaviour may even become "extreme at times, perhaps even lethal." Other creatures also bite, scratch and scar these whales. The careful analysis of these scars can aid the process of photo-identification, as well as contributing to our understanding of migration patterns and the impacts of parasites, predators, and anthropogenic factors on these animals.

MATERIALS AND METHODS

Our studies included both land-based observations from permanent observation points and boat-based work at sea. The field study efforts were conducted regularly from mid-May until late September and irregularly during the rest of the year between 2007 and 2011.

Land-based observations

We made visual observations from shore by uniformly scanning the entire visible water area and measuring bearing and distance to the whales using Bushnell 7×50 and Fujinon 7×50 binoculars with a built-in compass and a goniometric scale, which allowed us to calculate the geographic coordinates for each animal and plot the registrations on a map showing depth contours. Our permanent observation point (54° 58' 53.5" N, 166° 10' 30.7" E) was located on a cliff 39m above sea level. The observations were made on shifts during all daylight hours, weather permitting. We scanned each sector with a gradual movement of the binoculars (about 10° per minute). The total coverage area was 156°. We made two 15-min scans per hour. During the 15-min breaks between scans we surveyed the area by eye.

In winter and spring, irregular observations were conducted from another observation point (55° 01' 31.9" N, 166° 07' 41.4" E) 40m above sea level.

Every time Baird's beaked whales were observed, we noted the number of animals in the group. During the analysis we excluded groups that appeared to be repeated sightings of the same group (for example, if two groups with the same number of animals were noted in two consecutive scans).

We calculated the distance to the registered groups from the height of the observation point and the vertical angle to the whales using the Lerzak-Hobbs formula (Lerzak and Hobbs 1998). The distance and the bearing angle were used to calculate the coordinates of the whales, which were then put on the depth chart.

Boat-based observations

While working directly with the animals at sea (0 to 20km from shore), we cautiously approached groups of whales at a distance of 20-30m to make photographs. We registered the total number of individuals in a group, type of activity and the coordinates for each encounter. In some cases we made recordings of underwater vocalizations.

Photo-identification of individual animals

All photographs were analysed and individual animals were identified through natural markings including scars and scratches on the body and notches on the dorsal fin. Identified animals were arranged into a photo-identification catalogue, and matches of the same animals from different encounters were analysed.

Traumatic body markings

While analyzing the photographs, we noted specific scars on beaked whale bodies – scars and scratches from killer whale (*Orcinus orca*) bites (Fig. 1), scars which we consider to be the results of drift net entanglement (Fig. 2), scars from cookie-cutter shark bites (*Isistius brasiliensis*) (Fig. 3), and other unusual scars and injuries. All these marks were different from species-specific scars from the conspecific teeth, which are typical for all adult animals. Killer whale teeth scars are usually five or more parallel scars 30mm or more apart, equally shaped and typically starting with a deep bite mark. We did not consider parallel scars in groups of four and less, because they could be caused by conspecifics. When the scars from killer whales were present, we noted their position on the animal's body and estimated the number as "few", "some" and "many".

Many Baird's beaked whales had specific scars behind the dorsal fin, which we consider are caused by the whale's entanglement in drift (and/or other) nets. Some photographs clearly show the entanglement marks. In most cases the marks from the nets represent regular scars behind the dorsal fin and on the ridge of the caudal peduncle. We estimated their number as "few", "some" and "many". Animals for which we had no photographs of the caudal area were excluded from the analysis.

Scars from cookie-cutter shark bites usually appear as round, oval or half-moon marks (Jones 1971, Papastamatiou et al. 2010). We found such scars on most animals; they were absent only on calves. We estimated the number of these scars as "none", "few", "some" and "many". All photographs of insufficient quality, which did not allow the estimation of presence and extent of scarring, were excluded from the analysis.

