Status of Killer Whales (*Orcinus orca*) in Eastern Kamchatka (Russian Far East) Based on Photo-Identification and Acoustic Studies. Preliminary Results

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ABSTRACT

From 1999-2006, a long-term study of killer whales (*Orcinus orca*) off eastern Kamchatka has conducted photo-identification and acoustic studies from a field station in Avacha Gulf. From 2002-2005, wide-area large ship surveys have expanded the study to other regions in the Russian Far East (RFE) including: northeast Kamchatka, Commander Islands, Chukotka, Kuril Islands and northeast Sakhalin. In this paper we mainly discuss the killer whale status on the eastern coast of Kamchatka, and give a brief review of available information regarding the killer whale status in other areas of the RFE. During the field seasons 2005-2006, a total of 434 individuals were identified in Avacha Gulf in at least three acoustic clans with different dialects. Most are resident-type fish-eating whales. Some transient-type marine mammal eating whales have also been recorded in Avacha Gulf and in other areas of the RFE. Transients as well as some residents show bites from the cookie cutter shark (*Isistius brasiliensis*) which may indicate long distance travel along the Asian coast or out to sea. To date, live captures have removed at least two subadult females from the Avacha Gulf residents. A live-capture quota of 6-10 killer whales in the RFE has been granted every year since 2002 (8 for 2007) although data remain inadequate to support this. The conflict between whales and fishermen in the Sea of Okhotsk due to killer whale depredation merits further study.

KEYWORDS: KILLER WHALE, PACIFIC OCEAN, PHOTO-ID, ACOUSTICS, FOOD/PREY, DISTRIBUTION, SOCIAL, HABITAT

INTRODUCTION

In Russian waters regular investigations of killer whales (*Orcinus orca*) were not conducted until 1999. Information collected during whaling in the mid-20th century included mainly morphological descriptions and gastric contents analysis of killed animals (Sleptsov 1955, Tomilin 1957, 1962, Betesheva 1961, Ivanova 1961). More recent publications (Shuntov 1993) provide mostly general information about killer whale abundance and sightings made opportunistically.

In 1999 we established a long-term project to study killer whales in eastern Kamchatka coastal waters (Avacha Gulf field station), and in subsequent years expanded our efforts to other regions in the Russian Far East (RFE), including: northeast Kamchatka, Commander Islands, Chukotka, Kuril Islands and northeast Sakhalin. This study aims to obtain results which will help the management and protection of killer whales in RFE waters. In this paper we mainly discuss the killer whale status on the eastern coast of Kamchatka, and give a brief review of available information regarding the killer whale status in different areas of the Russian Far East.

METHODS

Study area and duration

The data presented here were obtained from two different survey units:

a) Studies conducted in the central part of Avacha Gulf, Kamchatka Peninsula, Russia (Far East Russia Orca Project).The data were collected during summer and early fall in 1999 – 2006 for a total of 150 days work with killer whales.

b) The Alaska SeaLife Center (ASLC) and FEROP joint wide-area sighting surveys in the summer seasons of 2002-2005. These surveys covered the area from Olyutorsky Cape to Lopatka Cape (Eastern Kamchatka coast) in 2002, from southeast Kamchatka to the southern Kuril Islands and Sakhalin Island in 2003, along the eastern Kamchatka coast to Anadyr Gulf (including Commander Islands) in 2004, and from the eastern Kamchatka coast to Bering

Strait in 2005. From a total of 63 days of survey effort, a total of 25 days were spent working with killer whales.

Data collection methods

Avacha Gulf surveys

We used a 4m inflatable boat to approach the whales for observations, obtain photographs, take limited biopsy samples and make underwater sound recordings. During the field seasons of 2005-2006, two boats were used: one specialized on obtaining the photographs and another one specialized on underwater sound recordings. The position of the boat was determined using a global positioning system (GPS).

A Canon EOS 1D camera and 100-400 mm lens were used for taking the photographs. The photographs of the left side of individual whales were taken to show the details of dorsal fin and saddle patch.

Sound recordings were made using a Sony TCD-D100 DAT recorder at a sampling frequency of 44.1 or 48 kHz. For omnidirectional recording we used an Offshore Acoustics hydrophone with a bandwidth of 10 Hz to 40 kHz and a sensitivity of -154 dB ± 4 dB re 1V/µPa at 100 Hz. It was lowered to a depth of 5-10m.

