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Long-term Photo-Identification Studies of Gray Whales (Eschrichtius robustus) offshore Northeast Sakhalin Island, Russia, 2002-2017

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INTERNATIONAL WHALING COMMISSION

LONG-TERM PHOTO-IDENTIFICATION STUDIES OF GRAY WHALES (*Eschrichtius robustus*) OFFSHORE NORTHEAST SAKHALIN ISLAND, RUSSIA, 2002-2017

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ABSTRACT

Photo-ID studies of the Sakhalin feeding aggregation of North Pacific gray whales (*Eschrichtius robustus*) have been conducted annually since 2002 offshore northeast Sakhalin Island as part of an industry-sponsored monitoring program jointly funded by the Sakhalin-1 (operated by Exxon Neftegas Limited) and Sakhalin II (operated by Sakhalin Energy) oil and gas development projects. With the addition of nine calves in 2017, the Sakhalin gray whale catalog now contains 283 identified individual gray whales. Of the nine new calves, six cow/calf pairs and three calves without mothers were recorded off Sakhalin. One of the identified mothers was sighted for the first time as a nursing cow, bringing the total identified numbers of cows in the database since 2003 to 29.

The photo-ID catalog compiled over the last 16 years provides strong evidence of the steady increase in the number of gray whales observed off Sakhalin Island each year. For incorporation into gray whale population modeling, the annual effort and observations of the studies are detailed in the paper and the results are compared with the other long-term gray whale photo-ID studies of the area.

INTRODUCTION

Photo-identification (photo-ID) is a valuable tool in gray whale studies (Darling, 1984; Würsig *et al.,* 1999, Calambokidis *et al.,* 2002; Yakovlev and Tyurneva, 2005), because individual gray whales bear unique identifiable markings on their skin. Photo-ID studies of the Sakhalin feeding aggregation of North Pacific gray whales (*Eschrichtius robustus*) have been conducted annually since 2002 offshore northeast Sakhalin Island as part of an industry-sponsored monitoring program jointly funded by the Sakhalin-1 (operated by Exxon Neftegas Limited) and Sakhalin II (operated by Sakhalin Energy) oil and gas development projects.

The Joint Program studies off Sakhalin Island basically encompass the two traditional summer-fall whale feeding areas – the Piltun area (52°20' N–53°30' N), stretching 120 km along the shore of Piltun Bay, where the whales feed primarily at depths of less than 20 m, and the Offshore area, located further offshore from Chayvo Bay (51°40' N–52°20' N) with depths of 35–60 m (Maminov and Yakovlev, 2002; Yakovlev *et al.*, 2009). Researchers from the National Science Center of Marine Biology of the Far East Branch of the Russian Academy of Science (henceforth "NSCMB") have been working in both Piltun and Offshore feeding areas every year since 2002 (Yakovlev and Tyurneva, 2005; Yakovlev *et al.,* 2018). Additional studies of the southeast coast of

the Kamchatka Peninsula were conducted from 2006-2012 (Yakovlev *et al.,* 2009; Tyurneva *et al.,* 2010a,b, 2012, 2013).

METHODS

The 2017 data were collected by three photo-ID teams. One team was based on the Sakhalin Energy support vessels, and two teams were based at field camps on the coast.

The vessel-based team conducted 5 photographic surveys of gray whales in the Piltun and Offshore feeding areas during the period from August 9 through October 13, 2017. The details of the field studies by the vessel-based photo-ID team are presented in the annual report (Yakovlev *et al.*, 2018).

The 2017 onshore surveys were conducted from July 2 through September 26 with the teams split between the southern and northern parts of the Piltun feeding area (Figure 1). Teams moved along the shore in vehicles taking imagery of the whales they encountered directly from shore. DJI Phantom 4Pro drones with video cameras were added to the onshore teams' equipment. Drone photo-ID missions were conducted only in good weather: mandatory condition of over 500 meters visibility and maximum force 5 wind (Beaufort scale). Often, both photo camera and drone were used together. During operations, one of team members acted as a spotter helping to locate the whales. In most cases, the drone was used at average distance about 800 meters from the shore with standard flight height 8 meters, but they were able to go as far as 2.5 km from the shore. A detailed description of vehicle-based drone photo-ID methods is provided in the 2016 field report (Yakovlev *et al.*, 2017).

The field procedure for the photo-ID work used since 2002 is based on recommendations for photo-ID work of marine mammals set forth by the International Whaling Commission in Hammond *et al.,* (1990). The whales' position (determined by GPS), time, behavior, number of whales in the group, direction of their movement, the presence of other groups of gray whales, killer whales, passing vessels, and airplanes or helicopters in the observation area were noted. The presence of mud plumes, both at whale feeding sites and when no whales were visible, was recorded.

Attempts are made to photograph all aspects (head, back flanks and flukes) of each whale. Preference is given to photographing the right sides (flanks) of the subject animal as right sides have been arbitrarily chosen among gray whale researchers as a baseline identifier. With the availability of photographs from the drones taken at height above a whale, a new aspect ("Back") was added in the whale catalog. Also, a new catalog was created with video imagery of 35 individuals.

During lab processing of the collected materials, each photo and video is studied for the purpose of identifying it as a specific individual. After all the pictures have been identified and supplied with a detailed description of the animal and its catalogue number, the best available photos for each whale that, if possible, best describe the animal are selected. The whales encountered for the first time are assigned new catalog numbers. Afterwards all the data are input into a data base, which makes it possible to extract any information on a specific animal, for any observation period, and groups of animals in each of the studied areas. A catalog of identified individuals is prepared for each study year and is used as the basis for compiling a master catalog that is updated annually. Procedures for whale identification and recording cow/calf pairs are described in detail in the 2012 photo-ID report (Yakovlev *et al.,* 2013).