Fig. 1. Killer whale scars on a Baird's beaked whale

Fig. 2. Scars on Baird's beaked whale from drift net entanglement

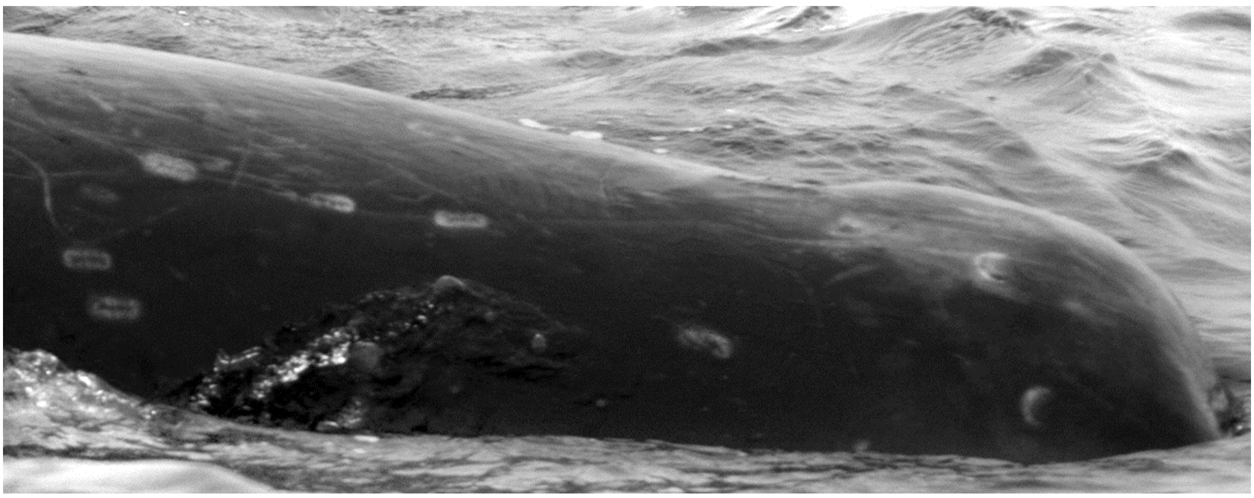

Fig. 3. Cookie-cutter shark scars on a Baird's beaked whale

RESULTS AND DISCUSSION

Land-based observations

The total duration of visual observations was 1778 hours 10 minutes, including 819 hours 18 minutes of area scanning as described above (total = 3250 scans). During the research period 2007-2011, we observed 85 groups of Baird's beaked whales (a total of 597 individuals) from shore. (Note that land-based observations do not allow us to distinguish between individual animals.) The group size was (mean±SD) 7.1±5.01 animals. The average distance from the observation point to the plotted whales was 6.1 ± 2.29 km. As can be seen on the map (Fig. 4), almost all of the Baird's beaked whale registrations were in the slope area, which is consistent with the known information about the ecology of the species (Balcomb 1989, Culik 2011).