Killer whales were found visually from boats and from the top of Starichkov Island (Avacha Gulf) and by using a mobile hydrophone stereo system (Filatova et al. 2006).

To describe the behavior of whales we distinguished "groups" and "encounters". The group was defined as an aggregation of killer whales at a distance of less than 3 body lengths from each other that moved in one direction and displayed the same type of activity. Solitary animals were considered to be a separate group. The encounter was defined as an aggregation of groups of killer whales that were within visual range of the observers, moving in a common direction, and displaying a similar type of activity.

The data recorded for each group included the date, time, duration of the time spent with that group, location of the group, number of animals in the group, group composition and type of activity. Animals that could not be photographed were also noted. To describe the composition of the group we distinguished males, juveniles, females with calves and animals that were impossible to put in either category (other animals).

Land-based observers from the top of Starichkov Island focused on group size and composition, type of activity, direction of movement and location of animals. Observations were made using binoculars (Baigish 10X50) and field scopes (Geoma-65-S 25X) in 2000 and 2001, and in 2002-2004 we used the theodolite method of tracking individual killer whale pods which allowed us to describe whale locations more accurately. We used a Nikon DTM-520 theodolite with a laptop computer.

Wide-area surveys

Surveys were done primarily in the 12 nm zone of Russian territorial waters in the Northwest Pacific. More than 13,000 nm were traversed in four summer cruises. Killer whales were found visually. The inflatable boat was used to approach killer whale groups to obtain photographs, take biopsy samples, and make underwater sound recordings. GPS was used to determine the position of the boat during the work with the whales.

Data analysis methods

Photo-identification

The individual identifications of killer whales were made using the technique developed by Bigg et al. (1990). Each whale was assigned an individual number. A preliminary catalog of the killer whales of Eastern Kamchatka was created in 2006 (Burdin et al. 2006).

Determining killer whale ecotype

To determine the ecotype, we used features of behavior and morphology described for transient and resident killer whales of the Northeast Pacific (Baird and Stacey 1988, Baird and Whitehead 2000,

Morton 1990, Ford and Ellis 1999, Baird 2000, Ford et al. 1998, Ford et al. 2000). Ecotype in Northeast Pacific killer whales is also defined by group size. Therefore, in Avacha Gulf, we compared numbers of animals per group in encounters with residents (n=75) and transients (n=8) using the Mann-Whitney U-test.

Association analysis

The data collected in 2004-2006 during the work in Avacha Gulf were used to check if the killer whales of Avacha Gulf form groups non-randomly and to determine the membership of stable social units. Direct observations and statistical association analysis were used. The degree of association between individuals was measured using SOCPROG 2.2, a program developed in MATLAB 6.5 (Whitehead 2004) and a simple ratio association index (SRI) (Whitehead 2004, Ginsberg and Young 1992). The whales that we saw in one group were considered to be associated for the day (the sampling period). Whales that we saw on more than three occasions in groups and on more than two days were included in the analysis. Whales that were seen more rarely were included in the analysis only if they were seen in groups with those already included in the analysis. In total, 977 groups and 267 individual resident killer whales were included in the analysis. The results of direct observations were compared with the results of the association analysis to reveal the social units.

Sound analysis

For most of the social units identified in the Avacha Gulf we defined a repertoire of discrete calls, the vocal dialect, as has been done in the Northeast Pacific (Ford 1984, 1991, Yurk et al. 2002) and the Northeast Atlantic (Moore et al. 1988, Strager 1995). Discrete call classification was based on an existing catalogue (Filatova et al. 2004) with some additional call types found in groups rarely visiting the area.

A quantitative measure of similarity of call repertoires for each pair of social units was obtained by calculating an index from the degree of discrete call sharing. This index is based on Dice's coefficient of association, which normalizes the data to account for differences in repertoire size:

index of similarity =2(Nc+ Ns) /(R1+ R2)

where Nc is the total number of call types shared, Ns is the total number of subtypes shared, and R1 and R2 are the repertoire sizes (call types plus subtypes) of the two pods.

We discerned three major levels of acoustic similarity:

1. If two groups shared all discrete calls in their repertoires, their index of acoustic similarity was 1, and they were considered to belong to the same *acoustic pod*.
2. If two groups shared some discrete calls in their repertoires, their index of acoustic similarity was between 0 and 1, and they were considered to belong to different *acoustic pod*s, but to the same *acoustic clan*.
3. If they shared no calls, their index of similarity was 0, and they were considered to belong to different *acoustic clans*.