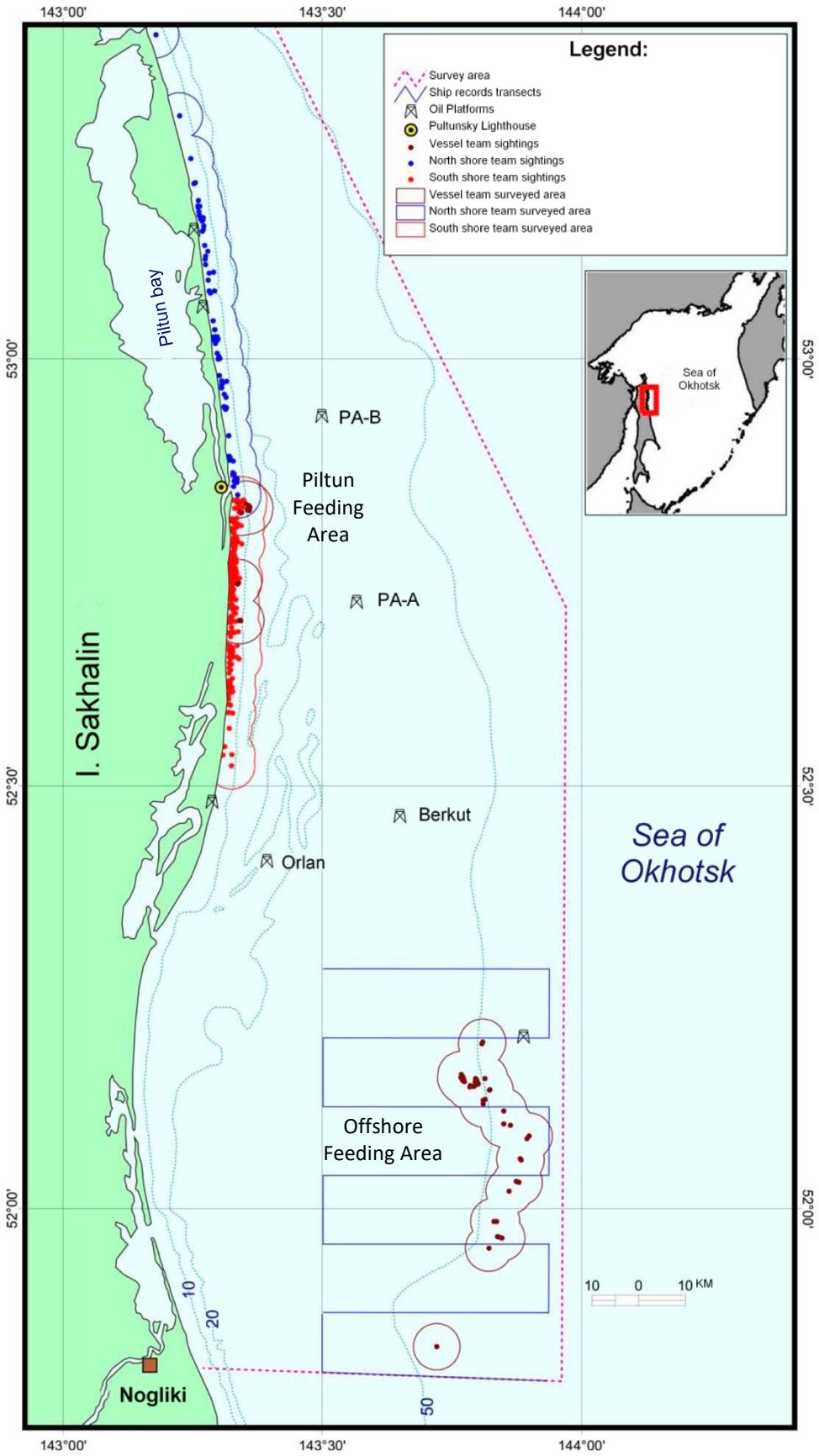

Figure 1. Map showing the location of photo-identified gray whale encounters off NE Sakhalin Island in 2017.

RESULTS AND DISCUSSION

The main results of the photo-identification studies in 2017 conducted offshore Sakhalin are as follows:

Catalog Overview

The photographs collected in 2017 were post-processed and matched with whale images from previous years. Of particular interest is not only the information gathered relating to new whales, but also data pertaining to whales that have been identified in previous years, since combining these data expands sighting history information about individual whales. Data on the number of whales identified offshore northeast Sakhalin Island over the study years of 2002-2017 are presented in Table 1. The Sakhalin gray whale catalog now contains 283 identified individual gray whales. Most of these whales were sighted repeatedly over several years, whereas 9 calves were new to the catalog in 2017.

A separate Kamchatka Gray Whale catalog consists of photographs of whales observed off the coast of Kamchatka in three areas, Khalaktyrskyi Beach, Vestnik Bay, and Olga Bay, during 2004 and 2006-2012. At present, this catalog contains 161 individual gray whales, including 85 that are also found in the Sakhalin catalog.