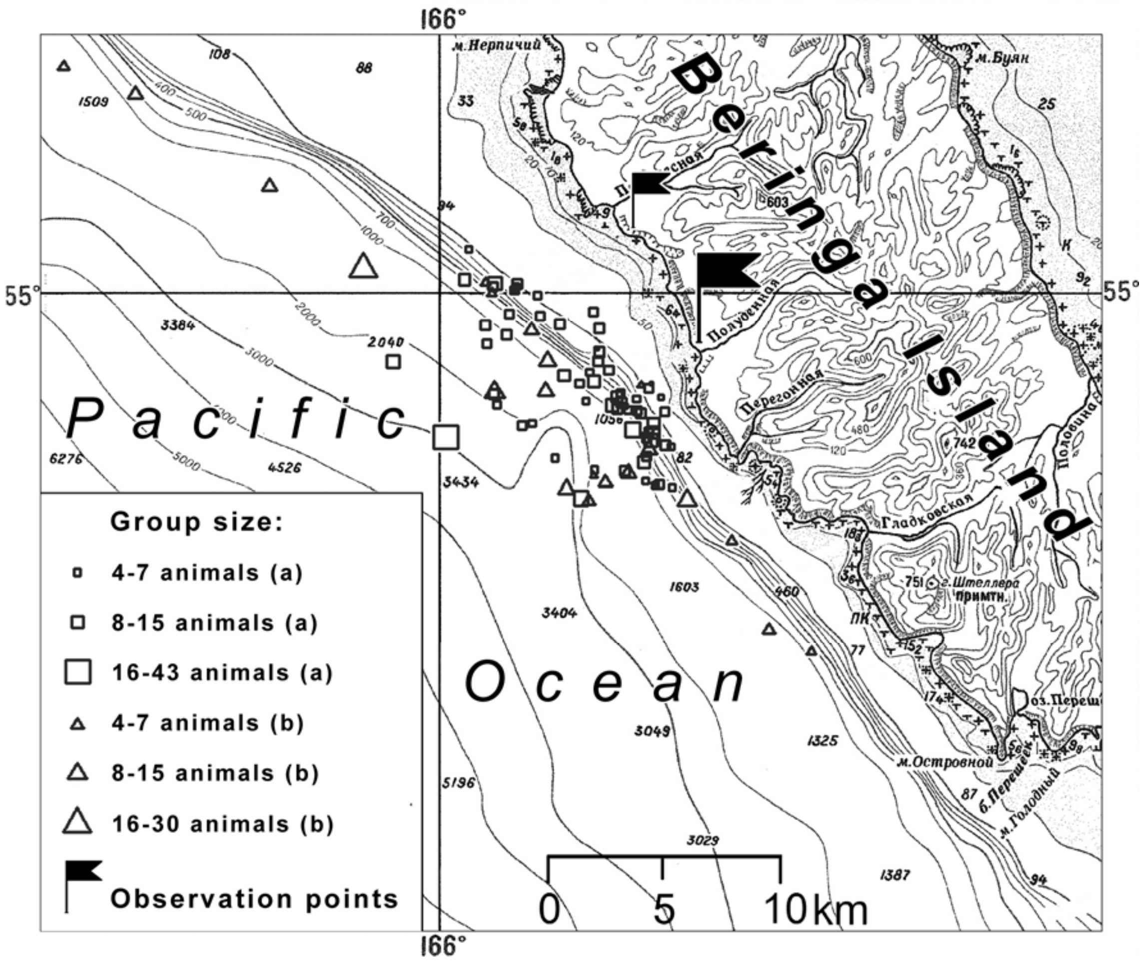

Fig. 4. The positions of Baird's beaked whales recorded on the depth chart: squares - from shore, and triangles - during boat-based work at sea.

Boat-based observations

We encountered 21 groups (188 individuals) during our boat-based work at sea. Many individuals were seen repeatedly. The size of groups encountered at sea was (mean±SD) 9.0±5.55 animals.

Examining the photo-identification catalogue allowed us to find matches of individual beaked whales both within and between field seasons. No matches between Commander Islands and other regions of the Russian Far East (Avacha Gulf, Ozernoy Gulf and Karaginskiy Gulf of Kamchatka) were found. The presence of cookie-cutter shark bites on many animals indicate that these whales probably migrate to subtropical waters.

Baird's beaked whales were observed much more frequently in April-June and August-November, than in mid-summer (Fig. 5). This suggests that the waters of the Commander Islands are not a summer feeding ground, but the whales pass the area in the course of their spring and autumn migrations. Alternatively, it is possible that whales stay in the area but move farther from shore in mid-summer, so that we are not able to detect them.