The difference in regularity of occurrence in Avacha Gulf between acoustic clans was established. The number of field seasons when the social units visited the study area (range = 1–8 seasons) and the relative frequency of encounters per season for each unit were counted. The comparison between clans was made using a Mann-Whitney U-test.

Analysis of land-based observations

Theodolite data was processed with Pythagoras software (Gailey and Ortega 2000), which allowed us to compute the coordinates where killer whales foraged. These coordinates were then put on the map of Avacha Gulf which showed depth measurements over the study area. We estimated the arrangement of the areas utilized by killer whales and prey species of fish, by the Kernel method, usually used for home-range studies (Worton 1989). Areas where foraging was most probable (95% certainty) were correlated to the depths shown on existing maps with known fish distribution using MapInfo Professional Version 6.5 Release Build 19.

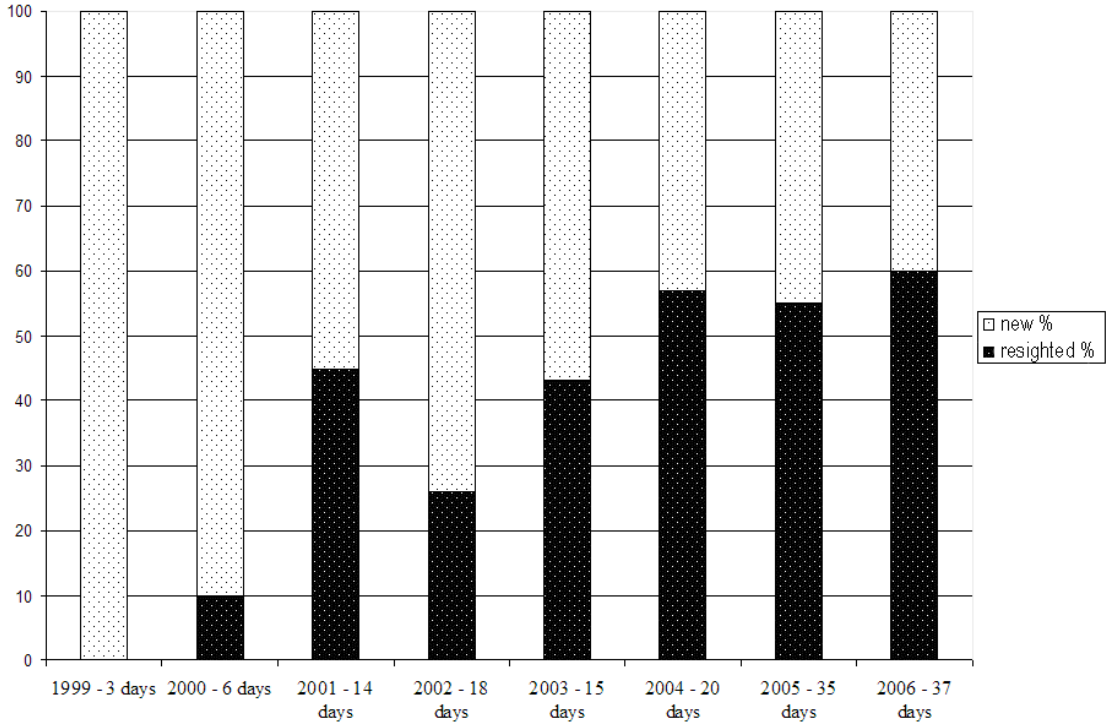
RESULTS

Distribution & Stock Structure

Avacha Gulf research

During the field seasons 2005-2006, a total of 434 individuals were identified in Avacha Gulf. 195 of them were met for the first time in the gulf (this number does not include calves). The percent of new animals identified each year decreased from 1999 to 2004, but from 2004 until 2006, it has been staying about the same (Figure 1). This could be explained by the increased effort (there were increases in the number of work days per year, the duration of work on each encounter and the number of working boats (the latter only for 2005 and 2006).

Figure 1. The percentage of new and resighted killer whales met in Avacha Gulf during each season



Wide-area surveys

As a result of the 2002-2005 joint ASLC-FEROP-SPLASH surveys, 61 killer whale groups with a total of 789 individual orcas were observed (Table 1). In total, about 450 different killer whales were photo-identified during the four-season survey.

