WESTERN GRAY WHALE RESEARCH AND MONITORING PROGRAM IN 2009, SAKHALIN ISLAND, RUSSIA

VOLUME II

RESULTS AND DISCUSSION

Photo taken by Y.M. Yakovlev

Prepared for
Exxon Neftegas Limited and Sakhalin Energy Investment Company Limited

March 2010

TABLE OF CONTENTS

CHAPTER 1: DISTRIBUTION AND ABUNDANCE 1

1.1 RESEARCH EFFORT AND COLLECTED DATA 11

1.1.1 Vessel Based-Surveys 11

1.1.2 Onshore Surveys 14

1.2 STUDY RESULTS 16

1.2.1 Gray Whale Distribution and Abundance 16

1.2.1.1 Piltun Area 16

1.2.1.1.1 Vessel-based Surveys 16

1.2.1.1.2 Onshore Surveys 17

1.2.1.1.2.1 Spatial and Seasonal Distribution 17

Late June - July 19

August 22

September 25

June/July-September 27

1.2.1.1.2.2 Whale Distribution Based on Distance from Shore and Water Depth 33

1.2.1.1.2.3 Whale Population Dynamics in the Piltun Area 37

1.2.1.2 Offshore Area 40

1.2.1.3 Arkutun-Dagi License Area 42

1.2.1.4 Piltun-Astokh License Area 42

1.2.1.5 Total Number of Gray Whales Feeding in Sakhalin Waters 44

1.2.2 Whale Groups 46

1.2.2.1 Piltun Area 46

1.2.2.1.1 Vessel-based Surveys 46

1.2.2.1.2 Onshore Surveys 47

1.2.2.2 Offshore Area 48

1.2.2.3 Piltun-Astokh License Area 48

1.2.2.4 Arkutun-Dagi License Area 48

1.2.2.5 Whale Groups Observed by MMOs During July-September 2009 49

1.2.3 Distribution of Cows with Calves 49

1.2.4 Anthropogenic Impacts on Gray Whales 51

1.2.5 Sightings of Other Marine Mammal Species 52

1.3 DISCUSSION OF RESULTS 53

1.4 CONCLUSIONS 58
1.5 ACKNOWLEDGMENTS 61
1.6 LIST OF CITATIONS 62
1.7 APPENDICES 66

CHAPTER 2: PHOTOGRAPHIC IDENTIFICATION 106

2.1 FIELD EFFORT RESULTS 110
2.2 FINAL PHOTO-ID RESULTS POST PROCESSING 114
2.2.1 Identification and the Numbers of Individual Animals 115
2.2.2 Whale Group Size 117
2.2.3 Frequency of Sightings and Movement of Identified Whales between Known Feeding Areas Offshore Sakhalin Island 121
2.2.4 Repeat Sightings of Whales Offshore North-east Sakhalin 124
2.2.5 Cow/Calf Pairs 125
2.2.6 Body Condition* 126
2.2.6.1 Body Weight 126
2.2.7 Skin Sloughing 130
2.2.8 Other Skin Condition Impairments 131
2.3 PHOTO IDENTIFICATION OF GRAY WHALES OFFSHORE EASTERN KAMCHATKA PENINSULA 131
2.3.1 Scope of Work 131
2.3.1.1 Identification and the Number of Whales 131
2.3.1.2 Kamchatka Catalogue Assessment: Photographic Coverage of Four Standard Body Aspects 136
2.3.1.3 Cow/Calf Pairs 137
2.4 BODY CONDITION 138
2.4.1 Body Weight 138
2.5 THE TOTAL NUMBER OF WHALES IDENTIFIED BY THE TWO 2009 EXPEDITIONS OFFSHORE SAKHALIN ISLAND ND KAMCHATKA PENINSULA 139
2.6 MOVEMENT OF GRAY WHALES BETWEEN THE SOUTH-EAST COAST OF KAMCHATKA, THE OFFSHORE WATERS OF NORTH-EAST SAKHALIN AND OTHER AREAS 140
2.6.1 Stranded Dead Gray Whale 140
2.6.2 Brief History of the Whale 142
2.7 DISCUSSION 142
2.7.1 Whales Movement Among Feeding Areas 142

2.7.2 Whale Movement Between Southeastern Kamchatka and Sakhalin 143
2.7.3 Whale Movement between Other Areas and Sakhalin 144
2.7.4 Cow/Calf Pairs 146
2.7.5 Body Condition 147
2.8 CONCLUSIONS 149
2.8.1 Catalogue Overview 149
2.8.2 Whales Identified in 2009 on Both the Sakhalin and Kamchatka Shelves 150
2.8.3 Dead Gray Whale 151
2.8.4 Migration of Gray Whales Between Sakhalin Feeding Areas in 2009 151
2.8.5 Body Condition 152
2.8.6 Cow-calf Pairs 153
2.9 ACKNOWLEDGEMENTS 154
2.10 LIST OF CITATIONS 156
2.11 APPENDICES 173
CHAPTER 3: BENTHIC STUDIES 228
3.1 CHARACTERISTICS OF WATER COLUMN AND BOTTOM SEDIMENTS 232
3.1.1 Water Temperature 232
3.1.2 Particle Size Distribution of Bottom Sediments 233
3.1.3 Classification of Stations According to Similarity of Particle Size Distribution 234
3.1.4 Particle Size of Bottom Sediments at Gray Whale Feeding Sites 237
3.1.5 Concentrations of Key Pollutants in Sediments 237
3.2 BENTHOS COMPOSITION AND QUANTITATIVE DISTRIBUTION IN THE AREAS 241
3.3 PILTUN AREA 241
3.3.1 Quantitative Distribution 242
3.4 COMPOSITION AND DISTRIBUTION OF BENTHOS COMPLEXES 257
3.5 OFFSHORE AREA 260
3.5.1 Quantitative Abundance and Distribution of Benthos 260
3.5.2 Composition and Distribution of Benthos Complexes 263
3.6 INTERMEDIATE AREA 268
3.6.1 Quantitative Abundance and Distribution of Benthos 268
3.6.2 Composition and Distribution of Benthos Complexes 268

3.7 BENTHOS AT GRAY WHALE FEEDING SITES 271
3.7.1 Whale Feeding Sites in the Piltun Area.....271
3.7.2 Whale Feeding Sites in the Chayvo Subarea.....272
3.7.3 Whale Feeding Sites in the Offshore Area.....276
3.8 COMMENTS FOR ASSESSING YEAR-TO-YEAR CHANGES IN FORAGE BENTHOS IN THE PILTUN AND OFFSHORE FEEDING AREAS 278
3.9 TROPHODYNAMICS USING STABLE ISOTOPE AND FATTY ACID ANALYSES 282
3.10 CONCLUSION 285
3.11 LIST OF CITATIONS 287

CHAPTER 4: BEHAVIOR..... 298

4.1 EFFORT 298
4.2 SCAN DATA.....298
4.3 THEODOLITE TRACKLINES.....317
4.4 FOCAL BEHAVIOR OBSERVATIONS.....323
4.5 BEHAVIORAL STATES.....325
4.6 ABUNDANCE, MOVEMENT, AND RESPIRATION NEAR PILE DRIVING ACTIVITY 338
4.7 KILLER WHALES.....342
4.8 DISCUSSION.....343
4.9 ACKNOWLEDGEMENTS.....360
4.10 LIST OF CITATIONS 361

CHAPTER 1

DISTRIBUTION AND ABUNDANCE OF OKHOTSK-KOREAN (WESTERN) GRAY WHALES IN THE WATERS OFF NORTHEAST SAKHALIN ISLAND, JUNE – SEPTEMBER 2009

(based on data from onshore and vessel-based surveys)

RESEARCH REPORT
UNDER THE "OKOTSK-KOREAN (WESTERN)
GRAY WHALE MONITORING PROGRAM
OFF THE NORTHEAST COAST OF SAKHALIN ISLAND, 2008-2010"

V. A. Vladimirov (VNIRO), S. P. Starodymov (VNIRO),
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Prepared for Exxon Neftegas Limited
and
Sakhalin Energy Investment Company Limited

March 2010

Russian Federal Research Institute
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_____ 2010

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Moscow
2010

EXECUTIVE SUMMARY

This report presents the results of vessel-based and onshore surveys of the western gray whale population in the summer and fall of 2009 under the Okhotsk-Korean (Western) Gray Whale Monitoring Program off the northeast coast of Sakhalin Island. Survey results revealed that in the Piltun feeding area, the maximum number of observed whales was 55% higher than in 2008 (i.e., increased from 47 to 73 individuals), while in the Offshore area, the opposite occurred: the maximum number of observed whales during early September decreased by 59% (i.e.,from 63 to 26 individuals). The smaller number of whale sightings during Offshore area surveys in 2009 may at least partly be explained by the low number of Offshore area surveys that were carried out during 2009 (due to bad weather conditions, only two full surveys could be performed) as well as by the fact that considerable numbers of whales were observed to the northeast of the Offshore area transect lines outside the survey grid. In 2009 no gray whales were seen in the waters of the Arkutun-Dagi license area (Sakhalin-1 Project), while in the Piltun-Astokh license area (Sakhalin-2 Project), a small number were observed in September and a single whale was seen in July.

Photo ID data indicate that in 2009, the observed number of gray whales off the northeast coast of Sakhalin increased: 117 gray whales were identified in the waters offshore northeast Sakhalin compared to 98 in 2008. The total number of photo-identified whales in this region has remained relatively stable over recent years at about 100-120 individuals. Furthermore, based on photo ID effort from 2007 onwards, there has been evidence of fairly active whale migrations between two existing feeding areas in Far East seas (the northeastern Sakhalin and southeastern Kamchatka feeding grounds).

Whale densities throughout the Piltun feeding grounds in 2009 were higher than during the previous year over all of the Piltun feeding area: most whales in the nearshore zone were concentrated in the central and southern parts of the area but higher whale concentrations than in 2008 were also observed in parts of the northern section of the Piltun feeding area. As in previous years, cows with calves kept to the near-shore waters in the southern half of the Piltun feeding grounds. Similar to 2008, the number of calves observed during the 2009 onshore

distribution surveys was 2 individuals but photo-identification studies observed eight calves offshore Sakhalin in 2009 (Yakovlev et al, 2010).

The 2009 surveys found no evidence that construction, installation, or production activity at onshore Sakhalin-1 Project facilities on the Piltun Spit had any apparent adverse impact on the abundance or distribution of gray whales in the neighboring water area.

In general, results from the 2009 distribution surveys together with results from the 2009 photo-ID surveys indicate that the Western Gray Whale population is in stable condition.

Key words: gray whale, Sakhalin, Piltun, survey, feeding, distribution, abundance, anthropogenic impact.

Tables 9, Figures 7, bibl. 19, App. 2, pp.103

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LIST OF TABLES

Table 1 Recorded Results of Vessel-Based Surveys of Marine Mammals from the *Academic Oparin* Scientific Research Vessel in the Waters of Eastern Sakhalin, July-September, 2009 12
Table 2 Results of Systematic Gray Whale Vessel-Based Surveys on the Northeast Sakhalin Shelf, July-September 2009 13
Table 3 Time Spent on Shore-Based Surveys of Gray Whales in the Piltun Area, June-October 2009. Survey Results 15
Table 4 Results of Shore-based Surveys of Gray Whales in the Piltun Area, June–September 2009 21
Table 5 Quantitative Distribution of Gray Whales in the Piltun Area, ... 23
Table 6 Distribution of Gray Whales in the Piltun Area by Distance from Shore, July - September 2009 (Based on All Shore-Based Surveys) 33
Table 7 Distribution of Gray Whales in the Piltun Area by Sea Depth, ... 36
Table 8 Gray Whale Groups Recorded in the Waters of Northeastern Sakhalin in 2009 47
Table 9 Number of Gray Whales in Groups Recorded in the Piltun Area in 2009 48

LIST OF FIGURES

Figure 1 Gray whale distribution in the Piltun and Offshore feeding areas in July–September 2009 18
Figure 2 Gray whale distribution in the Piltun area in June–September 2009 from shore-based survey data 20
Figure 3 Space-time variations in gray whale distribution in the Piltun area in July–September 2009 29
Figure 4 Year-to-year variations of gray whale average seasonal abundance in the Piltun area in 2004–2009 30
Figure 5 Gray whale distribution in the Piltun and Offshore feeding areas in 31
Figure 6 Gray whale distribution in the Piltun area by distance from shore 34
Figure 7 Gray whale distribution in the Piltun Area by water depth 34

LIST OF APPENDICES

Appendix 1 Data on Gray Whales and Other Marine Mammals Recorded during Surveys from the *Akademik Oparin* Scientific Research Vessel in the Waters of Eastern Sakhalin, July-September 2009

Appendix 2 Results of Shore-Based Surveys of Gray Whales and other Cetaceans in the Piltun Feeding Area, July-September 2009

CHAPTER 1: DISTRIBUTION AND ABUNDANCE

1.1 Research Effort and Collected Data

1.1.1 Vessel Based-Surveys

In 2009, vessel-based surveys of gray whales and other marine mammals were conducted offshore northeast Sakhalin from the *Akademik Oparin* scientific research vessel from July 5 to September 28, with an interruption from August 3 to 7 to visit the port of Korsakov. The 2009 transects in the Piltun and Offshore feeding areas and the Arkutun-Dagi license area were the same as those used in 2008, with the addition of latitudinal transects in the Piltun-Astokh license area. As a result, the survey area encompassed all known gray whale feeding grounds in eastern Sakhalin waters. The vessel-based survey program planned to do 13 systematic surveys during the survey period (four in the Piltun feeding area, four in the offshore feeding area, two in the Arkutun-Dagi license area, and three in the Piltun-Astokh license area). However, due to adverse summer and fall weather, the vessel was forced to leave the survey area prematurely, and only four of the planned surveys were completed (two in the Offshore feeding area and one each in the waters of the Arkutun-Dagi and the Piltun-Astokh license areas). Five more surveys (one in the Piltun feeding area, two in the Offshore area, one in the Arkutun-Dagi license area, and one in the Piltun-Astokh license area) were suspended due to deteriorating weather conditions (Table 2). During the voyage, “opportunistic” surveys of marine mammals were also conducted in daylight hours, weather permitting, but due to the non-systematic nature of these surveys, their data were not incorporated into the analyses presented here.

A total of 1,438 marine mammals of various species were recorded during both the opportunistic and systematic surveys, of which 708 were gray whales (Table 1), 131 of these gray whales were sighted during systematic surveys along the northeast Sakhalin coast (Table 2).

More detailed data on gray whales and other marine mammals recorded during the 2009 vessel-based survey is presented in the following sections and in Appendix 1.

Table 1. Recorded Results of Vessel-Based Surveys of Marine Mammals from the *Academic Oparin* Scientific Research Vessel in the Waters of Eastern Sakhalin, July-September, 2009.

	Identified Species													Unidentified Species				Total	
	GW	MW	KW	DP	HP	NF	SL	SS	BW	BS	FW	PWSD	RS	UBW	UTW	UW	US	UMA	
July	145	16	25	25	21	41	4	14	-	-	-	-	-	-	-	-	-	-	291
August	183	30	4	99	36	43	2	5	22	1	4	25	-	-	-	1	5	1	461
September	380	9	2	3	12	247	2	20	-	-	-	-	1	1	1	-	-	-	678
October	-	-	-	7	-	-	-	1	-	-	-	-	-	-	-	-	-	-	8
Total:	708	55	31	134	69	331	8	40	22	1	4	25	1	1	1	1	5	1	1438
Percent of total	49.24	3.82	2.16	9.32	4.80	23.02	0.56	2.78	1.53	0.07	0.28	1.74	0.07	0.07	0.07	0.07	0.35	0.07	100

Note: GW – gray whale, MW – Minke whale, KW – killer whale, DP – Dall's porpoise, HP – harbor porpoise, NF – northern fur seal, BS – bearded seal, SL – sea lion, SS – spotted seal, BW – Baird's beaked whale, BS – bearded seal, FW – finwhale, PWSD – Pacific white-sided dolphin, RS – ringed seal, UBW - unidentified baleen whale, UTW – unidentified toothed whale, UW – unidentified whale, US – unidentified seal, UMA - unidentified marine animal.

Table 2. Results of Systematic Gray Whale Vessel-Based Surveys on the Northeast Sakhalin Shelf, July-September 2009.

Planned Survey Date	Survey Area	Actual Survey Date	Number of sighted whales	Notes
6 July	Piltun Feeding Area	-	-	Two attempts made. Survey canceled due to poor visibility
7 July	Piltun-Astokh License Area	11 July	0 (7 whales sighted outside of area boundaries)	Survey incomplete due to decreased visibility.
	- « -	17 July	1	Continued July 11 survey
19 July	Piltun Feeding Area	-	-	Canceled
20 July	Offshore Feeding Area	21 July	1 (20 whales sighted outside of area boundaries, 9 of them are possible resights)	Completed
21 July	Arkutun-Dagi License Area	22 July	0	Completed
22 July	Piltun-Astokh License Area	-	-	Canceled
14 August	Piltun Feeding Area	-	-	Canceled
15 August	Offshore Feeding Area	15 August	0	Visibility 2 - 6 km. Survey incomplete due to decreased visibility.
16 August	Arkutun-Dagi License Area	16 August	0	Visibility 2 - 6 km. Survey incomplete due to decreased visibility.
31 August	Piltun-Astokh License Area	2 September	32 (10 whales sighted outside of area boundaries), 18 possible resights	Completed
1 September	Offshore Feeding Area	1 September	15 (11 whales sighted outside of area boundaries), 3 possible resights	Completed
15 September	Piltun Feeding Area	17 September	33	Survey incomplete due to decreased visibility.
16 September	Offshore Feeding Area	15 September	0 (1 whale sighted outside of area boundaries)	Survey incomplete due to decreased visibility.

1.1.2 Onshore Surveys

Onshore gray whale observations were performed in 2009 over a 95 day survey season (from June 25 through September 27). Weather conditions during late June, early July, and the last three weeks of August (from the 11th onward) were very unfavorable for these whale observations due to wave activity and frequent, long periods of fog at sea. As a result, researchers managed to complete only three synchronized surveys (in which observations were recorded at all thirteen survey stations) during this time (Table 3). Over the entire three-month survey season, only 15 complete, synchronized surveys were performed in the Piltun area. In addition, 11 asynchronous surveys[1] were completed (1 in the Odoptu-Piltun and 10 in the Astokh-Chayvo areas), when weather made it impossible to perform a complete survey in the other section on the same day. In 30 other cases, surveys that had been initiated had to be suspended due to worsening weather conditions (reduced visibility or high sea state). The total time spent conducting the surveys in 2009 was 103 hours 30 minutes (Table 3). For comparison, in 2004, 2005 and 2007, when weather conditions were considerably better, more synchronized surveys were completed over the same time period: 27, 34, and 28, respectively. Only in 2006, when the weather was similarly unfavorable, was the number of complete surveys (i.e., 15) as low as in 2009.

A total of 1,027 sightings of individual gray whales or groups were made in 2009, with a total count of 1,356 whales (Table 3).

In addition to gray whales, other cetacean species were observed during the onshore surveys. Information on these species is presented in section 1.2.5 and in Appendix 2.

[1] As described in Volume I, Chapter 2, Distribution introduction and methods, the survey area is divided into two sections by the channel that connects Piltun Bay to the sea. The “Odoptu-Piltun” section is located north of the channel and is surveyed by the northern 8 stations. The “Astokh-Chayvo” section is sampled by the southern 5 stations. An asynchronous survey occurs when all stations were sampled in only one of the sections.

Table 3. Time Spent on Shore-Based Surveys of Gray Whales in the Piltun Area, June-October 2009. Survey Results.

Month	Odoptu-Piltun Area (Survey Stations ## 1-8)					
	Full surveys		Partial surveys		Number of whale sightings	Total number of recorded whales
	n	*hour*	*n*	*hour*		
June	0	0:00	0	0:00	0	0
July	2	4:46	10	11:04	87	111
August	6	14:19	4	4:29	146	182
September	8	19:04	4	2:58	180	234
Total:	16	38:09	18	18:31	413	527

Month	Astokh–Chayvo Area (Survey Stations ## 9-13)					
	Full surveys		Partial surveys		Number of whale sightings	Total number of recorded whales
	n	*hour*	*n*	*hour*		
June	1	1:32	0	0:00	9	11
July	5	7:40	6	4:32	125	166
August	10	15:18	3	2:08	319	439
September	9	13:48	3	1:52	162	213
Total:	25	38:18	12	8:32	614	829

Month	T o t a l (Survey Stations ## 1-13)							
	Full surveys				Partial surveys		Number of whale sightings	Total number of recorded whales
	Synchronous		Asynchronous					
	n	*hour*	*n*	*hour*	*n*	*hour*		
June	0	0:00	1	1:32	0	0:00	9	11
July	2	7:50	3	4:36	16	15:36	212	277
August	5	19:33	6	10:04	7	6:37	465	621
September	8	31:20	1	1:32	7	4:50	342	447
Total:	15	58:43	11	17:44	30	27:03	1027	1356

Notes:

The times indicated in the table include only the time spent directly on observations; time spent in travel to the survey points and from one point to another is not included.
The number of gray whale sightings and the number of counted animals include all recorded whales and groups of whales including those spotted outside the 1-minute sector scanning periods ("out of scan")
Complete surveys in the same area are those during which monitoring was performed on the same day at all survey stations (survey stations 1–8 in the Odoptu-Piltun section and 9–13 in the Astokh-Chayvo section); complete synchronous surveys are defined as simultaneous surveys carried out in both sections; asynchronous surveys are complete surveys performed within these areas at different times. Partial surveys are those that for some reason were not carried out at all monitoring stations.

1.2 STUDY RESULTS

1.2.1 Gray Whale Distribution and Abundance

1.2.1.1 Piltun Area

1.2.1.1.1 Vessel-based Surveys

The only successful vessel-based survey in the Piltun area occurred on September 17, 2009 and could not be completed due to deteriorating weather conditions (Table 2). During that survey, 33 gray whales were counted (Table 2).

The whales were sighted individually or in groups of two to four individuals. The majority of whales observed during this survey were between the mouth of Piltun Bay and the latitude of the Yastreb onshore drilling rig in the central part of Piltun Spit (between observation stations 4 and 5), with another small cluster sighted along the southern boundary of the Piltun feeding area opposite Chayvo Bay (Figure 1 “September”).

Results from the 17 September survey indicate that the number of gray whales observed in the Piltun area was greater in September 2009 than in September 2008. Twenty two whales were counted in early September 2008 and only 10 were observed by the end of the month, compared to 33 individuals in the middle of the month in 2009. Results from the 17 September 2009 survey possibly represent an undercount since due to deteriorating weather conditions, the northernmost 17 km of the transect was not surveyed.

It should also be noted that maps showing gray whale distribution in the Piltun area based on vessel survey data (Figure 1, “September”), the estimated whale densities in the northern and southern parts of the area are based only on the September 17 survey or, in the central part of the area, on the average of two surveys i.e. the September 17 survey data in this part of the Piltun feeding area were combined with the September 2 survey data for the Piltun-Astokh license area. As a result, estimates of average whale density are biased high in areas where whales are not usually seen because at most, a single other sample with the more typical zero density estimates is included in the calculations of average density. This overestimation of whale density gave an inaccurate impression, based on maps of vessel-based surveys performed in the Piltun

area, that the deeper water along the 20-meter isobath far from shore is an area of higher gray whale concentration. In fact, the data only suggest that in September 2009 a relatively large number of whales was present in the Piltun area at a significant distance from shore in approximate water depths of 20 meters or more, and that the number of whales recorded there was greater than in 2008 (Vladimirov et al. 2009). More accurately, survey data from previous years indicate that whales are seldom encountered in this area and that the vast majority of individuals (~ 95%) spend the entire feeding season no more than 5 km from shore in waters less than 20 m deep, of which 85-90% keep to waters less than 15 m deep (Vladimirov et al., 2005, 2006, 2007, 2008, 2009).

1.2.1.1.2 Onshore Surveys

Much more detailed information on gray whale distribution within the Piltun feeding area and population dynamics in the summer-fall season was acquired through onshore surveys compared to the few vessel surveys that were conducted. It should be noted that the adverse weather present through most of July and August limited the number of synchronized surveys that could be performed during those months, particularly in July (only two synchronized surveys were completed in July). As a result, a detailed picture of the whale population dynamics could not be obtained for these months. However, the acquired data could be used to estimate gray whale abundance and distribution patterns on a monthly basis (i.e., averaged over one month) for the Piltun area during 2009.

1.2.1.1.2.1 Spatial and Seasonal Distribution

The results of the 2009 onshore surveys in the Piltun area are summarized in Table 4. To further analyze the distribution of gray whales within the surveyed area, this area was divided into 1 x 1 km cells, and the average density of whales within each cell was calculated (this methodology is described in greater detail in Volume 1, Chapter 2). The resulting maps illustrate variations in gray whale distribution and abundance within the Piltun area throughout the summer and fall.

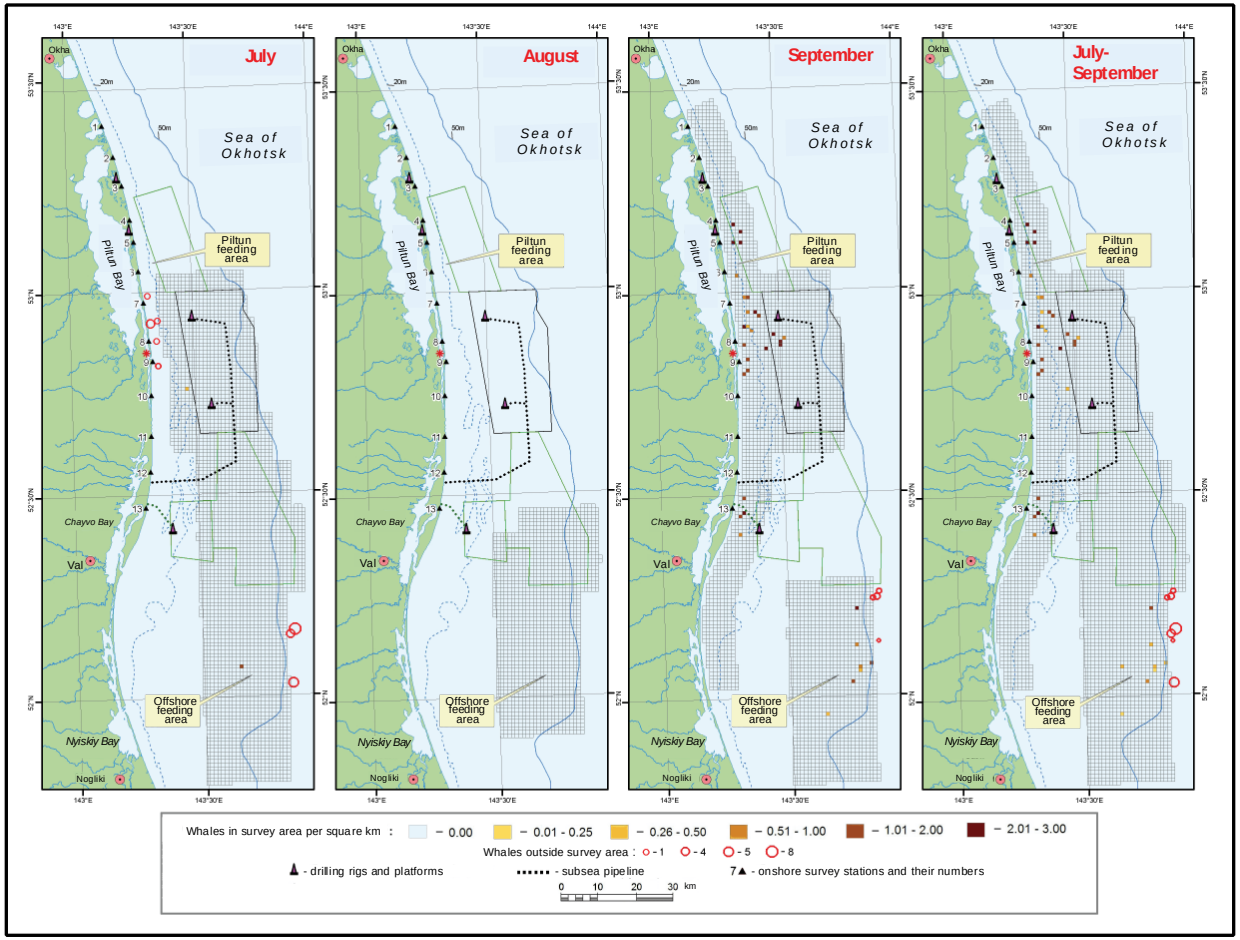

Figure 1. Gray whale distribution in the Piltun and Offshore feeding areas in July–September 2009 (from the vessel-based survey data). Whale sightings made beyond the ends of the transects were excluded in the density analysis (see Distribution methods for a detailed explanation) and are shown on the density maps as red circles whose size is proportional to the number of gray whales in the sighting.

Note: drilling rig to the north of onshore survey station 3 is a RosNeft facility

Late June - July

On 3 July 2009 during the first synchronized survey, 49 whales were counted in the near-shore zone, which was greater than the late June to early July counts during the 2004-2006 surveys (30-45 individuals)[2]. The next complete survey, conducted on July 11, showed that the number of observed whales in the area remained basically unchanged (44 individuals – Table 4). The pattern of whale arrivals after July 11 cannot be judged with accuracy because no complete survey was carried out for the remainder of that month. According to data from the two complete surveys, the average number of whales per survey in July was 46.5 individuals (Table 5).

During the late June-July period, gray whale distribution in the Piltun area was, as in previous years, more or less scattered – the whales occupied the entire area but did not form clearly defined aggregations (Figure 2). However, whale densities were markedly higher in the southern half of the Piltun area (near survey stations 8-13) than in most of the remaining Piltun area. A second, smaller area of moderately high whale densities was observed in the northern part of the Piltun area between survey stations 3 and 6. Based on data from the completed surveys, in July the southern group (stations 8-13) averaged about 66.6% of all whales present in the area, while the northern group (stations 3-6) averaged 23.7% (Table 5). Overall, the dispersed pattern of whale distribution in the nearshore area, and the higher densities of whales in the southern half of the Piltun feeding area were comparable to 2004 – 2007 during the same, i.e., late June through July, period when whales begin to arrive from their wintering grounds.

In late June and July 2009, gray whales occupied (based on the number of cells in which the presence of whales was recorded at least once during this time period) 121(15.6%) of the 775 square-kilometer cells scanned during the surveys – Figure 2). In the southern part of the area (in the vicinity of survey stations 8 – 13) this figure was 23.2%, and in the northern part it was less than half as much (10.9%).

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[2] - 2007-2008 were not used in this comparison, since in 2007 whale arrivals were uncharacteristically late owing to delayed breakup of pack ice in the near-shore waters off northeast Sakhalin. The 2008 surveys were begun only in August.

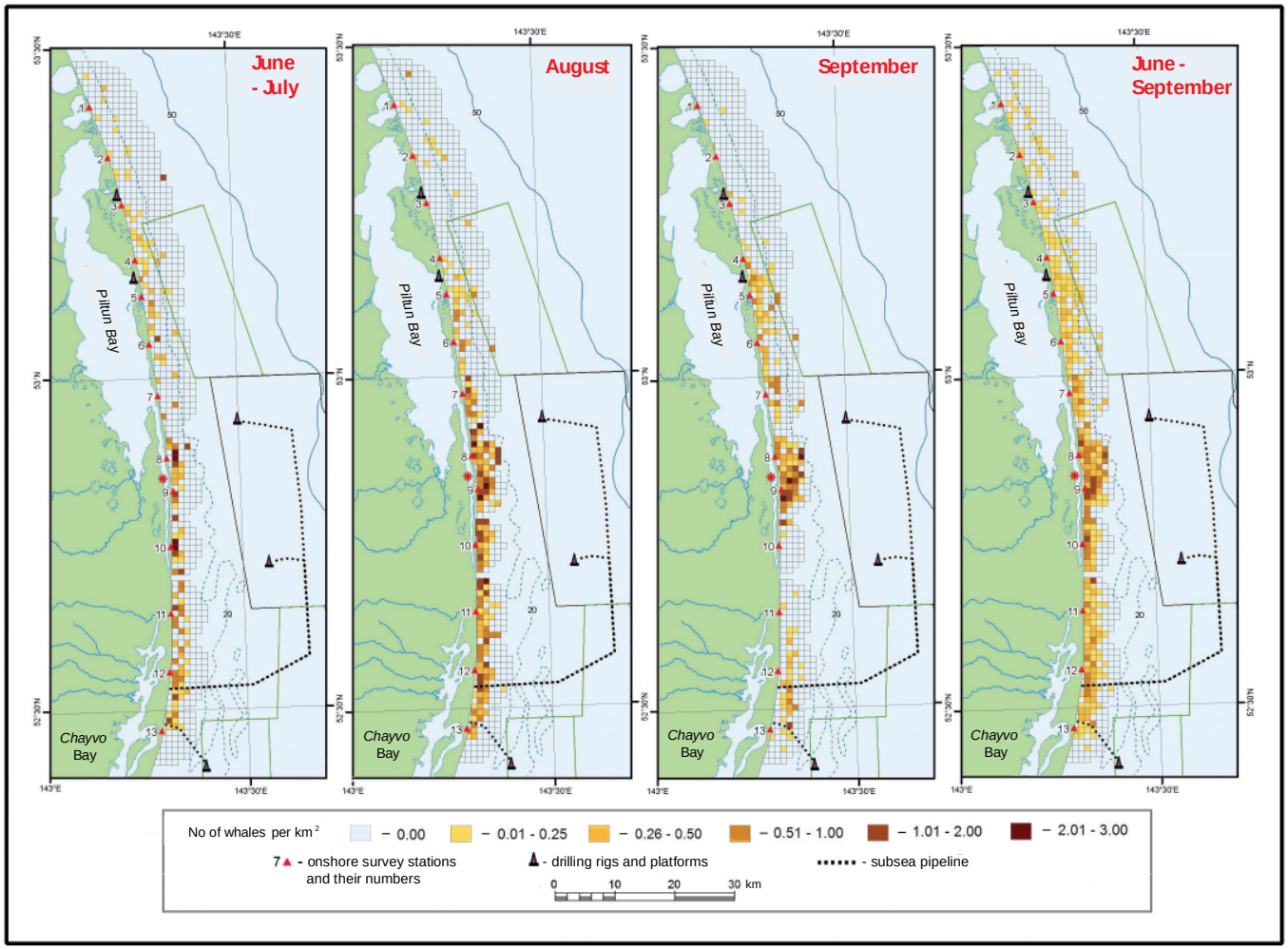


Figure 2. Gray whale distribution in the Piltun area in June–September 2009 from shore-based survey data (average population density per km2).

Note: drilling rig to the north of the onshore survey station 3 is a RosNeft facility

Table 4. Results of Shore-based Surveys of Gray Whales in the Piltun Area, June–September 2009.

Survey Date	Odoptu-Piltun Area (OPA)								Astokh-Chayvo Area (ACA)					Total* (full surveys)		
	Survey Point Number								Survey Point Number					OPA	ACA	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13			
June																
25									0	3	5	3	0		11	
July																
2	0	0	0													
3	0	2	3	1	5	2	2	11	2	6	7	5	3	26	23	49
4				0	0	2	2	11	4	2	3	5	5	*(15)*	19	
5									1	6	2	7	3		19	
7	2	0	1	3	0	2					2	4	0	*(8)*	*(6)*	
11	1	0	3	6	5	2	0	5	1	4	6	9	2	22	22	44
12								4	0					*(4)*	*(0)*	
13	0	0												*(0)*		
17	4	0	0	1	5	4					2	0	2	*(14)*	*(4)*	
18												6	2		*(8)*	
21										11	3	5	4		*(23)*	
22	0	0	1	4								5	2	*(5)*	*(7)*	
23	0	3	2											*(5)*		
24									12	6	6	6	1		31	
25	0	1	2	2										*(5)*		
31	0	0	0											*(0)*		
August																
1									5	12	11	8	0		36	
5												14	7		21	
6	**1**	**4**	0	0	5	0	5	4	10	10	4	13	1	19	38	57
7	0	0	1	1	2	1	2	11	13	7	11	7	3	18	41	59
8	0	0							15	12	5	9	11	*(0)*	52	
9	3	1	0	0	0	1	10	5	13	7	12	11	5	20	48	68
10	1	1	0						11	4	6	10	6	*(2)*	37	
11	0	2	1	1	0	0	0	7	8	4	17	12	5	11	46	57
15	1	0	0	0	0	2	4	6	6	4	2			13	*(12)*	
19													0		*(0)*	
24									9	4	3	0	2		18	
25	0	0	0	4	5	9	2	18	18	11	4	2	0	38	35	73
26				3	5	7	9	15	8	4	3	4	0	*(39)*	19	
31	0	0	0	1	6							3	5	*(7)*	*(8)*	
September																
1	1	1	3	1	3	4	6	8	12	5	1	4	4	27	26	51
2	0	0	0	1	5	7	5	13	16	1	1	2	3	31	23	54
3	0	1	1						18	2	2	4	0	*(2)*	*26*	
4	0	0	0	2	8	6	4	4	15	1	0	0	0	24	16	40
12	0	0	0	1	0	3	6	11	12	1	1	1	5	21	20	41
13						2	9	7	6	0				*(18)*	*(6)*	
14	0	0	1	2	8	2	3	4	11	0	0	6	7	20	24	44
15								10	10					*(10)*	*(10)*	
17											1	2	7		*(10)*	
18	0	0	0											*(0)*		
20	0	0	0	7	2	3	1	4	11	3	0	1	2	17	17	34
21	0	0	4	8	8	5	2	12	10	0	0	1	0	39	11	50
27	0	0	0	3	2	4	0	5	2	2	0	1	2	14	7/9	21

* - the results of partial surveys are added in italics within parentheses.

The number of whales shown in the table excludes repeated sightings of the same individuals near the boundaries of adjacent areas.

The average gray whale density in these waters during the same period was 0.08 whale per square kilometer of the entire scanned water area*, while in the occupied cells it averaged 0.5 whale/km^2. In the southern group, in the vicinity of survey stations 8-13, the average density was 0.15 whale/km^2, while in the occupied cells it was 0.64 whale/km^2, ranging from 0.08 to 2.82 whales/km^2 (the maximum density was recorded somewhat north of survey station 8, approximately 1-2 km from shore). In the northern group between survey stations 3-6 the average density (0.06 whale/km^2) was 2.5 times lower than in the southern group, and in the occupied cells it was also half as much – 0.31 whale/km^2, ranging from 0.1 to 1.94 whales/km^2 (the maximum was recorded near survey station 6, approximately 1-2 km from shore).

Throughout the rest of the Piltun feeding area the average whale density was 0.02 whale per square kilometer, although in the occupied cells it was virtually the same as in the northern group – 0.30 whale per square kilometer.

August

Since weather conditions were somewhat better in August than in July, five synchronized surveys were completed, although four were carried out during the first half of the month (August 6-11) and only one was conducted in the second half of the month (August 25). As in previous years, whale abundance was greater in August compared to July, ranging between 57 and 73 individuals (Table 4). The average number of whales per survey was 62.8 individuals (Table 5).

* - due to the unevenness of the shoreline, a number of cells adjacent to the coast were, to some extent, cut off along the western side and had areas less than 1 square kilometer. These cells have some degree of positive bias in estimates of non-zero density, particularly if the cell size is very small (as described in the section "Density Analysis" in Volume I, Chapter 2, density estimates are not calculated for grid cells with an area < 0.1 km^2) ; as the density analysis methodology is further refined this bias will be addressed.

Table 5. Quantitative Distribution of Gray Whales in the Piltun Area, July - September 2009 (Based on Complete Shore-Based Surveys).