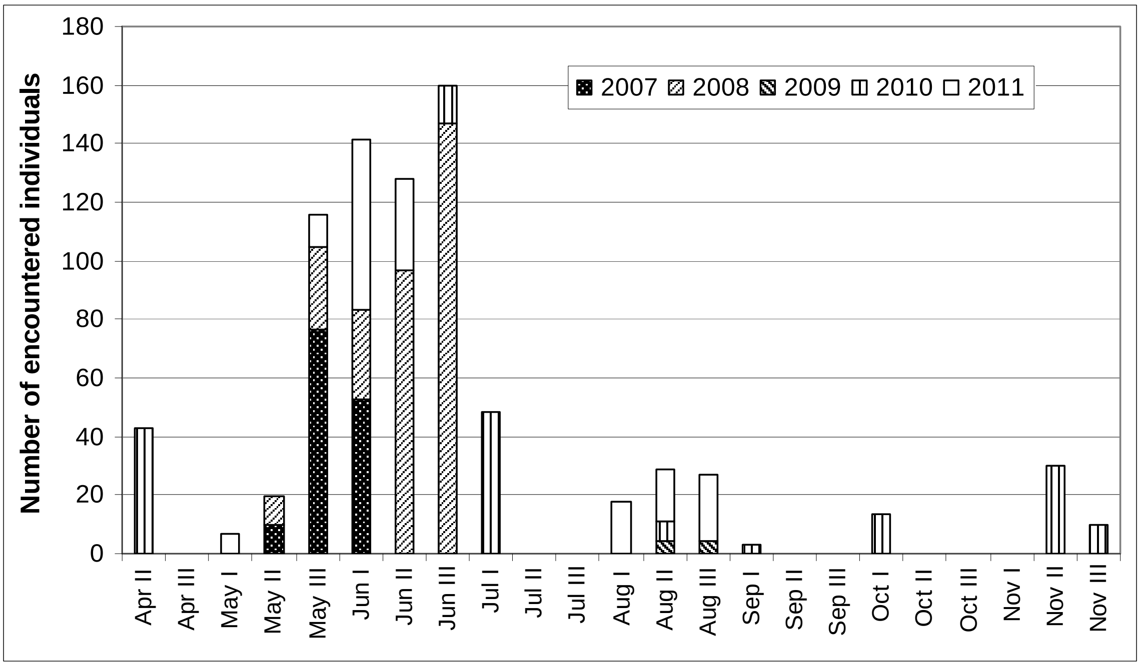

Fig. 5. The total number of Baird's beaked whales encountered at sea and observed from the shore in different years, grouped by months. Note that observations from October to mid-May were irregular.

Social associations

We analysed the photo-ID data from 20 encounters with Baird's beaked whales during four field seasons (2008-2011) and were able to identify 78 individual animals. We then identified 48 matches of individual animals: sixteen animals were encountered twice, three animals were encountered three times, six animals were encountered four times, and two animals were encountered five times. Two other animals were re-sighted after three years, five animals after two years, and nine animals after one year. We found several long-term social associations numbering two to five animals – in five cases *between* field seasons and in six cases *within* a field season. The periods between the re-sightings of these associations within a season were 4, 9, 14, 25, 73 and 130 days, and between seasons – 245, 286, 327 and 778 days. One stable alliance numbering two animals was registered four times (Co004 and Co008, see Table 1), and the maximum time between the re-sightings of this association was 1194 days (more than 3 years).

These stable alliances were encountered either on their own, or in groups with other animals for which no stable associations were registered. Three times we observed several stable alliances in the same large group (up to 15 - 30 animals). Animals in these groups demonstrated surface-active behaviour and, in two cases, produced underwater vocalizations of whistles and buzzes (Fig. 6). Whistles and buzzes, previously recorded from Baird's beaked whales, had a fundamental frequency of 4-8 kHz (Dawson et al. 1998). In our recordings we had some whistles in the same frequency range (Fig. 6a), but most whistles had higher fundamental frequencies up to 25.5 kHz and a characteristic multi-looped shape with a final down-sweep whistle (Fig. 6b).