Whales identified in 2017 offshore Sakhalin Island

In 2017, 72 gray whales were documented offshore Sakhalin Island. This number is the lowest since the first year of the study. The low number of identified gray whales off Sakhalin Island in 2017 is best explained by the reduction in survey efforts due to extremely poor weather conditions and vessel availability for the offshore area. The northern onshore team was only able to conduct surveys on 32 out of 90 survey days (36%). August was particularly bad with only 5 days of the month (16%) where the weather was good enough to work for at least part of the day. The southern onshore team had relatively better weather. They were able to work on 59 of the 90 survey days (66%) but were hampered by poor weather in August on 52% of the days. The vessel-based team had 30 good-to-variable weather days (40% of time on the vessel), but due to the tight schedule of supply boat operations, it was only able to work 2 days in the Piltun area and 2 days in the Offshore area.

The 2002-2017 Joint Program effort and results in the Piltun feeding area are detailed in Table 2. From 2002-2013, the majority of the effort was vessel-based with incremental work done by the behavior teams from 2006-2009, the satellite tagging team in 2011, and a shore-based photographer in 2013. Observation hours in this period ranged from 17 to 115 hours. In 2014, observation hours dramatically increased with both a shore-based small boat team and an onshore vehicle team were added. The biggest photo-ID effort occurred in 2015 when a second vehicle team was added to survey the northern Piltun area and the onshore and vessel-based teams started in early June as part of the ENL seismic monitoring program. After the 2016 season, it was determined that the shore-based small boat team and the southern onshore vehicle team were identifying the same whales. Rather than continue to duplicate the effort, the shored-based small boat team was not deployed in 2017. Instead, the start of the onshore vehicle program was moved to the beginning of July with the hope to observe more cow/calf pairs.

In 2017, of the 72 animals documented off Sakhalin, a total of 52 whales were identified in the Piltun feeding area, 51 of which were observed only in that area. Forty-seven whales were identified by the southern onshore team and 32 whales were identified by the northern onshore team. The vessel-based team identified 8 whales during the 2 surveys that were conducted in the area.

Table 1. Numbers of Gray Whales Identified off the Northeast Coast of Sakhalin Island Since 2002

Year	Annual Number of Whales Identified	Number that were Previously Identified	New Whales including Calves	New Whales not including Calves	Whales in Catalog but not Encountered	Number of Whales in Catalog
2002	49	0	49			**47**
2003	86	38	48	38	11	**92**
2004	99	78	21	18	19	**118**
2005	117	99	18	14	19	**136**
2006	121	108	13	8	27	**148**
2007	125	112	13	4	35	**160**
2008	98	93	5	0	67	**165**
2009	112	101	11	3	65	**177**
2010	104	94	10	6	82	**187**
2011	124	105	19	4	81	**205**
2012	144	130	14	5	75	**219**
2013	121	112	9	3	107	**228**
2014	139	124	15	3	104	**243**
2015	175	158	17	6	84	**259**
2016	128	114	14	0	146	**274**
2017	72	63	9	0	211	**283**

Table 2. Surveys and Numbers of Gray Whales Identified in the Piltun Feeding Area Since 2002

Year	Piltun Area Sampling Period		Teams	# Surveys	Observation Hours	Whales Identified
2002	20-Sep	30-Sep	1	8	17	13
2003	9-Aug	25-Aug	1	19	36	51
2004	29-Aug	1-Oct	1	23	54	95
2005	14-Jul	1-Oct	1	54	105	115
2006	14-Aug	9-Oct	2	22	49	112
2007	10-Jul	27-Sep	2	47	114	103
2008	2-Jul	1-Oct	2	21	31	62
2009	13-Jul	20-Sep	2	28	43	91
2010	4-Aug	27-Sep	1	22	57	98
2011	19-Aug	25-Sep	2	20	63	103
2012	9-Aug	5-Oct	1	32	75	90
2013	10-Jul	11-Oct	2	15	43	72
2014	26-Jul	26-Sep	3	101	374	82
2015	1-Jun	31-Oct	5	340	1350	113
2016	1-Jul	28-Sep	4	136	510	74
2017	2-Jul	28-Sep	3	153	950	52

The 2002-2017 Joint Program effort and results in the Offshore feeding area are detailed in Table 3. In 2017, a total of 21 individuals were identified in the Offshore feeding area. Of these whales, 20 individuals were sighted only there. Due to the small effort, the number of identified whales in 2017 is among the lowest annual totals of the program. However, there were more whales were in the area in 2017 as the number of gray whales recorded during vessel-based distribution surveys ranged from 32 to 70 during four work days over the summer.

Table 3. Surveys and Numbers of Gray Whales Identified in the Offshore Feeding Area Since 2002

Year	Offshore Area Sampling Period		# Surveys	Observation Hours	Whales Identified
2002	30-Aug	25-Oct	17	36	35
2003	21-Jul	27-Sep	24	52	35
2004	6-Sep	30-Sep	4	7	7
2005	6-Sep	23-Sep	2	3	7
2006	26-Aug	16-Sep	3	11	33
2007	17-Aug	5-Oct	8	29	71
2008	30-Aug	9-Sep	8	13	62
2009	24-Jul	21-Sep	3	8	39
2010	20-Aug	19-Sep	5	8	21
2011	2-Oct	8-Oct	6	12	14
2012	3-Aug	3-Oct	22	59	74
2013	17-Sep	20-Sep	5	13	68
2014	13-Sep	3-Oct	10	29	74
2015	9-Jul	23-Sep	32	58	102
2016	7-Sep	2-Oct	10	20	61
2017	9-Aug	13-Oct	3	7	21

One whale was sighted in both areas in 2017. During the 16 years of the study (2002-2017), 131 whales have been recorded using both the Piltun and Offshore feeding areas, either during the same year or over several years. In addition, 146 individual whales were recorded only in the Piltun area and 6 individual whales were recorded only in the Offshore area. Of these six, four were only identified in one year and the other 2 were identified in just two years.