Table 1. Summary of killer whale survey effort in the Russian Far East Seas (2002-2005)

Dates of survey/days of effort	Area surveyed	Killer whale groups encountered/ total number of individuals seen
July 17-August 5, 2002/ 13 days	Eastern Kamchatka (Olutorsky Cape-Lopatka Cape)	18/252
July 18 –August 16, 2003/ 9 days	Southeast Kamchatka, Kuril Islands, northeast Sakhalin	9/124
July 15 –August 21, 2004/ 25 days	Northeast Kamchatka, Anadyr Gulf, Commander Islands	24/329
July 17 –August 15, 2005/ 22 days	Northeast Kamchatka, Chukotka, Commander Islands	10/84

Matches between areas

From the wide-area surveys we have found a few matches between killer whales photographed in Avacha Gulf and from northeast Kamchatka and the Commander Islands. No matches were found between Avacha Gulf and Chukotka, Kuril Islands and Sakhalin Island. In 2002, resident killer whales

that regularly visit Avacha Gulf were met during the wide-area survey in northeast Ozernoy Gulf at a distance of about 800 km from Avacha Gulf.

Genetic and contaminant analysis

The examination of skin samples obtained by the biopsy method in Kamchatka and in the Kuril Islands has revealed that resident killer whales represent an SR haplotype (Burdin et al. 2004a), which was described for the resident clan AD from southwest Alaska, various resident clans from the Central Aleutian Islands, and also southern resident killer whales, which normally occur off southern Vancouver Island in Canadian and US waters. A biopsy sample from Sakhalin Island, the only one analyzed to date, was collected from a lone killer whale male off northeast Sakhalin during the wide-area survey in 2003. Analysis of blubber showed very high PCB and DDT levels — three times that of resident-type killer whales. The genetic characteristics of this male were similar to the AT1 transient haplotype, it was concluded that this animal was transient-type (Burdin et al. 2004a).

Resident and transient killer whales

Among the 61 groups met during the wide-area surveys, up to 52 (85.3%) were identified as resident and at least 9 (14.7%) were identified as transient killer whale groups. The transient group size varied from one (lone males) to 3-6, while resident groups contained from 8 to 80 whales. One kill was observed in 2004 near the east coast of Bering Island, presumably by a transient group; a pinniped, likely a fur seal female, was killed by group of 5 whales. Biopsy samples collected during the cruises remain to be analyzed before we can make a more accurate estimation of the ratio between resident and transient whales in the study area.

Resident and transient killer whales were never seen together in one encounter. The comparison between group sizes of encounters with resident and transient killer whales of Avacha Gulf showed a significant difference ($p<0.001$, $U=22.5$). The five encounters of transient whales consisted of a minimum of 1-2 animals (range = 1-10, average = 3.8). The minimum size of encounter of resident killer whales was four (range = 4-98, average = 28.6). Resident, fish-eating, killer whales were never seen alone or in numbers of 2-3 in the gulf. We believe that the transient killer whales seen in Avacha Gulf are similar to the transient killer whales of the Northeast Pacific not only in appearance but also in ecology.

Direct observations from the inflatable boats indicate that the main prey of fish-eating (resident) killer whales in Avacha Gulf is Atka mackerel (*Pleurogrammus monopterygius)* and various salmon species (*Oncorhynchus* sp.*)* but we have also documented killer whales feeding on cod (*Gadus macrocephalus*) in Listvinichnaya Bay.

We have observed several types of foraging behavior in the study area: “carousel”, when killer whales surround a school of fish and swim into the center one after another, and “asynchronous diving”, when a group is foraging within a determined area, either in a tight group or in subgroups of 2-5 animals. The foraging time using these methods differs: “carousel” lasts 7 min on average, and foraging by “asynchronous diving” – 45 min on average (Tarasyan et al. 2005). We never observed transient killer whales killing other marine mammals in the study area of Avacha Gulf, despite the presence of a haul out site for largha seals in this area. Most encountered transient groups were traveling, and some were milling, presumably searching for prey. At the same time, there are some reports of killer whales attacking largha seals from the local fishermen and tourists at Khalaktyrsky beach (in the northern part of Avacha Gulf). In the Commander Islands both resident-type fish eaters and transient-type mammal eaters have been reported. Marakov (1967) indicated that in different seasons on Medny Island, killer whales have fed on Pacific cod and Atka mackerel, and he also reported killer whale superpods of up to 150-200 animals. Over a 10-year observation period on Medny Island, Marakov (1967) noted only one case when killer whales attacked fur seals but since the late 1990s, transient-type killer whales have been regularly feeding on northern fur seals (Mamaev and Burkanov 2006).