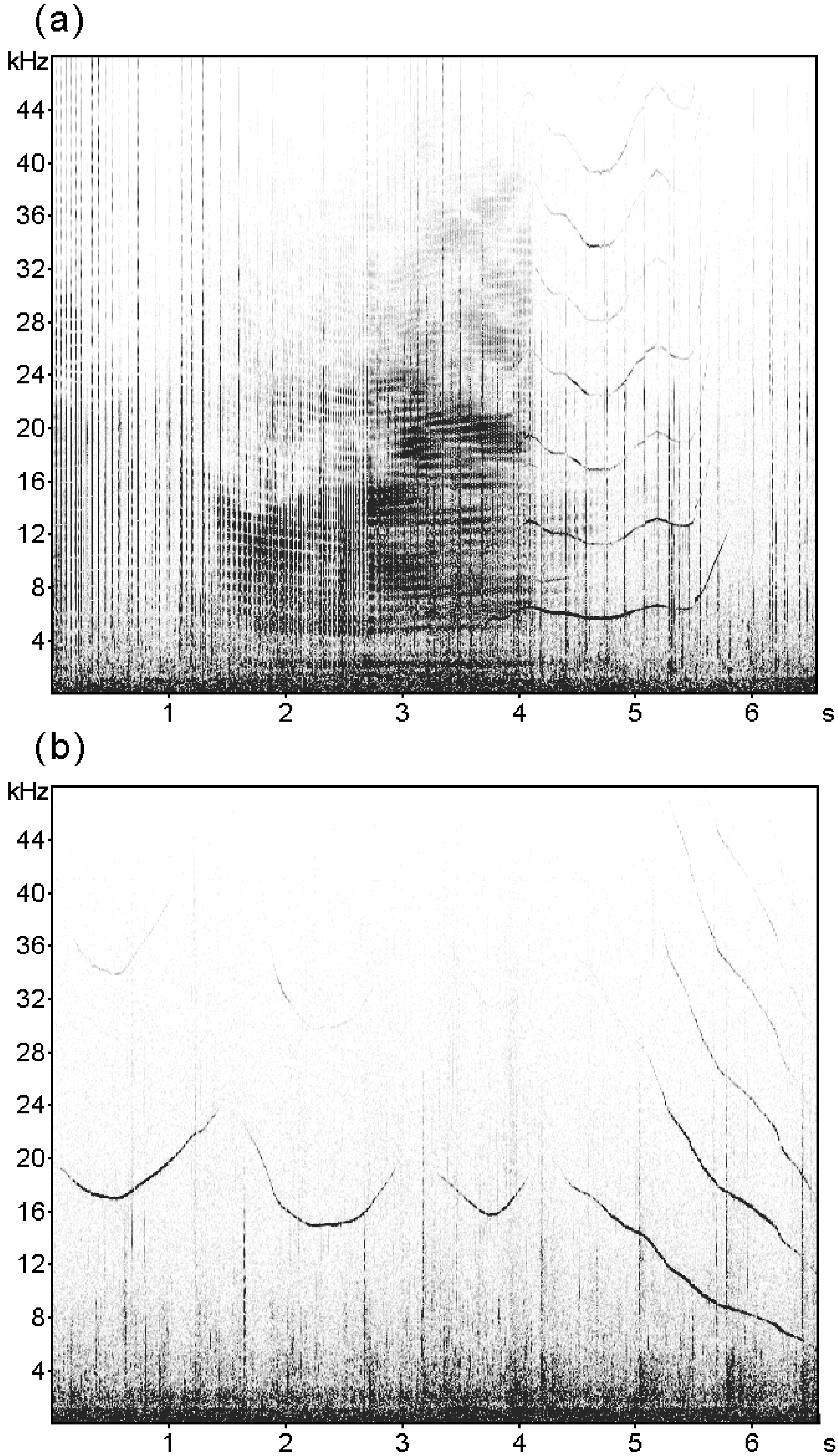

Fig. 6. Sounds recorded from Baird's beaked whales: (a) buzz and low-frequency whistle; (b) high-frequency multi-looped whistle.

Table 1. The resightings of Baird's beaked whales in the waters of the Commander Islands (only individuals encountered two and more times are shown).