During the period of the multi-year studies, a few gray whales were also sighted outside of the main feeding areas. One whale was documented near Cape Elizabeth (northern tip of Sakhalin Island) in 2005 and has not been seen since. Twelve whales have been encountered near Okha, and all of them have also been seen in other areas. In 2015, two whales were sighted in the waters off the Vostochny wildlife refuge and since then have not been encountered again in Sakhalin. One, however, was recorded off Kamchatka in 2016 (Burdin *et al.*, 2017). We believe that gray whales' use of all available feeding grounds offshore Sakhalin is a normal behavior aimed at optimal utilization of an ever-changing distribution of food resources.

Every year, primarily the same individual whales return to feed off the Sakhalin coast. A group of 175 whales has been identified that come to the northeast coast of Sakhalin Island for feeding on a regular basis. KOGW005 and KOGW022 are the most regular of all as they have been identified in all 16 years of the program. Four others have been sighted in 15 of the 16 years. Twenty-seven whales were recorded in this area at intervals greater than three years; this group is classified as rarely-sighted whales. A total of 71 individuals have been recorded only once. Forty-

eight of these whales were recorded as calves, excluding the 9 new calves in 2017. One whale is known to be deceased (KOGW126 in 2009).

Over the last two years, 136 non-calf individuals have seen identified at least once. This value grows to 187 when individuals that were last seen in 2015 are added. These tallies do not include 4 calves from 2015 and 10 calves from 2016 who have not yet been re-sighted.

Cow/Calf Pairs

During all of the study years, cow/calf pairs have been observed and recorded only in the Piltun area and not in the Offshore area. In 2017, despite the smaller number of whales observed due to poor weather, nine calves were identified off Sakhalin Island. No new non-calves were identified for the second consecutive year.

Of the nine new calves, six cow/calf pairs and three calves without mothers were recorded off Sakhalin. Five of the identified mothers were previously known as cows. KOGW127 was sighted for the first time as a nursing cow. KOGW127, aka "Agent", was observed as a calf in 2005, making her 12 years old. She was also tagged with a satellite transponder in 2011 and her winter migration was tracked to the Gulf of Alaska before the transponder quit working (Mate *et al.*, 2015).

The first cow-calf pair was sighted in the Piltun area on July 7, and the last was sighted on August 23. Unpaired calves were encountered on several occasions (Table 4), both in the company of other calves' mothers and in "calf groups", which is why they could be more confidently identified as calves.

In accordance with the adopted procedure (Yakovlev *et al.*, 2013), all cows and calves were assigned confidence indices. Table 4 presents the results of this classification.

Table 4. 2017 Sighting Frequency and Assigned Confidence Indices of Paired and Unpaired Calves*

Calf KOGW#	Number of Survey Days	Calf Identification Confidence Index	Cow KOGW#	Number of Survey Days with Calf	Mother Identification Confidence Index
275	8	A	127	4	I
276	10	A	108	7	I
277	11	A	63	4	I
278	14	A	7	10	I
279	12	A	5	6	I
280	10	A	110	3	I
281	7	A	-	-	-
282	11	A	-	-	-
283	10	A	-	-	-

Note: *The grading system is described in the 2012 program report (Yakovlev *et al.*, 2013).

Since 2003, 127 calves have been identified. Table 5 lists the annual number of both paired and unpaired calves. Eighty calves (63%) have been paired with a cow while 47 calves were unassociated. Twenty-nine whales in the Sakhalin catalog have been associated with calves in the coastal feeding areas off Sakhalin and Kamchatka (Yakovlev *et al*, 2018).

Table 5. Annual Numbers of Gray Whale Calves Identified

Year	# Paired Calves	# Unpaired Calves	Total Number of Calves	# Resighted in Future Years
2003	5	5	10	9
2004	3	0	3	2
2005	4	0	4	4
2006	2	3	5	3
2007	7	2	9	7
2008	2	3	5	4
2009	7	1	8	7
2010	7	0	7	6
2011	7	8	15	8
2012	1	8	9	7
2013	3	3	6	3
2014	9	3	12	9
2015	9	2	11	7
2016	8	6	14	4
2017	6	3	9	-
Total	**80**	**47**	**127**	

Twenty-five of these females were sighted with calves 2-5 times. Twenty-three calves have been identified during the last two years suggesting that twenty-three of the 29 known cows successfully reproduced (79%). Fourteen cows were paired with calves.

Because we have regularly observed calves without cows, we obviously cannot account for all females with calves in the current year. For example, KOGW022 was sighted with a calf in 2014. In 2017, she was observed near other cow-calf pairs and calf groups during the whole season, but was never recorded in a stable pair with a calf. Her body condition was poor (class 4), which is common for lactating females. Her calf probably was weaned before we encountered her and we failed to find any relationships between her and the three unpaired calves.