Indicator	Segment between monitoring stations														Total
	< 1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 >	
July (2 complete synchronized surveys)															
Total number of whales	1	2	3	5	9	8	3	15	4	7	14	11	11	0	93
Average number of whales	0.5	1.0	1.5	2.5	4.5	4.0	1.5	7.5	2.0	3.5	7.0	5.5	5.5	0.0	46.5
% of Total	1.1	2.2	3.2	5.4	9.7	8.6	3.2	16.1	4.3	7.5	15.1	11.8	11.8	0.0	100.0
August (5 complete synchronized surveys)															
Total number of whales	3	6	4	1	7	20	8	37	54	56	33	52	30	3	328
Average number of whales	0.6	1.2	0.8	0.2	1.4	4.0	1.6	7.4	10.8	11.2	6.6	10.4	6.0	0.6	62.8
% of Total	1.0	1.9	1.3	0.3	2.2	6.4	2.5	11.8	17.2	17.8	10.5	16.6	9.5	1.0	100.0
September (8 complete synchronized surveys)															
Total number of whales	0	2	3	4	41	43	25	41	72	63	1	7	30	4	321
Average number of whales	0.0	0.3	0.4	0.5	5.1	5.3	3.1	5.1	9.0	7.9	0.1	0.9	3.8	0.5	42.0
% of Total	0.0	0.6	0.9	1.2	12.2	12.8	7.4	12.2	21.4	18.8	0.3	2.1	8.9	1.2	100.0
Total for July – September (15 complete synchronized surveys)															
Total number of whales	4	10	10	10	57	71	36	93	130	126	48	70	71	7	742
Average number of whales	0.3	0.7	0.7	0.7	3.8	4.7	2.4	6.2	8.6	8.4	3.2	4.6	4.7	0.5	49.5
% of Total	0.5	1.3	1.3	1.3	7.7	9.6	4.9	12.5	17.5	17.0	6.5	9.4	9.6	0.9	100.0

Gray whale distribution in the nearshore area during August was fairly similar to July. As in July, whales were mostly in the southern half of the feeding area, although the area of higher whale densities extended somewhat farther north, reaching the vicinity of survey station 7 (Figure 2). Whale distribution south of station 7 was relatively uniform, although somewhat higher densities in this area were noted in the waters around survey stations 8-9, i.e. near the mouth of Piltun Bay. Overall, throughout August, the southern group (between survey stations 7-13) contained 86.6% of the average number of gray whales present in the area, with 34.1% near the mouth of the bay (Table 5). Substantially fewer whales were observed in the northern part of the Piltun area in the vicinity of survey stations 1-6 however, a somewhat higher concentration was still observed in the vicinity of stations 4-6 (Figure 2). 13.1% of all whales were seen between station 1-6, with about 8.6% of all whales observed between survey stations 4-6, and 4.5 % observed north of station 4, with very few whales between station 2 and 4. The overall spatial coverage of the Piltun area by gray

whales (the number of cells in which whales were observed to be present) was 1.5 times higher in August than in June-July. Whales were observed in 181 (23.9%) of the 756 square-kilometer cells scanned during the surveys – Figure 2). In the southern half of the area, in the vicinity of survey stations 7 – 13, whales were observed in 137 of the 339 surveyed cells, i.e. 40.4 %, while in the northern half (in the vicinity of survey stations 1-6) –whales were only present in 10.6% (44 of 417) of the surveyed cells. In other words, the number of occupied cells in the southern part of the Piltun area was 1.75 times greater in August than in July, while in the northern part the number of occupied grid cells remained practically the same. However, the distribution of occupied cells in the northern half of the Piltun area was not uniform. In the area between the 4th and 6th survey stations, where, as already noted above, there was an increased concentration of animals, whales were observed in 25.0 % of the scanned survey area (28 of 112 cells scanned), while north of survey station 4, they were encountered in only 4.6% of the survey area (13 of 280 cells scanned)

In August the average whale density was 0.14 whale/km^2 in all surveyed cells (i.e. more than 1.5 times higher than in July), but in the occupied cells the average density remained almost unchanged (increased from 0.5 to 0.6 whale/km^2). In the southern group, in the vicinity of survey stations 7 – 13, the average whale density increased almost two-fold during August to 0.29 whale/km^2, but in the occupied cells the increase was very slight – from 0.64 to 0.71 whale/km^2. The range of whale densities in the southern group was also little changed from July – from 0.13 to 2.73 whales/km^2 (maximum values were observed mainly near the mouth of Piltun Bay within 2 km of shore).

In August in the northern part of the area (in the vicinity of survey stations 1-6) the overall average whale density (0.03 whale/km^2) was an order of magnitude lower than in the southern part, and in the “occupied” cells it was more than 2.5 times lower (0.27 whale/km^2) than in the south, ranging from 0.09 to 0.92 whale/km^2.

At the same time, in the area between stations 4-6 where there was a higher concentration of whales, the average density was 0.07 whale/km^2, while in the occupied cells it was 0.3 whale/km^2. North of survey station 4, the average

whale density was much lower and dropped to 0.01 whale/km^2, and to 0.18 in the occupied cells.

As was true in July, gray whale densities in the southern part of the Piltun were considerably higher than in the northern part of the area, with the highest densities observed in the vicinity of stations 7-13, moderately high densities observed in the vicinity of stations 4-6, and the lowest densities observed in the vicinity of stations 1-3.

September

From September 1 through September 27, 2009 weather conditions were relatively favorable and 8 complete synchronized surveys were conducted, which showed that during this month in the Piltun feeding area there was a continuous, although irregular, decrease in whale abundance (from 51-54 individuals on September 1-2 down to 21 individuals on September 27 - Table 4, Figure 8). As a result the average number of whales per survey (42.0) was substantially lower than in August (i.e. an average of 20.8 fewer individuals were counted per survey than in the previous month).

In September, the distribution of gray whales in the Piltun area changed considerably. Whale abundance decreased slightly in the northern reaches of the area (in waters between survey stations 1 and 4), constituting 2.7% of the total number of whales in the Piltun area (compared to 4.5% in August). The southern aggregation of whales also shrank significantly in the vicinity of survey stations 10 – 13 (from 46.5% in August down to 14.9% in September), and whales vanished almost entirely from the waters between survey stations 10 and 11 (Tables 4-5, Figure 2). The majority of the whales present in the Piltun area during September were concentrated in the central part of the study area, between survey stations 4 and 10, where 84.8% of the whales were observed (Table 5). Here, too, a localized and concentrated aggregation of whales was clearly evident near the mouth of Piltun Bay (in waters around survey stations 8 and 9), that contained at least 44.6% of all the whales present in the near-shore waters (Table 4). In addition, the cluster of whales in the area between survey stations 4 and 6 that was first observed in July-August, maintained and even increased its numbers and percentages (Table 5). By September this cluster

contained an average of 10.4 gray whales or 25.0% of their average monthly abundance in the Piltun area (in August the corresponding figures for this section of the water area were only 5.4 and 8.6%, respectively).

The number of cells in which gray whales were observed to be present decreased in September compared to August and totaled 19.0% (whales occupied 144 of the 757 square-kilometer cells scanned during the surveys). In the southern part of the area, in the vicinity of survey stations 10 – 13, whales were observed in 32 (16.4%) of the 199 square-kilometer cells that were scanned in September, while in the central part, between survey stations 4 and 10 whales were observed in 103 of 278 cells (37.1%), and in the northern part (i.e, north of survey stations 4) whales were present in only 9 of the 280 scanned cells (3.2%). Thus, in keeping with the September decrease in gray whale abundance in the Piltun area, the number of occupied cells also decreased during that month compared to August, and even in the most "densely populated" part of the area (near the mouth of Piltun Bay), the level of habitat use (i.e., percentage of occupied cells) proved to be lower than that recorded in the entire southern half of the area one month earlier.

In September, the average whale density in the near-shore area was 0.09 whale/km^2 of the entire scanned water area (i.e. had dropped almost 1.5 times below the August level and had almost returned to the July level), dropping a little even in the occupied cells – from 0.60 to 0.46 whale/km^2, which was also comparable to the July level (0.50). In the southern part of the area in the vicinity of survey stations 10 – 13, the average whale density throughout the scanned area dropped very sharply in September, totaling just 0.05 whale/km^2 (i.e. almost 6 times lower than that recorded in the southern half of the area in August, and 3 times lower than in July). In September, in the occupied cells in the southern part of the area, the average whale density dropped as well, though not as much – from 0.64-0.71 whale/km^2 in July-August down to 0.34 (with a range of 0.16 to 1.62 whales/km^2). A locally elevated density persisted during this period only near the southern boundary of the area, in waters surrounding survey stations 11-13, where almost all the whales located in this part of the feeding area were actually present (Figure 2).

In the central part of the area (between survey stations 4 and 10), the average whale density in September was almost four times higher than in the southern part (0.19 whale/km^2), while in the occupied cells it was roughly 1.5 times higher (0.53 whale/km^2). However, these parameters showed considerable spatial variability throughout this water area. In the group near the bay mouth, which formed in waters roughly from the midpoint between survey stations 7-8 to the midpoint between survey stations 9-10 (Figure 2) and which covered a scanned area of 66 cells, the average whale density was 0.49 whale/km^2, while in the occupied cells, which made up 65% of this water area, it was 0.75 (ranging from 0.16 to 2.17). Another, noticeably smaller and less consolidated group of whales was observed somewhat farther north of the bay mouth group, although still in the central part of the Piltun area, in the vicinity of survey stations 4 – 7, (Figure 2). There, the average whale density over all surveyed grid cells in September was only 0.10 whale/km^2, while in the occupied cells (28.1% of the 210 cells that were scanned) it was 0.34 whale/km^2 (ranging from 0.09 to 0.85 whale/km^2).

In the northern part of the Piltun area, to the north of the latitude of survey station 4 (280 cells), the average monthly whale density over all scanned cells in September was negligible – 0.01 whale/km^2, while in the occupied cells (9 km^2 or 3.2% of its area) it was 0.17 whale/km^2 (ranging from 0.08 to 0.34).

June/July-September

Based on the results presented above, it can be stated that during the summer and fall of 2009 the following key changes were observed in the distribution of gray whales in the near-shore Piltun area. In late June-July and August, whale distributions were generally quite similar – during these months most whales were concentrated in the southern half of the area, with a much smaller number present in the northern half of which most were found in the vicinity of stations 4 to 7 (Figures 2-3). A noticeable increase in the amount of area they inhabited within the feeding area and a growth in average density from July to August resulted from continuing whale arrivals from their wintering grounds (although the reasons for their almost total disappearance in August from the water area between survey stations 2 and 4 remain unclear). In September, however,

correlating with a drop in the abundance of whales in the Piltun area, the nature of their distribution changed considerably – the number of whales in the southern part of the area, in the vicinity of survey stations 10 – 13, and farther north, in the vicinity of survey stations 1-2, dropped substantially. In September there existed only one clearly pronounced aggregation of whales in the near-shore feeding area – near the mouth of Piltun Bay (in the waters around survey stations 8 and 9), as well as two small areas with slightly elevated whale concentrations near survey stations 4-7 and 11-13 (Figure 3). A key characteristic of gray whale distribution in the Piltun area in the summer and fall of 2009 was that, for the first time in six years of whale monitoring, a persistent, although relatively small, local cluster of whales appeared in the vicinity of survey stations 4 – 7 and remained there throughout all the survey months (Figures 2-4, 11). Although the number of whales present there in 2004-2006 was just as high, at that time this location was only a marginal part of the large northern group that existed in those years, and as that aggregation disintegrated, the elevated abundance of whales in this part of the water area was no longer observed (Figure 4).

Based on the number of square-kilometer cells in which the presence of gray whales was recorded (which is conditionally taken to be evidence that, in one way or another, they are using this location as part of their feeding area), in summer and fall 2009 the whales, to one degree or another, used roughly 287 square kilometers of water area in the Piltun feeding area for their foraging. The whales were most widely distributed in August, when they were observed over a total area of roughly 181 km^2.

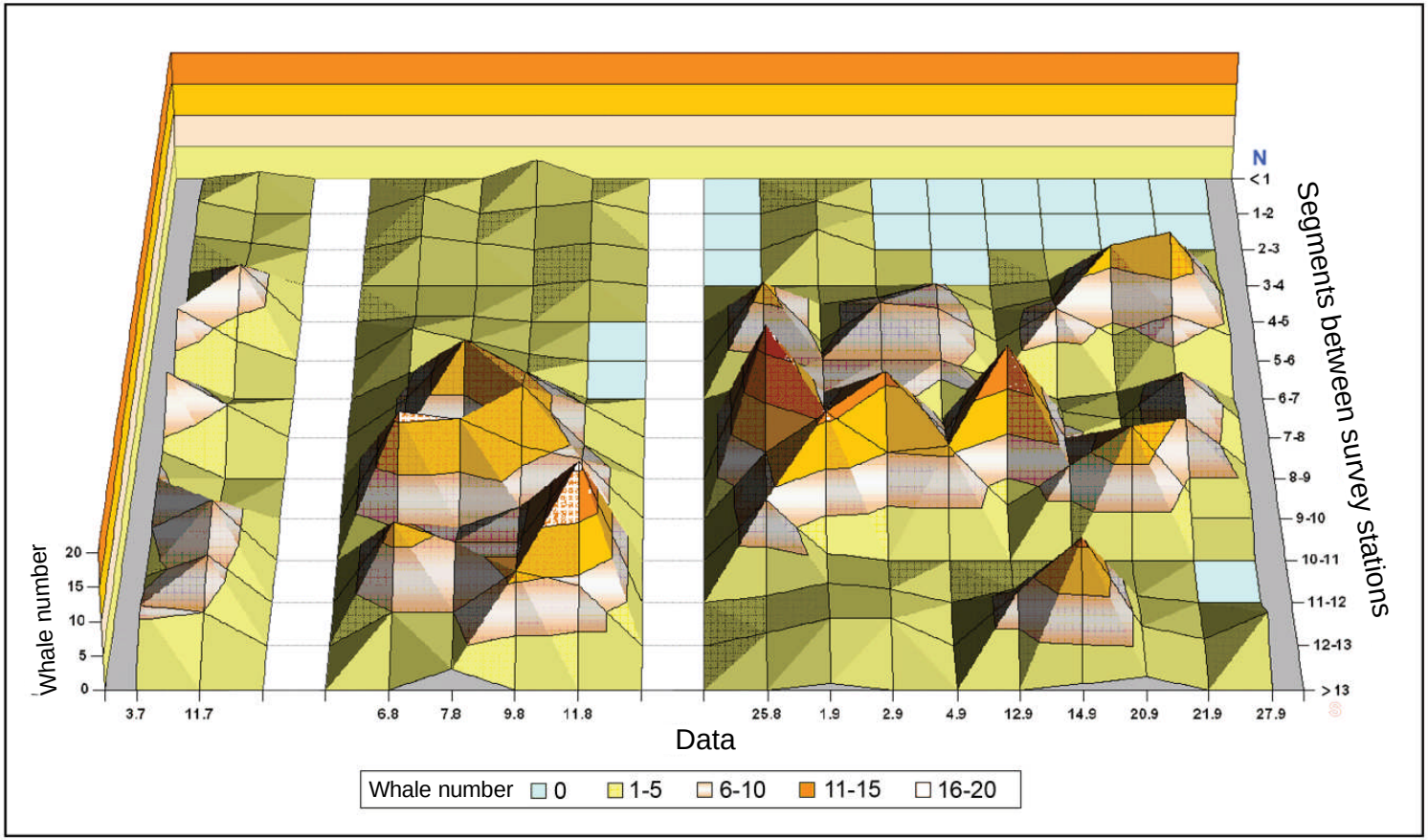
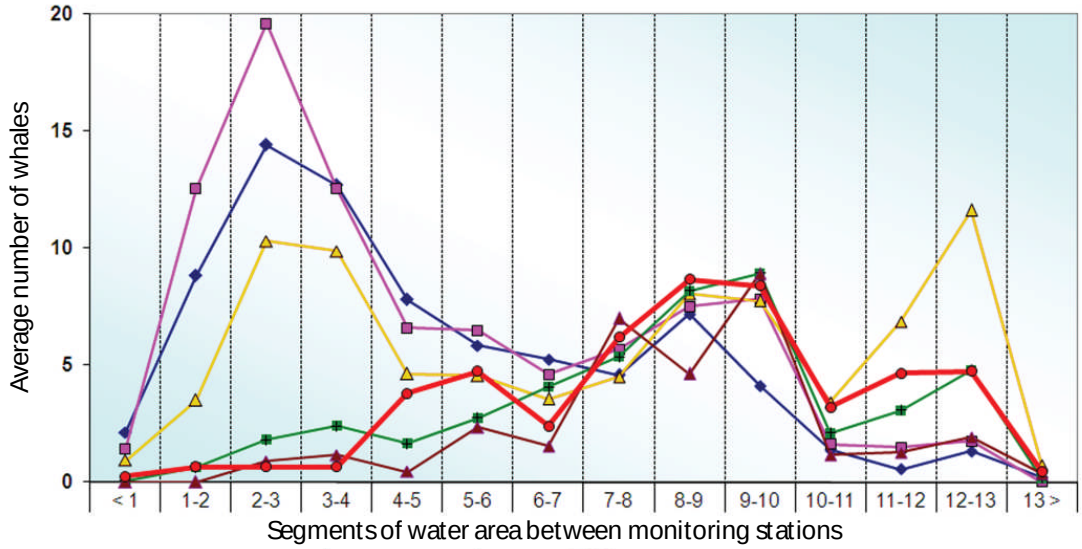


Figure 3. Space-time variations in gray whale distribution in the Piltun area in July–September 2009 (from comprehensive synchronized shore-base survey data). White indicates interval between survey series.



year	Average number of whales in segments													
2004	2,14	8,83	14,42	12,69	7,81	5,83	5,25	4,58	7,19	4,14	1,39	0,56	1,33	0,19
2005	1,43	12,55	19,60	12,55	6,60	6,50	4,60	5,68	7,53	7,83	1,63	1,50	1,75	0,03
2006	0,94	3,50	10,31	9,88	4,63	4,56	3,56	4,50	8,06	7,75	3,44	6,88	11,63	0,75
2007	0,07	0,64	1,82	2,39	1,64	2,75	4,07	5,36	8,18	8,93	2,11	3,07	4,79	0,18
2008	0,00	0,00	0,91	1,18	0,45	2,36	1,55	7,00	4,64	8,91	1,18	1,27	1,91	0,36
2009	0,27	0,67	0,67	0,67	3,80	4,73	2,40	6,20	8,67	8,40	3,20	4,67	4,73	0,47

Figure 4. Year-to-year variations of gray whale average seasonal abundance in the Piltun area in 2004–2009. ***(from comprehensive synchronized shore-based survey data)***

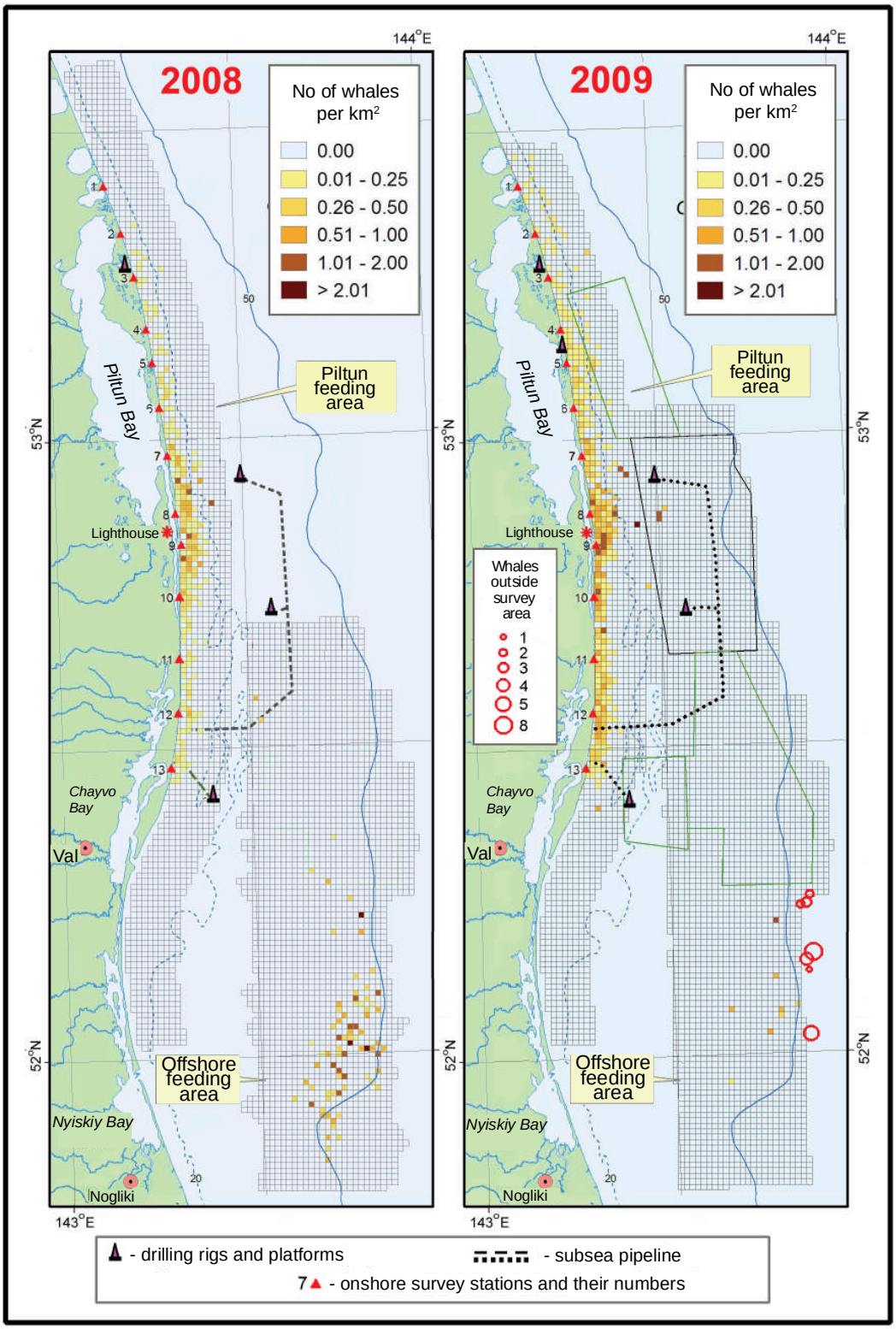


Figure 5. Gray whale distribution in the Piltun and Offshore feeding areas in 2008–2009 (from the combined shore-based and vessel-based survey data).

Note: drilling rig to the north of the onshore survey station 3 is a RosNeft facility

The overall pattern of gray whale distribution in the Piltun area during this season shows two distinct differences to observations made in 2008: First, the overall density throughout the area was higher in 2009 than in 2008 (Figures 4 and 5), Second, denser accumulations of whales were found in the northern part of the area between survey stations 4-7, where they had been observed in smaller numbers during both 2008 and 2007 (Figures 4 and Figure 5). In the past two years, most of the whales have been concentrated in the central and southern parts of the area, being dispersed there fairly uniformly and forming only one distinct cluster in the waters near the mouth of Piltun Bay (which existed, invariably, throughout all the monitoring years). The percentage of whales recorded in 2008 and 2009 in the central and southern parts of the area, i.e., in the vicinity of survey stations 7-13, was predominant and rather close (80.7% and 73.4%, respectively). In the northern part of the area, between survey stations 1-7, 20.3 % of all whales were recorded in 2008 and 26.6% in 2009, indicative of a growth of whale numbers in this region, particularly in the vicinity of survey stations 4-7, where 13.7% of all whales were recorded in 2008 and 22.2% in 2009. Especially noticeable was a presence of whales (1.8%) in the very northern part of the Piltun area at stations 1 and 2 where they had been absent in 2008 (Figures 4 and 5), showing that whales began returning to this region in 2009. Figure 5 also clearly shows the year-to-year differences in average whale densities throughout the area, which are primarily attributable to the fact that in 2009 the number of whales feeding in the near-shore zone in the summer and fall was more than 1.5 times higher than one year earlier. The maximum number of whales recorded during the 2009 surveys was 73 individuals (Table 4), compared to 47 in 2008 (Vladimirov et al., 2009). The habitat usage index (i.e., percentage of occupied cells) for the overall monitoring season (standardized for an equal value of scanned area) was proportionally higher in 2009 than in 2008 (36.9% versus 23.4%), and the seasonal average whale density was also roughly 1.5 times higher (0.11 whale/km^2 versus 0.07), although the seasonal average in the occupied cells remained the same (0.29 whale/km^2).

1.2.1.1.2.2 Whale Distribution Based on Distance from Shore and Water Depth

Gray whale distribution in the Piltun area throughout all the survey years has been characterized by the concentration of the vast majority of individuals within the first 5 km of the near-shore zone. The year 2009 was no exception in this regard, since 98.0% of the animals sighted from shore were confined within this zone. Many whales were seen within 1 km (36.8%), most whales (41.2%) were sighted at a distance of 1 to 2 *km* from shore, another 36.6% – within 1 *km*, 12.2% were observed at a distance of 2 to 3 *km*, and 8.0% at a distance of 3 to 5 *km* (Table 6, Figure 6). No major difference was found between the Odoptu-Piltun and Astokh-Chayvo areas with respect to whale distribution with distance from shore. The only difference was in the percentage of whales that stayed more than 3 km from shore: in the Odoptu-Piltun area, a significantly greater number of whales were observed at that distance than in the Astokh-Chayvo area (17.8% versus 4.9%).

Table 6. Distribution of Gray Whales in the Piltun Area by Distance from Shore, July - September 2009 (Based on All Shore-Based Surveys).

Distance, *km*	Number of whales by month (%)			
	July	August	September	Season average
Odoptu-Piltun Area				
0-0.5	3.6	9.9	17.5	12.0
0.5 - 1	27.0	27.5	17.5	23.0
1 - 2	43.3	35.2	35.0	36.8
2 - 3	5.4	12.6	11.1	10.4
3 - 5	19.8	13.7	13.3	14.8
5 - 10	0.9	1.1	5.6	3.0
Astokh–Chayvo Area				
0-0.5	6.2	12.1	7.0	9.6
0.5 - 1	39.0	30.7	13.6	28.1
1 - 2	48.6	44.9	38.5	44.0
2 - 3	5.1	11.4	24.4	13.4
3 - 5	1.1	0.7	11.8	3.6
5 - 10	0.0	0.2	4.7	1.3
Entire Piltun Area				
0-0.5	5.2	11.4	12.5	10.5
0.5 - 1	34.4	29.8	15.7	26.1
1 - 2	46.5	42.0	36.7	41.2
2 - 3	5.2	11.8	17.5	12.2
3 - 5	8.3	4.5	12.5	8.0
5 - 10	0.4	0.5	5.1	2.0

Note: the results of the incomplete June 25 survey are combined with July results

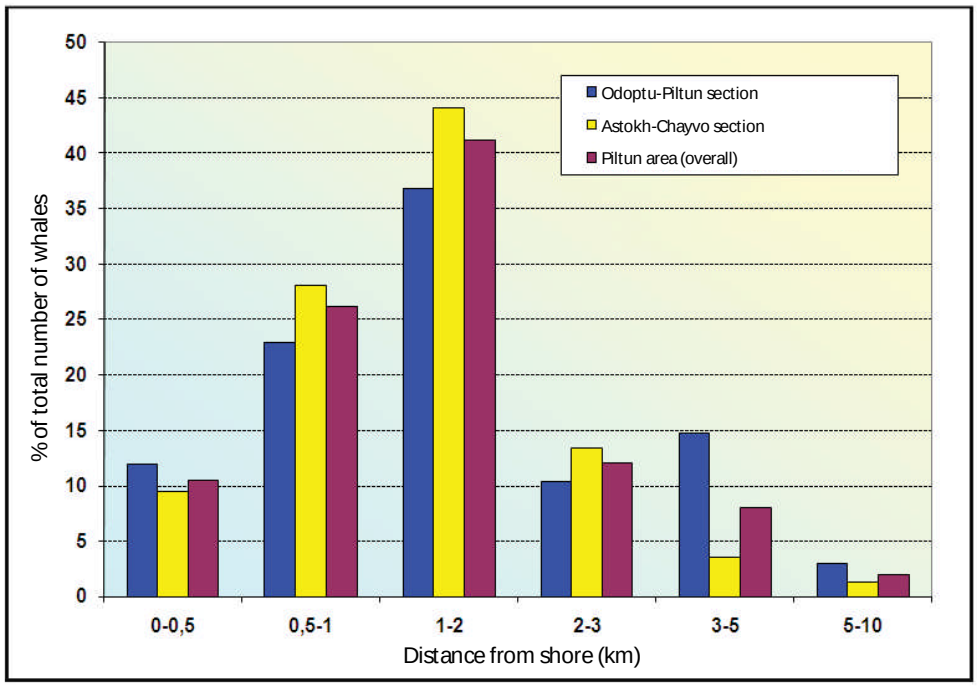


Figure 6. Gray whale distribution in the Piltun area by distance from shore, June–September 2009 (from all shore-based survey data).

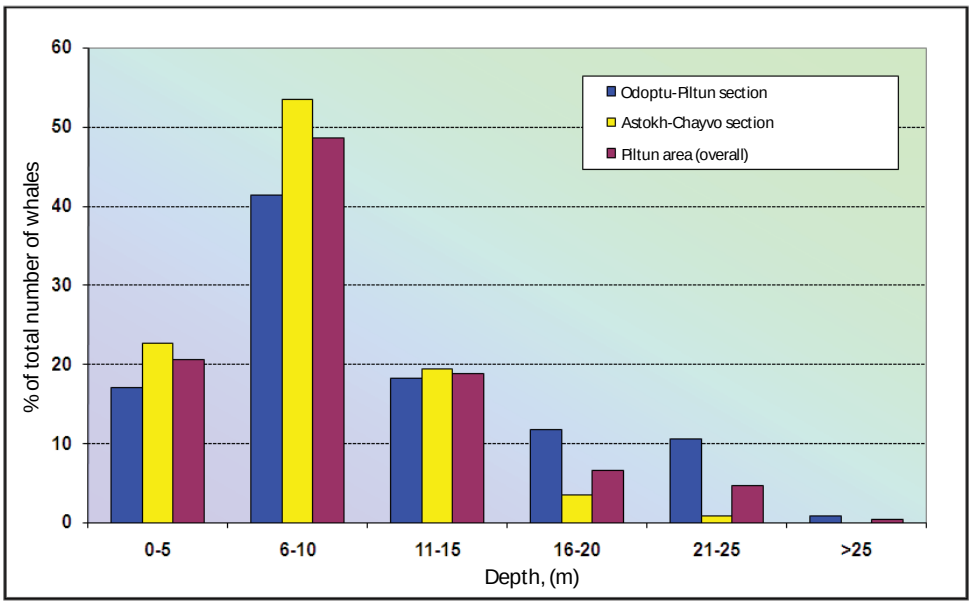


Figure 7. Gray whale distribution in the Piltun Area by water depth, June–September 2009 (from all shore-based survey data).

In the Odoptu-Piltun area, no clearly expressed seasonal dynamic was observed in whale distribution as a function of distance from shore. However, in the Astokh-Chayvo area, the number of whales observed in the zone from 0.5 to 2 km declined from July to September (from 87.6% to 52.1%) and the number in the 2-10 km zone increased by almost the same amount (from 6.2% to 40.9%, - Table 6). Throughout the area, whales were also observed to have migrated farther from shore by season's end: from July to September the proportion of whales found at a distance of more than 2 km from shore increased from 13.9% to 35.1%, with a corresponding decrease in animals found 0.5-2 km from shore (Table 6).

In 2009, the distribution of gray whales in the Piltun area as a function of water depth was generally similar to their distribution as a function of distance from shore. This similarity is expected since distance from shore correlates to water depth. As in previous years, most of the whales (95.0% overall for the area) remained in waters up to 20 m deep throughout the season (Table 7, Figure 7), with their largest concentration (48.8%) observed at depths of 6 to 10 m, with another 20% encountered at water depths of 0 to 5 m and 19.0% at depths of 11 to 15 m. The vast majority of whales in the near-shore zone at both sites (76.7% at Odoptu-Piltun and 95.7% at Astokh-Chayvo) remained in areas with water depths of up to 15 m throughout the season. A substantially greater proportion of whales kept to deeper waters (16+ m) at the Odoptu-Piltun site than at the Astokh-Chayvo site (23.3% versus 4.3%), which correlates with the results of distribution as a function of distance from shore.

Similarly, seasonal fluctuations in gray whale distribution as a function of water depth also correlated with the seasonal dynamics of distribution as a function of distance from shore. No distinct seasonal variations in whale distribution with depth or distance from shore were observed in the Odoptu-Piltun feeding area, although such variations were readily apparent at the Astokh-Chayvo site – from July to September the percentage of whales in the immediate nearshore zone (0-10 m depth) dropped substantially (from 90.4% to 46.5%), but in deeper waters the percentage grew proportionally – from 9.6% to 53.5%, with the greatest increase observed in the 11-15 m depth range (from 8.5 to 43.2%).

Between 2008 and 2009 (Vladimirov et al., 2009), the proportion of whales concentrated in the shallowest waters (0-5 m) increased from 9.9% to 20.5%, accompanied by a 28.9% to 19.0% decrease in the concentration of whales in the 10-15 m depth range. The percentage of the whale population in the 6-10 m and 16+ m depth ranges remained virtually unchanged (48.4% and 12.8% in 2008 and 48.8% and 11.7% in 2009).

Table 7. Distribution of Gray Whales in the Piltun Area by Sea Depth, July-September 2009 (Based on All Shore-Based Surveys).

Depth, *m*	Number of whales by month (%)			
	July	August	September	Season average
Odoptu-Piltun Area				
0-5	6.3	23.6	17.1	17.1
6-10	55.9	41.2	34.6	41.4
11-15	13.5	15.4	22.6	18.2
16-20	9.0	10.4	14.1	11.8
21-25	14.4	8.8	10.3	10.6
> 25	0.9	0.6	1.3	0.9
Astokh–Chayvo Area				
0-5	24.9	26.2	13.6	22.7
6-10	65.5	58.8	32.9	53.6
11-15	8.5	12.3	43.2	19.4
16-20	1.1	2.7	7.0	3.5
21-25	0.0	0.0	3.3	0.8
> 25	0.0	0.0	0.0	0.0
Entire Piltun Area				
0-5	17.7	25.4	15.4	20.5
6-10	61.8	53.6	33.8	48.8
11-15	10.4	13.2	32.5	19.0
16-20	4.2	5.0	10.7	6.7
21-25	5.6	2.6	6.9	4.6
> 25	0.2	0.2	0.7	0.4

Note: the results of the incomplete June 25 survey are combined with July results

The reasons for annual changes in the distribution of gray whales in the Piltun area as a function of water depth (and distance from shore) are not yet clear, but are most likely related to seasonal variations in the availability and biomass of benthic prey in the various shelf zones.

1.2.1.1.2.3 Whale Population Dynamics in the Piltun Area

In 2009 the first synchronous onshore surveys were conducted in early July (July 3 and 11) during the migration of gray whales from their wintering grounds into the Piltun area (Table 4). The average number of gray whales recorded during these two surveys was 46.5 individuals (min – 44, max – 49). In 2008 no monitoring was performed during this same period, but judging from data from prior years (Vladimirov et al. 2005, 2006, 2007, 2008), the timing and pace of whale arrivals along the Sakhalin coast were normal, i.e.similar to previous years.

Due to adverse weather conditions, the next series of synchronized surveys could only be started and completed a month later, from August 6 to August 11, 2009 (Table 4). Multi-year studies have shown that the mass migration of gray whales from their wintering grounds into the Piltun area is almost complete by this time and the whales are entering the main phase of their feeding season. Based on the results of the four completed 2009 surveys, whale abundance had stabilized by early August, averaging 60.2 individuals (range 57 to 68 individuals). These numbers are higher than in 2008, when only 47 whales were sighted in the Piltun area during the first half of August. However, it should be noted that at that time in 2008, due to bad weather, only one survey could be completed, and so to judge the number of whales present in the area on that basis is highly questionable. Moreover, the 2009 data very closely approximate the figures for 2007, when the average number of whales recorded during this same period was 57.0 individuals (Vladimirov et al., 2008).

In late August 2009, when the weather allowed for the another synchronized survey, 73 gray whales were recorded in the Piltun area, which, was the highest number for the entire monitoring season (Table 4, Figure 8). In 2008, the corresponding figure for the second half of August (also based on only a single synchronized survey) was only 37 individuals (Vladimirov et al. 2009). One year earlier, the average number of whales recorded near Piltun between August 21 and 31, 2007 was 58.6 individuals with a maximum of 73 individuals (Vladimirov et al., 2008), i.e. the whale abundance in that year was similar to that of 2009.

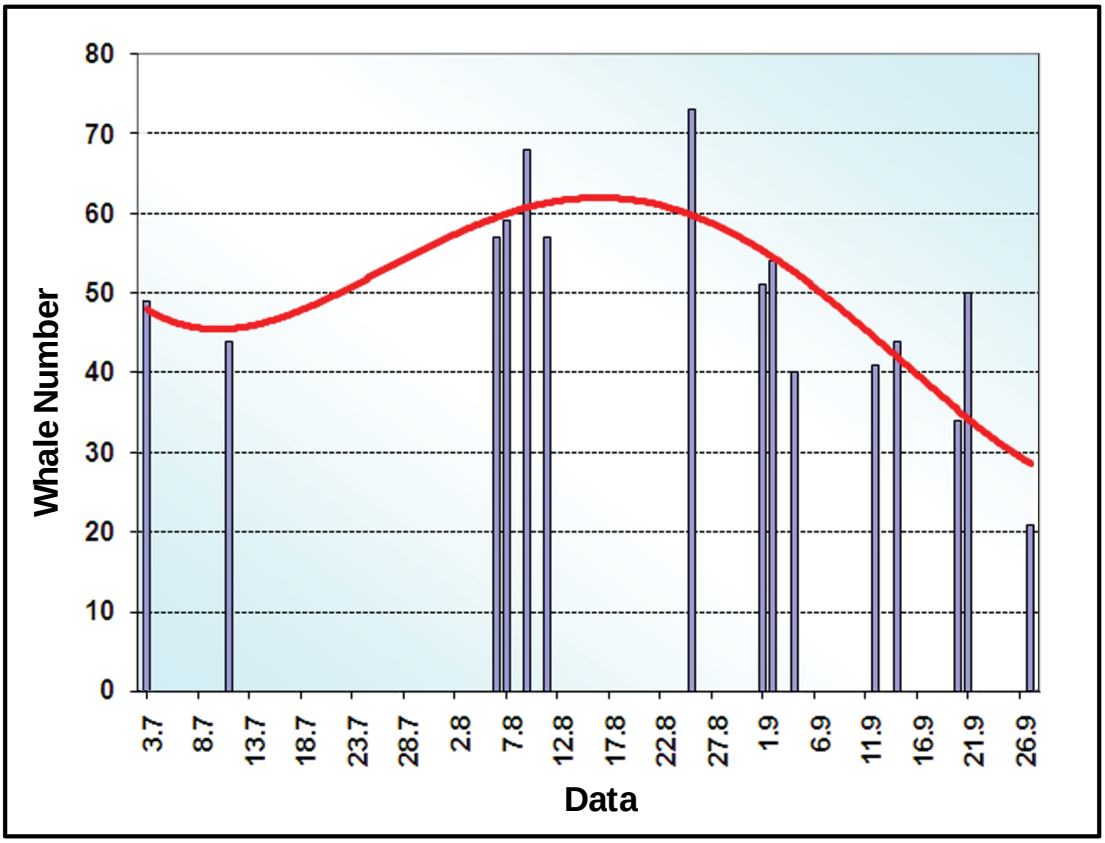


Figure 8. Seasonal dynamics of gray whale abundance in the Piltun area in July–September 2009 (from comprehensive synchronized shore-based survey data) Red line – polynomial trend.

Judging from survey data, whale abundance began to decline throughout the Piltun area in September 2009 (Table 4, Figure 8). During the first four days of the month (September 1-4), the average number of whales recorded by the three synchronous surveys was 48.3 individuals (min – 40. max – 54). During September 11-15, according to data from two completed surveys (September 12 and 14), the average number of whales dropped to 42.5 individuals (range of 41-44). From September 20 to 29, whale population dynamics in the Piltun area exhibited an unusual pattern. On September 20, a total of 34 whales were sighted. The next day, September 21, the whale count rose to 50 individuals, after which, on September 27, the number dropped back down to 21 individuals (Table 4). This surge in gray whale abundance has occurred twice before in previous years. Therefore, let us examine these incidents more closely.

Although a slight decline in whale abundance was expected based on existing data, the period from 21-30 September 2005 witnessed a sudden increase by 30-35 individuals (Vladimirov et al., 2006). This increase in abundance was observed three times during that week, after which the survey numbers returned to their previous level and the customary autumnal decline in whale abundance continued.

A similar situation was also observed in the Piltun area in late August 2006 (Vladimirov et al., 2007). In that year the maximum number of whales recorded during onshore surveys over the entire period from early August through early October was relatively stable, except for one instance, which occurred during the August 23 survey, when approximately 35-40 more whales were sighted than were sighted either before or after that survey day. Unfortunately, not a single survey was completed in the area during the preceding two days or the following ten days owing to unfavorable weather conditions. Therefore, it is unknown whether such a high number of whales was a one-day surge or whether the surge was sustained for some period of time (just as the duration of the abundance surge in 2009 remained unknown since no survey could be completed over the following 6 days due to bad weather).

One possible explanation for the sudden surges in gray whale abundance recorded in 2005, 2006, and 2009 in the Piltun area is that whales migrated in from other feeding areas, and then left again. Photo-ID studies have confirmed there is intra annual WGW migration between the Piltun and Offshore feeding areas, and between eastern Kamchatka and Sakhalin (Yakovlev and Tyurneva 2008, Yakovlev et al. 2009, 2010).

V. V. Melnikov and S. P. Starodymov (2004) also observed the migration of a group of whales from the north into the Piltun area in 2003.

Seasonal dynamics in the abundance of gray whales sighted during complete surveys in the Piltun area over the July-September period in 2009 are depicted graphically (Figure 8). As there were only two synchronized surveys completed in the period 3 July – 5 August, patterns of migration into the feeding grounds could not be determined. Subsequently, however, the seasonal dynamics of

whale abundance were fairly normal. During August, the first half of the main feeding period, the abundance of whales present in the area, as was true during all the years that monitoring was conducted, was relatively stable, ranging from 57 to 73 individuals. In September, as was true one year earlier, the abundance of whales in the Piltun area began gradually to decline and by the end of that month numbers had dropped to 20-30 individuals (Figure 8). A drop in the abundance of gray whales in near-shore waters in September is a normal occurrence associated with the start of the fall migration and the gradual withdrawal of whales from the near-shore feeding area. But in 2009, this fall decline in whale abundance began about 10 days earlier than in 2008. In previous Septembers the whales began to migrate in substantial numbers to the Offshore area, where it is hypothesized by this time, owing to seasonal warming and the growth of benthos, its food resources have increased. However, a possible movement of whales from the Piltun to the Offshore feeding area in September cannot be confirmed for 2009, since no surveys could be completed in the Offshore area during the second half of September or early October).