Social units, acoustic pods and acoustic clans of the killer whales of Avacha Gulf

We distinguished 37 stable social units according to cluster analysis and direct observations (including 3 distinguished only by direct observations). The comparison of association patterns between field seasons 2005 and 2006 showed that membership of social units did not change. By the end of the summer 2006, these 37 units included 277 killer whales. The mean number of killer whales in a social unit was 7.2 ±0.5 (range 1-16 animals). The typical unit consisted of 2 males, 1 female accompanied by a calf, 1-2 calves, 1 juvenile and 1-2 other animals. The sex and age compositions and sizes of Avacha

Gulf resident groups were similar to those of the social units (matrilines/subpods) of Northeast Pacific resident killer whale groups.

Besides the above 37 social units in Avacha Gulf, 11 additional groups were recognized that could represent at least 11 separate units. The composition of the units was impossible to describe because of the lack of data.

We have found two main acoustic clans in Avacha Gulf: Avacha clan and K20 clan. Avacha clan is more common and numerous. There are 14 acoustic pods in Avacha clan. It is interesting to note that acoustic similarity does not always correspond with the amount of time groups spend together. For example, the AV2 social unit and Winny's unit were never found in the same group during 2004-2006, but they belonged to one pod according to their vocal dialects.

During the wide-area surveys, we recorded calls which were similar to Avacha clan and K20 clan dialects from killer whale groups off northeast Kamchatka (Ozernoy Gulf) and in the Commander Islands.

We have also identified K19 clan. Whales from K19 clan sometimes associate with Avacha and K20 clans and have been seen in the same encounters with members of Avacha and K20 clans, although we never observed them in mixed groups. We recorded calls similar to the K19 clan dialect from a killer whale group in the northern Kuril Islands in 2003.

There are some pods that infrequently visit the Avacha Gulf that have dialects different from the above three clans. We have also recorded killer whale groups with different dialects in other parts of the Russian Far East – in Chukotka, eastern Koryakia, northeast Kamchatka, Commander Islands, and the northern and middle Kuril Islands. The clans for these pods and individual composition of the pods are not defined to date because the data are insufficient.

Social units from Avacha clan were seen in the area during more seasons than social units from other clans ($p<0.05$, $U=26.0$). They also visited the area more frequently during the season than other units ($p<0.05$, $U=27.0$). Other groups of resident-type killer whales were seen traveling through Avacha Gulf only once or twice during the eight-year study period.

We suppose that Avacha, K20 and K19 clans could represent one community of killer whales. But there are other killer whales that visit the Avacha Gulf area occasionally that could represent another community.

Habitat Degradation

Visual observations in 2000-2001 showed that killer whales foraged in certain areas of Avacha Gulf. In 2002-2004, with the use of a theodolite, we described this foraging area using geographic coordinates. Comparing killer whale foraging areas and published data about fish distribution in Avacha Gulf (Zolotov 1992) allowed us to connect killer whale feeding areas and Atka mackerel (*Pleurogrammus monopterygius*) concentrations (Tarasyan et al. 2005). In 2005 and 2006, we did not make theodolite observations, but fixed the geographic coordinates for feeding events using GPS from a boat. Comparing the collected GPS data for the feeding events in 2005 and 2006, we found that in summer 2006, killer whales used a smaller area within our study area for all feeding activities and the mean latitude was lower ($p<0.01$, Mann-Whitney test), showing a generally southward shift to feeding sites (Nagaylik et al. 2007). This was consistent with the extremely intensive fishing activity by the "mosquito fleet" for Atka mackerel which has moved steadily south from the main fishing area in the Avacha Gulf, close to Petropavlovsk-Kamchatsky. A similar situation may be occurring in other parts of Avacha Gulf located within striking distance of small fishing boats from the Petropavlovsk-Kamchatsky port. The Atka mackerel harvest for these numerous local fishermen making 1-2 day fishing trips during summer, can be roughly up to 100-150 tons per day. Discussions with fishermen confirm our observations that the (formerly) best areas for Atka mackerel have become exhausted.