According to our studies, the interval for cows between births varies from year to year. Of the 51 recorded births of post-first calves of a cow, 24 have occurred in a 2-year cycle and 9 in a 3-year cycle. Both birth cycles have been observed with 5 whales. The other 18 intervals range from 4 to 10 years between recorded births. There are also 10 current intervals of three years or more. The longer intervals may be broken into shorter 2-3 year intervals by filling in with the unpaired calves. The number of possible 2-year cycle births during these extended intervals is 53, which is slightly more than the number of unpaired calves (47). Another explanation for who may be the mother of an unpaired calf is that the pairing of the true first-born calf of our first-time mothers was not recorded. For example, the last two new mothers in the database, 13 year-old KOGW108 and 12 year-old KOGW127, are one birth cycle interval past the mean parturition age of 10.3 years reported by Cooke *et al.*, 2016. Lastly, there are several female whales older than the reported minimum reproductive age of 7 (Cooke *et al.*, 2016) who have not been observed with a calf yet.

From past data we established that cow-calf pairs usually start to separate in approximately mid-August and continue to separate until mid-September. The 2017 survey confirms these data, although the observers noted earlier separation of some pairs during this

season. Most cow-calf pairs separated in August and all identified calves were able to procure food independently by mid-August. The last cow-calf pair was observed on August 23.

Use of Drones for Gray Whales Photo-ID in the Piltun Area

During the field work, groups of stationary whales were successfully photographed at distances up to 2 km from the shore, and individuals were positively identified. Safely operating UAVs offshore over large distances however is only possible with onshore wind at low speed and good visibility. The drone operators collected 4,503 photographs during the season and recorded a substantial amount of video material. Figure 2 contains three examples of the photographs.

Drones allowed the onshore photo-ID teams to obtain quality imagery and video when taking photographs in unfavorable light and adverse atmospheric conditions (backlight or while working in turbulent or cloudy weather). Being able to maneuver, the operator was able to find the optimal camera position in order to improve the quality of photographs and videos — something that could not be done in similar conditions in previous years.

Working from height significantly improved the quality of the photographs. This viewpoint makes it possible to identify, very accurately, mother/calf pairs and calves encountered without mothers, since the difference in the size of the animals is clearly visible from the height. Gray whales can be tracked to their feeding points throughout the field season; also reliable data can be obtained on the transition of calves to independent feeding.

This material is an excellent addition to the data collection methods used previously. Photographing from a height allows getting images of whale bodies from a new perspective for further identification, as well as identifying whales underwater, provided that the seawater has a sufficient degree of transparency.

Throughout July and early August, drones helped to observe and film interesting mother/calf behavior, as well as whale interactions. Often, near-shore mothers appear in the surf zone with their calves, hardly showing parts of their back which makes it difficult to identify them from the coast. A drone image gives a full view of the whale back and tail, thus enabling a positive identification of them.

On several occasions, females that had been with a calf in 2016 were recorded conjoining with cow/calf pairs for several days in 2017. This may be an example of pod-behavior where adult females assist mothers with the care of their calves.

Most of the mother/calf pairs were identified in the first half of July. With the help of the drones, the size difference between the mother and calf, and the calf's behavior such as nursing or hiding close to or under the mother helped detect mother/calf pairs and differentiate more accurately between cow whales and individual calves after they switched to self-feeding. For example, mother KOGW110 was seen resting in the surf zone about 50 meters from the beach, while her calf was trying to nurse. The mother/calf pair was accompanied by KOGW108 calf, which appeared to have been weaned already, but nevertheless was making persistent attempts to also nurse from KOGW110.

The drones allowed photographing groups of young weaned whales and documenting their behavior, which varied from collective resting/sleeping to energetic play-activities.

GPS-referenced video observations of whales expelling mud made it possible to identify and track feeding areas favored by the whales during the field season. There were 115 locations recorded along both the northern and southern sections of the coast.