Based on the number of whales sighted during the surveys, the largest observed feeding group of gray whales present in the near-shore waters of the Piltun area from July to September 2009 totaled 73 individuals, which is 1.5 times higher than the corresponding number for the prior year (47 whales) and is comparable to the number for 2007. However, considering that the feeding group congregating in the near-shore waters of the Piltun area is not isolated and is constantly exchanging members with other feeding groups of the same whale stock (Yakovlev and Tyurneva, 2005, 2006, 2008; Yakovlev et al., 2007, 2009, 2010), the issue of population dynamics must be examined in conjunction with an analysis of the condition of the Offshore area group, whose fate is closely intertwined. This issue will be discussed at greater length below in Section 1.2.1.7.

1.2.1.2 Offshore Area

The first complete survey of gray whales in the Offshore area during 2009 was performed on July 21. At that time most of the whales were observed east of the transect lines in the central and northern part of the area (Figure 1). The

only whale encountered within the survey area bounded by the transect lines was a transitory or migratory whale (i.e. did not remain in one place, but rather moved purposefully in a certain direction). A total of 21 whales, of which 9 animals were identified as possible resights, were observed during this survey, all of which, except for the solitary transitory whale, were in groups of 3 to 8 individuals.

The next survey was conducted on August 15, during which no whale sightings were recorded. This survey was incomplete, with the two most southerly transects left unsampled. In addition, the survey was performed under poor visibility conditions (2-6 kilometers) and in 2009 the whales were observed feeding mainly outside the area bounded by the transect lines so additional whales outside the visible range of the transect lines may have been missed. All of these factors may account for the fact that no whales were sighted during this survey.

The third survey in the Offshore area was performed on September 1. This was the second complete survey of the season. A total of 26 whales, of which 3 were identified as possible resights, were sighted either alone or in groups of 2-3 individuals during the survey. No large groups (more than 3 individuals) were seen. The whales were primarily observed in the eastern part of the survey area, although 11 of the 26 whales were sighted to the east of the transect lines (Figure 1).

The last survey was conducted on September 15 under strong winds and could not be completed due to deteriorating weather conditions (the two northern transects were not sampled). During this survey only one whale was sighted in the northern part of the Offshore area to the east of the transect lines. The low number of whale sightings was likely caused by unfavorable observation conditions and the possible presence of whales to the east of the survey area outside the visible range of the transect lines.

The following conclusions can be drawn after reviewing the results of the first and third surveys that were completed. In 2009, in the Offshore area, gray whales were found primarily in the northeastern part of the area, and frequently

were sighted to the east of the survey transects (outside the water area that was available for the density analysis; the maps reflect actual sighting data for these whales).

Whales were sighted within and to the northeast of the surveyed Offshore feeding area in substantial numbers as early as late July, which had not been observed in previous years. By early September the number of whales (26, with 3 individuals possibly resighted) had increased compared to late July (21, with 9 whales possible resighted), but still remained substantially lower than during the same period in 2008 (63 individuals on September 2, with 2 possibly resighted). It is difficult to evaluate the seasonal dynamics of whale abundance in the Offshore area due to the insufficient number of completed surveys and the fact that in 2009 gray whales were frequently observed east of the survey transects during both systematic and opportunistic surveys (Figure 9). Thus, additional whales outside the visible range of the transect lines during systematic surveys in 2009 may have been missed.

1.2.1.3 Arkutun-Dagi License Area

Two systematic surveys were conducted within the Arkutun-Dagi license area (Sakhalin-1 Project) on July 22 and on August 16, 2009. During these surveys not a single gray whale was sighted (Fig. 1), which confirmed a fact already established by prior surveys that gray whales are almost completely absent from this area.

1.2.1.4 Piltun-Astokh License Area

During the summer and fall of 2009 an additional series of vessel-based surveys was conducted in the waters of the Piltun-Astokh license area (Sakhalin-2 Project). The first survey on July 11 was suspended due to deteriorating visibility after 4.5 of the northern transects were sampled. Seven whales were sighted in the Piltun feeding area to the west of the survey transects. These sightings were excluded in the density analysis and were plotted instead on the map according to their actual sighting locations – Figure 1). One group of four whales was sighted, all the rest were sighted as individuals. The repeat survey on 17 July was also incomplete and sampled

only the 4 southern transects. Only one whale, a migratory whale, was sighted within the Piltun-Astokh license area near its western boundary (Figure 1).

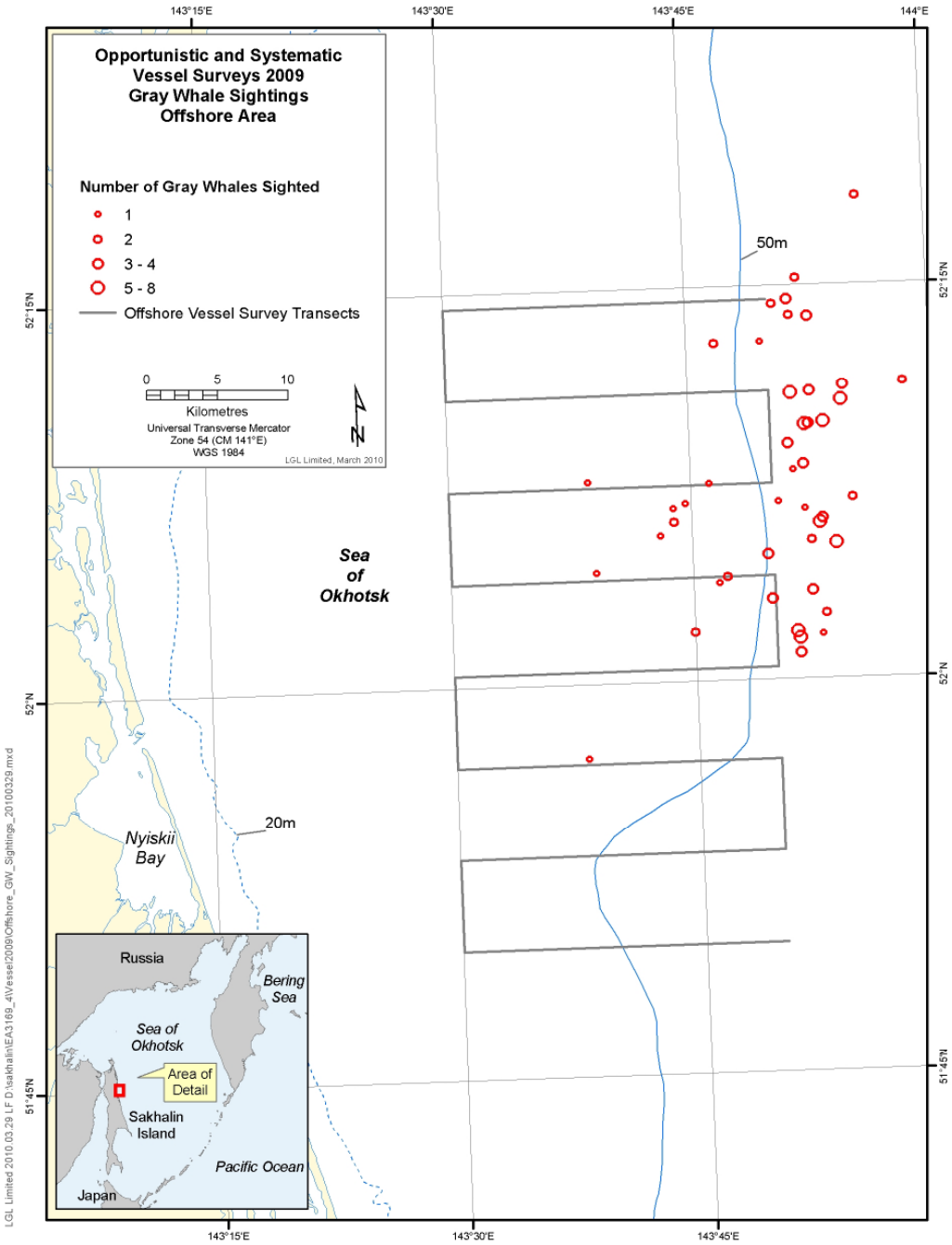


Figure 9. All gray whale sightings made in the Offshore feeding area by opportunistic and systematic vessel surveys during 2009.

The final survey was conducted on September 2. During this survey 42 whales were sighted of which 18 individuals were identified as possible resights. Thirty two whales were located within the boundaries of the Piltun-Astokh license area; the other 10 whales were closer to shore outside the license area. The whales were sighted individually and in groups of 2 to 7 individuals. All 32 whales sighted within the license area occurred in its northwestern portion.

Thus, in September, when an increase was noted in the number of whales in water depths of 20 meters or more in the near-shore area, a portion were within the Piltun-Astokh license area, near its western boundary. After all, these waters are little more than the outer, seaward zone of the Piltun feeding area. In July only one whale in the western part of the license area was sighted.

The overall distribution of gray whales in waters off northeast Sakhalin during the summer-autumn season of 2009, based on the combined data from all vessel-based and onshore surveys, is shown in Figure 5 (right panel). Of interest are those cells with an elevated density in the water area around the PA-B platform, however these findings, as discussed previously in Section 1.2.1.1 of this report, may be attributed to the small number of vessel surveys conducted in the vicinity of the Piltun-Astokh license area, and should not be taken alone as evidence that patches with very high whale densities are typical for this area. In past years, whales were rarely encountered in these waters, and if they were, then only in small numbers (Vladimirov et al., 2005, 2006, 2007, 2008, 2009). In the rest of the Piltun area, where observations performed during a single vessel-based transect survey can be averaged with data from the more numerous onshore surveys, whale distribution takes on a normal pattern (Figure 5).

1.2.1.5 Total Number of Gray Whales Feeding in Sakhalin Waters

Summarizing the results of the survey work carried out in 2009, it can be concluded that in the Piltun feeding area, the maximum number of gray whales sighted during onshore surveys was higher than in 2008, increasing from 47 to

73 individuals and was comparable to the 2007 level[*]. In the Offshore area, a comparison of survey data acquired at almost the same time of year (9/1/2009 and 9/2/2008), reveals the opposite trend – a more than twofold decrease in the number of whales from 63 to 26 individuals between 2008 and 2009, respectively, i.e. a decline of 58.7%. (It is known that in recent years, the maximum number of whales in the Offshore area was observed at the very end of September or early October. In October 2008, 82 whales were sighted in the Offshore area. Unfortunately a survey could not be carried out in that time frame in 2009). It should be noted, however, that observations made during both the 2009 systematic and opportunistic Offshore surveys showed the presence of considerable numbers of whales to the northeast of the Offshore survey area, where whales have not been observed in previous years. Thus, additional whales outside the visible range of the transect lines during systematic surveys in 2009 may have been missed. It is unknown how many more whales (in addition to the maximum count of 26 on September 1) may have been feeding to the east of the Offshore area in 2009. Hence the maximum number of gray whales observed during vessel surveys is likely an underestimate of their abundance in the Offshore feeding area. Note that a vessel survey was designed to sample eastwards of the survey grid in late September 2009, but this survey could not conducted due to a storm.

Combining survey results in the Piltun and Offshore feeding areas to estimate the overall abundance of gray whales in their feeding habitat off the northeast coast of Sakhalin can only be justified if the surveys are synchronized (i.e., were carried out in both areas on the same day or on two consecutive days), thereby minimizing the likelihood of double-counting or undercounting the whales as a result of their migration from one area to another during the time between the surveys.

Synchronized surveys of this type were conducted in the Piltun and Offshore areas on September 1, 2009. In the Piltun area, 51 whales were sighted on that

[*] - vessel-based surveys also attest to the increase in 2009 of the observed number of gray whales in the Piltun area. However, considering that, from a vessel travelling 4.0 km from shore, quite a number of animals within the 2 km nearshore zone will go unnoticed, the results of these surveys are not used to estimate the overall number of whales in the feeding area.

day during the onshore survey, while in the Offshore area, 26 whales were sighted during the vessel-based survey (Tables 2, 4), i.e. the total simultaneously recorded number of gray whales in the waters of NE Sakhalin in 2009 was 77 individuals. In 2008, the total abundance of whales, based on combined data from the synchronized onshore and vessel-based surveys in the Piltun and Offshore areas during the first days of October, was 98 individuals, - Vladimirov et al., 2009). However, as discussed above, the estimate of 77 gray whales in 2009 is likely an undercount because of the observed shift in the whale distribution eastward of the known Offshore area. Thus, it is difficult to infer accurate estimates of whale abundance in 2009 from combined whale counts in the Offshore and Piltun area for the purpose of comparing these estimates to 2008 and other years.

The year-to-year dynamics of whale abundance will be examined more closely below in Section 1.3, “Discussion of Results.”

1.2.2 Whale Groups

1.2.2.1 Piltun Area

1.2.2.1.1 Vessel-based Surveys

During the only systematic survey in the Piltun area that could be brought near to completion (September 17, 2009), 18 gray whale sightings were recorded, during which 33 whales were sighted either alone or in groups of up to 4 individuals (Table 8). Most commonly observed in the near-shore water area were: (a) single whales, making up 50% of all sightings (27.4% of the number of recorded individuals), (b) groups of two individuals (22.2% of the total number of sighting incidents, or 24.2% of the number of recorded individuals), and (c) groups of three individuals (also 22.2% of the total number of sighting incidents, or 36.4% of the number of recorded individuals). The largest group, which consisted of four whales, was encountered only once, making up 5.6% of all sighting incidents (12.1% of the number of recorded individuals). The average number of whales per group was 1.83 individuals.

Table 8. Gray Whale Groups Recorded in the Waters of Northeastern Sakhalin in 2009 (based on Systematic Vessel-Based Surveys).

Month	Group size (number of individuals)													
	1		2		3		4		5		7		8	
	Number of groups	% of total	Number of groups	% of total	Number of groups	% of total	Number of groups	% of total	Number of groups	% of total	Number of groups	% of total	Number of groups	% of total
Piltun Feeding Area														
September	9	27.37	4	24.24	4	36.36	1	12.12	-	-	-	-	-	-
Offshore Feeding Area														
July	1	4.76	0	0	1	14.29	1	19.05	1	23.81	-	-	1	38.09
September	5	18.52	5	37.04	4	44.44	0	0	0	0	-	-	0	0
Season total:	6	12.50	5	20.83	5	31.25	1	8.33	1	10.42	-	-	1	16.67
Piltun-Astokh License Area														
July	4	50	0	0	0	0	1	50	0	0	0	0	-	-
September	9	21.43	2	9.52	2	14.29	1	9.52	1	11.90	2	33.33	-	-
Season total:	13	26.00	2	8.00	2	12.00	2	16.00	1	10.00	2	32.00	-	-
Whole Northeast Sakhalin shelf														
Season total:	28	21.37	11	16.79	11	25.19	4	12.21	2	7.63	2	10.69	1	6.11

Note: The "% of total" columns show the percent of the total number of gray whales seen in a group of each specific size

1.2.2.1.2 Onshore Surveys

By far most of the gray whales sighted in the Piltun area during onshore surveys (late June to September, 2009) were solitary (in 74.5% of the sightings, accounting for 56.4% of all encountered animals – Table 9). Groups of two whales accounted for 19.9% of the sightings or 30.1% of all observed whales. Groups of three were much more seldom encountered (4.8% of the sightings or 10.8% of all whales), and groups of four whales were seldom seen (0.9% of the sightings or 2.6% of all whales). No clear pattern could be discerned in the variations of sightings of groups of different sizes between June-July and September. In general, the relative proportions of solitary whales and groups of various sizes were virtually the same in 2009 as in 2008, and very close to the proportions for 2005-2007.

Table 9. Number of Gray Whales in Groups Recorded in the Piltun Area in 2009 (Based on All Shore-Based Surveys).

Month	Group size (number of individuals)							
	1		2		3		4	
	% of the number of sightings	% of the number of individuals	% of the number of sightings	% of the number of individuals	% of the number of sightings	% of the number of individuals	% of the number of sightings	% of the number of individuals
June–July	75.11	57.64	19.46	29.86	5.43	12.50	-	-
August	73.28	54.75	20.90	31.24	4.53	10.15	1.29	3.86
September	75.73	57.94	18.71	28.64	4.68	10.74	0.88	2.68
Total for the season:	74.49	56.42	19.86	30.09	4.77	10.84	0.88	2.65

1.2.2.2 Offshore Area

During the 2009 systematic vessel-based surveys in the Offshore area, 19 gray whale sightings involving 48 whales were recorded. The largest group that consisted of eight individuals was observed in the 21 July survey, though, as usual, the solitary whales (31.6% of sightings) and groups of 2 or 3 individuals (each at 26.3% of sightings – Table 8) were most frequently encountered. The average number in a sighting was 2.5 whales, which was more than in 2008 (1.6 whales). From July to September, the number of single whales and small groups increased, while large groups of four or more individuals were no longer encountered.

1.2.2.3 Piltun-Astokh License Area

In the course of the surveys in the Piltun-Astokh license area, 22 whale sightings involving 50 whales were recorded. Most of the whales sighted were in groups, the largest of which had seven individuals (Table 8). The average group size was 2.27 whales. It should again be noted that of the 50 whales recorded during these surveys, only 17 were within the boundaries of the Piltun-Astokh license area; the rest were shoreward of that water area.

1.2.2.4 Arkutun-Dagi License Area

No gray whales were sighted in the Arkutun-Dagi license area in 2009.

1.2.2.5 Whale Groups Observed by MMOs During July-September 2009

The total number of gray whale sightings throughout the 2009 vessel-based survey season in waters off NE Sakhalin was 377, involving 708 animals (Table 1). The animals were solitary or in groups of up to eight. The average number of whales per sighting between July and September was 1.87, which is just slightly higher than what was recorded in 2007-2008. (1.81).

Solitary whales were encountered most often – in 53.05 % of cases. Groups of two accounted for 23.87 % of the sightings, groups of three – 13.79 %, groups of four – 5.03 %, groups of five – 2.12 %, groups of six – 0.79%, groups of seven – 0.53%, and groups of eight – 0.79% (Table 8). These ratios changed only slightly since 2008, and no groups of 9 or 10 whales were observed in 2009.

1.2.3 Distribution of Cows with Calves

All gray whale cows with calves stayed exclusively in the near-shore Piltun area during the summer and early autumn (up to the time the calves are weaned).

In 2009 the total number of cow-calf pairs sighted throughout the onshore survey period was 16. The first cows with calves were sighted on June 25 in nearshore shallow waters of the southern part of the Piltun area (in the vicinity of survey station 12). The last cow-calf pair was sighted on September 12 (in the vicinity of survey station 9), which was similar in timing to 2008 when the last pair was observed on 21 September (Vladimirov et al. 2009). A young whale, apparently a yearling, was also sighted in the central part of the Piltun area (survey station 7) on September 1. The last unaccompanied calf was sighted on September 15, 2009 south of survey station 9.

Over the survey season, the vast majority of cow-calf pairs were sighted in the southern, shallower part of the Piltun area between survey stations 8 and 13 (Figure 9). Similarly, in 2008, almost all cow-calf pairs were observed between stations 9 and 13. However, on 1 September 2009 a pair was spotted feeding in the near-shore shallow waters near survey station 3 in the northern part of the Piltun area. The next day, the same pair was sighted in the vicinity of survey station 4, traveling southward (Figure 10).

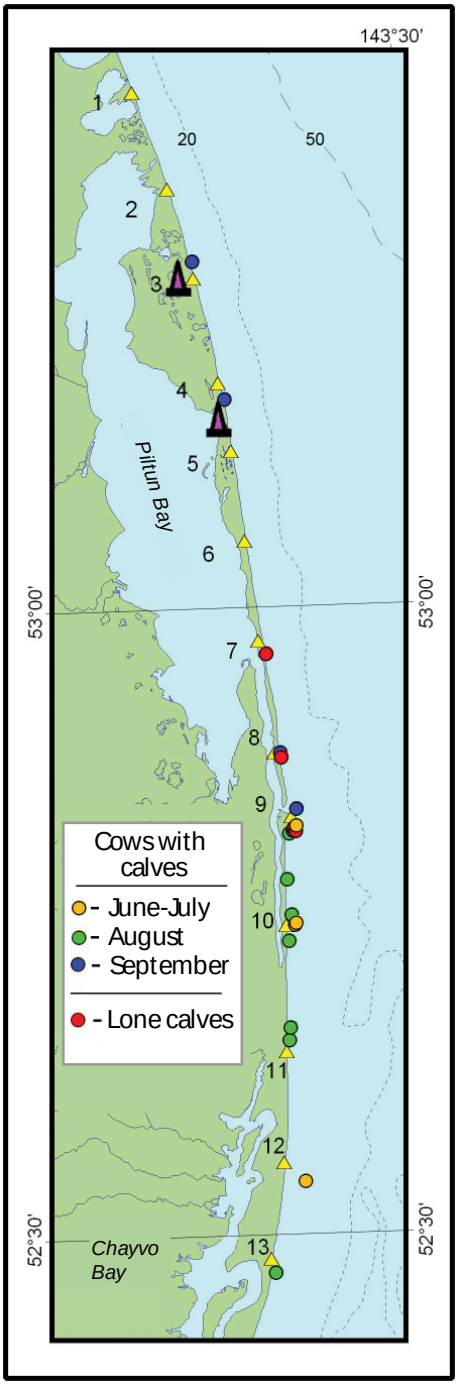


Figure 10. Distribution of mother-calf pairs of gray whales and young separated from their mothers in the Piltun area in June–September 2009 (from shore-base survey data).

Note: drilling rig to the north of the onshore survey station 3 is a RosNeft facility; drilling rig to the south of the onshore survey station 4 is an ENL facility

Unlike in previous years, when cows and their calves gathered primarily in water depths of 10-15 m in September, in 2009 they spent the entire season within the first kilometer of the nearshore zone in waters up to 10 m deep.

The maximum number of cows and calves (2 pairs) sighted during the 2009 onshore survey season was recorded on September 1 (one pair in the vicinity of survey station 3 and the second near survey station 8). This figure was identical to the data for 2008, when two mother-calf pairs were sighted during onshore surveys on August 9 and September 9. Of course, there is no certainty that all calves could be seen during the onshore surveys if it is borne in mind that at a distance exceeding 2-2.5 km they are difficult to detect because of their small body size and weak blows, which is why their statistics should be regarded as approximate (photo ID provides much more accurate data on this).

No cow-calf pairs were observed during vessel-based surveys, as was the case in preceding years.

1.2.4 Anthropogenic Impacts on Gray Whales

Potential sources of anthropogenic impact on gray whales feeding in waters off NE Sakhalin during the summer-autumn season of 2009 included:

- installation of onshore production infrastructure under the Sakhalin-1 Project (including pile driving), carried out on the Piltun Spit near the Yastreb drilling rig, roughly midway between survey stations 4 and 5;
- seismic survey operations to the north of the Piltun area and to the south of the Offshore feeding area; and
- the presence of numerous vessels of various types engaged in pollock fishing in the Offshore area.

Detailed analysis of acoustic data taken during the 2009 field season is currently underway. Given the absence of any clearly visible anomalies in whale distribution in the waters opposite the Sakhalin-1 work zone between stations 4 and 5, it appears that the onshore construction/installation operations

on the Piltun Spit did not adversely impact gray whale distribution. As was observed throughout the Piltun feeding area in 2009, the abundance of gray whales between survey stations 4 and 5 increased in 2009 compared to 2008 and was frequented by an average 7.7% of all the whales present in the Piltun area (Table 5), while the seasonal average in 2007 was only 1.6%, and an almost negligible 0.4% in 2008 (a solitary whale was sighted twice over the entire survey season). Similarly, whales also failed to exhibit avoidance reactions to construction work in 2006, when the pipeline was laid in the southern part of the Piltun area under Sakhalin-II. During that year, whale numbers in the waters of the Chayvo area increased compared to previous years and have remained higher since (Vladimirov et al., 2007).

1.2.5 Sightings of Other Marine Mammal Species

During vessel-based surveys performed in the waters off NE Sakhalin in 2009, 730 animals belonging to twelve other marine mammal species were sighted in addition to gray whales. The cetacean species encountered in the greatest numbers were the harbour porpoise (*Phocoena phocoena)* and Dall porpoise (*Phocoena dallii)* - 69 and 134 individuals, respectively. Also common were the Minke whale (*Balaenoptera acutorostrata*) - 55 individuals, killer whale (*Orcinus orca*) - 31 individuals, Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) - 25 individuals and Baird's beaked whale (*Berardius bairdii*) - 22 individuals. Four finback whales (*Balaenoptera physalus*) and three whales of undetermined species were also sighted (Appendix 1).

Pinnipeds were represented by the fur seal *(Callorhinus ursinus)* - 331 individuals, spotted seal (*Phoca largha*) - 40 individuals, sea lion (*Eumetopias jubatus*) - 8 individuals, one bearded seal (*Erignathus barbatus*), one ringed seal (*Pusa hispida*) and five seals of undetermined species (Appendix 1).

During the 2009 onshore surveys in the Piltun area, the following cetacean species were sighted in addition to gray whales: Minke whale (14 groups, 14 animals), harbour porpoise (14 groups, 19 animals) and killer whale (2 groups, 3 animals). They were found scattered throughout the entire water area without forming any congregations. The Minke whales were sighted in the northern deeper waters of the Piltun area at a distance of 1 to 4.5 km from shore. Killer

whales were sighted twice in the northern part of the area in early July and during the first ten days of August, but were not seen again during the rest of the survey season. The harbour porpoise was found scattered throughout the Piltun area at a distance of up to 1.5 km from the coast. Appendix 2 presents information on the dates and coordinates of all sightings of other cetaceans.

Pinnipeds in the Piltun area were mainly represented by ringed, spotted and bearded seals, the most numerous of which were the first two species. No systematic survey of pinnipeds was performed, but they were regularly sighted in small numbers along the route. There is a permanent mixed seal rookery near the mouth of Piltun Bay, numbering approximately 800-1000 animals.

1.3 Discussion of Results

The 2009 Western (Okhotsk–Korean) Gray Whale Monitoring Program in the waters off northeast Sakhalin made it possible to acquire new data on the distribution and abundance of these animals in their main summer and autumn feeding areas and update existing results. One of the chief objectives of the program is to evaluate the current condition of the population of these animals, which are classified as highly endangered, based largely on an assessment of WGW distribution and abundance throughout the whales' summer-fall feeding season.

Results indicate that in the near-shore Piltun area the maximum observed number of gray whales recorded during a complete onshore survey – a figure which had declined during the past three years (from 119-122 individuals in 2004-2005 to 99 individuals in 2006, 73 in 2007, and 47 in 2008) – increased by 55% and totaled 73 individuals, i.e. was comparable to the 2007 level. Vessel-based surveys also showed a substantial increase in the number of animals recorded here during a single survey (33) compared to 2008 (20).

On the other hand, the vessel-based survey performed on September 1, 2009 showed that the number of gray whales in the Offshore feeding area decreased compared to the same period the previous year and totaled 26 individuals (versus 63 recorded on 9/2/2008). It should be noted, however, that whale sightings made during both the systematic and opportunistic vessel surveys in

the Offshore area in 2009 showed the presence of considerable numbers of whales to the northeast of the Offshore survey area, where whales have not been observed in previous years. Thus, additional whales outside the visible range of the transect lines during systematic surveys in 2009 may have been missed. It is unknown how many more whales in addition to the maximum count of 26 on September 1 may have been feeding to the east of the Offshore area during this survey. Hence the maximum number of gray whales observed during the vessel surveys in 2009 is likely an underestimate of their abundance in the Offshore feeding area.

The total number of gray whales congregating to feed in the shelf waters off northeast Sakhalin, based on data from synchronized surveys performed on September 1, 2009 in both feeding areas, was 77 animals, which is 21.4% lower than the corresponding figure for 2008 (98 animals). However, no conclusions can be drawn from these data regarding the multiyear population dynamics of the gray whale feeding group that had gathered off Sakhalin in the summer and autumn of 2009 for several reasons. As described above, the estimate of abundance in the Offshore feeding area is likely an undercount because of the observed shift of whale encounters to the east of the transect lines of the Offshore Area in 2009 described above. Secondly, a very limited number of surveys were conducted in the Offshore area and in less than ideal survey conditions that likely reduced detection of whales by the MMOs. In addition, at least 16 gray whales were observed within the Piltun-Astokh license area during the September 2 vessel survey. Although these whales may have moved there overnight from the Piltun feeding area, it is possible that some or all of these whales were in the license area on 1 September.

Therefore, the 2009 survey data were compared with photo-identification results for whales in northeast Sakhalin waters during the past season. According to photo-ID data, a total of 117 gray whales were identified during July-September 2009 (Yakovlev et al., 2010). In the near-shore waters of the Piltun feeding area, 85 animals were sighted, while 39 were sighted within the Offshore area (a number of whales were counted in both surveys, after they migrated from one area to the other). In 2008, the total number of gray whales

identified offshore eastern Sakhalin was 98 individuals, 62 of which were sighted in the Piltun area and 61 in the Offshore area (Yakovlev et al. 2009). These results indicate that in 2009 the total number of gray whales in the eastern Sakhalin feeding habitat had increased from 2008 levels (from 98 to 117 individuals, i.e. by 19.4%), which contradicts the results of the distribution surveys, that indicate there were fewer whales. Furthermore, a comparison of the year-to-year dynamics of the number of whales photo-identified in each of the areas separately lends the same impression as these surveys –the number of whales in the Piltun area also increased since 2008 (from 62 to 85 individuals, i.e. by 37.1%), while in the Offshore area – the number of photo-identified whales decreased (from 61 to 39 individuals or by 36.1%) potentially because of limited vessel time for photo-ID and combined with bad weather conditions that were encountered throughout the entire field season (Yakovlev et al. 2010).

The discrepancies between the survey and photo ID data make it necessary to exercise caution when evaluating observed changes in the abundance of gray whales in Sakhalin waters. It is possible that the annual and seasonal migrations observed in recent years between the eastern Sakhalin and eastern Kamchatka regions, which were also observed in 2009 (Yakovlev et al., 2010) must be considered when assessing the presence of gray whales in eastern Sakhalin waters and their overall population numbers. Photo ID data taken offshore southeast Kamchatka since 2004 and particularly, since 2007 when the photo-ID effort in this region increased, indicate that whales from the Korean-Okhotsk population use the nearshore waters of eastern Kamchatka as foraging grounds, especially Olga Bay and Vestnik Bay.

Inter-annual variations in the intensity of use of the gray whale foraging grounds offshore Kamchatka and Sakhalin Island cannot yet be fully assessed and remain to be investigated as more data become available in the future. Changes in gray whale abundance and their distribution in the eastern Sakhalin feeding habitat may be associated with changes in the productivity of benthic communities in the near-shore shallow water areas of Sakhalin Island (Fadeev, 2007, 2008, 2009, 2010), particularly in the northern half of the Piltun Feeding

area (Figure 11). These issues definitely require a detailed investigation based on a comparative analysis of multiyear survey, photo ID, and benthic data.

In light of the photo ID data that in 2009 documented usage of the eastern Sakhalin feeding habitat by 117 whales (Yakovlev et al. 2010), it is justifiable to conclude that the total number of animals annually using this habitat has remained relatively stable in recent years at about 100-120 individuals, although this has been accompanied by active migration between at least two existing feeding habitats in Far East seas (eastern Sakhalin and eastern Kamchatka).

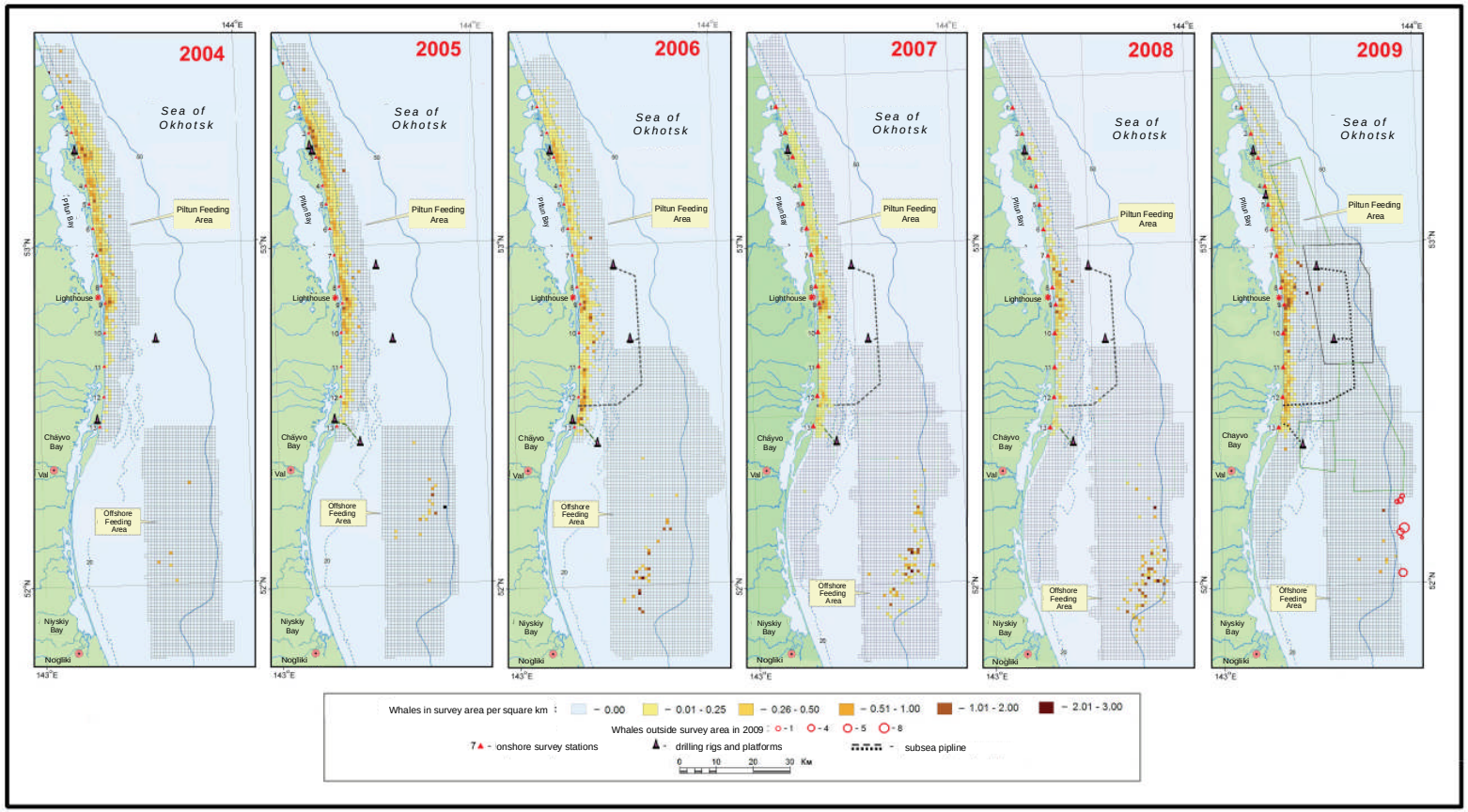


Figure 11. Variations in gray whale distribution in the Piltun and Offshore areas in 2004–2009 (from the combined shore-based and vessel-based survey data). Whale sightings made beyond the ends of the transects were excluded in the density analysis (see Distribution methods for a detailed explanation) and are shown on the density maps as red circles whose size is proportional to the number of gray whales in the sighting.

Note: drilling rig to the north of the onshore survey station 3 is a RosNeft facility.

1.4 Conclusions

The 2009 western (Okhotsk–Korean) gray whale monitoring program in the waters off northeast Sakhalin made it possible to acquire new data on the distribution and abundance of these animals and update existing results. The most important findings of the study can be summarized as follows:

1. Onshore survey results show that the decline in gray whale abundance in the Piltun area observed over 2006-2008 has reversed in 2009; the maximum number of whales recorded in 2009 rose by 55% over the previous year, totaling 73 individuals and was comparable to the 2007 level. Vessel-based surveys in 2009 also showed a substantial increase in the number of animals (33) sighted in this area compared to 2008 (20).

2. Average gray whale density over the entire Piltun feeding area was higher during the 2009 field season compared to 2008 (Figure 5). The highest whale densities in 2009 were found in the central (i.e., in the vicinity of stations 8 and 9) and southern parts of the area. The increase in whale densities in the northern part of the Piltun feeding area was observed mainly in the vicinity of stations 4 to 7, with only slight increases in the vicinity of stations 1 to 3.

3. In 2009, whale distribution shifted to the northeast within and outside of the known Offshore feeding area. Vessel-based surveys showed that in early September, the number of gray whales in the Offshore feeding area declined by 58.7% compared to the same period in 2008. This result may have been partly attributable to two causes:

    - Only two complete Offshore surveys could be performed in 2009 due to adverse weather conditions.

    - Observations made during both the 2009 systematic and opportunistic Offshore surveys showed the presence of considerable numbers of whales to the northeast of the Offshore survey area, where whales have not been observed in previous years. Thus, additional whales outside the visible range of the

transect lines during systematic surveys in 2009 may have been missed.

In October 2008, 82 whales were sighted in the Offshore area, but no survey was conducted in October, 2009.

4. In 2009 no gray whales were sighted in the waters of the Arkutun-Dagi license area (Sakhalin-1 Project). Only in September did small numbers of whales appear in the Piltun-Astokh license area (Sakhalin-2 project).

5. In 2009, the total abundance of whales, based on combined data from the synchronized onshore and vessel-based surveys in the Piltun and Offshore areas on 1 September was estimated to be 77 individuals. However, the estimate of 77 individual gray whales in 2009 is likely biased low because of the observed eastward shift (i.e., to the east of the visibility range of the vessel-based surveys) in the whale distribution in the known Offshore feeding area compared to earlier years. In addition, a very limited number of surveys were conducted in the Offshore area under less than ideal weather conditions that likely reduced detection of whales by the MMOs. Furthermore, at least 16 gray whales were observed within the Piltun-Astokh license area during the September 2 vessel survey. Although these whales may have moved there overnight from the Piltun feeding area, it is possible that some or all of these whales were in the license area on 1 September. Therefore the estimate of total abundance in 2009 from combined whale counts in the Offshore and Piltun area is likely inaccurate and needs to be used with caution when making any comparisons with previous years, or with Photo-ID results in 2009.

   In addition, estimating whale abundance by combining whale counts from the Piltun and Offshore areas does not take into account the active migration between at least two existing feeding habitats (eastern Sakhalin and eastern Kamchatka) observed during photo-ID efforts (Yakovlev et al. 2008, 2009, 2010): Photo-ID data identified 138 Western Gray Whales offshore Kamchatka and Sakhalin combined in 2009

(Yakovlev et al. 2010). These results indicate that the actual number of whales present in Sakhalin waters and therefore, the number which can be recorded during simultaneous distribution surveys in the Piltun and Offshore feeding areas, is likely lower than the total number of whales in the Korean-Okhostk population.

6. Sixteen sightings of cow-calf pairs were made throughout the 2009 onshore survey period, with a maximum of two pairs sighted on the same survey day (which is similar to the previous year). The last cow-calf pair was sighted on September 12 which was similar to 2008 when the last pair was observed on 21 September. The majority of cows and calves were sighted in the southern, nearshore part of the Piltun area between survey stations 8 and 13. Similarly, in 2008, almost all cow-calf pairs were observed between stations 9 and 13. All cows and calves were observed within the first kilometer of the nearshore zone in waters up to 10 m deep throughout the season, unlike previous years when cows and their calves gathered primarily in water depths of 10-15 m in September.

7. The 2009 surveys showed no evidence that Sakhalin-1 onshore construction, installation, and production in the central part of the Piltun Spit have resulted in any negative impacts on gray whale distribution or abundance in adjacent waters. As was observed throughout the Piltun feeding area, gray whale densities near the Odoptu site, i.e., between survey stations 4 and 5, increased in 2009 compared to 2008.

8. In general, results from the 2009 distribution surveys together with results from the 2009 photo-ID surveys indicate that the Western Gray Whale population is in stable condition.

1.5 Acknowledgments

We consider it our duty to express our most sincere appreciation to the large group of people who took part in planning and organizing the 2009 survey program: R. Melton, S. Werner and M. Jenkerson (ExxonMobil Upstream Research Company - Houston, Texas, USA), E.N. Kalinin (Exxon Neftegas Limited – Yuzhno-Sakhalinsk, Russia), D. Bell, K. Broker and V. Yefremov (Sakhalin Energy Investment Company LTD – Yuzhno-Sakhalinsk, Russia), and I.N. Zhmaev, V.N. Yetskalo, and S.A. Tyurin (LGL Sakhalin, Vladivostok, Russia).

We would also like to extend our heartfelt thanks to the ENL operators at the Chayvo and Odoptu production facilities in the town of Nogliki for their assistance and support in carrying out the onshore survey, especially O. Pokhil – Camp 840 operator, and I. Aiyupov and S. Melnik – managers of the Odoptu camp, and to the group of land-surveyors from the Chayvo camp – M. Klyopov and T.Gernaey.

We are indebted to Ye. Smorchkov and T. Zhalimov – vehicle drivers who supported the onshore route surveys, and to the navigational crew of the *Academician Oparin* scientific research vessel for help in conducting the vessel-based surveys.

Special thanks are also due to D.S. Samarin, A.A. Samarina, and A.S. Tishchuk (DVGTRU), P.I. Marchenko (TINRO-Center), R.E. Sidorenko (DVGU), and A.G. Afanasyev-Grigoryev, O.Yu. Nemchinov, and V.B. Stekhov (all from the Marine Biology Institute of the Far East Branch of the Russian Academy of Sciences) for their active participation in the onshore and vessel-based surveys and collecting field data.

We thank Yu. Bychkov and L. Ferreira of LGL Limited for the preparation of the WGW density maps.