Whale ID	19 May 08	26 Jun 08(I)	26 Jun 08(II)	30 Jun 08	06 Jul 10	03 Oct 10(I)	13 Nov 10	05 May 11	23 May 11	01 Jun 11	02 Jun 11	05 Jun 11	14 Jun 11	17 Jun 11	26 Aug 11(II)
Co007	+						+								
Co001	+						+								
Co004	+				+		+								+
Co008	+				+		+								+
Co010	+				+										
Co022					+		+								
Co021					+		+								
Co023					+		+	+							
Co024					+		+								
Co025					+		+		+					+	
Co017		+			+										
Co011			+	+											
Co012			+	+						+			+		
Co013			+	+											
Co014			+	+					+					+	
Co037						+									+
Co035						+	+					+	+		+
Co036						+						+			
Co026							+								+
Co044							+								+
Co062											+	+			
Co055										+	+	+	+		
Co056										+	+	+	+		+
Co057										+		+	+		
Co068												+	+		
Co060									+					+	
Co061								+	+					+	

It is possible that the social structure of Baird's beaked whales in the waters of the Commander Islands resembles a fission-fusion society with some animals forming long-term social associations. Similar social structures were described in some odontocete species, such as common bottlenose dolphins (*Tursiops truncatus*) (Connor et al. 2000) and northern bottlenose whales (*Hyperoodon ampullatus*) (Gowans et al. 2001).

Traumatic body markings

Scars from killer whale teeth were found on 15% of the whales (20 animals out of 75 total). Eight animals had "few" scars, seven had "some" scars and five – "many" scars (40%, 35% and 25% of all animals with killer whale scars, respectively). Most of the killer whale scars were localized in the anterior part of the animal's body: mostly on the dorsal part of the pectoral area, dorsal part of the jugular area and on the lateral parts of the pectoral area. On two occasions these scars were present on the dorsal fin. These scars were not observed in the caudal area. The appearance and degree of healing of these scars suggest that both juvenile and adult animals experience killer whale attacks.

Marks from the drift nets (and/or probably other nets) were found in 56% of animals (36 of 64 total): 18 with "few" scars, 14 with "some" scars and 4 with "many" scars (50%, 39% and 11% of all animals with net scars, respectively). There are few reports of Baird's beaked whales as part of the bycatch in drift nets. Ohsumi (1975) reported two cases of entanglement during Japanese scientific drift vessel operations in 1962-1971, which was 0.03 individuals per 1000 km of nets (compared with bycatch of Dall's porpoise (*Phocoenoides dalli*) at 11.38 individuals per 1000 km of nets, and killer whale – 0.01 individuals per 1000 km of nets) (Ohsumi 1975). Artukhin et al. (2010) reviewed and analysed all known data on marine mammal bycatch in Russian and Japanese drift net salmon fisheries in the western North Pacific from 1962-2008, but they also reported only two cases of Baird's beaked whale bycatch. Therefore, we can suppose that Baird's beaked whales have regular contact with nets, but usually manage to avoid or break out of them. However, it is not known how many animals subsequently die due to the traumas caused by the entanglement and pieces of nets which can stay on their bodies for weeks, months or years.

Three whales (4% of the total 75 animals) had other (most likely anthropogenic) scars. In one case it looked like a wound from the unsuccessful harpooning of an animal (Fig. 7). Scars from the cookie-cutter shark bites were found in 97% of whales (73 of 75 whales) and were absent only in two calves. Twenty-one animals had "few" scars, 33 had "some" scars and 19 had "many" scars (29%, 45% and 26% from all animals with cookie-cutter shark bites, respectively). These scars were localized more often on the anterior part of the animals' body. We also recorded at least one case of attachment from lampreys (*Lethenteron camtschaticum* or *Entosphenus tridentatus*) to a Baird's beaked whale (Fig. 8). We found many scars probably from lamprey attachments, which suggests that it occurs regularly. In July-September, before the spawning migration of Arctic lamprey (*Lethenteron camtschaticum*) (Tokranov 2004), we regularly saw the lampreys attached to humpback whales (*Megaptera novaeangliae*) and sperm whales (*Physeter macrocephalus*). Lampreys do not leave deep wounds on skin as do cookie-cutter sharks and scars from lamprey attachments differ from the latter in shape, smaller size and are faster healing (Samarra 2011). Cookie-cutter sharks occur in the North Pacific to the south of 38°N (Nakano and Tabuchi 1990), so the scars from their bites suggest that Baird's beaked whales from the waters of the Commander Islands perform long migrations to warm subtropical waters.