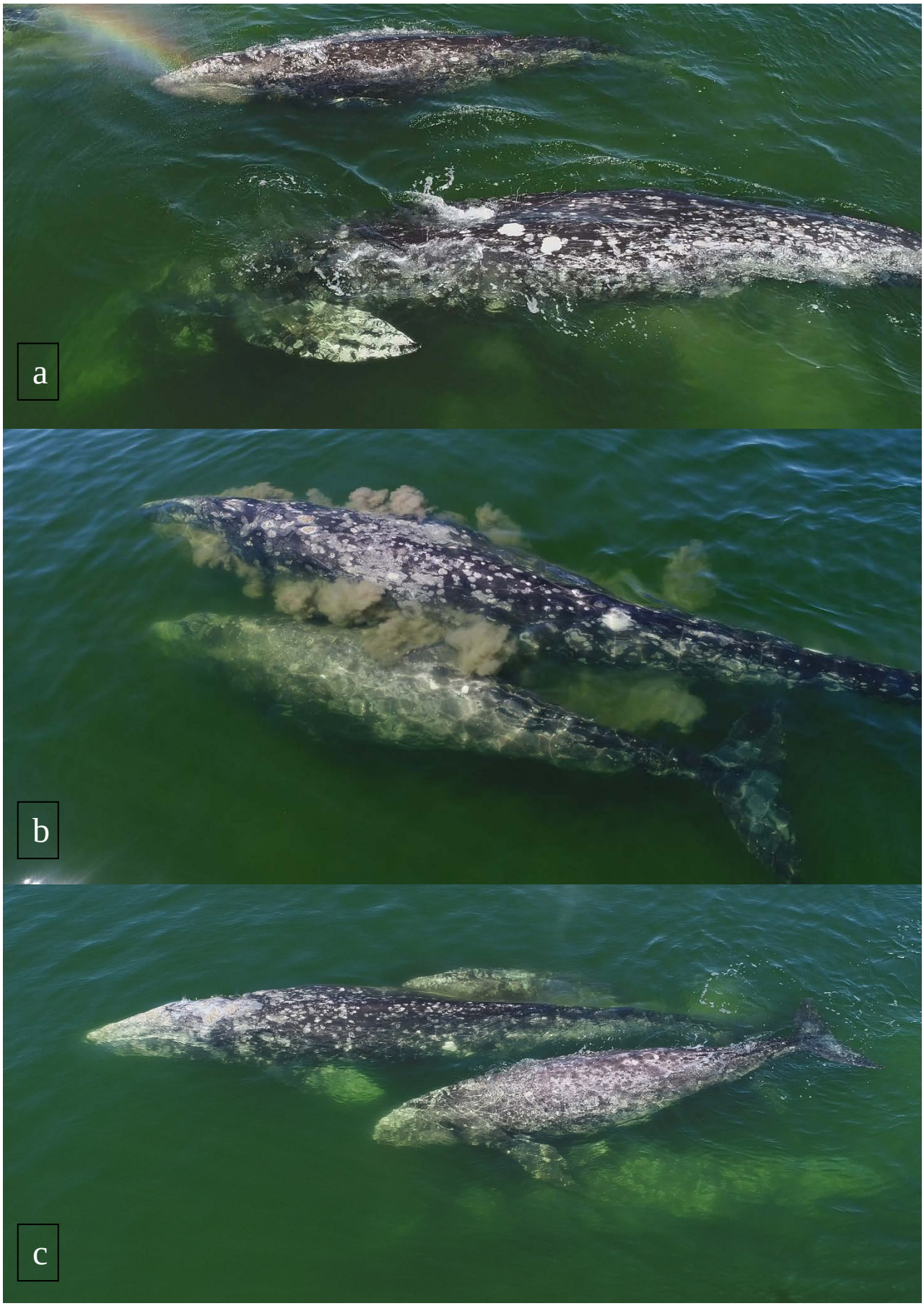

Figure 2. Drone photographs of a) cow/calf pair KOGW007 / KOGW278, b) cow/calf pair KOGW108 / KOGW276 and c) the two pairs together (from top to bottom: KOGW278 / KOGW007 / KOGW276 / KOGW108 (submerged).

Comparison of Sakhalin Gray Whale Photo-ID Studies

In addition to the studies of the gray whales of Sakhalin conducted under the Joint Program, a separate photo-identification study of the area centered on the mouth of Piltun Bay has been conducted annually since 1997 by the Russian Gray Whale Project (Russian Project) (Burdin *et al.*, 2017). This catalog has a total of 267 distinct individual whales following the 2017 field program (WGWAP-18, 2017).

The catalogs of the two programs were last cross-matched after the 2011 field season. As of 2011, the two Sakhalin photo-ID catalogs contained a total of 222 whales, of which 186 were common to both. Seventeen were found only in the Russian Project catalog and 19 only in the Joint Program catalog (IUCN, 2013).

A new cross-match exercise is needed and the Joint Program is in discussion with IWC to facilitate it. However in order to share information of the results of the programs since 2011, a simple comparison of the two identification programs is illustrated in the following 3 figures.

Figure 3 compares the number of gray whales identified in the nearshore Piltun feeding area each year since 2002. In addition, the total number of whales identified each year during the Joint Program studies in both the Piltun and Offshore feeding area is designated by the yellow line. In most years, the Joint Program identified more whales in the Piltun feeding area than the Russian Project.

Figure 4 compares the reported annual effort of the two surveys in Piltun feeding area since 1994. Effort is the biggest factor in determining the number of whales identified. Weather is another factor. Survey results may also be due to differences in survey methodologies such as the larger Joint Program survey area, type of effort (shore-based small boat used by the Russian Project versus vessel-based small boats and onshore vehicles), and timing of survey (Russian Project is usually conducted July and August while the Joint Program surveyed in August and September). The size of the Joint Program effort grew significantly beginning in 2014 when onshore small boat and vehicle teams were added. While the onshore small boat team surveyed the same area as the Russian Project, the vehicle team had the flexibility to search a broader section of the coastline for whales and not be dependent on the sea state and weather at the mouth of Piltun Bay.

Figure 5 compares the number of calves identified by the two programs each year since 2003. The Russian Project has identified 104 calves in this period while the Joint Program has identified 127. In the period from 2003 to 2010, both programs identified 51 calves. Since then, the Joint Program has identified 23 more calves (43%).

The discussion of the difference in the results of the two long-term programs can go on in much greater detail. In the end, however, the intention of both programs is to monitor the unique population of gray whales and contribute to a greater understanding of their life science. The next step is to cross-match the databases in order to have the best-available population data for modeling exercises.