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1.7 Appendices

Appendix 1

Data on Gray Whales and Other Marine Mammals Recorded during Surveys from the *Akademik Oparin* Scientific Research Vessel in the Waters of Eastern Sakhalin, July-September 2009

(Notes are at the End of the Table)

Date (Дата)	Observer 1 Наблюдатель 1	Observer 2 Наблюдатель 2	Latitude DEGREES Широта, ГРАДУСЫ	Latitude MINUTES Широта, МИНУТЫ	Latitude hundredth MINUTES Широта, СОТЫЕ ДОЛИ МИНУТЫ	Longitude DEGREES Долгота, ГРАДУСЫ	Longitude MINUTES Долгота, МИНУТЫ	Longitude HUNDREDTH MINUTES Долгота, СОТЫЕ ДОЛИ МИНУТЫ	Heading DEGREES Курс судна, ГРАДУСЫ	TIME, HOUR Время, ЧАСЫ	Time, MINUTES Время, МИНУТЫ	Visibility, KM Видимость, KM	Seastate, Beaufort Scale Состояние моря, шкала Бофорта	Light or dark Светло или темно	Glare Интенсивность отблеска	Glare Position Местоположение отблеска	Species Виды	Number of MM individuals Количество особей ММ	MM movement relative to vessel Передвижение ММ относительно судна	ACTIVITY 1 ПОВЕДЕНИЕ 1	ACTIVITY 2 ПОВЕДЕНИЕ 2	Direction FROM Направление появления ММ, ОТКУДА	Direction TO Направление перемещения ММ, КУДА	Distance, number of reticles Расстояние: визирные метки	Horizon (H) / shoreline (Sh) retical count	Distance to vessel, m Расстояние до судна, м	Azimuth to marine mammal, degrees Азимут ММ, град.	Binocs or naked eye? Увидел в бинокль или нет?	MM sightign cue Характерная черта ММ	Movement pace Интенсивность движения животного	REMARKS, Y - refers to above record Примечания, Y- относится к предыдущей строке
08/04/09		VS	46	44	22	144	7	76	197	08	30	3.00	1	L	NO		BW	10	SP	FD		9		2.0	H	850	110	E	BO	MO	
08/06/09		VS	47	3	98	144	16	72	20	10	24	8.00	1	L	NO		BW	6	SP	FD		2	12	4.0	H	460	80	E	BO	MO	
08/06/09	ON		47	35	47	144	33	36	20	13	30	10.00	1	L	NO		BW	6	SA	BR		2	10	2.0	H	850	11	B	BO	VI	
08/10/09		ON	52	43	0	143	22	80	229	10	20	8.00	1	L	SE	8\9	BS	1	NO	SW		10	9	E		800	170	E	BO	SE	
08/04/09		VS	46	34	87	144	2	90	197	09	25	99.00	0	L	NO		DP	6	SA	FD		10		E		200	160	E	BO	VI	
08/06/09	MK		46	22	24	143	54	69	19	06	23	8.00	0	L	LI	1\2	DP	4	MI	FD		11		1.2	H	1310	345	B	BO	SE	
08/06/09	MK		46	22	86	143	55	1	19	06	26	8.00	0	L	LI	1\2	DP	3	ST	FD		2	10	2.0	H	860	60	E	BO	SE	
08/06/09	MK		46	23	50	143	55	33	19	06	30	8.00	0	L	SE	1\2	DP	5	MI	FD		1		E		150	45	E	BO	SE	
08/06/09	MK		46	24	6	143	55	63	20	06	34	8.00	0	L	SE	1\2	DP	4	SA	FD		11		2.3	H	760	350	E	BO	SE	
08/06/09	MK		46	24	82	143	56	2	20	06	38	8.00	0	L	SE	2	DP	4	SA	FD		2	5	4.0	H	460	65	E	BO	SE	

08/06/09	MK		46	25	22	143	56	23	20	06	40	8.00	0	L	SE	2	DP	3	ST	FD		12	4	8.0	H	240	10	E	BO	SE	
08/06/09	MK		46	25	93	143	56	61	20	06	44	8.00	0	L	SE	2	DP	4	SP	FD		10	6	6.0	H	320	340	E	BO	SE	
08/06/09	MK		46	26	73	143	57	2	20	06	49	8.00	0	L	SE	2	DP	3	SA	FD		1	4	0.6	H	2180	50	B	BO	SE	
08/06/09	MK		46	32	66	144	0	9	20	07	24	8.00	0	L	SE	2	DP	5	SA	FD		10	7	4.0	H	460	335	E	BO	SE	
08/06/09		VS	46	45	22	144	6	70	22	08	37	99.00	0	L	NO		DP	10	SA	FD		10	7	E		200	325	E	BO	VI	
08/06/09		VS	46	45	53	144	6	87	22	08	39	99.00	0	L	NO		DP	8	ST	FD		10	12	E		300	320	E	BO	VI	
08/07/09		ON	50	59	72	144	31	23	326	09	05	10.00	0	L	NO		DP	2	SP	FD		1	5	E		400	350	E	SP	VI	
09/12/09		MK	52	57	22	143	23	91	170	19	51	5.00	0	L	NO		DP	1	SA	FD		10	7	3.5	H	527	130	B	BO	VI	
09/14/09		MK	53	12	39	143	29	19	347	16	30	10.00	0	L	SE	8	DP	1	SP	FD		2	6	E		300	55	E	BO	SE	
10/02/09		VS	42	44	95	133	45	52	242	18	06	6.00	0	L	SE	12	DP	4	SA	SW	FD	2	3	E		250	300	E	BO	MO	
07/21/09	VS	MK	51	59	67	143	50	40	171	13	55	10.00	1	L	NO		DP	2	ST	FD	FL	12	3	1.5	H	1000	160	B	BO	SE	
08/01/09		MK	52	52	61	143	27	25	330	10	08	4.00	1	L	NO		DP	1	SP	FD		3	6	4.0	H	460	50	E	BO	MO	
08/04/09		VS	46	42	36	144	6	39	197	08	42	99.00	1	L	NO		DP	3	SA	FD		2		3.0	H	600	250	E	BO	VI	
08/04/09	MK		46	6	55	143	40	29	230	12	24	10.00	1	L	LI	9\10	DP	2	SA	FD		3	3	E		200	310	E	BO	SE	
08/06/09		MK	47	44	56	144	38	27	20	14	26	10.00	1	L	LI	5\7	DP	5	SA	FD		1	2	2.0	H	850	40	E	SP	VI	
08/07/09	VS		50	40	78	144	37	93	16	07	17	10.00	1	L	SE	1\2	DP	6	SP	FD		9	6	3.5	H	520	290	E	BO	SE	
08/07/09		ON	50	51	95	144	36	89	340	08	17	10.00	1	L	SE	3\4	DP	7	SP	BR		1	5	8.0	H	240	20	E	BO	VI	
10/01/09		MK	45	11	62	137	34	89	255	08	43	10.00	1	L	SE	6	DP	3	SA	TH		10	9	E		100	210	E	SP	MO	
07/03/09	VS		45	21	66	139	54	98	56	08	00	10.00	2	L	NO		DP	5	SP	FD		1	2	E		800	40	E	FI	VI	
07/04/09		MK	49	29	3	144	48	30	342	18	56	99.00	2	L	NO		DP	5	MI	TH		12		E		200	335	E	BO	VI	
08/07/09	MK		51	25	90	144	18	82	315	11	51	10.00	2	L	LI	6	DP	10	MI	FD		10		1.7	H	1000	250	E	SP	VI	
09/21/09	ON	VS	52	5	29	143	49	72	190	14	50	10.00	2	L	SE	1	DP	1	NO	FD		11		1.2	H	1300	140	B	SP	VI	
07/03/09	AA		45	43	88	141	39	26	90	15	05	10.00	3	L	NO		DP	3	SP	FD		2	1	E		300	160	E	BO	VI	
07/03/09	AA		45	43	69	141	43	5	90	15	19	10.00	3	L	NO		DP	4	SA	FD		1	2	E		500	130	E	BO	VI	
07/03/09	AA		45	43	19	141	53	1	90	15	52	10.00	3	L	NO		DP	6	ST	FD		1	12	E		400	115	E	BO	VI	
08/03/09		MK	50	30	26	144	34	29	171	10	40	8.00	4	L	LI	11	DP	4	MI	TH		1		E		350	200	E	SP	VI	
08/03/09	VS		49	12	68	144	53	35	171	18	07	5.00	1	L	LI	3	FW	2	SP	FD		2		1.5		1000	200	B	BL	SE	
08/03/09	VS		49	8	5	144	54	52	170	18	34	8.00	1	L	SE	3	FW	2	SP	FD		2		1.5		1000	200	E	BO	SE	Maneuvered to the left by 155 degrees
07/05/09	AA		52	38	51	143	23	93	339	18	25	9.00	0	L	NO		GW	2	NO	BR	FD	11		0.5	SH	2000	315	E	BO	SE	

07/05/09	AA		52	41	62	143	23	61	357	18	42	9.00	0	L	NO		GW	2	NO	FD		11		0.3	SH	2600	335	B	BL	SE	
07/05/09	AA		52	42	93	143	23	61	357	18	50	9.00	0	L	NO		GW	1	NO	FD		11		E		800	340	E	FL	SE	Maneuvered aport to avoid a whale. However, the whale came very close - to about 100 m from the vessel
07/16/09	MK		53	8	29	143	20	14	119	18	00	99.00	0	L	NO		GW	2	NO	FD		10		2	H	860	80	E	BO	SE	
07/24/09		MK	52	12	23	143	48	26	127	10	30	10.00	0	L	NO		GW	8	NO	FD	FL	12		0.2	H	4000	125	B	FL	SE	
07/24/09	VS	MK	52	9	51	143	49	83	250	12	16	8.00	0	L	NO		GW	3	NO	FD	FL	8		0.3	H	3300	135	B	BL	SE	
07/24/09	VS	MK	52	8	29	143	50	41	0	13	06	99.00	0	L	NO		GW	3	NO	FD	FL	2		0.3	H	3300	40	B	BL	SE	
07/24/09	VS	MK	52	8	29	143	50	41	0	13	06	99.00	0	L	NO		GW	8	NO	FD	FL	2		0.2	H	4000	50	B	BL	SE	
07/29/09		VS	53	15	48	143	20	3	142	09	36	0.10	0	L	NO		GW	2	SP	FD		3		E		100	190	E	BO	SE	
08/08/09		MK	53	23	47	143	13	76	165	10	23	99.00	0	L	NO		GW	2	NO	FD	FL	10		0.4	H	2900	140	B	BL	SE	
09/12/09		MK	52	52	89	143	25	25	173	20	15	0.50	0	D	NO		GW	2	SA	FD		11	10	1.3	H	1250	150	B	BO	SE	
18.09.09	VS	ON	53	1	44	143	19	17	253	10	18	8.00	0	L	NO		GW	2	NO	FD		10		0.7	H	2000	170	B	BL	SE	
09/20/09	MK	VS	52	51	95	143	22	41	90	14	21	10.00	0	L	MO	4	GW	3	NO	FD		9		1.0	H	1500	15	E	BL	SE	
09/20/09	MK	VS	52	53	89	143	23	15	270	14	44	10.00	0	L	NO		GW	1	NO	FD		12		0.1	SH		280	B	BL	SE	
09/20/09	MK		52	51	13	143	26	32	160	16	41	10.00	0	L	SE	3	GW	4	NO	FD		12		0.1	H	5750	150	B	BL	SE	
09/20/09	ON	VS	52	49	23	143	28	36	110	17	15	10.00	0	L	SE	4\5	GW	1	NO	FD		12		2.0	H	870	100	E	BL	SE	
09/25/09	MK		52	52	89	143	20	78	215	15	34	8.00	0	L	NO		GW	1	NO	FD		4		0.7	H	2000	325	B	BO	SE	
09/25/09	MK		52	52	83	143	20	75	240	15	44	8.00	0	L	NO		GW	1	NO	FD	FL	7		0.3	H	3500	100	B	BO	SE	
09/28/09		MK	53	5	69	143	19	49	265	08	39	99.00	0	L	NO		GW	1	NO	FD		12		1.5	SH		250	E	BO	SE	
07/08/09	MK		53	8	57	143	19	60	37	05	48	9.00	1	L	NO		GW	1	SP	FD		9	12	3.5	H	500	320	E	BO	SE	
07/08/09	MK		53	8	62	143	19	55	157	07	30	9.00	1	L	NO		GW	1	NO	FD	FL	1		0.6	H	2182	180	B	BL	SE	
07/10/09	MK		52	46	26	143	26	70	2	17	18	10.00	1	L	MO	8\9	GW	2	NO	FD		9		0.2	SH	2999	280	B	BL	SE	
07/11/09	VS	AA	52	59	91	143	21	9	305	10	45	8.00	1	L	NO		GW	1	NO	FD		11		0.4	Sh	2300	250	E	BL	SE	
07/11/09	VS	AA	52	56	60	143	22	87	265	13	26	8.00	1	L	NO		GW	1	NO	FD		11		0.5	Sh	2000	225	E	BL	SE	
07/11/09	VS	AA	52	56	39	143	21	77	175	13	30	8.00	1	L	NO		GW	4	NO	FD	FE	1		0.2	Sh	3000	230	E	BL	SE	
07/11/09	VS	AA	52	53	42	143	22	30	175	13	48	8.00	1	L	NO		GW	1	NO	FD		1		0.8	Sh	1550	230	E	BL	SE	
07/11/09	MK	VS	52	49	25	143	24	34	180	16	43	8.00	1	L	NO		GW	1	NO	FD		3		0.2	Sh	3000	260	B	BL	SE	
07/13/09	AA		53	6	50	143	22	48	312	12	00	10.00	1	L	NO		GW	1	NO	FD		11		0.4	SH	2300	280	B	BL	SE	
07/13/09	AA		53	8	63	143	20	75	25	12	21	6.00	1	L	NO		GW	4	NO	FD		11		0.7	H	2000	355	E	BL	SE	

07/13/09	AA		53	15	40	143	20	70	330	13	44	8.00	1	L	NO		GW	3	NO	FD		12		0.2	H	4000	320	B	BL	SE	
07/13/09	MK	VS	53	17	63	143	18	78	278	14	00	8.00	1	L	NO		GW	2	NO	FD		1		0.6	H	2200	315	B	BL	SE	Photo-ID Zodiac launch
07/13/09	MK	VS	53	19	21	143	17	36	37	14	25	10.00	1	L	NO		GW	1	NO	FD		11		0.5	H	2400	350	B	BL	SE	
07/13/09		VS	53	23	45	143	15	60	320	15	40	10.00	1	L	NO		GW	2	NO	FD		1		0.1	H	5500	350	B	BL	SE	
07/16/09		MK	53	29	16	143	11	89	146	09	03	99.00	1	L	NO		GW	3	NO	FD	FL	2		E		800	205	E	BO	SE	
07/16/09	AA	MK	53	29	5	143	12	35	186	09	25	99.00	1	L	NO		GW	1	NO	FD	FL	2		E		1000	220	E	BO	SE	Photo-ID launch
07/17/09	AA		52	49	34	143	22	67	225	08	52	10.00	1	L	NO		GW	1	NO	FD		12		0.8	Sh	1500	215	E	BL	SE	
07/17/09	AA	VS	52	49	25	143	21	90	62	09	05	10.00	1	L	NO		GW	1	NO	FD		9		0.5	Sh	2000	330	B	BL	SE	
07/17/09	AA	MK	52	47	6	143	22	77	187	10	04	10.00	1	L	NO		GW	1	NO	FD		12		0.1	Sh	3600	205	B	BL	SE	
07/17/09	AA	MK	52	46	79	143	22	74	176	10	07	10.00	1	L	NO		GW	1	NO	FD		3		0.6	Sh	1850	270	E	BL	SE	
07/17/09	AA	MK	52	46	71	143	22	77	150	10	10	10.00	1	L	NO		GW	3	NO	FD		3		0.2	Sh	2999	225	B	BL	SE	
07/17/09	AA	MK	52	45	90	143	22	1	143	10	53	10.00	1	L	NO		GW	1	NO	FD		2		0.1	Sh	3600	210	B	BL	SE	
07/17/09	AA	MK	52	45	90	143	22	1	143	10	53	10.00	1	L	NO		GW	1	NO	FD		2		0.1	H	5400	205	B	BL	SE	
07/17/09	MK	AA	52	45	98	143	28	56	267	14	11	8.00	1	L	NO		GW	1	ST	FD	FL	11	2	2.5	Sh	670	220	E	BO	SE	A whale unexpectedly surfaced near the vessel - decision made in accordance with item 10 (General Precautions)
07/21/09	MK	VS	52	11	1	143	50	0	270	08	00	10.00	1	L	NO		GW	8	NO	FD	FL	7		0.3	H	3300	135	E	BL	SE	A large group - 0.2-0.3 of the graduation line
07/21/09	MK	AA	52	7	50	143	48	17	85	10	31	10.00	1	L	NO		GW	4	NO	FD	FL	11		0.2	H	4000	50	B	BL	SE	Repeat of ID 1
07/21/09	MK	AA	52	4	94	143	50	56	174	10	53	10.00	1	L	NO		GW	3	NO	FD		11		0.3	H	3300	145	E	BL	SE	
07/21/09	MK	AA	52	3	99	143	39	54	260	11	34	10.00	1	L	NO		GW	1	SA	FD		1	5	2.0	H	860	310	E	BL	SE	Actions taken to avoid a whale. The whale swam away towards the northeast; the vessel maneuvered to the left and slowed down; the distance between the vessel and the whale was700 m
07/21/09	VS	MK	52	0	49	143	48	21	90	13	43	10.00	1	L	NO		GW	5	NO	FD		11		0.2	H	4000	55	B	FL	SE	Possibly repeat of ID 3
07/25/09	MK		53	3	45	143	22	84	125	06	30	8.00	1	L	NO		GW	3	NO	FD		3		0.4	SH	2280	195	E	BL	SE	
07/25/09	MK		53	3	48	143	22	84	150	07	05	10.00	1	L	SE	9	GW	1	NO	FD		3		0.4	SH	2280	260	B	BL	SE	
08/01/09	VS		53	2	19	143	20	99	306	12	12	5.00	1	L	NO		GW	1	NO	FD		10		0.5	SH	2000	260	B	BL	SE	
08/08/09		VS	53	21	94	143	18	62	129	12	16	10.00	1	L	LI	12	GW	2	NO	FD		2		0.3	SH		205	B	BL	SE	

08/08/09		VS	53	18	28	143	19	25	180	12	40	10.00	1	L	LI	11	GW	1	NO	FD		12		0.3	H	3400	170	B	BL	SE	
08/08/09	ON		53	20	14	143	16	62	345	15	45	10.00	1	L	LI	8\9	GW	4	NO	FD		11		0.5	H	2100	310	B	BL	SE	
08/09/09	MK		53	8	95	143	18	14	274	06	45	10.00	1	L	NO		GW	1	NO	FD		3		0.1	H	5700	355	B	BL	SE	
08/09/09		VS	53	16	52	143	19	37	1	08	00	10.00	1	L	SE	3	GW	1	NO	FD		11		0.2	H	4200	340	B	BL	SE	
08/09/09		MK	52	54	14	143	23	60	184	14	00	8.00	1	L	LI	12	GW	1	NO	FD		1		0.7	SH		225	E	BL	SE	
08/09/09		MK	52	54	7	143	23	27	179	14	43	8.00	1	L	LI	1	GW	3	NO	FD		1		0.3	SH		220	E	BO	SE	
08/09/09		MK	52	53	45	143	23	26	176	14	49	8.00	1	L	LI	1	GW	2	NO	FD		1		0.3	H	3460	195	E	BL	SE	
08/09/09		MK	52	53	7	143	22	0	240	15	00	8.00	1	L	LI	11	GW	2	NO	FD		12		0.2	SH		230	E	BL	SE	
08/09/09	ON	MK	52	54	61	143	21	58	50	16	20	8.00	1	L	LI	5\6	GW	1	SP	FD		3	6	0.2	H	4280	140	E	BL	SE	
08/10/09		ON	52	43	96	143	25	56	278	08	23	8.00	1	L	SE	5	GW	1	NO	FD		1	7	0.3	SH		320	B	BL	SE	
08/10/09		ON	52	43	73	143	24	74	90	08	50	8.00	1	L	SE	12\1	GW	2	NO	FD		8	9	0.7	SH		350	B	BL	SE	
08/10/09		ON	52	43	72	143	23	0	229	10	20	8.00	1	L	SE	8\9	GW	1	SP	FD		1	1	1.2	SH		300	E	BL	SE	
08/10/09		MK	52	41	76	143	22	77	187	11	30	8.00	1	L	LI	10\11	GW	2	NO	FD		1		0.2	SH		210	B	BL	SE	
08/10/09		MK	52	41	3	143	21	34	147	13	06	8.00	1	L	NO		GW	1	ST	FD		2	7	1.3	H	1250	190	E	BL	SE	
08/10/09		MK	52	41	3	143	21	34	147	13	06	8.00	1	L	NO		GW	3	NO	FD		2		0.1	H	5740	190	B	BL	SE	
08/10/09		MK	52	42	52	143	23	51	350	13	56	5.00	1	L	LI	6	GW	1	SA	FD		12	9	1.0	H	1100	350	E	BL	SE	
08/11/09		MK	52	53	19	143	24	87	147	07	40	8.00	1	L	NO		GW	1	NO	FD		3		0.2	SH		235	B	BL	SE	
08/11/09	VS	MK	52	52	89	143	23	32	155	08	00	10.00	1	L	NO		GW	4	NO	FD		4		0.3	SH		270	E	BL	SE	Photo-ID launch
08/11/09	VS	MK	52	52	75	143	23	25	154	08	07	10.00	1	L	NO		GW	1	NO	FD		2		0.0	H		200	B	BL	SE	
08/11/09	VS	MK	52	52	49	143	23	19	150	08	17	10.00	1	L	NO		GW	1	NO	FD		2		0.2	SH		210	B	BL	SE	
08/11/09	VS	MK	52	52	31	143	23	15	140	08	23	10.00	1	L	NO		GW	2	NO	FD		6		0.1	SH		330	B	BL	SE	
08/11/09	VS	MK	52	52	25	143	23	13	132	08	26	10.00	1	L	NO		GW	3	NO	FD		6		0.4	SH		295	B	BL	SE	Repeat sighting of 8:00
08/11/09	VS		52	54	11	143	23	26	338	11	36	10.00	1	L	NO		GW	1	NO	FD		4		1.0	H	1500	100	E	BL	SE	
08/11/09		MK	52	39	80	143	22	93	227	18	44	8.00	1	L	NO		GW	1	NO	FD		12		0.2	SH		230	B	BL	SE	
08/16/09	VS	MK	52	17	98	143	54	91	89	06	57	5.00	1	L	NO		GW	2	NO	FD	FL	11		1.3	H	1250	55	E	BO	SE	
08/24/09		MK	53	14	55	143	19	11	190	16	30	8.00	1	L	SE	2	GW	2	NO	FD		1		0.1	SH		210	B	BL	SE	
08/24/09		MK	53	13	33	143	19	3	180	16	36	8.00	1	L	MO	2	GW	2	NO	FD		12		0.1	SH		195	B	BL	SE	
08/24/09		MK	53	13	33	143	19	3	180	16	36	8.00	1	L	MO	2	GW	2	NO	FD		12		0.1	SH		190	B	BL	SE	
08/24/09		MK	53	12	21	143	19	0	180	16	43	8.00	1	L	MO	2	GW	1	NO	FD		12		0.1	H	5760	185	B	BL	SE	

08/24/09		MK	53	10	52	143	19	0	170	16	52	8.00	1	L	SE	2\3	GW	1	NO	FD		1		0.6	SH		200	B	BO	SE	
08/24/09	VS		53	9	7	143	19	79	87	17	08	8.00	1	L	SE	5	GW	1	NO	FD		10		0.7	H	2000	30	B	BL	SE	
08/24/09	VS		53	4	63	143	19	34	84	19	27	8.00	1	L	SE	6	GW	1	SA	FD		2		1.2	H	1300	155	B	BO	SE	
08/25/09	VS		53	4	65	143	22	34	356	07	00	8.00	1	L	SE	3	GW	1	NO	FD		8		0.8	SH		230	B	BL	SE	
08/25/09	VS		53	4	65	143	22	34	356	07	25	8.00	1	L	SE	3	GW	1	NO	FD		12		0.2	H	4300	350	B	BL	SE	
08/25/09	VS		53	4	65	143	22	34	355	07	30	8.00	1	L	SE	3	GW	2	NO	FD		9		0.7	SH		250	B	BO	SE	
08/25/09	MK		53	2	17	143	23	19	214	11	19	10.00	1	L	SE	9	GW	3	ST	FD		12	5	0.2	SH		210	B	BL	MO	
08/25/09	MK		53	0	47	143	21	83	240	11	53	10.00	1	L	MO	9	GW	3	NO	FD		2		0.3	SH		285	B	BL	SE	
08/25/09	MK		53	0	47	143	21	59	240	11	53	10.00	1	L	MO	9	GW	1	NO	FD		1		0.6	SH		270	E	BL	SE	
08/25/09	MK	VS	53	0	39	143	21	51	239	12	30	10.00	1	L	MO	9	GW	2	NO	FD		11		0.4	SH		215	B	BL	SE	
08/25/09	MK	ON	53	0	25	143	21	17	215	13	33	10.00	1	L	MO	11	GW	1	NO	FD	FL	9		1.2	H	1300	105	E	BL	SE	
08/25/09	MK	ON	53	0	25	143	21	15	215	13	40	10.00	1	L	MO	11	GW	4	NO	FD		10		0.1	H	5760	150	E	BL	SE	
08/28/09		VS	52	57	47	143	24	69	330	16	00	8.00	1	L	NO		GW	3	NO	FD	FL	5		0.8	H	1800	120	B	BL	SE	
08/28/09		VS	52	58	75	143	23	24	330	16	13	8.00	1	L	NO		GW	1	NO	FD		9		0.3	SH		250	B	BL	SE	
08/28/09		VS	52	59	13	143	22	86	335	16	17	8.00	1	L	NO		GW	1	NO	FD		9		0.3	SH		260	B	BL	SE	
08/28/09		VS	53	0	31	143	21	99	353	16	38	8.00	1	L	LI	8	GW	2	NO	FD		11		0.2	SH		320	B	BL	SE	
08/28/09		VS	53	2	37	143	21	33	350	16	51	8.00	1	L	LI	8\9	GW	1	NO	FD		9		0.1	SH		260	B	BL	SE	
08/28/09	ON		53	4	27	143	20	40	224	17	30	8.00	1	L	SE	1	GW	3	NO	FD		8	10	1.0	H	1500	340	B	BL	SE	
08/28/09	ON	VS	53	7	75	143	18	23	261	19	00	99.00	1	L	MO	12	GW	2	NO	FD		6	5	1.5	H	1111	90	E	BL	SE	
08/28/09	ON	VS	53	7	96	143	18	21	40	19	20	8.00	1	L	SE	8	GW	3	SA	FD		11	10	0.7	H	2013	20	B	BL	SE	
08/28/09	MK		53	10	99	143	19	44	352	20	17	2.00	1	L	NO		GW	1	NO	FL		1		1.4	H	1176	40	E	FL	SE	
09/01/09	ON	VS	52	7	50	143	44	35	93	16	00	8.00	1	L	SE	7	GW	1	NO	FD		12		0.7	H	2013	87	B	BL	SE	
09/01/09	ON	VS	52	7	28	143	50	50	180	16	23	8.00	1	L	SE	99	GW	1	NO	FD		11		0.6	H	2244	130	B	BL	SE	
09/03/09	VS		52	47	43	143	26	21	165	06	43	5.00	1	L	NO		GW	3	NO	FD		4		1.0	SH		310	E	BL	SE	
09/03/09	VS		52	47	43	143	26	21	154	06	48	8.00	1	L	LI	9\10	GW	1	NO	FD		7		0.3	H	3400	355	B	BL	SE	
09/03/09	VS		52	47	44	143	26	21	154	06	55	8.00	1	L	LI	9\10	GW	2	NO	FD		5		1.0	SH		320	E	BL	SE	
09/04/09		MK	52	52	74	143	25	18	165	18	28	8.00	1	L	SE	3	GW	1	NO	FD		1		0.3	SH		210	E	BL	SE	
09/04/09		MK	52	52	10	143	25	39	170	18	30	8.00	1	L	SE	3	GW	1	NO	FD		1		0.4	H	2920	200	E	BL	SE	
09/04/09		MK	52	51	78	143	25	51	169	18	34	8.00	1	L	SE	3	GW	1	NO	FD		1		0.3	H	3460	190	B	BL	SE	

09/04/09		MK	52	51	78	143	25	51	169	18	34	8.00	1	L	SE	3	GW	2	NO	FD		12		0.2	H	4284	165	B	BL	SE	
09/04/09		MK	52	51	22	143	25	71	168	18	37	8.00	1	L	MO	3	GW	1	ST	FD		12	9	0.6	H	2240	175	B	BL	SE	
09/04/09		MK	52	49	97	143	25	23	256	18	51	8.00	1	L	LI	12	GW	1	NO	FD		10		1.3	H	1250	200	E	BL	SE	
09/13/09	ON		52	51	72	143	25	59	185	06	50	8.00	1	L	NO		GW	3	NO	FD		3		0.8	SH		285	B	BL	SE	
09/13/09	ON		52	51	70	143	25	62	91	07	07	8.00	1	L	NO		GW	2	NO	FD		2		0.8	SH		270	B	BL	SE	
09/13/09	VS	MK	52	49	87	143	23	45	250	08	10	10.00	1	L	SE	7	GW	1	NO	FD		12		0.1	SH		260	B	BL	SE	Photo-ID launch
09/14/09	MK		53	14	9	143	17	58	207	07	05	6.00	1	L	NO		GW	1	NO	FD		12		0.3	SH		220	B	BL	SE	
09/14/09	VS		53	9	3	143	19	2	212	18	15	10.00	1	L	SE	1\2	GW	3	NO	FD		12		0.3	SH		210	E	BL	SE	
09/14/09	VS		53	8	76	143	18	78	190	18	30	10.00	1	L	SE	2\3	GW	3	NO	FD		12		0.2	SH		195	B	BL	SE	
09/14/09	VS	MK	53	8	76	143	18	78	190	18	30	10.00	1	L	SE	2\3	GW	1	NO	FD		3		0.3	SH		295	E	BL	SE	Photo-ID launch
09/14/09	ON		53	9	49	143	20	81	88	20	26	2.00	1	L	NO		GW	2	NO	FD		9		0.5	H	2500	10	E	BL	SE	
09/17/09	VS	MK	52	22	8	143	17	59	25	09	55	10.00	1	L	NO		GW	1	NO	FD		12		0.2	H	4800	15	B	BL	SE	
09/17/09	VS	MK	52	24	17	143	19	7	10	10	08	10.00	1	L	NO		GW	4	NO	FD		12		0.1	H	5750	10	B	BL	SE	
09/17/09	VS	MK	52	25	32	143	19	50	12	10	14	10.00	1	L	NO		GW	1	NO	FD		12		0.3	SH		350	B	BL	SE	
09/17/09	VS	MK	52	27	58	143	20	43	40	10	34	10.00	1	L	NO		GW	1	NO	FD		11		0.2	SH		355	B	BL	SE	
09/18/09		ON	53	8	62	143	19	79	170	08	30	8.00	1	L	NO		GW	2	NO	FD		11		0.8	H	1900	180	B	BL	SE	
09/18/09		ON	53	7	69	143	20	1	170	08	38	8.00	1	L	NO		GW	2	NO	FD		2	12	1.2	SH		240	E	BL	SE	
09/18/09		ON	53	4	50	143	20	14	180	09	00	8.00	1	L	NO		GW	2	NO	FD		11	10	0.5	H	2500	145	B	BL	SE	
09/18/09		ON	53	3	40	143	20	8	180	09	10	8.00	1	L	NO		GW	2	NO	FD		12		0.6	H	2200	180	E	BL	SE	
09/18/09	VS	ON	53	3	43	143	20	13	90	09	12	8.00	1	L	NO		GW	1	NO	FD		11		0.7	H	2000	87	B	BL	SE	Photo-ID launch
09/18/09	MK		52	54	17	143	25	41	147	12	00	5.00	1	L	NO		GW	1	NO	FD		11		0.4	H	3000	120	B	BL	SE	
09/18/09	MK		52	54	48	143	25	59	350	12	14	99.00	1	L	NO		GW	2	NO	FD	FL	6		E		2000	185	B	BO	SE	
09/19/09		MK	52	51	65	143	25	4	177	07	47	5.00	1	L	NO		GW	1	NO	FD		2		0.3	SH		235	B	BL	SE	
09/19/09	MK	ON	52	29	58	143	21	62	38	18	40	8.00	1	L	LI	8	GW	2	NO	FD		6		0.3	SH		210	B	BL	SE	
09/20/09	MK		52	51	49	143	25	55	326	07	11	4.00	1	L	NO		GW	2	NO	FD		10		0.1	SH		290	B	BL	SE	
09/20/09	MK		52	51	49	143	25	54	340	07	15	5.00	1	L	NO		GW	2	NO	FD		9		0.1	SH		240	B	BL	SE	
09/20/09	MK		52	51	49	143	25	54	337	07	22	8.00	1	L	NO		GW	1	NO	FD		9		0.1	SH		235	B	BL	SE	
09/20/09		VS	52	51	57	143	25	58	60	08	00	8.00	1	L	SE	1	GW	3	NO	FD		3		0.5	H	2500	150	B	BL	SE	
09/20/09	ON	VS	52	50	95	143	24	79	230	08	10	10.00	1	L	SE	8	GW	1	NO	FD		10		0.5	H	2500	130	B	BL	SE	

09/20/09	ON	VS	52	49	89	143	22	68	160	09	00	10.00	1	L	SE	10\11	GW	1	NO	FD		2		0.2	SH		210	B	BL	SE	
09/20/09	ON	VS	52	49	5	143	21	70	233	09	15	10.00	1	L	SE	8	GW	3	NO	FD		9		0.2	H	4300	150	B	BL	SE	
09/20/09	MK	VS	52	49	58	143	22	99	12	09	42	10.00	1	L	SE	3	GW	3	NO	FD		12		0.3	H	3500	20	B	BL	SE	
09/20/09	MK	VS	52	48	48	143	21	47	227	10	40	10.00	1	L	SE	9	GW	3	NO	FD		3		0.4	SH		305	B	BL	SE	
09/20/09	MK	VS	52	48	49	143	21	49	210	10	43	10.00	1	L	SE	10	GW	1	NO	FD		3		0.4	SH		295	E	BL	SE	
09/20/09	MK	ON	52	47	68	143	21	50	260	11	00	10.00	1	L	SE	8	GW	2	NO	FD		10		0.7	SH		180	B	BL	SE	
09/20/09		ON	52	51	89	143	20	86	355	13	37	10.00	1	L	SE	6	GW	1	NO	FD		11		0.5	SH		340	B	BL	SE	
09/21/09	ON	MK	52	4	10	143	51	87	148	15	36	10.00	1	L	SE	2	GW	4	NO	FD		1		0.1	H	5750	185	B	BL	SE	
09/21/09	ON	MK	52	2	92	143	51	6	174	17	30	10.00	1	L	SE	3	GW	6	NO	FD		12		0.5	H	2500	170	B	BL	SE	
09/25/09		ON	52	53	33	143	23	72	50	16	20	8.00	1	L	NO		GW	2	ST	FD		2	12	1.4	H	1170	120	B	BO	SE	Changed course to avoid whales
09/27/09		VS	53	8	86	143	19	47	32	15	00	10.00	1	L	NO		GW	1	NO	FD		3		0.5	H	2500	120	E	BL	SE	
09/25/09		VS	53	8	98	143	17	78	305	16	30	10.00	1	L	SE	9	GW	1	NO	FD		10		0.7	SH		250	E	BL	SE	
09/25/09		VS	53	8	0	143	19	30	135	16	55	10.00	1	L	SE	2	GW	3	NO	FD		2		0.5	SH		190	B	BL	SE	
09/25/09	ON		52	54	75	143	25	25	150	19	00	10.00	1	L	SE	3	GW	1	NO	FD		10		1.0	H	1540	90	E	BL	SE	
09/28/09		MK	53	3	51	143	19	19	248	10	12	10.00	1	L	NO		GW	1	NO	FD		9		0.6	H	2250	145	B	BO	SE	
07/05/09		AA	52	6	96	143	36	37	357	10	35	9.00	2	L	NO		GW	1	NO	FE	FL	2		0.4	H	2800	60	B	FL	SE	
07/06/09		MK	53	3	31	143	23	89	0	22	12	9.00	2	L	NO		GW	1	NO	FD		9		0.1	SH	4384	260	B	BL	SE	
07/07/09		MK	53	3	38	143	23	86	140	07	47	9.00	2	L	SE	10	GW	1	NO	FD		3		0.3	SH	2588	230	B	BL	SE	
07/07/09		MK	53	3	38	143	23	86	150	07	50	9.00	2	L	SE	10	GW	1	NO	FD		3		0.2	SH	2999	225	B	BL	SE	
07/07/09		MK	53	3	66	143	20	20	190	10	19	10.00	2	L	SE	9	GW	2	NO	FD		12		0.3	H	3332	180	B	BL	SE	
07/07/09	AA		53	9	46	143	22	27	240	11	30	10.00	2	L	MO	9	GW	1	NO	FD		1		0.3	SH	2600	310	E	BL	SE	
07/07/09		VS	53	12	67	143	17	15	255	14	43	10.00	2	L	NO		GW	1	NO	FD		2		0.2	SH	3000	320	B	BL	SE	
07/08/09		MK	53	16	41	143	15	31	329	14	22	8.00	2	L	NO		GW	1	NO	FD		11		0.6	SH	1848	310	E	BL	SE	
07/08/09		MK	53	16	41	143	15	31	329	14	22	8.00	2	L	NO		GW	1	NO	FD		10		1.0	SH	1300	290	E	BL	SE	
07/08/09	AA		53	14	23	143	19	23	177	17	40	7.00	2	L	NO		GW	1	NO	FD		11		1.0	H	1500	150	E	BL	SE	
07/09/09		AA	52	8	2	143	43	83	95	16	41	9.00	2	L	NO		GW	1	NO	FE		3		0.5	H	2500	180	E	FL	SE	
07/09/09		AA	52	8	2	143	43	86	110	16	44	9.00	2	L	NO		GW	2	NO	FD		3		0.3	H	3300	180	E	BL	SE	
07/09/09		AA	52	7	90	143	43	67	250	16	48	9.00	2	L	NO		GW	1	NO	FD		11		0.2	H	4100	190	E	BL	SE	
07/09/09		AA	52	7	79	143	43	3	250	16	51	9.00	2	L	NO		GW	1	NO	FD	FE	8		0.5	H	2500	135	E	BL	SE	

07/10/09	MK		52	48	44	143	26	68	0	17	41	99.00	2	L	SE	9	GW	1	NO	FD		12		0.5	H	2461	5	B	BL	SE	
07/10/09	MK		52	54	34	143	23	68	342	18	30	9.00	2	L	SE	10	GW	1	NO	FD	FL	12		0.3	H	3332	340	B	BO	SE	
07/12/09	MK		52	58	80	143	22	70	0	11	53	2.00	2	L	NO		GW	2	NO	FD	FL	10		1.0	SH	1350	320	B	BL	SE	
07/12/09	MK		53	0	9	143	22	77	0	12	09	8.00	2	L	NO		GW	1	NO	FD		10		0.4	SH	2281	313	E	BL	SE	
07/23/09		MK	52	16	89	143	52	73	181	17	04	8.00	2	L	NO		GW	2	NO	FD	BR	12		0.1	H	5400	195	B	BL	SE	
07/23/09		MK	52	13	27	143	52	84	183	17	24	8.00	2	L	NO		GW	3	NO	FD		12		0.2	H	4000	185	B	BL	SE	
07/23/09		MK	52	12	69	143	52	86	191	17	30	8.00	2	L	NO		GW	6	NO	FD		11		0.2	H	4000	155	B	BL	SE	
07/23/09		MK	52	12	25	143	52	43	250	18	05	8.00	2	L	NO		GW	1	NO	FD		2		0.3	H	3300	290	E	BL	SE	
07/25/09	MK		53	1	72	143	19	50	190	11	00	10.00	2	L	LI	10	GW	1	NO	FD		12		0.3	SH	2590	185	E	BL	SE	
08/01/09	VS		53	2	98	143	19	23	300	12	28	6.00	2	L	NO		GW	2	NO	FD		1		0.1	SH	3500	335	B	BL	SE	
08/01/09	VS		53	3	19	143	20	25	122	13	00	6.00	2	L	LI	1\2	GW	1	NO	FD		11		1.0	H	1300	90	E	BL	SE	
08/01/09	VS		53	2	61	143	20	66	157	13	09	6.00	2	L	LI	12	GW	1	NO	FD		2		0.2	H	3000	190	B	BL	SE	
08/01/09	VS		52	58	86	143	22	45	266	13	42	6.00	2	L	LI	9	GW	1	NO	FD		1		0.1	SH	3500	285	B	BL	SE	
08/08/09	MK		53	10	87	143	19	21	175	18	08	10.00	2	L	SE	3	GW	1	NO	FD		1		0.2	SH		215	B	BL	SE	
08/09/09	ON		53	0	26	143	21	48	263	12	23	8.00	2	L	LI	9	GW	2	SA	FD		10	10	0.2	SH		220	B	BL	SE	
08/09/09	ON		52	54	73	143	23	80	180	13	45	8.00	2	L	LI	12\1	GW	3	SA	FD		2	4	0.2	SH		250	B	BL	SE	
08/09/09		ON	52	47	25	143	26	26	237	20	48	8.00	2	L	SE	2	GW	1	NO	FD		3		0.2	SH		330	B	BL	SE	
08/10/09	VS		52	45	67	143	26	28	0	15	30	99.00	2	L	NO		GW	1	NO	FD		9		0.2	SH		270	B	BL	SE	
08/10/09	VS		52	53	21	143	26	53	355	16	30	6.00	2	L	NO		GW	1	NO	FD		1		0.1	SH		290	B	BL	SE	
08/10/09	VS		52	53	39	143	24	50	258	16	42	6.00	2	L	SE	11	GW	1	NO	FD		1		0.4	SH		300	B	BL	SE	
08/11/09	ON		52	53	97	143	24	7	357	06	15	8.00	2	L	NO		GW	1	SP	FD		7	11	0.3	SH		200	B	BL	SE	
08/11/09	ON		52	53	97	143	24	6	2	06	57	8.00	2	L	NO		GW	2	SP	FD		9	10	0.5	SH		270	B	BL	SE	
08/11/09		ON	52	51	40	143	25	89	170	14	00	6.00	2	L	LI	12	GW	1	NO	FD		2		0.3	SH		280	B	BL	SE	
08/11/09	MK		52	45	49	143	25	57	245	15	36	6.00	2	L	NO		GW	4	NO	FD		12		0.1	SH		260	B	BL	SE	
08/11/09	VS	ON	52	44	0	143	21	23	255	16	30	6.00	2	L	NO		GW	1	ST	FD		12	9	E		250	290	E	BO	SE	
08/11/09	VS	MK	52	44	31	143	21	13	127	17	00	6.00	2	L	NO		GW	1	NO	FD		2		0.2	H	4280	195	B	BL	SE	
08/11/09	VS	MK	52	43	86	143	21	54	147	17	12	8.00	2	L	NO		GW	3	NO	FD		2		0.1	H	5740	190	B	BL	SE	
08/11/09	VS	MK	52	43	83	143	21	57	127	17	15	8.00	2	L	NO		GW	3	ST	FD		12	3	1.4	H	1170	120	E	BL	SE	
08/25/09	VS	ON	52	55	0	143	24	99	180	14	50	10.00	2	L	MO	12\1	GW	5	NO	FD		12		0.5	H	2500	180	B	BL	SE	