Directed Takes

The first attempt to catch killer whales in Russian waters was initiated by the Utrish Dolphinarium in 2002. After about one month of unsuccessful attempts to catch killer whales near Kamchatka and

Eastern Sakhalin, capture operations were suspended until the following year. On 26 September 2003, some 32-37 resident-type killer whales were encircled by seine nets in Zhirovaya Bay, Avacha Gulf, by a catcher boat rented by Utrish Dolphinarium. The animals captured, all of which had been traveling together, included 3 mother-calf pairs, 3 small juveniles, 8 young to mature males and 15-20 others. Six of these animals were known through previous photo-ID to the FEROP research team, having been photographed in previous years in Avacha Gulf (Burdin et al. 2004b). According to the permit held by the Utrish Dolphinarium, up to four killer whales were allowed to be taken in 2003 from eastern Kamchatkan waters.

During the capture, one subadult female became entangled in the net and drowned. A second young animal, sex unknown, also became entangled but it is not known if this animal survived. A third young whale, a female, was removed from the group, and kept in a pen for nine days before being transported 11,270 km by air on 5 October to the Utrish Marine Station owned by the Utrish Dolphinarium Ltd., on the Black Sea coast. The captive female died just 13 days after transfer on 19 October 2003. The cause of death of this whale was reported by Rozanova et al. (2004) to be abscessed pneumonia, due to the *Pseudonomas* bacteria.

Incidental Takes

Incidental takes of killer whales have not been reported in Russia, except official announcements that at least one killer whale died in the process of capture in 2003, as noted above. But from unofficial sources we know that the conflict between fishermen and killer whales has been increasing, especially in the Sea of Okhotsk around long-line and bottom net fisheries (partly for Greenland halibut) (Kornev et al. 2005). Fishermen suffering from orca depredation try to frighten whales away by different means, and in many cases use guns. But even shooting may not keep them away. Fishermen report that killer whales may learn how to avoid danger and will not appear on the surface near fishing boats, although they may continue to "poach" some fish.

Other

We have a few data about killer whales in other areas of the Russian Far East.

Sakhalin Island area

According to opportunistic data, killer whales are relatively less abundant in the Sakhalin Island area than in Kamchatka. In ten summer field seasons of gray whale research in the Piltun lagoon area (northeast Sakhalin), researchers have encountered killer whales 9 times in 5 years (1-3 times a season) (D. Weller and G.Tsidulko, pers. comm.). All 9 encountered killer whale groups were identified as transient, and this was confirmed by a biopsy of a lone male, as noted above (Burdin et al. 2004). Interviews with local fishermen and hunters (from Okha) in the area reveal that killer whales attack largha seals.

Razlivalov (2004) reported that in August-September 2003 in the Lunskoi Bay region (Sakhalin Island), killer whales were sighted 13 times, 70 individuals being counted. Solitary killer whales were sighted 4 times (all males); a group of 2 individuals was sighted once; groups of 3 were sighted 3 times; 5 killer whales in a group were sighted twice; groups of 8 and 12 killer whales were sighted once each. The maximum number of killer whales in one encounter was 26.

Chukotka

Grachev et al. (2002) recorded killer whale observations near the Chukotka coast from 1983-2001. He reported that killer whales migrate south in November, and visit Chukotka coastal waters seasonally, mostly July to September. He estimated the total number of killer whales near Chukotka to be 45-50 (in 4-5 killer whale pods). On 30 July 2005, during our whale survey cruise near Meechkin Spit in Anadyr Gulf, we met a superpod of killer whales (an estimated 68 whales). Additional information about killer whales near Chukotka peninsula has been reported by Melnikov and Zagrebin (2005). They reported sighting 788 killer whales in 10 years (1990-2000) from shore, and 11.6% of observed killer whales were involved in marine mammal attacks.

Sea of Okhotsk

A joint Russian-Japanese survey in July-September 2003 in the open part of the Sea of Okhotsk found killer whales common throughout the area. The occurrence rate of killer whales was 0.73 groups (3.47

individuals) per 100 nm of the route. Previous cruises in 1998-1999 reported 1.87 individuals/100 nm. Maximum observed killer whale group size in 2003 was 20, and in 1998-1999 – 12 individuals (Vladimirov et al. 2004).

Primorsky Krai

In September 2006, we conducted one-week of land-based observations at Primorsky Krai near Lazovsky zapovednik (reserve). During this week we saw a killer whale group only once, although that time is said by local people to have the maximum abundance of killer whales in the area. We suppose that killer whales are much less abundant there than off eastern Kamchatka.