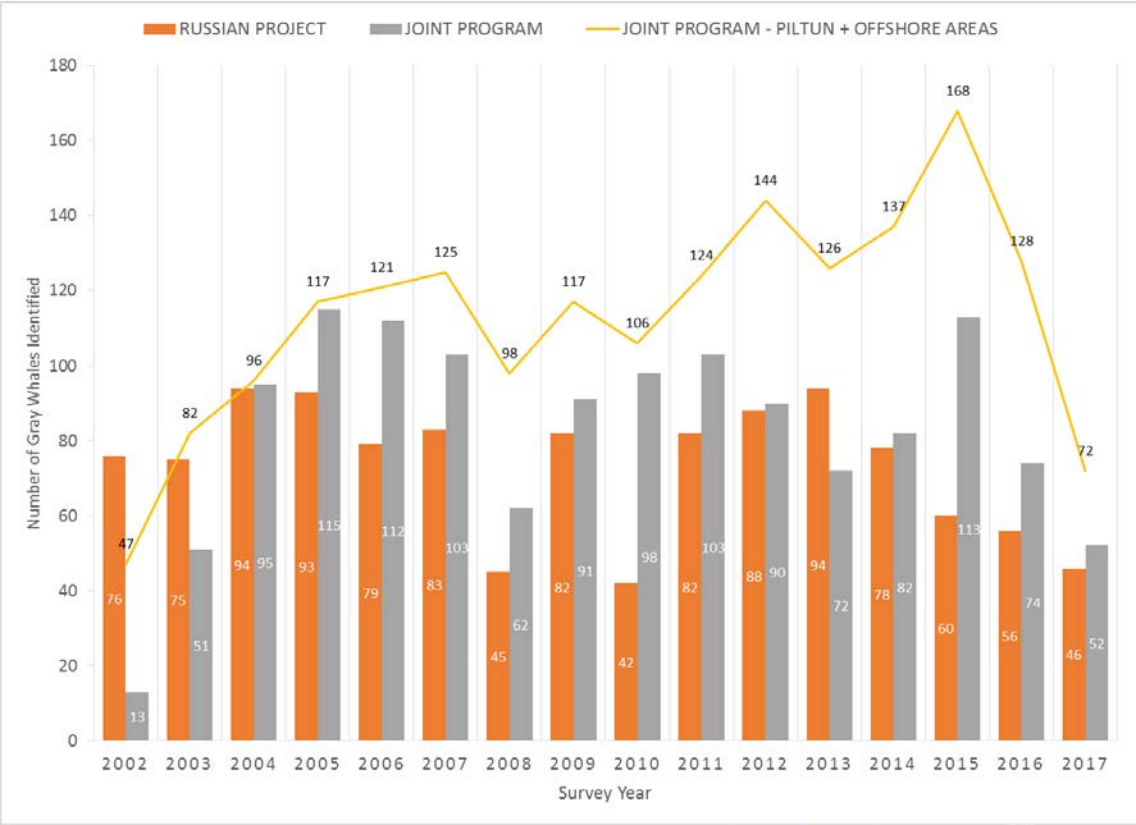

Figure 3. Comparison of number of gray whale identified during annual Piltun feeding area surveys, 2002-2017

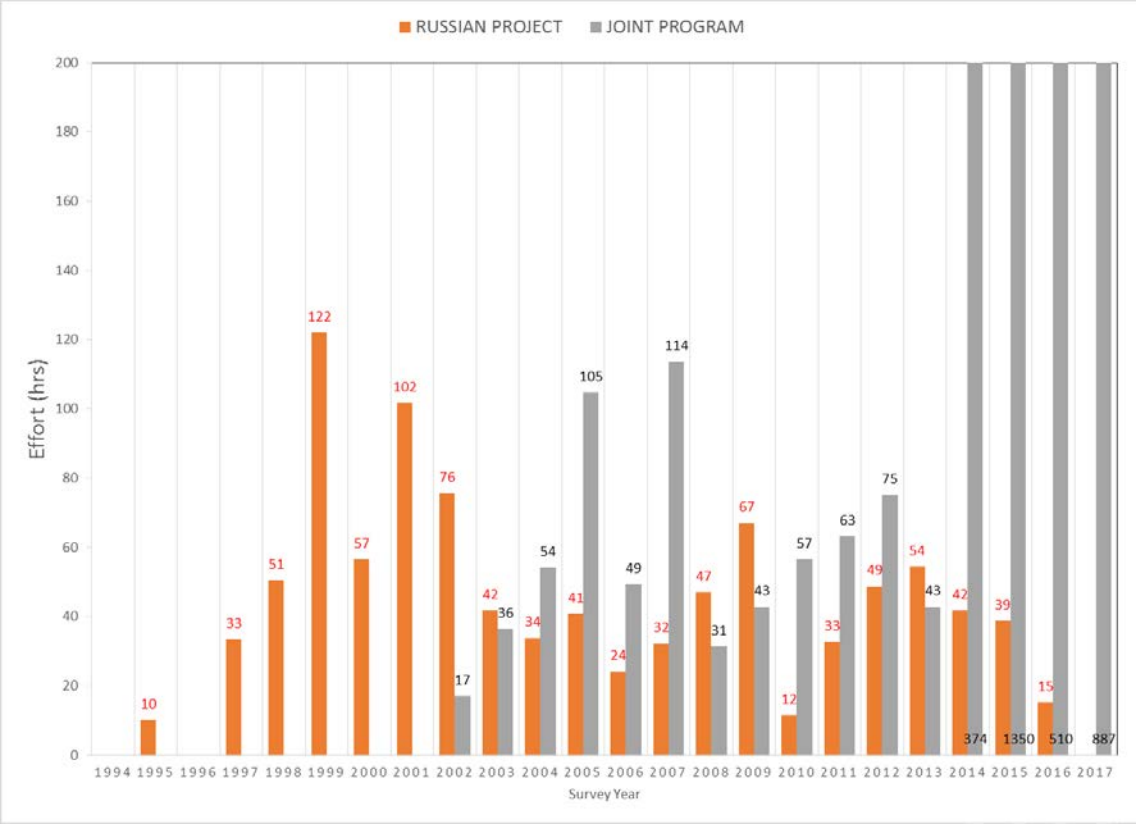

Figure 4. Comparison of photo-ID effort during annual Piltun feeding area surveys, 1994-2017