08/25/09	VS	ON	52	55	0	143	24	99	180	14	50	10.00	2	L	MO	12\1	GW	2	NO	FD		1		1.0	SH		220	E	BL	SE		
08/25/09	ON		53	8	98	143	19	22	220	19	00	10.00	2	L	SE	11	GW	1	SA	FD		1		0.3	SH		240	E	BL	SE		
08/26/09		MK	52	30	45	143	20	3	90	09	21	8.00	2	L	SE	12	GW	1	NO	FD		9		0.4	H	2900	5	B	BL	SE		
08/26/09		MK	52	30	51	143	20	1	45	09	30	8.00	2	L	SE	2	GW	5	NO	FD		11		0.3	H	3400	10	B	BL	SE		
08/31/09	MK		53	8	99	143	25	80	192	12	15	8.00	2	L	SE	11	GW	4	NO	FD		2		0.3	SH		260	B	BL	SE		
08/31/09	MK		53	3	39	143	23	43	290	12	54	8.00	2	L	MO	8\9	GW	1	NO	FD		12		0.1	SH		290	B	BL	SE		
08/31/09	MK		53	3	43	143	21	43	278	13	06	8.00	2	L	MO	8\9	GW	4	NO	FD		10		0.2	SH		205	B	BL	SE		
08/31/09	MK		53	3	43	143	21	43	278	13	06	8.00	2	L	MO	8\9	GW	3	NO	FD		9		0.2	H	4280	185	B	BL	SE		
08/31/09	MK		53	3	42	143	19	42	278	13	20	8.00	2	L	MO	8\9	GW	1	NO	FD		11		0.3	SH		250	E	BL	SE		
08/31/09	MK		53	3	30	143	18	67	169	13	30	8.00	2	L	MO	12	GW	2	NO	FD		1		1.0	SH		195	E	BL	SE		
08/31/09		VS	52	59	24	143	21	22	5	16	00	8.00	2	L	SE	7\8	GW	3	NO	FD		7		0.2	SH		180	B	BL	SE		
08/31/09	ON		53	2	68	143	22	2	3	17	24	8.00	2	L	SE	8\9	GW	3	NO	FD		11		0.3	H	3462	355	B	BL	SE		
08/31/09	ON		53	4	7	143	20	90	295	17	40	8.00	2	L	SE	10	GW	2	NO	FD		12		0.2	SH		295	B	BL	SE		
09/01/09	VS	ON	51	57	1	143	38	53	270	10	52	6.00	2	L	SE	7\8	GW	1	SA	FD		1	2	3.0	H	600	310	E	BL	SE		
09/01/09	VS	MK	52	0	49	143	43	0	88	12	35	6.00	2	L	LI	2\3	GW	2	NO	FD	FL	10		0.3	H	3500	40	B	BL	SE		
09/01/09	VS	MK	52	1	55	143	50	0	358	13	11	6.00	2	L	LI	6	GW	3	NO	FD	FL	12		0.4	H	2960	355	B	BL	SE		
09/01/09	VS	MK	52	4	3	143	50	9	272	13	30	6.00	2	L	LI	9	GW	3	NO	FD	FL	3		1.0	H	1540	340	E	BL	SE	Repeat of ID 3	
09/01/09	VS	MK	52	4	2	143	49	30	250	13	32	6.00	2	L	LI	9	GW	2	NO	FD	FL	12		0.5	H	2540	270	B	BL	SE	Maneuvered away from the transect line to avoid collision	
09/01/09	VS	MK	52	5	84	143	47	72	240	13	38	6.00	2	L	LI	11	GW	1	NO	FD		1		1.2	H	1300	265	E	BL	SE		
09/01/09	ON	VS	52	11	14	143	50	0	0	16	48	8.00	2	L	SE	7\8	GW	3	NO	FD		1		0.1	H	5700	30	B	BL	SE		
09/01/09	MK	VS	52	11	2	143	46	72	264	17	06	6.00	2	L	SE	11	GW	2	NO	FD		3		0.3	H	3500	0	B	BL	SE		
09/01/09	MK	ON	52	14	49	143	47	3	89	19	33	8.00	2	L	SE	6	GW	2	NO	FD		12		0.1	H	5740	75	B	BL	SE		
09/01/09	MK	ON	52	14	50	143	47	34	89	19	34	8.00	2	L	SE	6	GW	2	NO	FD		12		0.3	H	3460	95	B	BL	SE		
09/01/09	MK	VS	52	14	49	143	48	24	89	19	37	8.00	2	L	SE	6	GW	3	NO	FD		12		0.3	H	3460	90	B	BL	SE		
09/02/09	ON	MK	52	45	99	143	25	3	264	12	13	10.00	2	L	SE	8\9	GW	1	NO	FD		2		0.1	SH		325	B	BL	SE		
09/02/09	ON	MK	52	46	50	143	24	53	355	12	22	10.00	2	L	SE	5\6	GW	3	NO	FD		11		0.2	SH		320	B	BL	SE	ID 1	
09/02/09	ON	VS	52	48	47	143	24	67	1	12	32	10.00	2	L	SE	5\6	GW	5	NO	FD		1		0.1	H	5740	20	B	BL	SE		
09/02/09	ON	VS	52	49	51	143	25	27	90	12	44	10.00	2	L	SE	2	GW	7	NO	FD		9		0.2	H	4280	25	B	BL	SE	ID 3	

09/02/09	MK	VS	52	53	9	143	34	19	267	14	55	10.00	2	L	MO	10	GW	1	NO	FD		12		0.2	SH		275	B	BL	SE	
09/02/09	MK	VS	52	53	3	143	33	17	265	15	00	10.00	2	L	MO	10	GW	7	NO	FD	FL	11		0.2	SH		245	B	BL	SE	ID 3,4
09/02/09	MK	VS	52	53	3	143	33	17	265	15	00	10.00	2	L	MO	10	GW	3	NO	FD		11		0.2	SH		255	B	BL	SE	
09/02/09	MK	VS	52	53	1	143	31	15	265	15	05	10.00	2	L	MO	10	GW	4	NO	FD		1		0.3	SH		285	B	BL	SE	
09/02/09	MK	VS	52	53	0	143	29	49	269	15	10	10.00	2	L	MO	10	GW	1	SA	FD		2	4	1.0	SH		315	E	BL	SE	Maneuvered around a number of whales
09/02/09	MK	ON	52	53	17	143	24	59	256	15	41	10.00	2	L	MO	11	GW	2	NO	FD		12		0.1	SH		260	E	BL	SE	
09/02/09	MK	ON	52	54	27	143	22	4	355	16	00	10.00	2	L	MO	8\9	GW	1	NO	FD		12		0.1	H	5470	330	B	BL	SE	
09/02/09	MK	ON	52	56	22	143	22	8	353	16	10	10.00	2	L	SE	8\9	GW	1	NO	FD		10		0.1	SH		300	B	BL	SE	
09/02/09	MK	ON	52	56	48	143	22	45	85	16	21	10.00	2	L	SE	5\6	GW	2	NO	FD		12		0.5	H	2500	85	E	BL	SE	
09/02/09	MK	ON	52	56	50	143	22	45	85	16	23	10.00	2	L	SE	5\6	GW	1	ST	FD		9	10	2.3	H	769	0	E	BL	SE	ID 12
09/02/09	VS	MK	53	0	0	143	22	94	273	19	15	10.00	2	L	SE	12	GW	1	NO	FD		1		0.1	SH		310	B	BL	SE	
09/02/09	VS	MK	53	0	0	143	22	94	273	19	15	10.00	2	L	SE	12	GW	1	NO	FD		11		0.3	SH		240	B	BL	SE	
09/02/09	VS	MK	53	0	0	143	22	31	273	19	17	10.00	2	L	SE	12	GW	1	NO	FD		10		1.3	H	1250	220	E	BL	SE	
09/02/09		MK	53	0	83	143	21	71	0	19	37	10.00	2	L	SE	9	GW	2	NO	FD		11		0.1	SH		335	B	BL	SE	
09/02/09	ON		53	1	99	143	21	57	0	19	44	10.00	2	L	SE	9	GW	3	NO	FD		11		0.2	SH		320	B	BL	SE	
09/03/09		ON	52	47	52	143	26	22	167	08	00	10.00	2	L	NO		GW	1	NO	FD		11		0.4	H	2600	160	B	BL	SE	
09/03/09	MK		52	43	73	143	25	71	27	12	16	10.00	2	L	LI	4	GW	1	SA	FD		12	10	0.4	H	1960	15	B	BL	SE	
09/04/09	ON		53	8	50	143	19	5	175	06	30	5.00	2	L	NO		GW	4	NO	FD		2	2	0.1	SH		210	B	BL	SE	
09/04/09		MK	53	5	29	143	24	9	194	10	05	8.00	2	L	LI	10	GW	4	NO	FD		2		0.1	SH		250	B	BL	SE	
09/04/09		MK	53	4	25	143	22	74	250	10	13	8.00	2	L	NO		GW	1	NO	FD		1		0.2	SH		270	B	BL	SE	
09/04/09		MK	53	4	25	143	22	74	250	10	13	8.00	2	L	NO		GW	6	NO	FD	FL	10		0.4	H	1960	180	E	BL	SE	
09/04/09		VS	53	3	50	143	24	97	184	12	30	8.00	2	L	NO		GW	4	NO	FD		12		0.3	H	3500	195	B	BL	SE	
09/04/09		VS	52	55	38	143	24	56	186	13	23	8.00	2	L	LI	11\12	GW	4	NO	FD	FL	12		0.5	H	2500	180	E	BL	SE	
09/04/09	ON	VS	52	54	57	143	25	6	165	13	30	8.00	2	L	LI	12\1	GW	1	NO	FD		8		1.5	H	1100	55	E	BL	SE	Photo-ID launch
09/04/09	ON	MK	52	54	68	143	25	30	180	14	09	8.00	2	L	MO	12\1	GW	5	NO	FD		12		0.3	H	3400	180	E	BL	SE	
09/04/09	ON	MK	52	54	19	143	25	32	180	14	15	8.00	2	L	NO		GW	1	NO	FD		11		0.5	H	2500	165	B	BL	SE	
09/04/09	ON	MK	52	53	73	143	25	37	170	14	22	8.00	2	L	NO		GW	1	NO	FD		10		1.7	H	1000	110	E	BL	SE	
09/04/09	ON		52	54	12	143	23	15	278	16	11	8.00	2	L	NO		GW	1	NO	FD		12		0.4	SH		270	B	BL	SE	
09/04/09	ON		52	52	70	143	20	82	220	16	45	8.00	2	L	MO	1	GW	2	NO	FD		11		0.5	SH		195	B	BL	SE	

09/04/09		MK	52	52	66	143	20	84	310	17	30	8.00	2	L	MO	10	GW	1	NO	FD		7		0.1	H	5740	180	B	BL	SE	
09/04/09		MK	52	49	7	143	24	78	235	19	14	8.00	2	L	MO	1	GW	3	NO	FD	FL	1		0.2	SH		270	E	BL	SE	
09/11/09		VS	53	8	79	143	19	19	270	08	20	5.00	2	L	NO		GW	1	NO	FD		12		0.1	SH		260	B	BL	SE	
09/12/09	VS		53	6	75	143	20	10	331	06	52	5.00	2	L	NO		GW	2	NO	FD		2		0.6	H	2200	30	B	BL	SE	
09/12/09		ON	53	8	17	143	18	97	84	07	42	10.00	2	L	SE	12\1	GW	1	NO	FD		1		0.3	H	3500	130	E	BL	SE	
09/12/09		ON	53	9	12	143	19	93	0	08	12	10.00	2	L	SE	3	GW	2	NO	FD		9		1.0	SH		270	E	BL	SE	
09/12/09		ON	53	11	41	143	18	75	340	08	30	10.00	2	L	SE	4	GW	1	NO	FD		9		0.3	SH		250	B	BL	SE	
09/12/09		ON	53	12	82	143	16	85	110	09	30	10.00	2	L	SE	12	GW	1	SP	FD		4		E		600	210	E	BL	SE	White head. Vessel drifted
09/12/09		ON	53	12	57	143	16	85	162	09	35	10.00	2	L	SE	11	GW	2	NO	FD		1		0.1	H	6000	180	B	BL	SE	
09/12/09	ON		53	14	0	143	17	66	160	17	19	10.00	2	L	SE	3	GW	1	NO	FD		1		0.8	SH		210	B	BL	SE	
09/12/09	ON		53	9	68	143	17	82	240	17	42	10.00	2	L	SE	1	GW	2	NO	FD		11		0.7	SH		200	B	BL	SE	
09/12/09	ON		53	9	37	143	18	5	88	18	05	10.00	2	L	SE	6	GW	2	NO	FD		4		0.8	SH		190	B	BL	SE	
09/12/09	ON		53	6	1	143	18	95	225	18	30	10.00	2	L	SE	1	GW	1	NO	FD		11		0.2	SH		205	B	BL	SE	
09/12/09	ON		53	5	37	143	17	96	135	18	54	10.00	2	L	SE	5	GW	1	NO	FD		11		1.0	SH		155	E	BL	SE	
09/13/09		MK	52	52	90	143	25	53	350	09	48	99.00	2	L	NO		GW	1	SA	FD		12	9	E		600	350	E	BO	MO	
09/13/09		MK	52	52	54	143	25	81	347	10	11	6.00	2	L	NO		GW	1	NO	FD		12		0.3	H	3466	350	B	BL	SE	
09/13/09		MK	52	53	36	143	25	47	250	10	18	8.00	2	L	NO		GW	2	NO	FD		1		0.9	SH		270	E	BL	SE	
09/13/09	ON	MK	52	53	43	143	25	71	285	10	34	10.00	2	L	NO		GW	3	NO	FD		11		0.5	SH		250	B	BL	SE	
09/14/09		VS	53	11	86	143	18	50	177	07	53	10.00	2	L	SE	9	GW	4	NO	FD		11		0.2	H	4300	140	B	BL	SE	
09/14/09		VS	53	9	41	143	19	2	171	08	08	10.00	2	L	SE	9	GW	1	NO	FD		12		0.6	H	2200	165	E	BL	SE	
09/14/09		VS	53	6	61	143	20	78	191	10	48	8.00	2	L	SE	10	GW	1	NO	FD		2		0.7	SH		250	E	BL	SE	
09/14/09	ON		53	4	75	143	20	31	194	11	00	8.00	2	L	SE	10	GW	1	NO	FD		2		0.1	SH		230	B	BL	SE	
09/14/09	ON		53	2	95	143	19	62	140	11	23	8.00	2	L	SE	12	GW	1	SP	FD		4	2	8.0	SH		200	E	BL	SE	Over flight
09/17/09	ON	MK	52	45	48	143	22	72	0	12	30	8.00	2	L	NO		GW	1	NO	FD		11		0.1	SH		340	B	BL	SE	
09/17/09	ON	VS	52	46	82	143	22	82	0	12	37	8.00	2	L	NO		GW	1	NO	FD		12		0.3	H	3500	345	B	BL	SE	
09/17/09	ON	VS	52	48	95	143	22	92	0	12	51	5.00	2	L	NO		GW	1	NO	FD		11		0.5	SH		320	B	BL	SE	
09/17/09	ON	VS	52	51	37	143	22	94	351	13	06	5.00	2	L	NO		GW	1	NO	FD		11		0.5	SH		325	B	BL	SE	
09/17/09	ON	VS	52	51	84	143	22	85	350	13	10	5.00	2	L	NO		GW	2	NO	FD		12		0.2	H	4200	0	B	BL	SE	
09/17/09	ON	VS	52	52	56	143	22	69	352	13	14	8.00	2	L	NO		GW	1	NO	FD		12		0.2	H	4200	350	B	BL	SE	

09/17/09	ON	VS	52	53	31	143	22	54	352	13	19	8.00	2	L	NO		GW	3	NO	FD		12		0.3	H	3500	345	B	BL	SE	
09/17/09	ON	VS	52	55	56	143	22	11	350	13	33	8.00	2	L	NO		GW	2	NO	FD		2		0.3	H	3500	45	B	BL	SE	
09/17/09	ON	VS	52	58	30	143	21	64	353	13	50	8.00	2	L	NO		GW	3	NO	FD		2		0.5	H	2700	30	B	BL	SE	
09/17/09	MK	VS	53	1	36	143	21	12	353	14	09	8.00	2	L	NO		GW	1	NO	FD		12		0.4	SH		340	B	BL	SE	
09/17/09	MK	VS	53	4	22	143	20	62	354	14	30	8.00	2	L	NO		GW	3	NO	FD		1		0.1	H	5700	10	B	BL	SE	
09/17/09	MK	VS	53	5	77	143	20	38	352	14	38	8.00	2	L	NO		GW	2	NO	FD		12		0.3	H	3400	340	B	BL	SE	
09/17/09	MK	VS	53	8	11	143	19	90	349	14	54	8.00	2	L	NO		GW	2	NO	FD		2		0.6	H	2250	30	E	BL	SE	
09/17/09	MK	VS	53	8	87	143	19	64	349	15	00	8.00	2	L	NO		GW	3	NO	FD		12		0.5	H	2500	355	E	BL	SE	15:07 maneuvered around whales
09/19/09		MK	52	51	64	143	25	4	192	07	53	5.00	2	L	NO		GW	2	NO	FD		1		0.6	SH		205	B	BL	SE	
09/19/09		MK	52	51	64	143	25	4	195	08	00	5.00	2	L	NO		GW	1	NO	FD		3		0.1	SH		275	B	BL	SE	
09/19/09	VS	MK	52	51	65	143	25	10	117	08	30	5.00	2	L	NO		GW	1	NO	FD		3		0.3	H	3500	190	E	BL	SE	Photo-ID launch
09/19/09	VS	MK	52	50	90	143	24	62	300	09	00	5.00	2	L	NO		GW	1	NO	FD		10		0.1	SH		235	B	BL	SE	
09/19/09	VS	MK	52	51	4	143	24	34	291	09	03	6.00	2	L	NO		GW	1	NO	FD		10		0.6	SH		250	E	BL	SE	
09/19/09	VS	MK	52	51	14	143	24	16	270	09	08	6.00	2	L	NO		GW	1	NO	FD		12		0.5	SH		295	E	BL	SE	
09/19/09	MK		52	35	16	143	22	76	155	15	43	8.00	2	L	LI	2\3	GW	1	NO	FD	FL	1		2.0	H	870	170	E	FL	SE	
09/19/09	MK		52	32	93	143	20	83	195	16	55	8.00	2	L	NO		GW	2	NO	FD	FL	11		0.3	H	3500	180	B	BL	SE	
09/19/09	MK		52	32	93	143	20	83	195	16	55	8.00	2	L	NO		GW	1	NO	FD	FL	11		0.2	H	4300	180	B	BL	SE	
09/19/09	MK		52	32	93	143	20	83	195	16	55	8.00	2	L	NO		GW	2	NO	FD		11		0.4	H	3000	180	B	BL	SE	
09/19/09	MK		52	31	71	143	20	32	195	17	10	8.00	2	L	NO		GW	1	NO	FD		12		0.3	H	3500	195	B	BL	SE	
09/19/09	MK	VS	52	30	2	143	20	2	210	18	10	8.00	2	L	LI	2	GW	1	NO	FD		11		0.3	H	3500	200	B	BL	SE	
09/20/09		VS	52	45	80	143	36	59	133	19	16	10.00	2	L	SE	5	GW	2	NO	FD		10		1.0	H	1500	80	E	BL	SE	
09/22/09		MK	51	59	70	143	50	98	36	10	21	10.00	2	L	NO		GW	1	NO	FD		12		0.2	H	4300	30	B	BL	SE	
09/22/09		MK	51	59	70	143	50	98	36	10	21	10.00	2	L	NO		GW	2	NO	FD		12		0.1	H	5750	25	B	BL	SE	
09/22/09		MK	52	3	40	143	56	30	358	10	51	10.00	2	L	NO		GW	5	NO	FD		11		0.2	H	4300	320	B	BL	SE	
09/22/09		MK	52	3	90	143	56	30	359	10	54	10.00	2	L	NO		GW	2	NO	FD		12		0.1	H	5750	345	B	BL	SE	
09/23/09		ON	53	12	75	143	17	63	164	12	14	10.00	2	L	SE	9	GW	1	NO	FD		10		0.2	SH		200	B	BL	SE	
07/07/09	MK		53	8	75	143	19	11	300	19	16	10.00	3	L	SE	11	GW	2	NO	FD		12		0.3	SH	2588	295	B	BL	SE	
07/08/09	VS		53	11	38	143	18	63	340	13	30	10.00	3	L	NO		GW	1	NO	FD		12		0.2	SH	3000	340	B	BL	SE	
07/08/09		MK	53	19	86	143	16	45	49	16	00	7.00	3	L	NO		GW	1	NO	FL		9		0.5	SH	2041	300	E	FL	SE	

07/08/09	AA		53	9	20	143	18	98	204	18	11	9.00	3	L	NO		GW	1	NO	FD		2		0.4	SH	2300	250	E	BL	SE	
07/12/09		AA	52	54	53	143	24	37	165	14	55	8.00	3	L	NO		GW	2	NO	FD	FE	11		0.4	H	2800	120	E	BL	SE	
07/12/09		AA	52	50	6	143	23	70	310	16	00	8.00	3	L	NO		GW	2	NO	FD	FE	12		0.2	SH	3000	320	B	BL	SE	
07/12/09		AA	52	51	77	143	21	88	311	16	22	8.00	3	L	NO		GW	1	NO	FD	BR	11		0.8	SH	1550	270	E	BL	SE	
07/12/09	VS		52	53	85	143	20	86	86	17	20	8.00	3	L	NO		GW	1	NO	FD	FE	9		0.3	SH	2500	330	B	BL	SE	
07/12/09	VS		52	52	73	143	21	20	65	18	00	6.00	3	L	NO		GW	2	NO	FD	FE	4		0.5	SH	2000	195	B	BL	SE	
07/18/09		MK	52	21	41	143	23	74	230	20	13	99.00	3	L	NO		GW	1	ST	FD		2	10	E		500	265	E	BL	SE	
07/25/09	MK		53	12	73	143	23	85	119	18	23	8.00	3	L	NO		GW	1	NO	FD		3		0.4	H	2800	205	E	BL	SE	
07/25/09		VS	52	57	26	143	23	44	230	20	00	8.00	3	L	NO		GW	1	NO	FD		10		0.1	SH	3500	200	B	BL	SE	
08/01/09	VS		53	8	94	143	18	67	226	18	30	8.00	3	L	SE	2	GW	3	NO	FD		6		0.3	H	2500	45	E	BL	SE	
08/01/09	VS		53	8	82	143	18	61	150	18	34	8.00	3	L	SE	3	GW	1	NO	FD		3		0.2	SH	3000	210	B	BL	SE	
08/09/09	VS		52	49	54	143	25	4	68	18	30	8.00	3	L	SE	7	GW	1	NO	FD		3		0.2	H	2000	150	E	BL	SE	
08/10/09		ON	52	53	1	143	23	72	98	17	30	6.00	3	L	SE	5	GW	2	ST	FD		1		1.3	H	1200	290	E	BL	SE	
08/19/09	MK		53	18	90	143	17	98	330	13	04	2.00	3	L	NO		GW	1	NO	FD	FL	11		1.2	SH		290	E	BL	SE	
08/19/09	MK		53	22	6	143	15	18	280	13	55	3.00	3	L	NO		GW	1	NO	FD	FL	12		0.7	SH		285	E	BL	SE	
08/25/09	ON		52	58	55	143	23	27	352	17	52	10.00	3	L	SE	10	GW	1	NO	FD		11		0.5	SH		330	E	BL	SE	
08/25/09	ON		53	3	79	143	22	19	352	18	30	10.00	3	L	SE	9\10	GW	3	NO	FD		11		0.5	SH		330	E	BL	SE	
08/25/09	ON		53	4	61	143	21	83	340	18	34	10.00	3	L	SE	10	GW	2	NO	FD		11		0.3	SH		330	E	BL	SE	
08/27/09	MK		53	9	64	143	19	78	350	06	53	3.00	3	L	NO		GW	1	NO	FD		7		1.2	SH		220	E	BL	SE	
08/27/09	MK		53	9	56	143	19	11	210	07	00	3.00	3	L	NO		GW	2	NO	FD		12		0.5	H	2460	200	E	BL	SE	
08/27/09		ON	53	26	11	143	11	50	178	19	50	5.00	3	L	NO		GW	1	SA	FD		11	11	2.5	H	714	150	E	BL	SE	
08/31/09	ON		53	0	50	143	21	56	7	17	10	8.00	3	L	SE	8	GW	3	NO	FD		10		0.3	SH		315	B	BL	SE	
09/03/09		MK	53	8	40	143	19	5	53	20	00	4.00	3	L	LI	8	GW	5	NO	FD		5		0.2	SH		200	B	BL	SE	
09/03/09		MK	53	8	40	143	19	5	53	20	00	4.00	3	L	LI	8	GW	1	NO	FD		5		0.1	SH		195	B	BL	SE	
09/11/09	ON		53	0	69	143	25	20	186	12	42	8.00	3	L	SE	11	GW	1	SP	FD		11		0.8	H	1900	135	B	BL	SE	
09/11/09	ON		52	55	20	143	24	64	186	13	10	8.00	3	L	SE	11\12	GW	2	SP	FD		11		0.9	H	1700	130	B	BL	SE	
09/13/09		VS	53	3	27	143	20	47	280	13	20	10.00	3	L	MO	9	GW	2	NO	FD		12		0.5	SH		275	E	BL	SE	
09/14/09	ON		53	4	26	143	22	46	0	12	00	8.00	3	L	NO		GW	1	NO	FD		12		0.1	H	5500	5	E	BL	SE	
09/14/09	ON		53	6	41	143	23	58	33	12	15	8.00	3	L	NO		GW	2	NO	FD		10		0.8	SH		350	B	BL	SE	

09/15/09	VS	MK	52	7	49	143	48	40	96	15	58	8.00	3	L	SE	4\5	GW	1	NO	FD		11		0.3	H	3466	75	B	BL	SE	
09/19/09		MK	52	52	70	143	21	9	0	10	15	8.00	3	L	NO		GW	1	NO	FD		12		0.4	H	3000	350	B	BL	SE	
09/19/09		MK	52	53	10	143	21	14	0	10	20	6.00	3	L	NO		GW	1	NO	FD		11		0.3	H	3500	345	B	BL	SE	
09/19/09		MK	52	53	10	143	21	14	0	10	20	6.00	3	L	NO		GW	1	NO	FD		12		0.4	H	3000	0	B	BL	SE	
09/19/09		MK	52	54	59	143	21	13	355	10	37	6.00	3	L	NO		GW	1	NO	FD		12		0.8	H	1825	350	B	BL	SE	
09/19/09		MK	52	55	4	143	20	75	320	10	43	8.00	3	L	NO		GW	1	NO	FD		1		0.4	SH		335	E	BL	SE	
09/19/09	VS		52	53	48	143	25	45	159	12	21	8.00	3	L	NO		GW	2	NO	FD		12		0.5	H	2500	150	E	BL	SE	
09/21/09	MK		52	7	51	143	48	53	252	11	18	10.00	3	L	SE	8\9	GW	5	NO	FD		7		0.1	H	5750	120	B	BL	SE	
09/21/09	MK		52	7	44	143	48	48	260	11	22	10.00	3	L	SE	8	GW	4	NO	FD		7		0.1	H	5750	115	B	BL	SE	
09/21/09	MK		52	7	32	143	48	49	190	11	30	10.00	3	L	SE	11	GW	2	NO	FD		10		0.1	H	5750	130	B	BL	SE	
09/21/09	MK		52	7	22	143	48	50	120	11	37	10.00	3	L	SE	1	GW	1	SA	FD		12	8	0.6	H	2244	110	E	BL	SE	
09/22/09	VS		52	8	25	143	56	31	359	11	18	10.00	3	L	NO		GW	3	NO	FD		11		0.1	H	5750	340	B	BL	SE	
09/22/09	VS		52	10	23	143	56	35	358	11	30	10.00	3	L	NO		GW	2	NO	FD		2		0.4	H	3000	50	B	BL	SE	
09/22/09	MK		53	7	70	143	29	76	341	17	19	8.00	3	L	NO		GW	1	NO	FD		9		0.2	H	4300	235	B	BL	SE	
09/23/09	MK		53	4	2	143	25	24	214	15	49	10.00	3	L	SE	12	GW	3	NO	FD		2		0.3	SH		260	E	BL	SE	
09/23/09	MK		53	0	31	143	21	61	210	16	15	10.00	3	L	SE	1	GW	1	ST	FD		2	11	1.3	SH		255	E	BL	SE	
09/23/09	MK		52	59	38	143	21	48	160	16	34	10.00	3	L	SE	2\3	GW	3	NO	FD		3		0.5	SH		250	E	BL	SE	
09/23/09	MK		52	59	38	143	21	48	160	16	34	10.00	3	L	SE	2\3	GW	1	NO	FD		1		0.1	H	5750	180	B	BL	SE	
09/23/09		VS	52	55	5	143	23	51	186	17	00	10.00	3	L	SE	2	GW	1	NO	FD		12		0.2	SH		190	B	BL	SE	
09/23/09		VS	52	53	95	143	23	85	91	17	18	10.00	3	L	SE	5	GW	2	NO	FD		11		0.2	H	4300	50	B	BL	SE	
09/23/09		VS	52	54	11	143	25	63	87	17	25	10.00	3	L	SE	5	GW	1	NO	FD		2		E		1000	155	E	BL	SE	
09/27/09		ON	53	9	58	143	20	11	225	08	30	8.00	3	L	NO		GW	1	NO	FD		10		0.6	H	2244	180	B	BL	SE	
09/27/09		ON	53	8	3	143	19	93	150	09	00	8.00	3	L	NO		GW	1	NO	FD		2		1.0	SH		200	E	BL	SE	
09/27/09		ON	53	8	3	143	19	93	150	09	00	8.00	3	L	NO		GW	1	NO	FD		11		0.8	H	1825	140	B	BL	SE	
09/03/09	ON		53	8	74	143	19	22	220	19	30	8.00	4	L	SE	2	GW	1	NO	FD		1		0.3	SH		235	B	BL	SE	
09/11/09	ON		52	53	85	143	25	9	164	13	18	8.00	4	L	SE	12	GW	1	NO	FD		3		0.5	SH		250	B	BL	SE	
09/11/09	ON		52	51	69	143	25	95	164	13	30	8.00	4	L	SE	1	GW	1	NO	FD		10		0.5	H	2500	105	E	BL	SE	
09/11/09	VS		52	46	76	143	26	87	0	17	48	10.00	4	L	SE	8	GW	2	NO	FD		12		0.4	H	3000	350	E	BL	SE	
09/11/09	VS		52	47	98	143	28	12	1	18	00	10.00	4	L	SE	8\9	GW	2	NO	FD		10		0.6	SH		310	B	BL	SE	

09/11/09	VS		52	49	78	143	27	54	350	18	12	10.00	4	L	SE	9	GW	1	NO	FD		10		0.5	SH		290	B	BL	SE	
09/11/09	VS		52	52	3	143	26	92	0	18	30	10.00	4	L	MO	9	GW	1	NO	FD		10		2.0	SH		230	E	BL	SE	
09/11/09	VS		52	53	21	143	26	42	349	18	37	10.00	4	L	MO	9	GW	3	NO	FD		12		0.3	SH		330	B	BL	SE	
09/11/09	VS		52	54	22	143	26	22	358	18	44	10.00	4	L	SE	9	GW	2	NO	FD		12		0.5	H	2500	350	B	BL	SE	
09/11/09	VS		52	55	45	143	25	51	347	18	54	10.00	4	L	MO	9\10	GW	1	NO	FD		2		0.5	H	2500	40	B	BL	SE	
09/11/09		ON	53	4	94	143	21	30	340	20	00	8.00	4	L	NO		GW	1	NO	FD		12		0.5	H	2500	340	B	BL	SE	
09/13/09	ON		53	3	6	143	21	70	45	14	07	7.00	4	L	NO		GW	1	NO	FD		2		0.8	H	1900	90	E	BL	SE	
07/05/09	AA		52	24	60	143	33	13	330	17	10	9.00	0	L	LI	9	HP	1	SA	FD		10	9	E		200	270	E	FI	MO	
07/05/09	AA		52	27	90	143	30	93	333	17	27	9.00	0	L	NO		HP	1	SA	FD		11		E		500	290	E	FI	SE	
07/21/09	AA	MK	51	56	99	143	32	64	267	15	07	10.00	0	L	NO		HP	3	SP	FD		3	6	1.3	H	1230	355	B	BO	SE	
07/21/09	AA	VS	51	53	49	143	47	13	91	16	39	10.00	0	L	NO		HP	3	SA	FD		11		6.0	H	320	70	E	FI	SE	
07/21/09	MK	VS	51	50	3	143	39	72	264	17	46	8.00	0	L	NO		HP	2	SA	FD		11	7	1.4	H	1158	230	B	FI	SE	
08/04/09		VS	46	34	87	144	2	90	197	09	25	99.00	0	L	NO		HP	4	SA	FD		12		3.0	H	600	190	E	BO	SE	
08/04/09	MK		46	13	81	143	52	0	200	11	25	10.00	0	L	NO		HP	2	SA	FD		1	4	1.5	H	1000	230	B	FI	SE	
08/06/09		VS	46	47	37	144	7	89	22	08	49	5.00	0	L	NO		HP	2	SP	FD		11	6	E		350	350	E	BO	SE	
08/06/09		VS	46	47	37	144	7	89	22	08	49	5.00	0	L	NO		HP	3	SP	FD		2	5	E		300	80	E	BO	SE	
08/06/09		VS	46	53	13	144	11	2	21	09	22	6.00	0	L	NO		HP	2	SP	FD		2	6	3.0	H	600	85	E	BO	SE	
08/07/09		ON	51	0	0	144	30	2	326	09	16	10.00	0	L	NO		HP	7	SP	FD		10	7	E		600	270	E	BO	SE	
08/07/09		ON	51	1	65	144	30	3	12	09	21	10.00	0	L	NO		HP	2	SP	FD		1	5	E		200	40	E	BO	SE	
08/07/09		ON	51	3	57	144	30	5	9	09	30	10.00	0	L	NO		HP	2	SP	FD		1	5	E		500	30	E	BO	SE	
08/07/09		ON	51	4	8	144	30	79	10	09	35	10.00	0	L	NO		HP	3	SP	FD		1	5	E		200	30	E	BO	SE	
08/07/09		ON	51	4	58	144	30	93	9	09	38	10.00	0	L	NO		HP	3	SP	FD		1	5	E		200	30	E	BO	SE	
09/18/09	MK		52	59	77	143	22	5	163	11	11	3.00	0	L	NO		HP	5	MI	FD		1		E		400	190	B	BO	SE	
09/20/09	MK	VS	52	53	79	143	22	95	190	15	30	10.00	0	L	LI	1	HP	2	SA	SW		1	8	E		300	220	E	BO	SE	
07/05/09		MK	52	20	69	143	42	86	275	15	22	10.00	1	L	NO		HP	1	ST	FD		1	9	3.4	H	540	290	B	BO	MO	
07/06/09		VS	53	2	71	143	20	61	173	09	30	0.50	1	L	NO		HP	2	ST	FD		11	4	E		70	160	E	BO	SE	
07/19/09	AA		52	10	38	143	28	72	186	13	51	10.00	1	L	NO		HP	3	SA	FD		1		4.0	H	460	225	E	FI	SE	
07/21/09	AA	VS	52	14	50	143	40	74	87	07	05	6.00	1	L	NO		HP	1	SA	FD		10		E		250	50	E	BO	SE	
07/21/09	VS	MK	52	0	51	143	41	89	94	13	20	10.00	1	L	LI	3	HP	2	ST	FD		11	2	2.6	H	680	65	B	BO	SE	

07/21/09	AA	MK	51	57	0	143	38	84	265	14	48	10.00	1	L	NO		HP	1	SA	FD		11	7	2.3	H	760	220	B	BO	SE	
08/04/09		VS	46	48	30	144	9	86	197	08	06	3.00	1	L	NO		HP	3	SP	FD		10		10.0		400	150	B	BO	SE	
08/07/09		ON	50	51	93	144	36	85	340	08	15	10.00	1	L	SE	3\4	HP	3	SA	FD		3	9	3.5	H	520	340	B	BO	SE	
09/14/09	VS		53	10	98	143	22	64	237	18	00	10.00	1	L	SE	1	HP	2	SA	FD		12	3	E		400	240	E	BO	SE	
09/18/09		ON	53	11	62	143	19	0	170	08	10	8.00	1	L	NO		HP	1	SP	FD		10	10	0.1	H	1350	150	E	FI	SE	
07/22/09	AA	VS	52	28	51	143	45	93	95	16	30	10.00	2	L	NO		HP	1	SP	FD		3	4	E		150	170	E	FI	MO	
09/13/09	ON		53	12	63	143	16	2	171	15	30	8.00	4	L	NO		HP	2	NO	SP		1		5.0	H	380	190	E	BO	SE	
07/04/09		AA	48	51	45	144	52	70	345	13	43	0.20	0	L	NO		KW	2	SP	FD		11	9	E		50	300	E	FI	SE	Male and female
07/04/09		MK	52	12	23	143	48	26	127	10	30	10.00	0	L	NO		KW	4	ST	FD		11	2	0.5	H	2500	95	B	FI	SE	
07/05/09	MK		51	39	28	143	41	78	346	07	10	9.00	1	L	NO		KW	3	ST	FD		11	3	2.1	H	823	320	E	FI	MO	Females
07/21/09	VS	AA	52	1	32	143	29	72	179	12	24	10.00	1	L	NO		KW	2	NO	FD	BR	11		0.5	H	2500	140	E	BL	SE	Male and female
07/21/09	VS	MK	52	0	51	143	31	36	93	12	43	10.00	1	L	NO		KW	1	SA	FD		11	9	2.0	H	860	55	E	FI	SE	
07/17/09	VS	AA	52	49	50	143	40	70	92	12	38	10.00	2	L	NO		KW	3	ST	FD		12		1.7	H	1000	100	E	FI	MO	
07/22/09	MK	AA	52	21	49	143	51	13	110	12	47	10.00	2	L	LI	3	KW	10	ST	FD	BR	11	1	1.5	H	1000	80	E	FI	MO	Maneuvered off course to let pass
09/17/09	MK	VS	53	6	33	143	20	28	354	14	42	8.00	2	L	NO		KW	1	SA	FD		2	5	0.3	H	3500	35	B	FI	SE	Male
08/22/09		MK	54	6	94	142	24	23	330	20	30	3.00	3	L	NO		KW	2	SA	FD		12	9	4.0	H	460	330	E	FI	SE	Male and female. Swimming very slowly
09/15/09	ON	MK	51	53	50	143	40	20	90	08	53	8.00	3	L	SE	12\1	KW	1	ST	FD		2	11	1.3	H	1250	135	E	FI	SE	
08/03/09	VS		50	8	60	144	39	64	171	12	48	8.00	4	L	NO		KW	2	ST	FD		2		E		200	220	E	FI	VI	
07/05/09	AA		52	31	59	143	28	45	334	17	47	9.00	0	L	NO		MW	1	SA	FD		1		E		600	5	E	FI	SE	
07/05/09	AA		52	34	1	143	26	85	335	18	00	9.00	0	L	NO		MW	1	SP	FD		11	10	E		450	305	E	FI	SE	
07/16/09	MK		53	6	49	143	25	31	118	18	30	99.00	0	L	NO		MW	1	SA	FD		9	8	E		300	45	E	BO	MO	
07/24/09		MK	52	14	9	143	44	37	38	10	06	8.00	0	L	NO		MW	1	SA	FD		12	9	2.0	H	860	30	E	BO	VI	Emerged considerably above water line
09/20/09	MK	VS	52	53	77	143	23	39	345	14	39	10.00	0	L	NO		MW	1	ST	FD		7	5	1.0	SH		225	B	BO	MO	
07/05/09	MK		51	38	20	143	42	16	345	07	03	9.00	1	L	NO		MW	1	SA	FD		12	3	2.3	H	761	340	E	FI	SE	
07/05/09	MK		51	39	68	143	41	64	347	07	12	9.00	1	L	NO		MW	1	SA	FD		10	8	3.5	H	520	315	B	BO	MO	
07/11/09	AA	VS	52	46	0	143	30	45	90	17	23	99.00	1	L	NO		MW	1	ST	FD		12		E		100	87	E	FI	SE	
07/13/09		MK	52	51	15	143	24	24	205	09	08	99.00	1	L	LI	9	MW	1	ST	FD		1	11	0.8	SH	1555	245	E	BO	MO	
07/13/09	AA		52	59	18	143	32	26	317	11	00	10.00	1	L	NO		MW	1	SA	FD		11		E		150	290	E	FI	SE	
07/13/09	AA		53	0	74	143	30	18	318	11	12	10.00	1	L	NO		MW	1	NO	FD		12		1.5	SH	1000	318	E	FI	MO	