In other areas of the Russian Far East, data about killer whales are very limited or completely absent.

DISCUSSION

The status of killer whales in most areas of the Russian Far East is unknown due to minimal information about abundance, distribution and population structure. Killer whales were never an attractive subject for research by the generations of scientists from the former Soviet Union and modern Russian Federation. Often, observers simply ignored killer whales. Thus Berzin and Vladimirov (1989), synthesizing data from various whale surveys in the Sea of Okhotsk from 1979-1984, reported that killer whales are abundant in the entire Sea of Okhotsk, but at the same time, they cite only two observations totaling 18 animals. According to results from aerial surveys of pinnipeds and cetaceans in the central Sea of Okhotsk, conducted in April-May and November-December 1967-1981, and 1983, no killer whales were seen (Fedoseev 1984). This could mean that in winter killer whales are simply absent, or observers are ignoring them.

Killer whales have been seen in all areas of the Russian Far East, including the Chukchi Sea, where local hunters report killer whales attacking gray whales. We suspect that the transient, mammal-eating killer whales visit the Arctic Ocean, too, where pinnipeds (especially seals and walruses) and cetaceans (mostly gray whales) are abundant. The number of transient groups may be more in areas of high pinniped concentration (largha and ribbon seals) in the northern and western part of the Sea of Okhotsk, and off the east coast of Sakhalin Island where these seals are abundant, especially since the Russian seal harvest ended. In Eastern Kamchatka and around the Kuril Islands, where five species of Pacific salmon are abundant (along with other fish including Atka mackerel), the fish-eating resident-type killer whales are mainly observed. All the killer whale groups we encountered on the Kuril Islands in 2003 were resident-type. There are reports of killer whale presence in the southern area of the Russian Far East, off Primorsky Krai and in the Sea of Japan, but information on the distribution of killer whales is mostly absent.

Although Russian Far East killer whales can be divided into residents and transients as in the Northeast Pacific, there may be some fundamental differences due to the geomorphological characteristics of their habitat. The Russian Far East generally has a straighter shoreline with an absence of deep bays and small islands, unlike the fjordic western North American coast from Puget Sound to Alaska with its thousands of islands and islets. These differences may have an effect on killer whale distribution, size of home range, habitat use and social behavior.

The overall population structure of killer whales in the Russian Far East is unknown. Our insights come mainly from the resident killer whales that inhabit Avacha Gulf, with only rare appearances by transients. We have noticed that all transient-type whales, and even some presumed resident whales, in the Russian Far East carry scars from the bites of the cookie cutter shark (*Isistius brasiliensis)*. We suggest that transient as well as some resident groups may be traveling a very long distance along the Asian coast, from Chukotka, Anadyr Gulf and the East coast of Kamchatka down to Japan, because the known limit of the northern distribution of the cookie cutter shark is about 38° North (Nakano and Tabuchi 1990).

Among the Avacha Gulf residents most commonly seen every year, at least 35 social units consisting of 264 individuals were identified by the end of the field season 2006. None of them have scars from the bites of the cookie cutter shark. However, there are an additional 158 resident-type fish-eating whales that do have such cookie cutter scars. All of these are killer whales that have been seen only once or twice in Avacha Gulf and may well travel farther south compared to the Avacha residents.

Long movements across national borders (Russia, Japan, maybe Korea) could create additional threats and risks for the animals. If these whales are traveling for thousands of miles, the concept of "home range" may make less sense, except in terms of a seasonal home range. Efforts to protect their habitat through marine protected areas or other means will be more difficult.

To date, live captures have removed at least two subadult females from the Avacha Gulf residents. A quota of between 6 and 10 killer whales for the Russian Far East has been granted every year since 2002 (a quota of 8 was granted for 2007) although data remain inadequate to support any capture quotas.

Of growing concern in the Russian Far East, particularly in the Sea of Okhotsk, is the conflict between whales and fishermen due to killer whale depredation. It seems difficult to find a reasonable and quick solution to this problem especially in view of the intense pressure on fisheries in the Sea of Okhotsk. It is possible that killer whales have experienced depletion of their own usual food resources (including large oceanic fish such as halibut and cod). In any case, additional efforts should be undertaken to study this conflict in the Sea of Okhotsk, and technological and other solutions, including gear changes, should be systematically tried.

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