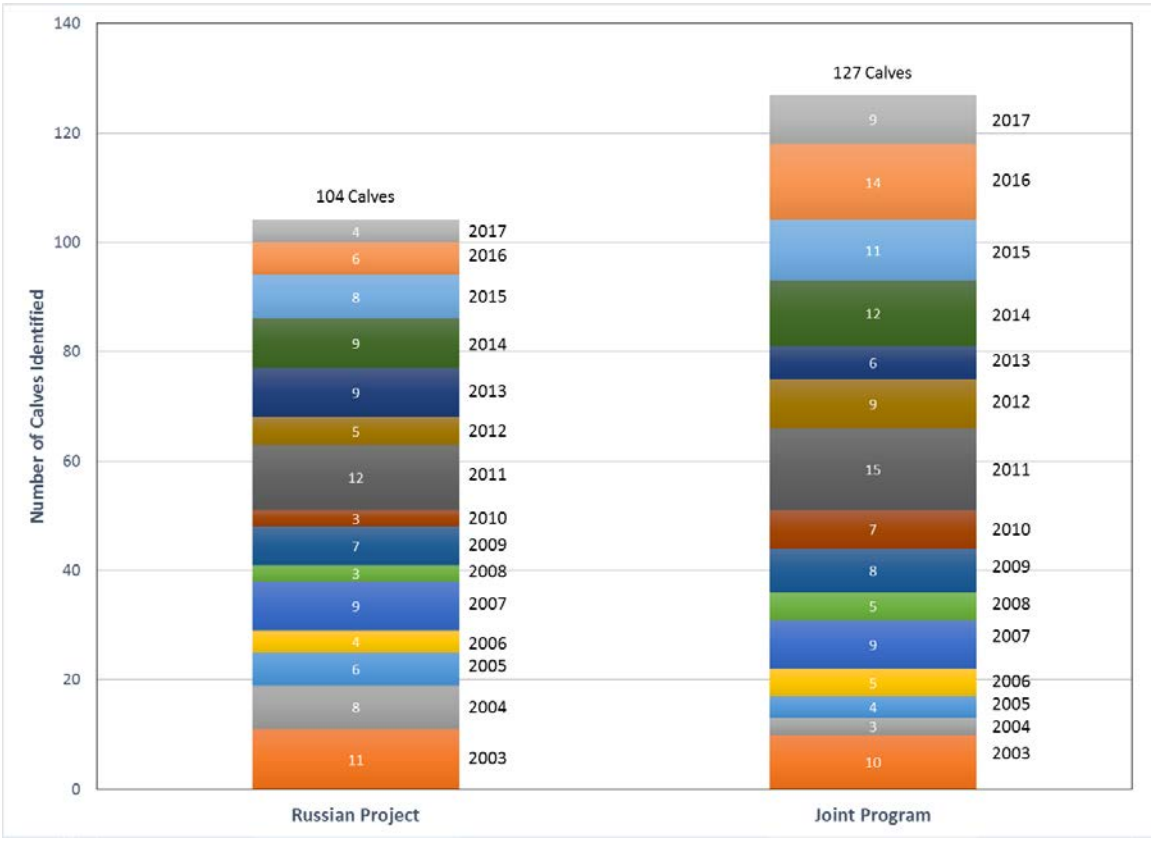

Figure 5. Comparison of number of gray whale calves identified during annual Piltun feeding area surveys, 2003-2017

CONCLUSIONS

Photo-ID has proven to be a useful and low-impact technique for monitoring the population and when incorporated into a long-term monitoring program, it can help answer ecological questions about the population dynamics of marine mammals. Tracking the movements of gray whales during their feeding period can broaden the understanding of their feeding ecology. As the whales move among feeding areas they may target certain prey species in each area. Photo-ID sighting data allows one to follow these movements through the seasons and establish patterns of habitat use.

Data about the whales' movements within and between seasons can only be collected through repeat sightings of individually recognizable whales within those seasons (Meier *et al.,* 2007; Vladimirov *et al.,* 2008). The frequency of sightings over the whole 2002-2017 period is another important factor in studying whale movement among different areas. In general, the time allocated for observational studies of cetaceans tends to be small due to the challenging, costly, and labor-intensive nature of this type of research. The benefit of a long-term monitoring program is that with increasing duration of the study, the same individuals continue to be photographed over time, resulting in more sighting data allowing more robust analyses of patterns regarding whale movement and feeding area utilization.

By incorporating geographic data in the sighting histories of known whales and whale groups, habitat use patterns can be established. These baseline datasets are useful for continued monitoring of the whales and for recording any potential deviations in geographic or temporal use patterns that may arise in the future.

The majority of identified gray whales return to Sakhalin feeding areas each year and some degree of fidelity to these areas is displayed by most of the identified individuals. Some

individual whales are sighted on the feeding areas off Sakhalin irregularly, not every season. The absence of those individuals during certain years is sometimes due to individuals being missed by the photo-ID teams.

The photo-ID catalog compiled over the last 16 years provides strong evidence of the steady increase in the number of gray whales observed off Sakhalin Island each year. It is a key piece of the Joint Program's multi-discipline studies of the gray whale population and ecology. The long-term information collected and analysis from it has increased the knowledge base of these animals and their remote habitat, been used to assess and mitigate real and perceived risks to the whales, and enable more effective management through science and risk-based decisions.

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