07/17/09	MK		52	49	95	143	24	27	105	06	13	10.00	1	L	NO		MW	1	ST	FD		6	5	E		200	300	E	BO	SE	
07/17/09	AA		52	49	98	143	24	28	158	08	06	10.00	1	L	NO		MW	1	SP	FD		8	9	5.0	H	375	20	E	FI	VI	
07/17/09		MK	52	49	17	143	23	95	34	11	41	8.00	1	L	NO		MW	1	ST	FD		12	3	E		100	90	E	BO	SE	
07/21/09	MK	AA	52	7	41	143	50	42	130	10	39	10.00	1	L	NO		MW	1	ST	FD		10		6.0	H	320	90	E	FI	SE	
08/04/09		VS	46	2	13	143	16	36	321	14	17	8.00	1	L	NO		MW	1	SP	FD		2	6	E		300	20	E	BO	SE	
08/04/09	MK		46	26	96	142	48	98	320	17	08	8.00	1	L	NO		MW	2	SP	FD		3	6	E		200	40	E	BO	SE	
08/08/09		VS	53	20	6	143	19	34	180	12	30	10.00	1	L	LI	11	MW	1	SA	FD		1		1.5	SH		200	B	BO	SE	
08/08/09		VS	53	16	53	143	18	52	180	12	53	10.00	1	L	LI	11	MW	1	SA	FD		1	3	E		50	185	E	BO	SE	
08/09/09		VS	53	17	12	143	18	14	262	08	08	10.00	1	L	SE	5	MW	1	SA	FD		1	4	E		400	300	E	BO	SE	
08/09/09	ON	MK	52	54	10	143	21	85	165	16	35	8.00	1	L	LI	3	MW	1	SP	FD		3	6	5.0	SH		230	E	FI	MO	
08/10/09		ON	52	45	39	143	25	98	260	09	50	8.00	1	L	SE	8	MW	1	SA	FD		2	10	2.0	SH		260	B	FI	MO	
08/10/09		ON	52	44	29	143	24	2	229	10	10	8.00	1	L	SE	8\9	MW	1	SP	FD		4	1	E		1100	290	E	FI	MO	
08/10/09		MK	52	40	86	143	22	66	230	12	45	8.00	1	L	LI	10	MW	1	ST	FD		11	1	2.7	SH		195	E	BO	SE	
08/10/09		MK	52	41	21	143	22	47	92	13	30	8.00	1	L	LI	3	MW	1	NO	FD		12		3.4	H	540	90	E	BO	SE	Flabbily dove at the same place
08/10/09		MK	52	42	29	143	23	54	350	13	53	5.00	1	L	LI	6	MW	1	SP	FD		9	6	4.3	SH		265	E	BO	MO	
08/11/09	VS		52	35	86	143	26	99	172	20	00	5.00	1	L			MW	1	SA	FD		11	7	E		200	150	E	BO	SE	
08/12/09	MK		52	21	57	143	30	67	10	07	30	8.00	1	L	NO		MW	1	SP	FD		9	12	4.0	H	460	280	E	BO	SE	
08/24/09	ON		54	4	57	143	4	92	167	11	48	10.00	1	L	LI	11	MW	1	ST	FD		2	7	E		100	220	E	BO	MO	
08/25/09		ON	53	9	54	143	30	3	38	09	50	9.00	1	L	SE	1	MW	1	SP	FD		11	6	4.0	H	446	0	B	FL	MO	
08/28/09		ON	53	26	1	143	11	55	300	08	04	3.00	1	L	NO		MW	1	SA	FD		11	10	E		400	280	E	BO	MO	
08/28/09		ON	53	21	2	143	20	3	127	10	05	4.00	1	L	NO		MW	2	ST	FD		4	2	2.5	SH		240	B	BO	MO	
08/28/09	MK		53	16	18	143	30	21	145	11	09	8.00	1	L	NO		MW	1	SP	FD		9	6	E		300	60	E	BO	SE	
08/28/09	MK		53	3	31	143	38	60	271	13	50	2.00	1	L	NO		MW	1	SA	FD		2	4	E		50	325	E	BO	MO	
09/20/09	MK	ON	52	47	79	143	22	43	40	11	13	10.00	1	L	SE	2	MW	1	MI	FD		6		E		600	220	E	BO	SE	
07/22/09	AA	MK	52	31	96	143	50	26	262	17	18	10.00	2	L	LI	12	MW	1	SP	FD		10	6	2.2	H	790	195	E	FI	SE	
08/09/09		VS	53	12	17	143	24	32	160	10	22	8.00	2	L	NO		MW	1	SP	FD		4	6	E		600	280	E	BO	SE	
08/11/09		ON	52	46	1	143	26	63	170	15	24	6.00	2	L	NO		MW	1	SA	FD		3	4	4.0	SH		230	B	BO	SE	
08/11/09	MK		52	45	57	143	25	80	245	15	34	6.00	2	L	NO		MW	1	ST	FD		12	3	0.6	SH		235	B	BO	MO	
08/11/09	MK		52	45	20	143	24	95	245	15	41	6.00	2	L	NO		MW	1	ST	FD		11	4	E		150	220	E	BO	MO	

08/24/09		VS	54	14	31	142	57	5	150	10	45	10.00	2	L	SE	11	MW	1	SA	FD		12	11	1.0	H	1500	150	B	FI	SE	
08/26/09	ON		52	29	16	143	22	32	70	15	00	8.00	2	L	NO		MW	1	SA	FD		1	3	E		100	100	E	BO	MO	
08/26/09	ON		52	29	64	143	24	65	65	15	13	8.00	2	L	NO		MW	1	MI	FD		1	9	E		400	160	E	BO	MO	
08/28/09		ON	53	20	51	143	21	57	127	10	10	4.00	2	L	NO		MW	1	SA	FI		4	3	4.5	H	417	190	B	BO	MO	
08/28/09		ON	53	18	44	143	26	8	124	10	30	8.00	2	L	NO		MW	1	ST	FI		2	1	3.6	H	513	145	E	BO	MO	
09/02/09	ON	MK	52	46	1	143	29	22	261	12	00	10.00	2	L	SE	8\9	MW	1	SA	FD		12	2	1	SH		275	B	BO	SE	
09/02/09	MK	ON	52	53	53	143	23	96	256	15	43	10.00	2	L	MO	11	MW	1	MI	FD		11		1.8	SH		230	B	FI	SE	
09/02/09	MK	ON	52	55	13	143	22	26	354	16	06	10.00	2	L	SE	8\9	MW	1	MI	FD		11		12.0	H	163	300	B	FI	SE	
09/02/09	MK	ON	52	56	53	143	28	55	88	16	42	10.00	2	L	SE	5\6	MW	1	SP	FD		9		4.0	H	466	0	E	BL	SE	
09/03/09		ON	52	46	17	143	26	37	274	08	50	10.00	2	L	SE	6\7	MW	1	PE	FD		12		13.0	H	300	268	E	FI	SE	
09/12/09		ON	53	10	32	143	19	46	340	08	22	10.00	2	L	SE	4	MW	1	SP	FD		2		1.5	H	1100	35	E	BO	SE	
07/08/09		MK	53	21	47	143	15	19	330	16	10	7.00	3	L	NO		MW	1	SA	FD		12		E		200	340	E	FI	MO	
09/19/09		MK	52	55	44	143	20	22	316	10	49	8.00	3	L	NO		MW	1	MI	FD		12	12	E		50	315	E	BO	VI	
07/04/09		MK	48	0	22	144	43	97	21	09	08	0.70	0	L	NO		NF	1	SA	SW		2	4	E		400	70	E	BO	MO	
07/04/09		MK	48	0	54	144	44	17	21	09	09	0.70	0	L	NO		NF	1	NO	RE		12		E		350	10	E	FP	SE	
07/04/09		MK	48	2	18	144	45	14	20	09	18	0.70	0	L	NO		NF	1	NO	RE		2		E		150	65	E	FP	SE	
07/04/09		MK	48	3	3	144	45	63	21	09	24	99.00	0	L	NO		NF	2	NO	RE		1		E		300	45	E	FP	SE	
07/04/09		MK	48	4	16	144	46	28	20	09	30	1.00	0	L	NO		NF	1	SA	SW		10	8	E		250	340	E	BO	SE	
07/04/09		MK	48	9	23	144	49	13	20	09	57	0.20	0	L	NO		NF	1	NO	RE		1		E		100	55	E	FP	SE	
07/04/09		MK	48	17	0	144	53	45	24	10	41	0.10	0	L	NO		NF	1	ST	BR		12	6	E		50	10	E	BO	VI	
07/04/09	AA		48	21	49	144	56	17	20	11	06	0.20	0	L	NO		NF	2	NO	RE	LO	11	9	E		150	350	E	BO	SE	Male and female
07/04/09	AA		48	24	21	144	57	71	20	11	21	0.20	0	L	NO		NF	2	NO	RE		3	4	E		250	100	E	HE	SE	
07/04/09	AA		48	25	74	144	58	61	20	11	30	0.20	0	L	NO		NF	2	NO	RE	LO	1	2	E		100	60	E	BO	SE	
07/04/09		VS	48	28	25	145	0	4	23	11	44	0.20	0	L	NO		NF	2	SP	SW		11	10	E		50	340	E	BO	SE	
07/04/09		VS	48	29	27	145	0	57	23	11	49	0.30	0	L	NO		NF	1	NO	RE		11		E		200	330	E	BO	SE	
07/04/09		AA	48	31	45	145	0	69	346	12	00	0.50	0	L	NO		NF	3	NO	RE	LO	12	9	E		500	346	E	BO	SE	
07/04/09		AA	48	32	16	145	0	43	346	12	03	0.50	0	L	NO		NF	1	NO	RE	LO	11	10	E		700	325	E	BO	SE	
07/04/09		AA	48	32	83	145	0	18	346	12	07	0.50	0	L	NO		NF	1	NO	RE		11	10	E		600	315	E	HE	SE	
07/04/09		AA	48	33	60	144	59	86	346	12	10	0.50	0	L	NO		NF	2	NO	RE		11	10	E		500	315	E	BO	SE	

07/04/09		AA	48	36	49	144	58	73	345	12	24	0.20	0	L	NO		NF	2	NO	RE	LO	12	2	E		150	355	E	BO	SE	
07/04/09		AA	48	40	66	144	57	8	345	12	46	0.20	0	L	NO		NF	1	NO	LO		12	1	E		150	345	E	HE	SE	
07/04/09		AA	48	41	79	144	56	64	344	12	51	0.20	0	L	NO		NF	2	NO	LO		2	3	E		100	30	E	BO	SE	
07/04/09		AA	48	44	62	144	55	45	344	13	06	0.20	0	L	NO		NF	1	SA	SW		12	3	E		100	340	E	BO	MO	
07/04/09		AA	48	53	43	144	52	1	345	13	53	0.20	0	L	NO		NF	1	NO	LO	RE	11	10	E		150	305	E	BO	SE	
07/04/09	VS		48	56	34	144	50	77	342	14	08	0.20	0	L	NO		NF	1	NO	LO	SI	10	88	E		150	300	E	HE	SE	
08/04/09	MK		47	4	41	144	18	19	200	06	30	99.00	0	L	NO		NF	1	NO	RE		8		E		100	115	E	FP	SE	
08/04/09		VS	46	29	60	144	0	18	197	09	55	99.00	0	L	NO		NF	2	NO	RE		2		E		70	260	E	BO	SE	
08/06/09		VS	46	54	18	144	11	56	20	09	28	6.00	0	L	NO		NF	1	NO	RE		12		6.0	H	300	20	E	BO	SE	Maneuvered 0° aport
08/07/09		ON	50	59	69	144	31	49	326	09	03	10.00	0	L	NO		NF	1	SP	BR		1	5	E		400	350	E	BO	SE	
08/07/09	ON		52	2	11	143	36	53	357	17	58	10.00	0	L	NO		NF	1	SA	SW		11	1	E		150	40	E	BO	VI	
07/04/09		MK	47	53	34	144	38	63	20	08	28	0.30	1	L	NO		NF	1	NO	RE		11		E		200	350	E	FP	SE	
07/04/09		MK	47	57	12	144	41	71	36	08	50	0.70	1	L	NO		NF	1	ST	SW		11	4	E		300	15	E	HE	SE	
07/04/09		MK	47	58	69	144	43	8	21	09	00	0.10	1	L	NO		NF	1	NO	RE		12		E		70	10	E	BO	SE	
08/03/09		MK	48	47	46	144	59	57	168	20	30	99.00	1	L	NO		NF	3	MI	SW	LO	1		8.0	H	240	195	E	HE	SE	
08/03/09		MK	48	44	59	145	0	28	171	20	45	3.00	1	L	NO		NF	1	ST	BR	SW	2	8	E		50	220	E	BO	VI	
08/03/09		MK	48	44	14	145	0	39	171	20	48	3.00	1	L	NO		NF	1	SA	SW		11	9	E		100	140	E	HE	SE	
08/06/09	ON		47	10	8	144	20	36	20	11	03	8.00	1	L	NO		NF	1	NO	RE		2		6.0	H	300	20	E	BO	SE	
08/06/09	ON		47	12	24	144	21	46	20	11	15	8.00	1	L	NO		NF	3	NO	RE		10		4.0	H	400	10	E	BO	SE	
08/06/09		MK	47	18	52	144	24	45	19	11	48	8.00	1	L	NO		NF	2	NO	RE		1		E		150	40	E	FP	SE	
08/06/09	ON		47	21	46	144	26	5	20	12	03	8.00	1	L	NO		NF	2	NO	RE		1		8.0	H	240	10	E	BO	SE	
08/06/09	ON		47	26	30	144	29	0	20	12	39	8.00	1	L	NO		NF	2	NO	SW		11	10	8.0	H	240	10	E	HE	SE	
08/06/09		MK	47	46	33	144	39	23	20	14	36	10.00	1	L	LI	5\7	NF	2	SA	SW		11	9	E		150	350	E	BO	MO	
08/06/09		MK	47	48	2	144	40	15	20	14	46	10.00	1	L	LI	6\8	NF	1	NO	RE		11		E		100	0	E	BO	SE	
08/06/09		MK	47	56	0	144	44	97	25	15	34	10.00	1	L	LI	6\8	NF	1	NO	RE		2		E		150	70	E	FP	SE	
08/16/09	MK	VS	52	25	1	143	51	9	267	11	07	3.00	1	L	NO		NF	1	SA	SW		2	5	E		250	310	E	HE	MO	
08/16/09	MK	VS	52	25	1	143	49	93	267	11	12	3.00	1	L	NO		NF	2	NO	RE		3		E		400	340	E	FP	SE	
09/21/09	ON		52	1	98	143	48	20	250	18	24	10.00	1	L	SE	12	NF	1	NO	RE		2		5.0	H	400	310	E	BO	SE	
09/29/09	VS		48	3	62	144	45	1	186	18	21	8.00	1	L	NO		NF	2	SP	SW	LO	2	6	E		150	240	E	BO	MO	

07/04/09		MK	49	18	21	144	41	61	344	17	05	8.00	2	L	NO		NF	1	NO	RE		1		E		100	5	E	BO	SE	
07/04/09		MK	49	19	41	144	41	13	344	17	11	8.00	2	L	NO		NF	2	NO	RE		11		2.2	H	791	315	E	FP	SE	
07/04/09		MK	49	23	55	144	39	42	345	17	35	9.00	2	L	NO		NF	1	NO	RE		10		0.9	H	1635	315	E	FP	SE	
07/04/09		MK	49	24	6	144	39	22	346	17	38	9.00	2	L	NO		NF	1	SA	SW		10		E		150	310	E	HE	SE	
08/03/09		MK	49	46	50	144	45	2	170	14	56	0.70	2	L	NO		NF	1	NO	LO		11		E		200	155	E	HE	SE	
08/03/09	VS		49	16	25	144	52	52	171	17	48	3.00	2	L	MO	3	NF	3	NO	BR		2		E		200	240	E	BO	VI	
08/03/09		MK	48	42	24	145	0	88	172	21	00	1.00	2	L	NO		NF	1	ST	SW		3	9	E		50	240	E	HE	SE	
08/03/09		MK	48	40	93	145	1	19	172	21	06	0.70	2	L	NO		NF	1	NO	RE		10		E		150	120	E	FP	SE	
08/03/09		MK	48	40	36	145	1	32	171	21	09	0.50	2	L	NO		NF	1	ST	SW		2	8	E		50	225	E	BO	SE	
08/06/09		MK	48	4	61	144	49	83	17	16	26	10.00	2	L	NO		NF	1	NO	RE	LO	2		E		100	85	E	HE	SE	
08/06/09		MK	48	9	9	144	52	15	17	16	53	8.00	2	L	MO	8\9	NF	1	NO	RE		12		E		200	5	E	FP	SE	
08/06/09		ON	48	38	79	145	0	98	350	19	48	8.00	2	L	LI	9\10	NF	1	SA	FE		1	2	E		30	60	E	HE	SE	Fish in jaws (probably salmon)
08/06/09		ON	48	47	33	144	58	93	350	20	45	8.00	2	L	NO		NF	1	ST	SW		2	9	E		30	60	E	BO	MO	
08/06/09		ON	48	48	15	144	58	72	350	20	48	8.00	2	L	NO		NF	1	NO	LO		2	2	E		40	60	E	HE	SE	
08/21/09		MK	54	20	95	142	36	55	115	15	09	4.00	2	L	NO		NF	1	SP	SW		3	12	E		100	190	E	BO	MO	
09/06/09	ON		51	48	76	143	38	95	115	17	48	0.60	2	L	NO		NF	2	NO	RE		1		E		100	120	E	BO	SE	
09/06/09	ON		51	48	72	143	43	73	88	18	05	5.00	2	L	NO		NF	1	NO	RE		2		4.0	H	470	140	B	BO	SE	
09/29/09	ON		49	11	39	144	52	96	160	11	22	3.00	2	L	NO		NF	1	NO	RE		11		E		400	140	E	BO	SE	
09/29/09		MK	49	8	65	144	53	61	160	11	43	3.00	2	L	NO		NF	2	NO	RE		10		E		200	105	E	FP	SE	
09/29/09		MK	49	7	82	144	53	80	160	11	47	3.00	2	L	NO		NF	6	NO	RE	LO	1		E		150	200	E	HE	SE	
09/29/09	ON		49	6	75	144	54	5	160	11	52	3.00	2	L	NO		NF	2	NO	RE		11		E		300	130	E	BO	SE	
09/29/09	ON		49	6	33	144	54	16	160	11	55	3.00	2	L	NO		NF	1	NO	RE		1		E		200	180	E	BO	SE	
09/29/09	ON		49	4	67	144	54	60	158	12	04	3.00	2	L	NO		NF	6	NO	LO	RE	11		E		400	140	E	BO	SE	
09/29/09	ON		49	4	10	144	54	74	159	12	07	3.00	2	L	NO		NF	1	NO	RE		1		E		200	200	E	BO	SE	
09/29/09	ON		49	4	10	144	54	74	159	12	07	3.00	2	L	NO		NF	1	NO	RE		11		E		200	140	E	BO	SE	
09/29/09	ON		49	3	53	144	54	88	160	12	10	3.00	2	L	NO		NF	1	NO	LO		11		E		200	140	E	BO	SE	
09/29/09	ON		49	3	17	144	54	98	160	12	12	3.00	2	L	NO		NF	4	ST	BR		1		E		100	170	E	BO	VI	
09/29/09	ON		48	59	45	144	55	86	160	12	35	3.00	2	L	NO		NF	4	ST	BR		1		E		100	170	E	BO	VI	
09/29/09	ON		48	56	33	144	56	56	160	12	50	3.00	2	L	NO		NF	3	ST	BR		12		E		300	170	E	BO	VI	

09/29/09	ON		48	55	86	144	56	66	160	12	52	3.00	2	L	NO		NF	2	NO	LO		11		E		200	140	E	BO	SE	
09/29/09	ON		48	54	18	144	57	7	160	13	00	3.00	2	L	NO		NF	3	NO	RE	LO	11		E		200	140	E	BO	SE	
09/29/09	ON		48	54	18	144	57	7	160	13	00	3.00	2	L	NO		NF	2	NO	RE	LO	1		E		300	170	E	BO	SE	
09/29/09	ON		48	53	49	144	57	26	160	13	05	3.00	2	L	NO		NF	2	NO	RE	LO	1		E		500	170	E	BO	SE	
09/29/09	ON		48	52	89	144	57	44	160	13	08	3.00	2	L	NO		NF	1	NO	RE		1		E		300	170	E	BO	SE	
09/29/09	ON		48	51	32	144	57	87	160	13	17	3.00	2	L	NO		NF	2	NO	RE	LO	1		E		300	170	E	BO	SE	
09/29/09	ON		48	51	1	144	57	98	160	13	19	3.00	2	L	NO		NF	13	NO	BR		11		E		300	140	E	BO	VI	
09/29/09	ON		48	50	15	144	58	15	160	13	24	3.00	2	L	NO		NF	12	NO	RE		1		E		300	140	E	BO	SE	
09/29/09	ON		48	49	65	144	58	29	160	13	27	3.00	2	L	NO		NF	2	NO	RE		11		E		300	140	E	BO	SE	
09/29/09	ON		48	49	41	144	58	35	160	13	30	3.00	2	L	NO		NF	4	NO	RE		1		E		400	170	E	BO	SE	
09/29/09	ON		48	48	40	144	58	61	160	13	34	3.00	2	L	NO		NF	2	NO	RE		1		E		400	170	E	BO	SE	
09/29/09	ON		48	48	0	144	58	72	160	13	36	3.00	2	L	NO		NF	10	NO	LO	BR	12		E		300	160	E	BO	SE	
09/29/09	ON		48	46	27	144	58	50	160	13	42	3.00	2	L	NO		NF	6	SP	BR		1		E		400	170	E	BO	VI	
09/29/09		MK	48	45	72	144	59	28	160	13	50	3.00	2	L	NO		NF	1	NO	LO		10		E		150	90	E	BO	MO	
09/29/09		MK	48	45	30	144	59	38	160	13	53	3.00	2	L	NO		NF	3	SA	SW	LO	11	8	E		70	130	E	BO	MO	
09/29/09		MK	48	45	8	144	59	43	160	13	54	3.00	2	L	NO		NF	1	NO	RE	LO	2		E		150	215	E	FP	SE	
09/29/09		MK	48	44	55	144	59	55	160	13	58	3.00	2	L	NO		NF	5	SP	SW		3	1	E		300	240	E	BO	MO	
09/29/09		MK	48	44	35	144	59	59	160	14	00	3.00	2	L	NO		NF	1	NO	RE		11		E		400	140	E	FP	SE	
09/29/09		MK	48	43	81	144	59	70	160	14	02	3.00	2	L	NO		NF	7	SA	SW	LO	9	7	E		250	80	E	BO	MO	
09/29/09		MK	48	43	40	144	59	78	160	14	05	3.00	2	L	NO		NF	6	NO	RE	LO	11		E		350	130	E	BO	SE	
09/29/09		MK	48	42	80	144	59	88	160	14	08	3.00	2	L	NO		NF	6	SA	SW	LO	11	7	E		250	135	E	BO	VI	
09/29/09		MK	48	42	36	144	59	98	160	14	11	3.00	2	L	NO		NF	1	SA	SW	LO	1	3	E		150	180	E	BO	MO	
09/29/09		MK	48	41	94	145	0	8	157	14	14	3.00	2	L	NO		NF	10	SP	SW	LO	11	6	E		200	135	E	BO	MO	
09/29/09		MK	48	41	45	145	0	20	157	14	17	1.00	2	L	NO		NF	1	SA	SW	LO	1	3	E		100	180	E	BO	MO	
09/29/09		MK	48	41	7	145	0	28	157	14	19	1.00	2	L	NO		NF	8	NO	RE	LO	2		E		400	205	E	FP	SE	
09/29/09		MK	48	40	50	145	0	42	157	14	22	2.00	2	L	NO		NF	7	SP	SW	BR	10	6	E		150	105	E	BO	VI	
09/29/09		MK	48	39	90	145	0	56	157	14	26	2.00	2	L	NO		NF	2	NO	RE		12		E		400	150	E	FP	SE	
09/29/09		MK	48	39	50	145	0	64	155	14	30	2.00	2	L	NO		NF	6	MI	SW	BR	12		E		400	165	E	BO	VI	
09/29/09		MK	48	39	10	145	0	75	155	14	31	2.00	2	L	NO		NF	3	NO	RE		10		E		250	110	E	FP	SE	

09/29/09		MK	48	38	40	145	0	92	155	14	36	4.00	2	L	NO		NF	7	NO	RE		11		E		600	130	E	FP	SE	
09/29/09		MK	48	38	10	145	1	0	155	14	37	4.00	2	L	NO		NF	3	NO	RE		12		E		400	160	E	FP	SE	
09/29/09		MK	48	37	82	145	1	7	155	14	39	6.00	2	L	NO		NF	5	NO	LO	RE	3		E		400	225	E	FP	SE	
09/29/09		MK	48	37	9	145	1	27	155	14	44	6.00	2	L	NO		NF	1	NO	RE		12		E		200	165	E	FP	SE	
09/29/09		MK	48	36	86	145	1	33	155	14	45	6.00	2	L	NO		NF	6	NO	RE		12		E		400	170	E	FP	SE	
09/29/09		MK	48	36	64	145	1	39	155	14	46	6.00	2	L	NO		NF	2	NO	RE		11		E		200	130	E	FP	SE	
09/29/09		MK	48	36	52	145	1	42	155	14	47	8.00	2	L	NO		NF	5	NO	RE	LO	12		E		300	180	E	FP	SE	
09/29/09		MK	48	36	32	145	1	47	155	14	48	8.00	2	L	NO		NF	4	NO	RE		11		E		500	125	E	FP	SE	
09/29/09		MK	48	35	94	145	1	58	155	14	51	8.00	2	L	NO		NF	5	NO	RE		12		E		400	165	E	FP	SE	
09/29/09		MK	48	35	46	145	1	69	155	14	54	8.00	2	L	MO	1\2	NF	5	NO	RE		1		E		200	210	E	FP	SE	
09/29/09		MK	48	34	80	145	1	86	155	14	58	8.00	2	L	MO	1\2	NF	4	MI	LO	BR	12		E		200	155	E	BO	VI	
09/29/09		MK	48	34	50	145	1	94	155	15	00	8.00	2	L	NO		NF	4	NO	RE		1		E		300	195	E	FP	SE	
09/29/09		MK	48	33	56	145	2	16	155	15	05	8.00	2	L	NO		NF	3	NO	RE	LO	10		E		250	105	E	FP	SE	
09/29/09		MK	48	32	78	145	2	33	155	15	10	8.00	2	L	MO	1\2	NF	1	NO	RE	LO	1		E		200	190	E	FP	SE	
09/29/09		MK	48	31	43	145	2	60	155	15	18	6.00	2	L	SE	2	NF	4	NO	RE		1		E		100	180	E	FP	SE	
09/29/09		MK	48	28	70	145	1	9	190	15	36	0.20	2	L	NO		NF	6	NO	RE	LO	1		E		150	230	E	HE	SE	
09/29/09		MK	48	26	53	144	59	67	190	15	50	0.20	2	L	NO		NF	3	NO	RE	LO	10		E		100	140	E	FP	SE	
09/29/09		MK	48	26	21	144	59	48	190	15	52	0.20	2	L	NO		NF	1	ST	SW	LO	10	5	E		50	145	E	BO	MO	
09/29/09		MK	48	25	74	144	59	17	190	15	55	0.20	2	L	NO		NF	1	SP	SW	LO	10	12	E		50	155	E	BO	MO	
09/29/09		MK	48	25	36	144	58	93	190	15	57	0.20	2	L	NO		NF	1	SA	SW	LO	11	8	E		100	155	E	BO	MO	
09/29/09		MK	48	25	6	144	58	73	190	16	00	0.30	2	L	NO		NF	4	NO	RE		1		E		100	210	E	FP	SE	
09/29/09		MK	48	24	68	144	58	47	190	16	02	0.40	2	L	NO		NF	5	SA	BR		11	8	E		150	150	E	BO	VI	
07/03/09	AA		45	43	5	141	57	58	75	16	06	10.00	3	L	NO		NF	1	NO	LO	RE	11	9	7	H	275	45	E	BO	SE	
08/06/09	VS		48	20	82	144	58	5	18	18	05	10.00	3	L	SE	8	NF	1	SP	BR		10	6	E		150	325	E	BO	VI	
08/06/09	VS		48	29	36	145	2	27	19	19	00	0.10	3	L	NO		NF	1	SA	BR		1	3	E		30	60	E	BO	VI	
08/07/09	VS		50	38	73	144	36	96	17	07	05	10.00	0	L	SE	1\2	PWSD	3	SP	FD		9	6	5.0	H	380	305	E	BO	SE	
08/04/09	MK		45	58	20	143	23	46	280	13	42	10.00	1	L	NO		PWSD	5	MI	FD		2		E		200	345	E	BO	VI	
08/06/09	ON		47	17	42	144	23	86	20	11	40	8.00	1	L	NO		PWSD	17	ST	FD	BR	2	4	3.0	H	460	60	E	BO	VI	
09/28/09		MK	53	6	21	143	19	35	350	08	46	99.00	0	L	NO		RS	1	SA	SW		2	5	E		70	45	E	BO	MO	

07/19/09		MK	52	21	37	143	23	66	151	08	30	99.00	1	L	NO		SL	1	MI	SW	LO	3		E		10	240	E	BO	SE	
08/10/09	VS	MK	52	42	74	143	21	63	98	11	00	8.00	1	L	LI	1	SL	1	MI	SW		7		E		10	310	E	BO	SE	
07/02/09	AA		43	54	71	136	46	67	55	17	36	10.00	2	L	LI	7	SL	1	SP	SW		11	9	E		100	25	E	HE	SE	
07/19/09	VS		52	21	34	143	23	66	93	06	30	99.00	2	L	NO		SL	1	NO	SW	LO	3		E		0	180	E	BO	SE	Under the side
07/22/09	AA	MK	52	31	96	143	49	48	265	17	20	10.00	2	L	LI	12	SL	1	SA	SW		2	3	8	H	240	310	E	HE	SE	Large male
08/11/09	VS	ON	52	44	10	143	20	95	332	16	45	6.00	2	L	NO		SL	1	SP	MI		9		E		20	210	E	BO	SE	
09/29/09	ON		48	55	13	144	56	82	160	12	56	3.00	2	L	NO		SL	1	NO	LO		11		E		500	150	E	BO	SE	
09/08/09		VS	54	21	3	142	36	65	149	08	30	3.00	3	L	NO		SL	1	MI	SW		5	12	E		10	280	E	BO	SE	
07/05/09	AA		52	25	17	143	32	72	330	17	13	9.00	0	L	NO		SS	1	SA	SW		11		9.0	H	215	305	E	BO	SE	
07/13/09		MK	53	24	72	143	12	52	140	19	11	8.00	0	L	MO	5	SS	1	ST	SW	LO	1	7	E		100	160	E	HE	SE	
07/13/09	AA		53	28	13	143	10	0	59	21	21	4.00	0	L	NO		SS	1	MI	SW	LO	11	88	E		30	30	E	BO	SE	
07/16/09	MK		53	7	57	143	22	21	114	18	09	99.00	0	L	NO		SS	2	ST	SW	LO	1	9	E		600	135	E	HE	SE	
07/16/09	MK		53	7	33	143	22	90	152	18	14	99.00	0	L	NO		SS	1	ST	SW		9	3	E		150	75	E	HE	SE	
07/22/09	VS	MK	52	33	15	143	29	19	357	18	34	99.00	0	L	NO		SS	1	SA	SW		2	3	3.5	H	520	45	B	HE	SE	
07/31/09	MK		53	1	55	143	23	55	107	18	00	0.10	0	L	SE	5	SS	1	SA	SW	LO	11	11	E		200	85	E	HE	SE	
08/08/09		MK	53	24	96	143	13	6	160	10	05	99.00	0	L	NO		SS	1	NO	LO		10		7.0	H	275	100	B	HE	SE	
09/20/09	MK	VS	52	52	24	143	23	34	0	14	30	10.00	0	L	NO		SS	1	NO	LO	SI	11		E		50	330	E	HE	SE	
09/20/09	MK	VS	52	52	92	143	23	36	0	14	34	10.00	0	L	NO		SS	4	MI	LO		2		E		100	50	E	HE	SE	Large number of spotted seals around vessel
09/20/09	MK		52	53	92	143	22	87	110	16	19	10.00	0	L	SE	4	SS	2	NO	LO		12		5.0	H	378	105	B	HE	SE	
09/20/09	MK		52	53	54	143	24	2	122	16	24	10.00	0	L	SE	4	SS	1	NO	LO		2		E		100	180	E	HE	SE	
09/20/09	MK		52	53	3	143	25	10	145	16	30	10.00	0	L	SE	3	SS	4	SA	SW		10	8	2.5	H	714	110	B	BO	MO	
09/28/09		MK	53	1	24	143	21	61	158	07	39	99.00	0	L	NO		SS	1	SA	SW	LO	11	9	E		100	130	E	HE	SE	
07/11/09	VS	AA	52	56	50	143	33	35	265	12	51	8.00	1	L	NO		SS	1	SA	SW		10	10	E		30	230	E	BO	SE	
07/13/09		MK	52	50	44	143	23	48	195	09	18	99.00	1	L	LI	9	SS	1	NO	LO		2		E		20	230	E	HE	SE	
07/16/09	AA	MK	53	29	5	143	12	16	160	09	36	99.00	1	L	NO		SS	1	NO	SW	LO	3	6	E		400	250	B	HE	SE	
07/17/09	MK		52	49	96	143	24	28	157	07	23	10.00	1	L	NO		SS	1	MI	LO	SW	3		E		100	235	E	HE	SE	
07/21/09	AA	MK	51	57	0	143	44	9	266	14	30	10.00	1	L	NO		SS	1	SA	SW		11	9	2.2	H	790	240	B	HE	SE	
07/24/09		MK	52	21	2	143	31	45	139	08	37	99.00	1	L	MO	10	SS	1	NO	RE		9		E		200	55	E	BO	SE	Lying on a log
08/10/09		MK	52	41	85	143	23	61	350	13	48	5.00	1	L	LI	6	SS	1	NO	LO		10		E		50	295	E	BO	SE	Calf

08/15/09	ON	MK	51	56	99	143	37	64	264	15	52	4.00	1	L	NO		SS	1	NO	LO		11		E		70	240	E	HE	SE	
08/16/09	MK	VS	52	25	3	143	53	60	267	11	00	3.00	1	L	NO		SS	1	NO	LO	SI	11		E		200	245	E	HE	SE	
09/20/09	MK	VS	52	49	13	143	21	77	152	09	30	10.00	1	L	SE	11	SS	3	MI	SW	LO	12	99	E		50	150	E	BO	SE	
09/20/09		ON	52	50	69	143	22	28	310	13	00	10.00	1	L	SE	7	SS	1	SA	LO	SW	9	99	E		100	210	E	HE	SE	
09/25/09		ON	52	52	87	143	21	20	295	15	30	8.00	1	L	NO		SS	1	NO	LO	SI	9		5	SH		220	E	BO	SE	
10/01/09		MK	45	11	60	137	30	85	256	09	00	10.00	1	L	SE	7	SS	1	DE	NO		9		E		150	160	E	BP	SE	
08/31/09	MK		53	10	6	143	25	93	142	12	07	8.00	2	L	SE	12	SS	1	NO	LO		2		E		50	205	E	HE	SE	
09/01/09	ON	MK	52	4	0	143	36	63	270	14	17	6.00	2	L	LI	10	SS	1	NO	LO		10		E		300	195	E	HE	SE	
09/11/09		MK	52	40	72	143	23	25	330	16	17	10.00	4	L	SE	9	SS	1	ST	SW		10	3	E		200	290	E	BO	MO	
09/29/09	ON		48	47	11	144	58	93	160	13	41	3.00	2	L	NO		UBW	1	SA	TH		1		E		300	170	E	BO	MO	
08/08/09	ON		53	13	1	143	16	7	60	14	07	10.00	1	L	LI	2\4	UW	1	NO	NO		11		E		200	40	E	SP	VI	
08/07/09	ON		51	57	81	143	37	5	353	17	17	10.00	0	L	NO		US	1	SP	SI		2	3	E		250	50	E	BO	SE	
08/07/09	ON		51	57	95	143	37	7	288	17	25	10.00	0	L	NO		US	1	SP	SI		2	3	E		250	330	E	BO	SE	
08/07/09	ON		51	58	59	143	36	72	356	17	37	10.00	0	L	NO		US	1	SP	SI		2	3	E		200	30	E	BO	MO	
08/07/09	ON		52	6	58	143	36	22	356	18	37	10.00	0	L	MO	9	US	1	SP	SI		1	5	E		150	40	E	BO	MO	
08/06/09		ON	48	40	82	145	0	48	350	20	06	8.00	2	L	NO		US	1	NO	LO		1	2	E		20	60	E	HE	SE	Probably a ribbon seal. Could see the head and a white ring on the neck
09/02/09	VS	MK	52	42	65	143	40	70	93	10	16	10.00	1	L	SE	6	UTW	1	SA	TH		12	11	E		50	90	E	SP	VI	A large cetacean about 4 m long surfaced before the vessel bow with a splash characteristic of dolphins and porpoises. After surfacing briefly 4 times during which the animal was moving away from the vessel at great speed, it disappeared. Only splashes observed, no body.
08/06/09	ON		47	25	76	144	28	0	20	12	30	8.00	1	L	NO		UMA	1	NO	RE		11		6.0	H	300	10	E	BO	SE	Unidentified brown object. Lying without movement, then sinking slowly. Turned away from the object

Appendix 2

Results of Shore-Based Surveys of Gray Whales and other Cetaceans
in the Piltun Feeding Area, July-September 2009

1 – Date **2** – Monitoring station number
3 – Cetacean species (GW – gray whale, MW – Minke whale,
HP – harbor porpoise, KW – killer whale)
4 – Number of individuals **5** – Latitude (N) **6** – Longitude (E)

Odoptu-Piltun Area

1	2	3	4	5	6
3.VII	2	GW	2	53.39626	143.17492
3.VII	2	MW	1	53.34437	143.21458
3.VII	3	GW	1	53.31374	143.21740
3.VII	3	GW	1	53.31325	143.24241
3.VII	3	MW	1	53.27583	143.23655
3.VII	3	GW	1	53.25839	143.24674
3.VII	4	GW	1	53.22335	143.26011
3.VII	5	GW	1	53.11253	143.28986
3.VII	5	GW	1	53.11296	143.29057
3.VII	5	GW	3	53.11050	143.28554
3.VII	6	GW	2	53.08109	143.28492
3.VII	6	GW	1	53.09390	143.29110
3.VII	6	GW	1	53.03242	143.31867
3.VII	6	GW	1	53.02982	143.30187
3.VII	7	GW	1	52.99755	143.30707
3.VII	7	GW	1	52.96431	143.33719
3.VII	8	GW	1	52.89773	143.33387
3.VII	8	GW	1	52.90057	143.33843
3.VII	8	GW	1	52.89927	143.34180
3.VII	8	GW	1	52.89157	143.33532
3.VII	8	GW	1	52.89053	143.33715
3.VII	8	GW	2	52.89276	143.34426
3.VII	8	GW	2	52.88082	143.33912
3.VII	8	GW	1	52.86567	143.34004
3.VII	8	GW	1	52.86224	143.34301
4.VII	8	GW	1	52.86008	143.33740
4.VII	8	GW	1	52.85760	143.34893
4.VII	8	GW	1	52.85730	143.34827

1	2	3	4	5	6
4.VII	8	GW	3	52.86933	143.33997
4.VII	8	GW	2	52.86908	143.34538
4.VII	8	GW	1	52.87164	143.34802
4.VII	8	GW	1	52.88009	143.34713
1	**2**	**3**	**4**	**5**	**6**
4.VII	8	GW	1	52.88977	143.33827
4.VII	7	GW	1	52.94927	143.31858
4.VII	7	GW	1	52.99999	143.35173
4.VII	6	GW	2	53.05946	143.29870
7.VII	1	GW	2	53.43842	143.18978
7.VII	3	MW	1	53.28665	143.25574
7.VII	3	GW	1	53.25342	143.27487
7.VII	4	GW	1	53.20338	143.26164
7.VII	4	GW	1	53.21675	143.26382
7.VII	4	GW	1	53.18941	143.30172
7.VII	5	GW	1	53.17846	143.27225
7.VII	6	GW	1	53.06506	143.35063
7.VII	6	GW	1	53.02530	143.31818
11.VII	1	GW	1	53.42010	143.19064
11.VII	3	GW	1	53.30880	143.24520
11.VII	3	GW	1	53.20238	143.28060
11.VII	3	GW	1	53.15420	143.29591
11.VII	4	GW	1	53.18843	143.32743
11.VII	4	GW	1	53.18768	143.32768
11.VII	4	GW	1	53.17705	143.27908
11.VII	4	GW	2	53.15556	143.28350
11.VII	4	GW	1	53.13157	143.29424
11.VII	4	KW	2	53.15003	143.27947