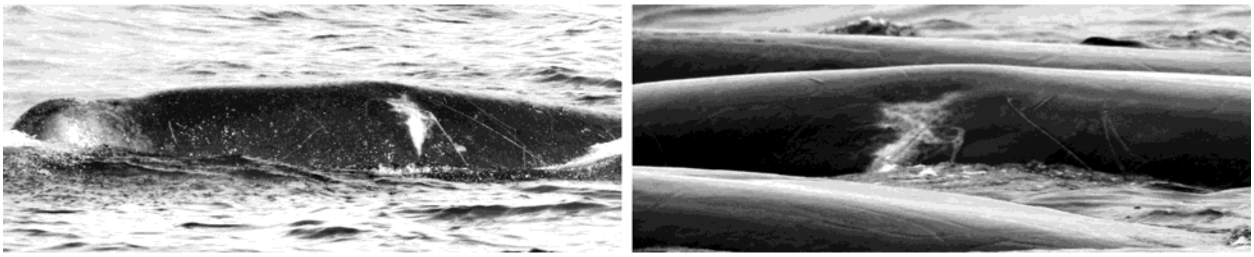

Fig. 7(a)+(b). Possible unsuccessful harpoon wound on a Baird's beaked whale

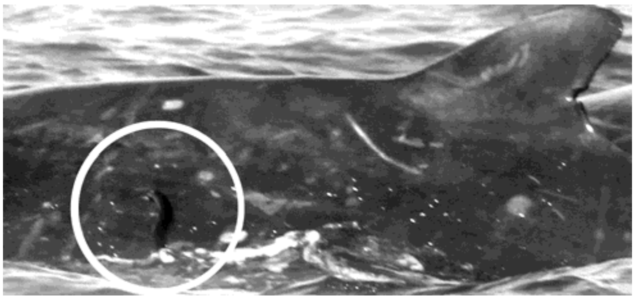

Fig. 8. Lamprey attachment to a Baird's beaked whale

Strandings

We have gained only limited information from Baird's beaked whale strandings in our study area. Reports of strandings of this species for the Commander Islands are surprisingly few (Table 2), though many more strandings of other whale species are regularly registered in the area (for example, strandings of Cuvier's beaked whale *Ziphius cavirostris* are registered every year). Besides these strandings, in November 2008, a 1-meter-long part of a Baird's beaked whale consisting of the dorsal fin and portion of the back was found at Bering Island (Fomin, S.V., pers. comm.) The remains were fresh and contained killer whale teeth marks. The animal had been killed and largely eaten by killer whales somewhere nearby in the waters of the Commander Islands.

Table 2. Known strandings of Baird's beaked whales in the Commander Islands.

Year	Date	Location	Sex	Age	Body length, m	Source
1879	August	Bering Island	n/d	n/d	n/d	(Malm 1883 in Tomilin 1952 and True 1910), (Nordenskiöld 1881)
1881	Autumn	Bering Island, Staraya Gavan Bay	n/d	n/d	n/d	(Stejneger 1883 in Tomilin 1952)
1883	June 5	Bering Island	Female	Juvenile	4,81	(Stejneger 1883 in Tomilin 1952)

1883-1929	n/d	Bering Island	n/d	n/d	n/d	(Davidson 1929 in Tomilin 1952)
1934	February	Bering Island, Monati Cape	n/d	n/d	n/d	(Tomilin 1936)
1952	November 3	Medniy Island	n/d	n/d	n/d	(Marakov 1967)
1956	May	Bering Island	n/d	n/d	n/d	(Marakov 1967)
2003	June 4	Bering Island, Outfall of Tablazhanka River	Female	n/d	10	(Zagrebelniy 2004)
2012	March 1	Bering Island, Yemelianovskaya Bay	Female	Mature	10,7	(This study)

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