1	2	3	4	5	6
11.VII	5	GW	2	53.15240	143.26881
11.VII	5	GW	1	53.17291	143.30972
11.VII	5	GW	1	53.13236	143.29092
11.VII	5	GW	1	53.09794	143.30007
11.VII	6	GW	1	53.05875	143.30231
11.VII	6	GW	1	53.05837	143.30266
11.VII	8	GW	2	52.90128	143.37565
11.VII	8	GW	2	52.88698	143.33588
11.VII	8	GW	1	52.90187	143.37504
12.VII	8	GW	2	52.88441	143.34292
12.VII	8	GW	1	52.90848	143.33159
12.VII	8	GW	1	52.90872	143.32996
17.VII	1	GW	1	53.46095	143.14336
17.VII	1	GW	3	53.39794	143.21521
17.VII	2	GW	3	53.37659	143.22312
17.VII	3	MW	1	53.29473	143.25542
17.VII	4	GW	1	53.19428	143.28757
17.VII	5	GW	1	53.13587	143.32107
17.VII	5	GW	1	53.13166	143.33590
17.VII	5	GW	1	53.11067	143.28596
17.VII	5	GW	2	53.11101	143.28679
17.VII	6	GW	1	53.09402	143.28869
17.VII	6	GW	1	53.07349	143.29557
17.VII	6	GW	2	53.06187	143.29995
22.VII	2	MW	1	53.37738	143.21945
22.VII	3	GW	1	53.30127	143.34302
22.VII	4	GW	1	53.21035	143.27485
22.VII	4	GW	1	53.20591	143.30028
22.VII	4	GW	1	53.16928	143.28004
22.VII	4	GW	1	53.13858	143.28156
23.VII	2	GW	1	53.34837	143.24420
23.VII	2	GW	1	53.34199	143.24311
23.VII	2	GW	1	53.30336	143.22039
23.VII	3	GW	2	53.25462	143.24580
25.VII	2	GW	1	53.34066	143.20466
25.VII	3	GW	2	53.24439	143.25755
25.VII	4	GW	1	53.21702	143.25839
25.VII	4	GW	1	53.21588	143.27132

1	2	3	4	5	6
6.VIII	1	GW	1	53.39083	143.22611
6.VIII	2	GW	1	53.35842	143.23978
6.VIII	2	GW	1	53.35782	143.23308
6.VIII	2	GW	1	53.33514	143.20355
6.VIII	2	GW	1	53.32575	143.23430
6.VIII	3	MW	1	53.31845	143.27276
6.VIII	5	GW	1	53.12959	143.33639
6.VIII	5	GW	1	53.09421	143.28739
6.VIII	5	GW	3	53.08660	143.28920
6.VIII	6	GW	1	53.06213	143.29330
6.VIII	6	GW	3	53.05027	143.29988
6.VIII	7	GW	1	53.01373	143.30137
6.VIII	7	GW	1	52.97149	143.32199
6.VIII	7	GW	2	52.96476	143.32217
6.VIII	7	GW	1	52.96024	143.32216
6.VIII	8	GW	1	52.90328	143.32526
6.VIII	8	GW	1	52.89023	143.32701
6.VIII	8	GW	1	52.87421	143.33611
6.VIII	8	GW	1	52.86943	143.33098
7.VIII	8	GW	1	52.85401	143.33889
7.VIII	8	GW	1	52.86067	143.33915
7.VIII	8	GW	1	52.88631	143.36660
7.VIII	8	GW	3	52.89564	143.36047
7.VIII	8	GW	1	52.89045	143.35412
7.VIII	8	GW	1	52.88818	143.32777
7.VIII	8	GW	1	52.90921	143.32502
7.VIII	8	GW	1	52.92014	143.31898
7.VIII	8	GW	1	52.92013	143.31784
7.VIII	7	GW	4	52.95537	143.31586
7.VIII	7	GW	1	52.95819	143.31733
7.VIII	7	GW	1	52.94009	143.33442
7.VIII	7	GW	1	53.00622	143.30428
7.VIII	6	GW	1	53.02101	143.30535
7.VIII	6	HP	1	53.04656	143.30006
7.VIII	6	GW	1	53.07427	143.31547
7.VIII	5	GW	1	53.09595	143.29435
7.VIII	5	GW	1	53.12122	143.33654
7.VIII	4	GW	1	53.15239	143.31314

1	2	3	4	5	6
7.VIII	3	GW	1	53.27284	143.30351
9.VIII	1	GW	3	53.45727	143.18527
9.VIII	1	HP	4	53.40162	143.16588
9.VIII	2	KW	1	53.36685	143.19539
9.VIII	2	GW	1	53.34770	143.23970
9.VIII	3	MW	1	53.27584	143.23883
9.VIII	3	MW	1	53.27013	143.26455
9.VIII	4	HP	1	53.18125	143.25840
9.VIII	6	GW	1	53.06753	143.28786
9.VIII	7	GW	1	52.99566	143.31812
9.VIII	7	GW	2	52.97787	143.32169
9.VIII	7	GW	1	52.97627	143.32100
9.VIII	7	GW	2	52.97408	143.32013
9.VIII	7	GW	2	52.94557	143.32500
9.VIII	7	GW	2	52.92568	143.33576
9.VIII	8	GW	1	52.91997	143.32586
9.VIII	8	GW	1	52.91990	143.32700
9.VIII	8	GW	1	52.91949	143.33153
9.VIII	8	GW	1	52.89510	143.38078
9.VIII	8	GW	1	52.87421	143.33611
9.VIII	8	GW	1	52.86200	143.34247
9.VIII	8	GW	1	52.86567	143.34004
9.VIII	8	GW	1	52.86447	143.33736
10.VIII	1	GW	1	53.40220	143.18479
10.VIII	2	GW	1	53.33283	143.20171
11.VIII	2	GW	1	53.39392	143.16089
11.VIII	2	GW	1	53.34171	143.26058
11.VIII	3	GW	1	53.33792	143.27096
11.VIII	4	GW	1	53.22934	143.33700
11.VIII	8	GW	1	52.91990	143.32700
11.VIII	8	GW	1	52.91972	143.32927
11.VIII	8	GW	1	52.90915	143.32585
11.VIII	8	GW	1	52.90209	143.33299
11.VIII	8	GW	1	52.89855	143.34340
11.VIII	8	GW	1	52.87666	143.34640
11.VIII	8	GW	1	52.85562	143.34409
15.VIII	1	GW	1	53.41633	143.17432
15.VIII	6	GW	1	53.06896	143.29648

1	2	3	4	5	6
15.VIII	6	GW	1	53.06721	143.29679
15.VIII	7	GW	2	52.96677	143.32441
15.VIII	7	GW	2	52.94410	143.31901
15.VIII	8	GW	3	52.90307	143.32723
15.VIII	8	GW	1	52.90290	143.32853
15.VIII	8	GW	2	52.88347	143.33523
25.VIII	4	GW	1	53.15428	143.33400
25.VIII	4	GW	1	53.12376	143.32507
25.VIII	4	GW	1	53.15682	143.26861
25.VIII	4	GW	1	53.11328	143.29096
25.VIII	5	GW	1	53.12680	143.33677
25.VIII	5	GW	1	53.12541	143.33683
25.VIII	5	GW	1	53.12145	143.31547
25.VIII	5	GW	1	53.10490	143.29152
25.VIII	5	GW	1	53.10560	143.29324
25.VIII	6	GW	1	53.08618	143.28890
25.VIII	6	GW	1	53.08600	143.29183
25.VIII	6	GW	3	53.09148	143.30873
25.VIII	6	GW	1	53.09877	143.33537
25.VIII	6	GW	2	53.05265	143.31453
25.VIII	6	GW	1	53.04070	143.31114
25.VIII	7	GW	1	52.99079	143.32295
25.VIII	7	GW	1	52.89039	143.34637
25.VIII	8	GW	2	52.89557	143.33103
25.VIII	8	GW	1	52.88972	143.36508
25.VIII	8	GW	1	52.88605	143.34555
25.VIII	8	GW	1	52.88848	143.38406
25.VIII	8	GW	2	52.88074	143.32397
25.VIII	8	GW	1	52.88300	143.38528
25.VIII	8	GW	2	52.87778	143.36737
25.VIII	8	GW	1	52.87540	143.38486
25.VIII	8	GW	1	52.87267	143.38412
25.VIII	8	GW	1	52.86651	143.35004
25.VIII	8	GW	1	52.86224	143.34301
25.VIII	8	GW	1	52.84867	143.35890
25.VIII	8	GW	1	52.86176	143.34194
25.VIII	8	GW	1	52.86200	143.34247
25.VIII	8	GW	1	52.86381	143.34604

1	2	3	4	5	6
26.VIII	8	GW	1	52.84536	143.35017
26.VIII	8	GW	1	52.85642	143.37192
26.VIII	8	GW	1	52.86748	143.35121
26.VIII	8	GW	1	52.88935	143.35494
26.VIII	8	GW	1	52.88556	143.33722
26.VIII	8	GW	1	52.89081	143.35383
26.VIII	8	GW	1	52.89477	143.36132
26.VIII	8	GW	1	52.89564	143.36047
26.VIII	8	GW	1	52.90128	143.37565
26.VIII	8	GW	3	52.88468	143.32427
26.VIII	8	GW	1	52.89758	143.33436
26.VIII	8	GW	1	52.91632	143.34786
26.VIII	8	GW	1	52.90307	143.32723
26.VIII	7	GW	1	52.93701	143.32297
26.VIII	7	GW	1	52.96273	143.30895
26.VIII	7	GW	1	52.92764	143.34267
26.VIII	7	GW	1	52.94079	143.33638
26.VIII	7	GW	2	52.97682	143.32213
26.VIII	7	GW	1	52.97576	143.32241
26.VIII	7	GW	1	52.97915	143.31612
26.VIII	7	GW	1	52.98050	143.32339
26.VIII	7	GW	2	53.02690	143.30876
26.VIII	6	GW	1	52.99930	143.31101
26.VIII	6	GW	1	52.99989	143.31408
26.VIII	6	GW	1	53.00021	143.31560
26.VIII	6	GW	1	53.03860	143.30369
26.VIII	6	GW	2	53.04093	143.30421
26.VIII	6	GW	1	53.04056	143.37474
26.VIII	6	HP	2	53.05231	143.29407
26.VIII	5	GW	1	53.12546	143.29873
26.VIII	5	GW	1	53.13100	143.30379
26.VIII	5	GW	1	53.13185	143.29634
26.VIII	5	GW	1	53.13587	143.27759
26.VIII	5	GW	1	53.16494	143.27404
26.VIII	4	GW	2	53.14684	143.30438
26.VIII	4	GW	1	53.17524	143.26205
31.VIII	4	GW	1	53.15117	143.29649
31.VIII	5	GW	1	53.12357	143.30976

1	2	3	4	5	6
31.VIII	5	GW	1	53.11857	143.32315
31.VIII	5	GW	4	53.10088	143.29202
1.IX	1	GW	1	53.40531	143.21873
1.IX	2	GW	1	53.38390	143.16687
1.IX	3	GW	2	53.27766	143.22650
1.IX	3	GW	1	53.28075	143.23040
1.IX	4	GW	1	53.16798	143.32632
1.IX	5	GW	1	53.14284	143.30482
1.IX	5	GW	1	53.12642	143.29092
1.IX	5	GW	2	53.11427	143.28110
1.IX	6	GW	1	53.09407	143.28265
1.IX	6	GW	1	53.04104	143.30774
1.IX	6	GW	1	53.03801	143.30246
1.IX	6	GW	1	53.02806	143.30959
1.IX	7	GW	2	52.98957	143.31407
1.IX	7	GW	1	52.98518	143.31739
1.IX	7	GW	1	52.95772	143.38515
1.IX	7	GW	1	52.95010	143.37981
1.IX	7	GW	1	52.96333	143.30789
1.IX	8	GW	2	52.88453	143.32287
1.IX	8	GW	1	52.88176	143.34111
1.IX	8	GW	1	52.87609	143.38500
1.IX	8	GW	1	52.86998	143.38306
1.IX	8	GW	1	52.86931	143.38274
1.IX	8	GW	1	52.84536	143.35017
1.IX	8	GW	1	52.85489	143.34190
2.IX	8	GW	1	52.85363	143.33735
2.IX	8	GW	1	52.84673	143.35415
2.IX	8	GW	1	52.85489	143.34190
2.IX	8	GW	1	52.85957	143.35274
2.IX	8	GW	2	52.86727	143.34288
2.IX	8	GW	1	52.86064	143.35451
2.IX	8	MW	1	52.86683	143.35044
2.IX	8	GW	1	52.87816	143.38529
2.IX	8	GW	1	52.88023	143.38541
2.IX	8	GW	1	52.89344	143.36251
2.IX	8	GW	1	52.89389	143.36213
2.IX	8	GW	1	52.90187	143.37504

1	2	3	4	5	6
2.IX	8	GW	1	52.90345	143.34877
2.IX	7	GW	1	52.94688	143.32908
2.IX	7	GW	1	52.92994	143.34927
2.IX	7	MW	1	52.99338	143.34461
2.IX	7	GW	3	52.99394	143.33283
2.IX	6	GW	1	53.02101	143.30535
2.IX	6	GW	1	53.02146	143.30716
2.IX	6	GW	1	53.04750	143.29193
2.IX	6	GW	3	53.09196	143.30645
2.IX	6	GW	1	53.08031	143.29563
2.IX	5	GW	3	53.10294	143.32583
2.IX	5	MW	1	53.11364	143.31177
2.IX	5	GW	2	53.11996	143.35888
2.IX	5	MW	1	53.13099	143.30854
2.IX	5	GW	2	53.16456	143.26010
2.IX	5	GW	1	53.16466	143.26126
2.IX	4	GW	1	53.14302	143.32041
2.IX	1	HP	1	53.41229	143.15887
3.IX	2	GW	1	53.35326	143.19245
3.IX	3	GW	1	53.26925	143.25964
4.IX	4	GW	1	53.15776	143.28818
4.IX	4	GW	1	53.14801	143.27054
4.IX	5	GW	1	53.15156	143.28146
4.IX	5	GW	1	53.13844	143.28788
4.IX	5	GW	1	53.14695	143.30992
4.IX	5	GW	1	53.13183	143.28943
4.IX	5	GW	2	53.10954	143.31771
4.IX	5	GW	1	53.11687	143.27659
4.IX	5	GW	1	53.08917	143.30001
4.IX	5	GW	1	53.08801	143.29578
4.IX	6	GW	1	53.09353	143.29589
4.IX	6	GW	1	53.10732	143.29805
4.IX	6	GW	1	53.06574	143.30478
4.IX	6	GW	1	53.04335	143.29854
4.IX	6	GW	1	53.00287	143.32596
4.IX	6	GW	1	53.01277	143.30558
4.IX	7	GW	1	53.00118	143.30627
4.IX	7	GW	1	53.00102	143.30860

1	2	3	4	5	6
4.IX	7	GW	1	52.98531	143.32332
4.IX	7	HP	2	52.97607	143.30656
4.IX	7	GW	1	52.96295	143.33079
4.IX	8	GW	1	52.89342	143.32172
4.IX	8	GW	1	52.89416	143.33519
4.IX	8	GW	1	52.86526	143.34835
4.IX	8	GW	1	52.85344	143.33657
12.IX	4	GW	1	53.15527	143.28280
12.IX	5	GW	1	53.14771	143.28197
12.IX	6	GW	3	53.06363	143.37499
12.IX	7	GW	1	53.00624	143.30335
12.IX	7	GW	2	52.98343	143.32565
12.IX	7	GW	2	52.96385	143.32754
12.IX	7	GW	1	52.88911	143.33901
12.IX	8	GW	2	52.88520	143.33400
12.IX	8	GW	1	52.86459	143.35969
12.IX	8	GW	2	52.86216	143.35672
12.IX	8	GW	2	52.85923	143.35213
12.IX	8	GW	1	52.85889	143.35151
12.IX	8	GW	2	52.85856	143.35088
12.IX	8	GW	1	52.84504	143.34915
13.IX	8	GW	1	52.84747	143.35609
13.IX	8	GW	1	52.87381	143.36629
13.IX	8	GW	1	52.86317	143.43170
13.IX	8	GW	1	52.87628	143.36707
13.IX	8	GW	1	52.88848	143.38406
13.IX	8	HP	1	52.88074	143.32873
13.IX	8	GW	2	52.88698	143.32412
13.IX	7	GW	1	52.95867	143.31239
13.IX	7	GW	1	52.98101	143.32518
13.IX	7	GW	3	52.98392	143.32511
13.IX	7	GW	3	52.99772	143.30369
13.IX	7	GW	1	53.02701	143.30571
13.IX	6	GW	1	53.02439	143.33578
13.IX	6	GW	1	53.06552	143.37429
14.IX	3	GW	1	53.24718	143.25310
14.IX	4	GW	2	53.17531	143.27505
14.IX	5	GW	2	53.16501	143.26938

1	2	3	4	5	6
14.IX	5	GW	1	53.11542	143.29094
14.IX	5	GW	2	53.11261	143.28279
14.IX	5	GW	2	53.08750	143.29361
14.IX	5	GW	1	53.09809	143.27933
14.IX	6	GW	1	53.08572	143.29474
14.IX	6	GW	1	53.07019	143.33253
14.IX	7	GW	1	52.92764	143.34267
14.IX	7	GW	1	52.92722	143.34131
14.IX	7	GW	1	52.89087	143.34880
14.IX	8	GW	1	52.89700	143.32179
14.IX	8	GW	1	52.86350	143.37907
14.IX	8	GW	1	52.85810	143.37393
14.IX	8	GW	1	52.83529	143.40778
15.IX	8	GW	1	52.85344	143.33657
15.IX	8	GW	2	52.84444	143.34708
15.IX	8	GW	1	52.82598	143.39187
15.IX	8	GW	1	52.85179	143.36503
15.IX	8	GW	2	52.85587	143.37121
15.IX	8	GW	1	52.87980	143.36757
15.IX	8	GW	1	52.88669	143.35646
15.IX	8	GW	1	52.90351	143.32128
20.IX	4	GW	2	53.15054	143.28118
20.IX	4	GW	1	53.14555	143.28184
20.IX	4	GW	2	53.12943	143.28565
20.IX	4	GW	2	53.14371	143.27368
20.IX	5	GW	2	53.13936	143.27321
20.IX	5	GW	1	53.13461	143.28819
20.IX	5	GW	2	53.13301	143.29025
20.IX	5	GW	1	53.11725	143.29296
20.IX	5	GW	1	53.11609	143.29175
20.IX	6	GW	1	53.08627	143.28498
20.IX	6	GW	1	53.09148	143.30873
20.IX	6	GW	1	53.03309	143.30218
20.IX	7	GW	1	52.93772	143.32619
20.IX	8	GW	1	52.90921	143.32502
20.IX	8	GW	1	52.90290	143.32853
20.IX	8	GW	1	52.87597	143.33417
20.IX	8	GW	1	52.82045	143.37860

1	2	3	4	5	6
21.IX	8	GW	1	52.85853	143.33126
21.IX	8	GW	2	52.84363	143.34392
21.IX	8	GW	2	52.88437	143.35093
21.IX	8	GW	1	52.88681	143.36643
21.IX	8	GW	2	52.91284	143.42214
21.IX	8	GW	2	52.91708	143.41815
21.IX	8	GW	2	52.89700	143.32179
21.IX	7	GW	1	52.95582	143.33463
21.IX	7	GW	1	52.98542	143.32684
21.IX	6	GW	2	53.00089	143.31862
21.IX	6	GW	1	53.06617	143.32643
21.IX	6	GW	1	53.08908	143.31753
21.IX	6	GW	1	53.13170	143.36189
21.IX	5	GW	4	53.11435	143.33445
21.IX	5	GW	1	53.12261	143.33672
21.IX	5	GW	1	53.14855	143.27589
21.IX	5	GW	1	53.15224	143.27519
21.IX	5	GW	1	53.14210	143.27229
21.IX	4	GW	2	53.14371	143.27368
21.IX	4	GW	3	53.14993	143.29396
21.IX	4	GW	1	53.15428	143.33400
21.IX	4	GW	1	53.19651	143.26517
21.IX	4	GW	1	53.20359	143.25326
21.IX	3	GW	3	53.17510	143.27695
21.IX	3	GW	1	53.17366	143.26915
27.IX	4	GW	1	53.20871	143.31047
27.IX	4	GW	1	53.12840	143.33443
27.IX	4	GW	1	53.14555	143.28184
27.IX	5	GW	2	53.12611	143.33681
27.IX	6	GW	1	53.06542	143.28856
27.IX	6	GW	1	53.07065	143.30532
27.IX	6	GW	2	53.05902	143.29390
27.IX	8	GW	1	52.90721	143.33793
27.IX	8	GW	1	52.89299	143.36287
27.IX	8	GW	1	52.89207	143.36357
27.IX	8	GW	1	52.88003	143.35158
27.IX	8	GW	1	52.85085	143.36335

Astokh–Chayvo Area

1	2	3	4	5	6
25.VI	12	GW	2	52.54457	143.33518
25.VI	12	GW	1	52.58401	143.33962
25.VI	11	GW	1	52.60609	143.34444
25.VI	11	GW	1	52.62295	143.35364
25.VI	11	GW	1	52.65463	143.34529
25.VI	11	GW	1	52.67620	143.33638
25.VI	11	GW	1	52.68724	143.34181
25.VI	10	GW	2	52.73853	143.33556
25.VI	10	GW	1	52.73719	143.34558
3.VII	13	GW	2	52.49171	143.31593
3.VII	13	GW	1	52.49735	143.32224
3.VII	12	GW	1	52.51977	143.31682
3.VII	12	GW	2	52.52052	143.32448
3.VII	12	GW	2	52.59465	143.33167
3.VII	11	GW	1	52.62284	143.33429
3.VII	11	GW	1	52.64611	143.33629
3.VII	11	GW	3	52.65355	143.33192
3.VII	11	GW	1	52.65379	143.32968
3.VII	11	GW	1	52.67057	143.33137
3.VII	10	GW	1	52.75379	143.33447
3.VII	10	GW	3	52.75358	143.33265
1	**2**	**3**	**4**	**5**	**6**
3.VII	10	GW	2	52.76867	143.34337
3.VII	9	GW	1	52.85380	143.34086
3.VII	9	GW	1	52.84895	143.33812
4.VII	9	GW	1	52.85362	143.34222
4.VII	9	GW	1	52.85291	143.34624
4.VII	9	GW	1	52.85195	143.35011
4.VII	9	GW	1	52.83098	143.35538
4.VII	10	GW	1	52.71294	143.33945
4.VII	10	GW	1	52.71208	143.33355
4.VII	11	GW	1	52.67463	143.34224
4.VII	11	GW	1	52.65079	143.33648
4.VII	11	GW	1	52.64326	143.33556
4.VII	12	GW	1	52.56062	143.34019
4.VII	12	GW	2	52.55623	143.32675
4.VII	12	GW	1	52.53724	143.32568
4.VII	12	GW	1	52.51977	143.31682
4.VII	13	GW	1	52.51360	143.31614

1	2	3	4	5	6
4.VII	13	GW	1	52.48938	143.32005
4.VII	13	GW	2	52.47515	143.31179
4.VII	13	GW	1	52.47804	143.33086
5.VII	13	GW	1	52.48266	143.30774
5.VII	13	GW	1	52.48533	143.30885
5.VII	13	GW	1	52.48488	143.30339
5.VII	12	GW	1	52.53483	143.33072
5.VII	12	GW	1	52.54356	143.33356
5.VII	12	GW	1	52.54733	143.33091
5.VII	12	GW	1	52.55488	143.34784
5.VII	12	GW	1	52.57320	143.34631
5.VII	12	GW	1	52.57775	143.33019
5.VII	12	GW	1	52.59578	143.32529
5.VII	11	GW	2	52.62565	143.34260
5.VII	10	GW	2	52.73849	143.32986
5.VII	10	GW	1	52.74429	143.33260
5.VII	10	GW	1	52.76353	143.34059
5.VII	10	GW	1	52.75622	143.33217
5.VII	10	GW	1	52.76407	143.33910
5.VII	9	GW	1	52.82037	143.33970
7.VII	12	GW	1	52.52140	143.32983
7.VII	12	GW	1	52.54711	143.33060
7.VII	12	GW	1	52.55402	143.32914
7.VII	12	GW	1	52.59486	143.33062
7.VII	11	GW	1	52.64526	143.34197
7.VII	11	GW	1	52.65927	143.33436
11.VII	13	GW	1	52.48852	143.31075
11.VII	13	GW	1	52.51187	143.32227
11.VII	12	GW	3	52.52067	143.32556
11.VII	12	GW	1	52.57204	143.32993
11.VII	12	GW	1	52.60458	143.34841
11.VII	12	GW	2	52.58668	143.33181
11.VII	12	GW	2	52.59442	143.33271
11.VII	11	GW	1	52.60366	143.33006
11.VII	11	GW	1	52.65121	143.33823
11.VII	11	GW	1	52.65788	143.34186
11.VII	11	GW	1	52.67600	143.33724
11.VII	11	GW	1	52.68794	143.33825
11.VII	11	GW	1	52.72037	143.33826

1	2	3	4	5	6
11.VII	10	GW	1	52.71208	143.33355
11.VII	10	GW	1	52.71351	143.34234
11.VII	10	GW	1	52.73209	143.34570
11.VII	10	GW	1	52.73773	143.34136
11.VII	9	GW	1	52.79677	143.34036
17.VII	13	GW	1	52.47918	143.31214
17.VII	13	GW	1	52.48745	143.31282
17.VII	11	GW	1	52.63310	143.35400
17.VII	11	GW	1	52.67674	143.33378
18.VII	13	GW	2	52.48938	143.32005
18.VII	12	GW	2	52.54213	143.32444
18.VII	12	GW	2	52.52846	143.35111
18.VII	12	GW	1	52.56481	143.33541
18.VII	12	GW	1	52.56606	143.33751
21.VII	13	GW	2	52.48470	143.30381
21.VII	13	GW	1	52.48505	143.30296
21.VII	13	GW	1	52.48831	143.30158
21.VII	12	GW	3	52.52723	143.31741
21.VII	12	GW	1	52.53257	143.32081
21.VII	12	GW	1	52.53892	143.32067
21.VII	12	GW	1	52.54933	143.31823
21.VII	12	GW	1	52.54918	143.31772
21.VII	12	GW	1	52.54996	143.31995
21.VII	11	GW	1	52.63531	143.32572
21.VII	11	GW	1	52.63548	143.32635
21.VII	11	GW	1	52.63669	143.32683
21.VII	10	GW	1	52.73047	143.32980
21.VII	10	GW	1	52.74163	143.33040
21.VII	10	GW	1	52.74515	143.33375
21.VII	10	GW	3	52.74711	143.33329
21.VII	10	GW	2	52.74855	143.33435
21.VII	10	HP	1	52.74807	143.33049
21.VII	10	GW	2	52.75006	143.33333
22.VII	13	GW	1	52.48114	143.30586
22.VII	13	GW	1	52.48726	143.30464
22.VII	12	GW	1	52.52760	143.32095
22.VII	12	GW	2	52.55270	143.32435
22.VII	12	GW	1	52.55287	143.32832
22.VII	12	GW	1	52.55885	143.33343
24.VII	13	HP	1	52.47105	143.29330

1	2	3	4	5	6
24.VII	13	GW	1	52.47816	143.29978
24.VII	12	GW	1	52.56059	143.32044
24.VII	12	GW	1	52.56995	143.32283
24.VII	12	GW	2	52.57384	143.31913
24.VII	12	GW	2	52.57554	143.31951
24.VII	11	GW	2	52.62838	143.32476
24.VII	11	GW	1	52.63501	143.32443
24.VII	11	GW	3	52.63270	143.32615
24.VII	11	GW	2	52.65083	143.32800
24.VII	10	GW	3	52.74677	143.33271
24.VII	10	GW	2	52.75641	143.33161
24.VII	10	GW	1	52.75305	143.32618
24.VII	9	GW	2	52.81965	143.33529
24.VII	9	GW	1	52.81157	143.34041
24.VII	9	GW	2	52.82528	143.33985
24.VII	9	GW	3	52.82671	143.33915
24.VII	9	GW	1	52.82662	143.34029
24.VII	9	GW	1	52.84085	143.34139
24.VII	9	GW	2	52.84524	143.34080
1.VIII	12	GW	1	52.53280	143.32228
1.VIII	12	GW	1	52.53306	143.32373
1.VIII	12	GW	2	52.54627	143.32572
1.VIII	12	GW	1	52.54813	143.32383
1.VIII	12	GW	1	52.54483	143.33557
1.VIII	12	GW	2	52.59465	143.33167
1.VIII	11	GW	2	52.63464	143.32781
1.VIII	11	GW	1	52.63587	143.33462
1.VIII	11	GW	1	52.63281	143.34535
1.VIII	11	GW	1	52.65020	143.33684
1.VIII	11	GW	3	52.67757	143.32846
1.VIII	11	GW	3	52.68923	143.32852
1.VIII	10	GW	2	52.71178	143.33055
1.VIII	10	GW	3	52.72678	143.32782
1.VIII	10	GW	1	52.72180	143.33128
1.VIII	10	GW	2	52.72703	143.33009
1.VIII	10	GW	1	52.74731	143.34124
1.VIII	10	GW	0	52.79102	143.39720
1.VIII	10	GW	1	52.76560	143.35050
1.VIII	10	GW	2	52.75458	143.33027
1.VIII	10	GW	3	52.78126	143.33230

1	2	3	4	5	6
1.VIII	10	GW	1	52.77181	143.32677
1.VIII	10	GW	2	52.78166	143.32627
1.VIII	9	GW	1	52.79649	143.33163
1.VIII	9	GW	1	52.82374	143.34268
1.VIII	9	GW	1	52.82334	143.34404
1.VIII	9	GW	1	52.82696	143.34784
1.VIII	9	GW	1	52.83025	143.35263
1.VIII	9	GW	1	52.86356	143.33915
5.VIII	13	GW	2	52.47059	143.29502
5.VIII	13	GW	2	52.47798	143.30971
5.VIII	13	GW	1	52.47872	143.30594
5.VIII	13	GW	2	52.49447	143.30930
5.VIII	12	GW	1	52.58310	143.32499
5.VIII	12	GW	3	52.54349	143.32273
5.VIII	12	GW	1	52.54507	143.33119
5.VIII	12	GW	2	52.55058	143.32589
5.VIII	12	GW	1	52.56347	143.33626
5.VIII	12	GW	2	52.57805	143.31716
5.VIII	12	GW	1	52.57196	143.31392
5.VIII	12	GW	1	52.53815	143.31501
5.VIII	12	GW	1	52.47242	143.33199
5.VIII	12	GW	2	52.53579	143.31818
6.VIII	13	GW	1	52.49697	143.32301
6.VIII	12	GW	1	52.52697	143.31205
6.VIII	12	GW	2	52.53236	143.31934
6.VIII	12	GW	1	52.54511	143.32284
6.VIII	12	GW	3	52.57461	143.32339
6.VIII	12	GW	1	52.56741	143.31713
6.VIII	12	GW	1	52.57487	143.32244
6.VIII	12	GW	1	52.57706	143.32272
6.VIII	12	GW	1	52.57993	143.32246
6.VIII	12	GW	2	52.58065	143.31802
6.VIII	11	GW	1	52.60465	143.33735
6.VIII	11	GW	1	52.62221	143.33154
6.VIII	11	GW	1	52.61817	143.34244
6.VIII	11	GW	1	52.66901	143.33744
6.VIII	10	GW	1	52.73540	143.33212
6.VIII	10	GW	2	52.74358	143.33136
6.VIII	10	GW	1	52.74167	143.33733
6.VIII	10	GW	1	52.75410	143.34296

1	2	3	4	5	6
6.VIII	10	GW	1	52.75781	143.33751
6.VIII	10	GW	1	52.76052	143.33800
6.VIII	10	GW	1	52.76242	143.33153
6.VIII	10	GW	1	52.76083	143.32506
6.VIII	10	GW	1	52.75909	143.32443
6.VIII	9	GW	2	52.81105	143.33442
6.VIII	9	GW	2	52.82330	143.33349
6.VIII	9	GW	1	52.82452	143.33803
6.VIII	9	GW	2	52.82486	143.34285
6.VIII	9	GW	1	52.82667	143.34272
6.VIII	9	GW	2	52.82889	143.34409
6.VIII	9	GW	1	52.83453	143.34693
6.VIII	9	GW	1	52.84883	143.33920
6.VIII	9	GW	1	52.85388	143.34017
6.VIII	9	GW	1	52.84909	143.33648
7.VIII	9	GW	2	52.84076	143.34170
7.VIII	9	GW	1	52.83610	143.34335
7.VIII	9	GW	1	52.83260	143.34671
7.VIII	9	GW	1	52.81511	143.34134
7.VIII	9	GW	1	52.81887	143.33925
7.VIII	9	GW	1	52.79695	143.34228
7.VIII	9	GW	1	52.81671	143.33634
7.VIII	9	GW	1	52.79677	143.34036
7.VIII	9	GW	1	52.82066	143.33479
7.VIII	9	GW	1	52.81105	143.33442
7.VIII	9	GW	2	52.82066	143.33122
7.VIII	10	GW	1	52.75972	143.33222
7.VIII	10	GW	1	52.76472	143.33705
7.VIII	10	GW	3	52.76390	143.33960
7.VIII	10	GW	1	52.75642	143.33570
7.VIII	10	GW	1	52.73908	143.33646
7.VIII	11	GW	2	52.65607	143.33270
7.VIII	11	GW	1	52.65543	143.33378
7.VIII	11	GW	1	52.64771	143.33263
7.VIII	11	GW	1	52.64426	143.34178
7.VIII	11	GW	1	52.62650	143.33110
7.VIII	11	GW	1	52.61621	143.33487
7.VIII	11	GW	1	52.62194	143.33014
7.VIII	11	GW	1	52.61532	143.32958
7.VIII	11	GW	2	52.61509	143.32779

1	2	3	4	5	6
7.VIII	12	GW	1	52.56654	143.32309
7.VIII	12	GW	1	52.56473	143.32310
7.VIII	12	GW	2	52.55253	143.32533
7.VIII	12	GW	1	52.55227	143.32386
7.VIII	12	GW	1	52.54136	143.32902
7.VIII	12	GW	1	52.53927	143.32232
7.VIII	13	GW	1	52.46708	143.29295
7.VIII	13	GW	1	52.46611	143.29344
7.VIII	13	GW	1	52.46109	143.30062
8.VIII	13	MW	1	52.46970	143.30688
8.VIII	13	GW	1	52.48687	143.30562
8.VIII	13	GW	1	52.48995	143.30744
8.VIII	13	GW	1	52.49979	143.31650
8.VIII	13	GW	1	52.49038	143.30629
8.VIII	13	GW	1	52.50010	143.31564
8.VIII	13	GW	1	52.49116	143.30391
8.VIII	13	GW	2	52.54320	143.34113
8.VIII	13	GW	3	52.54377	143.33902
8.VIII	12	GW	1	52.50645	143.31152
8.VIII	12	GW	2	52.52771	143.32183
8.VIII	12	GW	1	52.53724	143.32568
8.VIII	12	GW	2	52.54345	143.32798
8.VIII	12	GW	1	52.55168	143.32571
8.VIII	12	GW	1	52.55491	143.34344
8.VIII	12	GW	1	52.55561	143.34361
8.VIII	12	GW	1	52.58690	143.33099
8.VIII	12	GW	2	52.60673	143.34023
8.VIII	11	GW	2	52.60465	143.33735
8.VIII	11	GW	1	52.62378	143.33760
8.VIII	11	GW	1	52.66636	143.34421
8.VIII	11	GW	1	52.68643	143.34530
8.VIII	11	GW	1	52.65781	143.32402
8.VIII	11	GW	1	52.68814	143.33705
8.VIII	11	GW	1	52.72037	143.33826
8.VIII	10	GW	2	52.72837	143.33665
8.VIII	10	GW	1	52.72459	143.34353
8.VIII	10	GW	1	52.74955	143.34296
8.VIII	10	GW	2	52.75540	143.33758
8.VIII	10	GW	1	52.77751	143.35043
8.VIII	10	GW	2	52.77807	143.34863

1	2	3	4	5	6
8.VIII	10	GW	2	52.80465	143.36430
8.VIII	10	GW	1	52.80860	143.34345
8.VIII	9	GW	1	52.79742	143.34609
8.VIII	9	GW	1	52.80788	143.37476
8.VIII	9	GW	1	52.82531	143.34657
8.VIII	9	GW	1	52.82486	143.35771
8.VIII	9	GW	2	52.83617	143.34989
8.VIII	9	GW	2	52.83861	143.34672
8.VIII	9	GW	1	52.84164	143.35098
8.VIII	9	GW	1	52.83889	143.34622
8.VIII	9	GW	1	52.84444	143.35385
8.VIII	9	GW	1	52.83930	143.34544
8.VIII	9	GW	3	52.88901	143.35977
8.VIII	9	GW	1	52.89109	143.33892
9.VIII	13	GW	2	52.51108	143.32464
9.VIII	13	GW	1	52.51187	143.32227
9.VIII	13	GW	2	52.51360	143.31614
9.VIII	12	GW	1	52.52038	143.32339
9.VIII	12	GW	1	52.52084	143.32663
9.VIII	12	GW	1	52.52797	143.32357
9.VIII	12	GW	1	52.53462	143.33004
9.VIII	12	GW	1	52.53505	143.33138
9.VIII	12	GW	1	52.54285	143.33227
9.VIII	12	GW	3	52.57854	143.32790
9.VIII	12	GW	2	52.58711	143.33016
9.VIII	11	GW	1	52.61458	143.32052
9.VIII	11	GW	2	52.60426	143.33494
9.VIII	11	GW	1	52.62443	143.33953
9.VIII	11	GW	1	52.66921	143.33679
9.VIII	11	GW	2	52.66959	143.33546
9.VIII	11	GW	1	52.67558	143.33893
9.VIII	11	GW	1	52.67657	143.33465
9.VIII	11	GW	2	52.68814	143.33705
9.VIII	11	GW	1	52.68884	143.33220
9.VIII	10	GW	1	52.75496	143.35296
9.VIII	10	GW	1	52.76342	143.35412
9.VIII	10	GW	2	52.76725	143.34707
9.VIII	10	GW	1	52.77751	143.35043
9.VIII	10	GW	1	52.77953	143.34305
9.VIII	10	GW	1	52.77188	143.32531

1	2	3	4	5	6
9.VIII	9	GW	1	52.81957	143.33194
9.VIII	9	GW	2	52.76915	143.32702
9.VIII	9	GW	1	52.81792	143.34969
9.VIII	9	GW	2	52.83486	143.34861
9.VIII	9	GW	1	52.83534	143.34817
9.VIII	9	GW	1	52.84124	143.35865
9.VIII	9	GW	1	52.83737	143.34854
9.VIII	9	GW	1	52.83965	143.34895
9.VIII	9	GW	1	52.83982	143.33991
9.VIII	9	GW	1	52.85362	143.34222
9.VIII	9	GW	1	52.85388	143.34017
9.VIII	9	GW	1	52.86356	143.33915
10.VIII	13	GW	1	52.45607	143.29395
10.VIII	13	GW	1	52.46020	143.30773
10.VIII	13	GW	1	52.46924	143.30298
10.VIII	13	GW	1	52.47185	143.30666
10.VIII	13	GW	2	52.51328	143.31739
10.VIII	12	GW	1	52.52740	143.31919
10.VIII	12	GW	2	52.53236	143.31934
10.VIII	12	GW	1	52.54865	143.32975
10.VIII	12	GW	2	52.55097	143.33011
10.VIII	12	GW	1	52.55870	143.32802
10.VIII	12	GW	2	52.56053	143.33313
10.VIII	12	GW	1	52.58202	143.34389
10.VIII	11	GW	1	52.63226	143.33135
10.VIII	11	GW	1	52.63671	143.33277
10.VIII	11	GW	1	52.64136	143.33279
10.VIII	11	GW	2	52.67705	143.33203
10.VIII	11	GW	1	52.67800	143.32394
10.VIII	10	GW	2	52.72210	143.33341
10.VIII	10	GW	1	52.72796	143.33506
10.VIII	10	GW	1	52.75056	143.33390
10.VIII	10	GW	2	52.75328	143.33128
10.VIII	9	GW	1	52.82545	143.33619
10.VIII	9	GW	1	52.81550	143.34306
10.VIII	9	GW	1	52.81322	143.36155
10.VIII	9	GW	1	52.82346	143.34423
10.VIII	9	GW	1	52.82598	143.34421
10.VIII	9	GW	1	52.83331	143.36411
10.VIII	9	GW	3	52.83703	143.37129

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11.VIII	12	GW	4	52.56733	143.33314
11.VIII	12	GW	1	52.59281	143.33881
11.VIII	12	GW	2	52.59339	143.33681
11.VIII	12	GW	1	52.60572	143.34437
11.VIII	12	GW	2	52.59465	143.33167
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11.VIII	11	GW	1	52.61792	143.34163
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11.VIII	11	GW	1	52.60871	143.35342
11.VIII	11	GW	1	52.61206	143.36171
11.VIII	11	GW	2	52.66837	143.33937
11.VIII	11	GW	1	52.67558	143.33893
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11.VIII	11	GW	1	52.66234	143.32294
11.VIII	10	GW	2	52.75192	143.34895
11.VIII	10	GW	1	52.76241	143.35553
11.VIII	10	GW	1	52.75810	143.34279
11.VIII	9	GW	3	52.82060	143.33314
11.VIII	9	GW	1	52.82151	143.33462
11.VIII	9	GW	1	52.82627	143.34926
11.VIII	9	GW	1	52.83597	143.34753
11.VIII	9	GW	2	52.84617	143.36286
15.VIII	11	GW	1	52.65224	143.36967
15.VIII	11	GW	1	52.68614	143.34645
15.VIII	10	GW	3	52.72917	143.33922
15.VIII	10	GW	1	52.72953	143.34022
15.VIII	9	GW	2	52.82060	143.33342
15.VIII	9	GW	2	52.82348	143.33563
15.VIII	9	GW	1	52.84219	143.34996
15.VIII	9	GW	1	52.84036	143.33731
24.VIII	13	GW	2	52.49171	143.31593
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25.VIII	10	GW	2	52.72150	143.32840
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26.VIII	9	GW	1	52.83687	143.34915

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13.IX	9	GW	1	52.83331	143.36411
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15.IX	9	GW	1	52.82295	143.33866
15.IX	9	GW	1	52.80646	143.34103
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20.IX	9	GW	1	52.82084	143.34524
20.IX	9	GW	1	52.82563	143.34383
20.IX	9	GW	1	52.82629	143.34336
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21.IX	9	GW	1	52.84497	143.34210
21.IX	9	GW	1	52.84880	143.35834
21.IX	9	GW	2	52.85938	143.42170
21.IX	9	GW	2	52.83398	143.43386
21.IX	9	GW	1	52.82963	143.35261
21.IX	9	GW	1	52.82778	143.35224
21.IX	9	GW	1	52.82513	143.35785
21.IX	9	GW	1	52.79664	143.33843
21.IX	12	GW	1	52.50861	143.33495
27.IX	13	GW	1	52.49407	143.32814
27.IX	13	GW	1	52.51108	143.32464
27.IX	12	GW	1	52.53793	143.32805
27.IX	12	GW	1	52.54136	143.32902
27.IX	12	GW	1	52.54592	143.33705
27.IX	10	GW	2	52.80224	143.37250
27.IX	9	GW	1	52.82097	143.34551
27.IX	9	GW	1	52.81260	143.38051

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CHAPTER 2

PHOTOGRAPHIC IDENTIFICATION OF THE KOREAN-OKHOTSK GRAY WHALE (ESCHRICHTIUS ROBUSTUS) OFFSHORE NORTHEASTERN SAKHALIN ISLAND AND SOUTHEASTERN SHORE OF KAMCHATKA PENINSULA, 2009 RESULTS AND DISCUSSION[3]

Photo taken by V. Vertyankin

Yuri Yakovlev[a], Olga Turneyva[a], Vladimir Vertyankin[b], Glenn Gailey[c], Olga Sychenko[c], Judy Muir[d] and Christina Tombach Wright[d]

Prepared for

Exxon Neftegas Limited and Sakhalin Energy Investment Company Limited

March 2010

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[3] Chapter 2 *In:* 2010. Western gray whale research and monitoring program in 2009, Sakhalin Island, Russia. Volume II Results and Discussion

RUSSIAN ACADEMY OF SCIENCE
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Academician of the Russian Academy of Sciences

_____ A.V.Adrianov

REPORT
ON THE RESEARCH PROJECT

PHOTOGRAPHIC IDENTIFICATION OF THE KOREAN-OKHOTSK GRAY WHALE (*ESCHRICHTIUS ROBUSTUS*) OFFSHORE NORTHEASTERN SAKHALIN ISLAND AND SOUTHEASTERN SHORE OF KAMCHATKA PENINSULA, 2009

RESULTS AND DISCUSSION

VLADIVOSTOK
2010

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LIST OF FIGURES

Figure 1. Percentage of Animals in Groups Relative to the Total Number of Whales Sighted and Photographed Offshore Sakhalin, 2002-2009, (Field Data) 118
Figure 2. Whale Movement within the Known Feeding Areas Offshore North-East Sakhalin Island in the Summer/Autumn Season 2009 122
Figure 3. Percentage of Photo-identified Gray Whales within Each Body Condition (BC) Class Relative to the Total Number of Whales Sighted Offshore Sakhalin Island Averaged over 7-day Periods during the 2009 Field Season Offshore Sakhalin Island 127
Figure 4. Gray Whales Identified in Vestnik Bay (Kamchatka) for Each Day of Research during the 2009 Field Season. 132
Figure 5. Gray Whales Identified in the Vestnik and Olga Bays in 2009 133
Figure 6. Annual Number of Identified Gray Whales in Olga Bay (Kamchatka) 134
Figure 7. Number of Identified Whales in the Olga Bay (Kamchatka) per Day of Research in the 2009 Field Season 135
Figure 8. Recording of New Whales in the Olga Bay (Kamchatka) in 2009 136
Figure 9. Identification of the Gray whale Stranded Onshore of the Beach in the Chayvo Bay in 2009 141

LIST OF TABELS

Table 1. Photo-ID Works (Counted by Days) in Expeditions Offshore Sakhalin Island, 2002-2009 111
Table 2. Photo-ID Effort (Days) and Number of Photographs Taken Offshore Sakhalin from the *Zodiac* in 2009 112
Table 3. Descriptive Statistics of Photo-ID Work Carried out from the *Zodiac* during the 2009 Expedition to Sakhalin Island 114
Table 4. . Numbers of Whales Identified during 2002-2009 Offshore North-East Sakhalin Island 115
Table 5. Assessment of Photographic Coverage of Four Standard Aspects of Gray Whale Sightings Identified from 2002-2009 Offshore Sakhalin Island 116
Table 6. Gray Whale Group Size and Sighting Rates in Known Feeding Areas, Based on Photographs Taken Only from the Zodiac Offshore Sakhalin in 2003-2009 119
Table 7. Whale Movement among the Feeding Areas 2002-2009 Offshore North-East Sakhalin 122
Table 8. Frequency of Repeat Sightings of Identified Gray Whales (IDW) in 2009 North-East Sakhalin (the Presented Results are Based only on the Data Obtained by the Vessel-based Photo Identification Team) 124
Table 9. Inter and Intra-year Frequency of Sightings of Identified Gray Whales (IDW) North-East Sakhalin, 2002-2009 125
Table 10. Occurrence of Cow/calf Pairs and Calves Encountered without Mothers near Sakhalin Island Based on Data Provided by Two Teams (Shore-Based Behaviour Team BT and Vessel-based Photo Identification Team VT) with the Assigned Reliability Grades 126

Table 11. Body Condition (BC) Classes for the Whales Sighted offshore Sakhalin, 2003-2009 129
Table 12. Inter-year Comparison of the Body Condition of Cows and Calves Offshore North-Eastern Sakhalin, 2008-2009 130
Table 13. Number of Identified Gray Whales and Time of Work for the Whole Research Period in the Olga Bay (Kamchatka) 134
Table 14. Occurrence of Cow/calf Pairs and Calves Encountered without Mothers on the South-Eastern Shelf of the Kamchatka Peninsula with the Assigned Reliability Grades. 137

APPENDIX—FIGURES

Figure A1. Gray whale photo-ID sites along the NE coast of Sakhalin Island, 2009. 224
Figure A2. Gray whale photo-ID locations along the NE coast of Sakhalin Island in September throughout the study years, 2002 to 2009. 224
Figure A3. Boundaries of zones described in Appendix Table A6. 226
Figure A4. Locations of photo-identified gray whales off SE Kamchatka, Vestnik and Olga bays, 2009. 227

APPENDIX—TABLES

Table A1. Time spent at each gray whale sighting from the Zodiac, Sakhalin 2009 173
Table A2. Gray whale group size at each sighting in the course of photo-ID efforts from the Zodiac, Sakhalin 2009 174
Table A3. Depths recorded in the course of photo-ID efforts from the Zodiac, Sakhalin 2009 175
Table A 4. Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 176
Table A 5. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009гг. 186
Table A6. Number of encounters with identified gray whales by area off NE Sakhalin Island during the 2009 expedition. 193
Table A7. Sighting of gray whales by year, recorded sightings of cows with calves, physical body condition (PCB) class and skin condition, 2002-2009 196
Table A 8. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009гг 204
TABLE A9. Views from which individual gray whales were photographed off kamchatka Peninsula, all years 213
TABLE A10. Number of encounters with identified gray whales off Kamchatka Peninsula 2004, 2006 - 2009 гг and off Sakhalin Island 2002-2009гг. 216
TABLE A11. Occurence of gray whale from Sakhalin Catalog off Sakhalin Island and Kamchatka Peninsula in 2002-2009 220

CHAPTER 2: PHOTOGRAPHIC IDENTIFICATION

2.1 Field Effort Results

The results of the field effort are presented in this section. These results are based on unprocessed data as described in the field notes recorded during photo ID missions. Note that some numbers, particularly individual whale counts, typically change upon post processing and photo-ID matching in the laboratory where the data is based on individually identified whales.

Whales were photographed and video recorded during 13 July to 21 September 2009. The effectiveness of the photographic identification (Photo-ID) team largely depended on the weather conditions. Photo-ID effort in 2009 was often interrupted because of extended periods of fog. Photo-ID work also could not be performed while the vessel was moving to other areas for other tasks, was being sheltered against storms, or when other work was being conducted (e.g. benthic studies and acoustics) .

Table 1 contains a summary of the photo ID effort that was conducted during research vessel expeditions from 2002 to 2009. A day was counted as a survey day if a whale (or a group of whales) was photographed from either the Zodiac while conducting dedicated photo-ID surveys or opportunistically from the deck of the *Akademik Oparin* research vessel, if a gray whale was seen while the vessel was anchored or performing other research tasks. In 2009, the entire period of photographic identification activities of various intensity and duration was 25 days (including work both from the Zodiac and from the deck of the *Akademik Oparin)*. A total of 18 days were spent photographing the whales from the Zodiac. The number and duration of missions, the number of whale sightings during a mission, the number of observed whales per sighting, duration of each sighting, etc. were recorded (Table 2, Appendix A1 and A2).

Table 1. Photo-ID Effort (Counted by Days) in Expeditions Offshore Sakhalin Island, 2002-2009.

Year	Dates	Expedition Duration (Days)	Total Number of Survey Days	Time in Transit (Days) (including Stormy Days and Calls)	Ship Sheltered due to Storm (days)	Photo ID Days from Zodiac/ from Ship's Deck and Zodiac	Number of Missions (from Zodiac/ from Ship's Deck and Zodiac)	Number of Sightings from Zodiac	Number of Whales Seen from Zodiac/ from Ship's Deck	Total Number of Photos
2002	30.08 25.10	57	29	17	11	13/-	24	72	93/-	2602
2003	21.07 27.09	69	40	16	13	17/22	35	86	146/37	7482
2004	30.07 07.10	70	56	9	5	16/24	27	113	209/57	9647
2005	12.07 07.10	88	77	6	5	32/34	56	186	384/58	17600
2006	03.08 14.10	73	60	7	6	19/33	26/52	109	238/150	16703
2007	03.07 10.10	100	74	13	13	31/62	55/86	229	503/198	24230
2008	25.06 - 23.07 24.08 - 10.10	77	60	14	3	20/29	30/49	79	174/128	7713
2009	01.07 03.10	95	72	13	10	18/25	31/41	119	267/18	11146

Table 2. Photo-ID Effort (Days) and Number of Photographs Taken Offshore Sakhalin from the *Zodiac* in 2009.

No	Date	Area	Mission No.	Duration of Mission (hr: min)			Number of Photographs		
				Mission 1	Mission 2	Mission 3	Mission 1	Mission 2	Mission 3
1	13.07.2009	Piltun	1	0:34			299		
2	13.07.2009	Piltun	2		1:05			310	
3	13.07.2009	Piltun	3			0:49			118
4	16.07.2009	Piltun	1	1:01			180		
5	17.07.2009	Piltun	1	1:43			377		
6	24.07.2009	Offshore	1	2:53			1404		
7	08.08.2009	Piltun	1	0:57			150		
8	08.08.2009	Piltun	2		0:54			361	
9	08.08.2009	Piltun	3			0:43			66
10	09.08.2009	Piltun	1	0:40			110		
11	10.08.2009	Piltun	1	0:25			22		
12	11.08.2009	Piltun	1	2:51			547		
13	11.08.2009	Piltun	2		0:34			98	
14	11.08.2009	Piltun	3			2:07			568
15	25.08.2009	Piltun	1	3:40			556		
16	25.08.2009	Piltun	2		0:53			252	
17	26.08.2009	Chayvo area	1	1:28			403		
18	28.08.2009	Piltun	1	2:14			392		
19	04.09.2009	Piltun	1	1:45			310		
20	04.09.2009	Piltun	2		2:11			610	
21	13.09.2009	Piltun	1	0:35			27		
22	13.09.2009	Piltun	2		1:27			245	

No	Date	Area	Mission No.	Duration of Mission (hr: min)			Number of Photographs		
				Mission 1	Mission 2	Mission 3	Mission 1	Mission 2	Mission 3
23	14.09.2009	Piltun	1	1:18			296		
24	18.09.2009	Piltun	1	1:27			139		
25	19.09.2009	Chayvo area	2		2:17			673	
26	19.09.2009	Piltun	1	1:29			75		
27	20.09.2009	Piltun	1	4:05			423		
28	20.09.2009	Piltun	2		2:01			499	
29	20.09.2009	Piltun	3			1:34			568
30	21.09.2009	Offshore	1	1:02			51		
31	21.09.2009	Offshore	2		3:54			825	

In 2009, whales were photographed from the *Zodiac* over a total of 18 days, including 15 days in the Piltun area, 2 days in the Chayvo Bay area (note that on September 19 photo-ID was performed in the Piltun and Chayvo areas on the same day) and 2 days in the Offshore feeding area (Table 3). The Chayvo area constitutes the southern portion of the Piltun feeding area where sustained accumulations of whales were first observed in 2006 (Yakovlev et al., 2007) (Figure A4). Please refer to Chapters 1 and 3 of Volume I Background and Methods for detailed descriptions of the study area. Over the 2009 season, a total of 11,146 photographs were taken (Table 1). The total number of encountered gray whales was 285, including multiple sightings of the same whale during different missions. A total of 7,598 whale pictures were taken from the *Zodiac* in the Piltun area, 2,280 in the Offshore area and 1,076 near the Chayvo Bay. Over the whole expedition period, 192 photos were taken from the vessel deck of 18 encountered whales over a period of 6 h 34 min in total. The average number of whale sightings per day of photo-ID effort was 14.8 from the Zodiac and 1.8 sightings from the deck of the main vessel.

Table 3. Descriptive Statistics of Photo-ID Work Carried out from the *Zodiac* during the 2009 Expedition to Sakhalin Island.

Zodiac Operation Parameters	Piltun Area	Offshore Area	Chayvo Area	Total
Number of days of whales photographing	15	2	2	18*
Number of missions (and sightings)	26 (91)	3 (22)	2 (6)	31 (119)
Total number of whales sighted	182	65	20	267
Average number of whales sighted per day of survey	12.13	32.5	10	14.83
Average number of whales encountered per sighting	2.00	2.95	3.33	2.24
Total duration of sightings (hours:minutes)	23:49	5:10	2:35	31:34
Total duration of missions (hours:minutes)	39:02	7:49	3:45	50:36
Average duration of sighting (minutes)	15.70	14.09	25.83	15.92
Total number of whale photographs	7598	228	1076	10954
Average number of whale photographs per day	506.53	114.00	538.00	608.56
Average number of whale photographs per sighting	83.49	10.36	179.33	92.05
Average number of photographs per sighted whale	41.75	3.51	53.80	41.03

* On 19 September, photo ID work was conducted both in the Piltun and Chayvo areas.

Summary data on photographic and timing parameters (effort) and other survey characteristics are given in Tables A1 and A2 in the Appendix. Water depth measurements were taken at the places where whales were sighted in the Piltun, Offshore and Chayvo Bay areas (Table A3). The average water depth at whale sightings was 18.9 m in the Piltun area, 61.6 m in the Offshore area and 15.5 m in the Chayvo Bay area.

2.2 Final Photo-ID Results Post Processing

Whale counts and numbers from this point forward are based on post-processed and Photo-Identified (matched) data. These numbers may vary slightly from the field observations, but have been confirmed by the standard photo-identification techniques as described in the methods section.

2.2.1 Identification and the Numbers of Individual Animals

Of particular interest is not only the information gathered relating to new whales, but also data pertaining to whales that have been identified during previous years of observation, since these data provide more extensive and detailed information about individual animals. Data regarding the number of whales identified offshore the northeast coast of Sakhalin over the study years of 2002-2009 are given in Table 4.

Table 4. Numbers of Whales Identified during 2002-2009 Offshore North-East Sakhalin Island.

Year	Number of Whales (total for year)	First Observed in 2002	First Observed in 2003	First Observed in 2004	First Observed in 2005	First Observed in 2006	First Observed in 2007	First Observed in 2008	Number of New Whales Per Year	Number of Whales from Previous years not Sighted in Current Year	Number of Whales in Catalogue
A	B=C+D+E+F+G+H+I+J	C	D	E	F	G	H	I	J	K	L=B+K
2002	**47***								**47***		**47***
2003	**82**	**35**							**47**	**10****	**92****
2004	**96***	**39**	**33***						**24**	**22***	**118***
2005	**117****	**41**	**40***	**18**					**18****	**19**	**136**
2006	**121(5)[1]**	**42**	**37**	**15**	**14**				**13(5)**	**27**	**148(5)****
2007	**125(3)****	**40**	**39**	**16**	**10**	**7**			**13(3)****	**35(5)**	**160(8)****
2008	**98**	**33**	**33**	**17**	**5**	**3**	**2**		**5**	**67(8)****	**165(8)****
2009***	**117 total 111 VT + 6[2] BT**	**35 tot 33 VT +2 BT**	**36**	**17 tot 16 VT +1 BT**	**8**	**5 tot 4 VT +1 BT**	**3**	**1**	**12 tot 10 VT +2 BT**	**60(8)**	**177(8) total 175 VT +2 BT**

**Indicates that a better quality photograph was obtained and a temporary whale was matched during this field & laboratory season. The matched whale is added to the annual catalogue for the year in which the whale was first recorded as a temporary.*

*** Indicates that a better quality photograph was obtained and an internal match was made during this field & laboratory season. The temporary whale was found to match an already existing individual in the catalogue. The temporary whale sighting history was added to the annual catalogue for the year in which the matched individual was first recorded.*

****In 2009 data from the shore-based behavioural team (BT) was added as supplementary to the vessel team (VT)*

[1] *Given in parentheses are counts of individual animals issued a temporary identification number (Appendix A7).*

[2] *BT values indicate the number of individual animals recorded by the behaviour team and not encountered by the vessel-based (VT) photo identification team.*

With each subsequent year we obtain a more complete description of each individual as well as a more current catalogue of the Korean-Okhotsk gray whale population. This annual updating of the catalogue allows us to improve the matching process, as the number of known individuals in the catalogue increases and the chance of finding a whale not already in the catalogue decreases.

Not every whale in the catalogue is described by all four aspects (the right side, the left side, the dorsal fluke and the ventral fluke). The likelihood of obtaining complete coverage of all the four aspects of each whale increases each year as more photographs are added to the catalogue. Table 5 and Appendix Table A4 present data for all the years of observations and include the total number of aspects photographed per whale over all the years of observations.

Table 5. Assessment of Photographic Coverage of Four Standard Aspects of Gray Whale Sightings Identified from 2002-2009 Offshore Sakhalin Island.

2002	Number	17	3	9	18	**47[a]**
	%	36.17%	6.38%	19.15%	38.30	
2003	Number	42	11	21	8	**82**
	%	51.22%	13.41%	25.61%	9.76%	
2004	Number	52	12	26	6	**96[b]**
	%	54.17%	12.50%	27.08%	6.25%	
2005	Number	53	13	47	4	**117[c]**
	%	45.30%	11.11%	40.17%	3.42%	
2006	Number	59	16	40	11	**126[d]**
	%	46.83%	12.70%	31.75%	8.73%	
2007	Number	75	16	34	3	**128[e]**
	%	58.59%	12.50%	26.56%	2.34%	
2008	Number	41	15	31	11	**98[f]**
	%	41.84%	15.31%	31.63%	11.22%	
2009	Number	55	7	42	13	**117[g]**
	%	47.01	5.98	35.90	11.11	
2002-2009	Number	122	13	42	8*	**185[h]**
	%	65.95%	7.03%	22.70%	4.32%	

[a] Two whales photographed in 2002 were temporary whales that were issued catalogue ID #'s in 2009 increasing the total from 45 to 47 individuals included in the catalogue.
[b] One whale photographed in 2004 was a temporary whale that was issued a catalogue ID # in 2009 increasing the total from 95 to 96 individuals included in the catalogue.
[c] One whale photographed in 2005 was a temporary whale that was matched to a current catalogue whale decreasing the total from 118 to 117 individuals included in the catalogue.
[d] Five whales photographed in 2006 were temporary whales for a total of 126 whales sighted with 121 individuals included in the catalogue
[e] Three whales photographed in 2007 were temporary whales for a total of 128 whales sighted with 125 individuals included in the catalogue.
[f] In 2008 there were no temporary whales were photographed for a total of 98 whales, with 98 individuals included in the catalogue.
[g] In 2009, no temporary whales were photographed, so there are a total of 117 whales in catalogues including whales photographed only by the behaviour team.
[h] In 2002-2009, eight temporary whales were photographed for a total of 185 whales, with 177 animals included in the main catalogue.
** Of these 8 temporary whales that have only one photographed aspect, three individuals had their right side photo included in the annual catalogue. The other five animals were catalogued with only their left side photographs. All of them were assigned temporary numbers because of the lack of a high-quality right- side photo.*

Calves rarely showed their flukes, hence generally only their sides were photographed (Yakovlev and Tyurneva, 2003). Over all the years of observations, no cow/calf pair has been sighted in the Offshore feeding area. Whales feeding in deeper waters showed their flukes more frequently than whales in the shallow Piltun area.

As a result of photo-ID effort in 2002-2009, the current catalogue of western gray whales of the Marine Biology Institute of the Far Eastern branch of the Russian Academy of Sciences (MBI FEB RAS) contains 177 identified whales that are either fully (with all four aspects) or otherwise well described (two or three aspects) plus 8 temporary whales (Table A4).

2.2.2 Whale Group Size

In 2009, the observed group sizes of whales changed compared to previous years. As was the case in 2008, the percentage of solitary individuals in 2009 was less than in 2007 and previous years. On the other hand, the number of groups with three to four individuals grew in 2009 compared to 2007 and 2008, with much higher percentages of observed groups of three in 2009 than any other study year. In 2007 and 2009, large groups consisting of 12 and 11 whales respectively were recorded. Data on group sizes in 2009 and previous years are given in Table 6 and in Figure 1.

Figure 1. Percentage of Animals in Groups Relative to the Total Number of Whales Sighted and Photographed Offshore Sakhalin, 2002-2009, (Field Data).

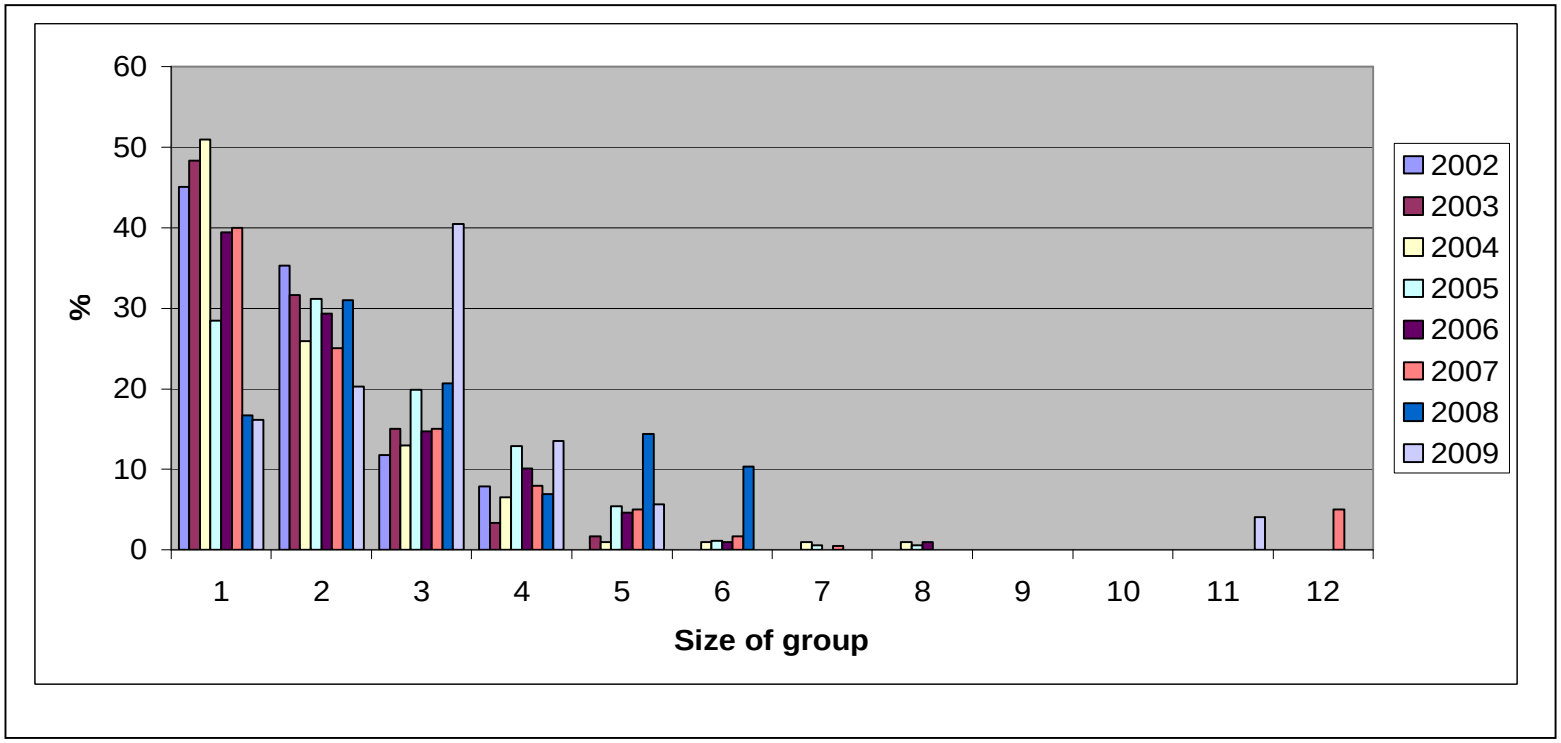


Table 6. Gray Whale Group Size and Sighting Rates in Known Feeding Areas, Based on Photographs Taken Only from the Zodiac Offshore Sakhalin in 2003-2009.

	Number of Groups in 2003	% Sighted in 2003	Number of Groups in 2004	% Sighted in 2004	Number of Groups in 2005	% Sighted in 2005	Number of Groups in 2006	% Sighted in 2006	Number of Groups in 2007	% Sighted in 2007	Number of Groups in 2008	% Sighted in 2008	Number of Groups in 2009	% Sighted in 2009
All areas														
1	58	48.33	55	50.93	52	28.11	43	39.45	96	40	28	35.9	43	36.13
2	38	31.66	28	25.93	57	30.81	32	29.36	60	25	27	34.6	27	22.69
3	18	15	14	12.96	37	20	16	14.68	36	15	12	15.4	36	30.25
4	4	3.33	0	6.48	25	13.51	11	10.09	19	7.91	3	3.8	9	7.56
5	2	1.66	0	0.93	10	5,41	5	4.59	12	5	5	6.4	3	2.52
6	0	0	0	0.93	2	1.08	1	0.92	4	1.66	3	3.8	0	0
7	0	0	0	0.93	1	0.54	0	0	1	0.41	0	0	0	0
8	0	0	0	0.93	1	0.54	1	0.92	0	0	0	0	0	0
11												0	1	0.84
12	0	0	0	0	0	0	0	0	12	5		0		
Total:	120		108		185		109		229		78		119	
Offshore area														
1	33	56.89	4	100	1	50	8	50	16	38.1	11	11	4	18.18
2	13	22.41	0	0	1	50	2	12.5	6	14.29	11	11	4	18.18
3	10	17.24	0	0	0	0	3	18.75	9	21.43	3	3	10	45.45
4	2	3.44	0	0	0	0	1	6.25	5	11.9	4	2	3	13.64
5	0	0	0	0	0	0	1	6.25	1	2.38				
6	0	0	0	0	0	0	1	6.25	3	7.14				
7	0	0	0	0	0	0	0	0	1	2.38				
11													1	4.55
12	0	0	0	0	0	0	0	0	1	2.38				
Total:	58		4		2		16		42		27		22	
Piltun area														
1	25	40.32	51	50	51	28.02	33	37.93	78	43.1	16	32.0	39	42.86
2	25	40.32	28	26.42	56	30.77	30	34.48	52	28.73	16	32.0	21	23.08
3	8	12.9	14	13.21	37	20.33	13	14.94	26	14.36	9	18.0	25	27.47
4	2	3.22	0	6.73	24	13.19	8	9,2	13	7.18	1	2.0	4	4.40
5	2	3.22	0	0.94	10	5.49	2	2,3	11	6.08	5	10.0	2	2.20
6	0	0	0	0.94	2	1.1	0	0	1	0.55	3	6.0		
7	0	0	0	0.94	1	0.55	0	0	0	0				
8	0	0	0	0.94	1	0.55	1	1.15	0	0				
Total:	62		104		182		87		181		50		91	
Cape Elizabeth														
1					1	50								

	Number of Groups in 2003	% Sighted in 2003	Number of Groups in 2004	% Sighted in 2004	Number of Groups in 2005	% Sighted in 2005	Number of Groups in 2006	% Sighted in 2006	Number of Groups in 2007	% Sighted in 2007	Number of Groups in 2008	% Sighted in 2008	Number of Groups in 2009	% Sighted in 2009
2					1	50								
Total:					2									
Northern*														
4					4	100								
Total:					4									
Chayvo area														
1							2	33.33	2	33.33	1	100.0		
2							0	0.00	2	33.33			2	33.33
3							0	0.00	1	16.66			1	16.67
4							2	33.33	1	16.66			2	33.33
5							2	33.33	0	0			1	16.67
Total:							6		6		1		6	

*This area is along Sakhalin, north of Okha

2.2.3 Frequency of Sightings and Movement of Identified Whales between Known Feeding Areas Offshore Sakhalin Island

Whale movement patterns between the shallow-water Piltun area and the deeper Offshore area have been studied based on repeat sightings of identified animals in both areas over the entire survey period (Figure A1, A2; Tables 7, 8, A5 and A6).

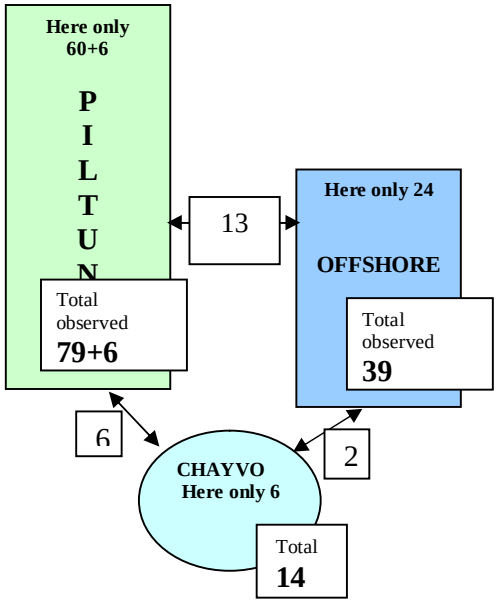
In the Offshore area, a smaller number of whales were photographed in 2009 compared to 2007 and 2008, but this can be attributed to the reduction of working hours designated for photo-ID due to limited vessel time for photo-ID combined with bad weather conditions that were encountered throughout the entire field season. Nonetheless, the number of identified whales in this area is comparable with results obtained in 2002, 2003 and 2006 (Table 8). In total, 297 whales were photographed on the shelf of Sakhalin Island in 2009 taking into account duplicate encounters.

There were four working Photo ID days in the Offshore area: two days on the Zodiac and two days onboard the vessel. In the Offshore area, 90 sightings of 39 individuals were recorded, including repeat encounters (Table 3 and Table A5). From these a total of 24 individuals were seen in the Offshore area only (i.e. they were not recorded in the Piltun or Chayvo areas) (Tables 3, 7, 9, A5 and A6 and Figures 2, A1 and A2).

The research team spent 20 days in the Piltun area, during which photo identification was conducted for 15 days from the Zodiac and 5 days from the deck of the base ship only. In the Piltun area, 185 sightings of 79 individuals were recorded including repeat encounters, of which 60 individuals were seen in the Piltun area only. The data presented here were obtained only by the vessel-based photo identification team, i.e. results from the shore-based photo ID team are not included.

In the shallow-water area adjacent to Chayvo Bay, 22 sightings of 14 individuals were recorded, including repeat encounters. Six of these animals were not seen anywhere else during this season (Tables 3, 7, 9 and Figure 2, Tables A5, A6 and Figures A1, A2 of Appendix).

Figure 2. Whale Movement within the Known Feeding Areas Offshore North-East Sakhalin Island in the Summer/Autumn Season 2009



During the eight years of this photo-ID study, use of the Offshore feeding area by gray whales varied in intensity. In 2004 and 2005, smaller numbers were observed here than in previous years (Table 7, Tables A5 and A6 in the Appendix).

Table 7. Whale Movement among the Feeding Areas 2002-2009 Offshore North-East Sakhalin.

Year	Number of Whales Identified in the Piltun Area	Number of Whales Identified in the Offshore Area	Number of Whales Identified in the Offshore and Piltun Areas	Number of Whales Identified in the Chayvo Area	Number of Whales Identified in the Chayvo/Piltun and Chayvo/Offshore	Number of Whales Identified in Northern areas	Number of Whales Identified in the Chayvo/Piltun/Offshore
2002	**13(12)**	**35(34)**	**1**				
2003	**51(47)**	**35(31)**	4				
2004	**95(89)**	**7(1)**	**6**				
2005	**115(105)**	**7(1)**	**6**			**5 (1)**	
2006	**105(67)**	**33(14)**	**17**	**28(7)**	**19/0**		**2**
2007	**103(45)**	**71(25)**	**38**	**20**	**12/0**		**8**
2008	**61(35)**	**62(36)**	**25**	**1(1)**			
2009	**79(60)** **6(6)***	**39(24)**	**13**	**14(6)**	**6/2**		

Values in parenthesis indicate the number of animals reported only in the given area and not sighted in other surveyed areas.
Numbers are reconciled annually with the updating of the catalogue and matching of any temporary whales.
**Bottom row indicates whales encountered by the behavior team only.*

In 2005, whales were sighted in two new areas along northern Sakhalin (see Yakovlev and Tyurneva 2006). In the first area north of the town of Okha, four whales were identified, of which one was new to the catalogue and had been seen earlier in the season in the Piltun area. Two whales from this group were observed in the Piltun area both earlier and later in the same season. These whales also had been sighted in the Piltun and Offshore feeding areas in previous years and were sighted again in these areas in subsequent years. One animal from the group was sighted once in 2005 in the new (northern) area after which it was encountered annually. In the second area, west of Cape Elizabeth in Severny Bay, two whales were sighted, but only one could be photographed and identified. This animal was new to the catalogue and was not sighted again in later years (Tables A5, A6 and A7 of Appendix).

In the following years, no encounters of gray whales were recorded offshore northern Sakhalin north of Okha and west of the Cape Elizabeth. Data for all the years of research are presented in Table 7.

In 2006, a total of five gray whales were photo-identified in the Offshore area in August. By mid-September of the same year, the number of sightings increased, so that we were able to photograph and identify 33 animals. In 2007, the number of photo-identified whales in the Offshore area reached 71, which was the highest number of photo-identified whales in that area over all the survey years (Table 7). In 2008, 62 animals were photo-identified in the Offshore area. It is possible that more whales were feeding here, but they were not captured on photographs because of unfavourable weather conditions and the necessity to perform other tasks as part of the integrated program.

Thirty-three sightings of 28 individual gray whales were recorded in the shallow waters next to the Chayvo Bay in 2006. Seven of the identified animals that year were sighted only in that area (Tables 7, 8 and Table A5 of Appendix). In 2007, a smaller number of whales were recorded in the Chayvo area compared to 2006, with only 20 animals observed (Table 8). In 2008, ship surveys indicated that the whales were not present in the region, with only one whale photographed (Table 7).

Over all the years of this study (2002-2009), 88 whales were sighted in both the Piltun and Offshore feeding areas during one or over several years. 71 whales were recorded only in the Piltun area, and 4 whales were encountered only in the Offshore area.

2.2.4 Repeat Sightings of Whales Offshore North-east Sakhalin

The occurrence of identified whales during the entire research period in 2009 is shown in Table 9. Repeat sightings of whales provides information about whale movements, supplies additional data for more precise matching of photographs, and allows researchers to track changes in a whale's body condition throughout the feeding season.

Table 8. Frequency of Repeat Sightings of Identified Gray Whales (IDW) in 2009 North-East Sakhalin (the Presented Results are Based only on the Data Obtained by the Vessel-based Photo Identification Team).

Number of Sightings per IDW	Number of Whales with This Number of Sightings	Total Number of IDW Sightings
1	28	28
2	40	80
3*	23	69
4	4	16
5	5	25
6	3	18
7	4	28
8	3	24
9	1	9
Total	111	297

** Example (row 3): A total of 23 IDWs were sighted three times each, resulting in 69 IDW sightings*

Analysis of the inter- and intra-year frequency of sightings of identified whales in 2002-2009 is of particular interest as patterns of habitat use can only be established by repeat encounters with the same individual over time. With a higher sighting frequency comes a larger, more reliable data set, which in turn allows for better explanations to a number of spatially and temporally sensitive monitoring questions. Repeat sightings of whales and photographing of whales over the course of a day, as well as sightings of the same whales over the course of a season, provide important data on whale movement within their feeding areas and the frequency of their visits to these areas. Sighting data are provided in Table 9 and Tables A5 and A6 of Appendix.

Table 9. Inter and Intra-year Frequency of Sightings of Identified Gray Whales (IDW) North-East Sakhalin, 2002-2009.

Year	2002	2003	2004	2005	2006	2007	2008	2009
Number of IDW sightings	66	154	228	384	390	678	275	297
Number of IDW per year *	47	82	96	117	126	128	98	111
Average frequency of IDW sightings per season*	1.40	1.88	2.38	3.28	3.10	5.30	2.81	2.67

**includes Temporary whales*

The presence or absence of whales by years during the 2002-2009 period is shown in Tables A6 and A11 of the Appendix.

2.2.5 Cow/Calf Pairs

In addition to monitoring the size of the western gray whale population, it is very important to determine the number of cows with calves and indirectly determine their health status through external physical indicators, such as the body weight and the skin condition. In 2009, the shore-based behaviour team recorded numerous encounters with cow/calf pairs and calves without mothers. Bad weather conditions and busy schedule of other vessel programme participants limited the amount of cow and calf data that could be collected by the vessel-based team. Therefore data provided by both the shore-based behavioural team, upon consent of the authors, and the vessel team are presented in this report.

In 2009, six cow/calf pairs and two calves without mothers were recorded. Among these, two pairs were recorded only by the behaviour team, and one calf was encountered only by the vessel-based photographic identification team. Reliability grades for all calves were assigned based on joint observations by the two teams (Table 10).

Table 10. Occurrence of Cow/calf Pairs and Calves Encountered without Mothers near Sakhalin Island Based on Data Provided by Two Teams (Shore-Based Behaviour Team BT and Vessel-based Photo Identification Team VT) with the Assigned Reliability Grades.

Main Calatogue Nr KOGW###	Number Days of Registration		Behaviour Team	Vessel Team	Reliability Grade and Criteria Used	Total Grade
	Behaviour Team	Vessel Team	Cow	Cow		
167	8	2	no data	92	A1,2,3+D3	A
168	3	3	97	97	A1,2,3+D3	A
169	3	1	31	31	B1,2,4+D3	A
173	8	1	50	50	B1,2,4+D3	A
174	No data	2	no data	no data	B1,2,3*	A
175	9	1	no data	no data	C1,2,5+D3	A
176	7	no data	20	no data	D3	A
177	6	no data	15	no data	B1,2,4+D3*	A

** Evaluation of whales KOGW174 and KOGW177 is explained in more detail in the Kamchatka section.*

The first mother-calf pair was recorded on July 17 by the vessel-based team. The shore-based behaviour team reported that separation of a pair was first recorded on 9 August. According to both the vessel-based and shore-based teams, the last recording of a pair took place on 19 September (Tables A5, A7 in the Appendix). One of the photo-identified mothers (KOGW050) had been recorded previously with calves in 2004 and 2006. (Table A7 in the Appendix). Two females (KOGW015 and KOGW097) that were identified as mothers in 2009 were also encountered with calves in 2007. The two unaccompanied calves were encountered in calf groups.

All the recorded calves were recorded as normal body condition and did not exhibit signs of being underweight.

2.2.6 Body Condition*

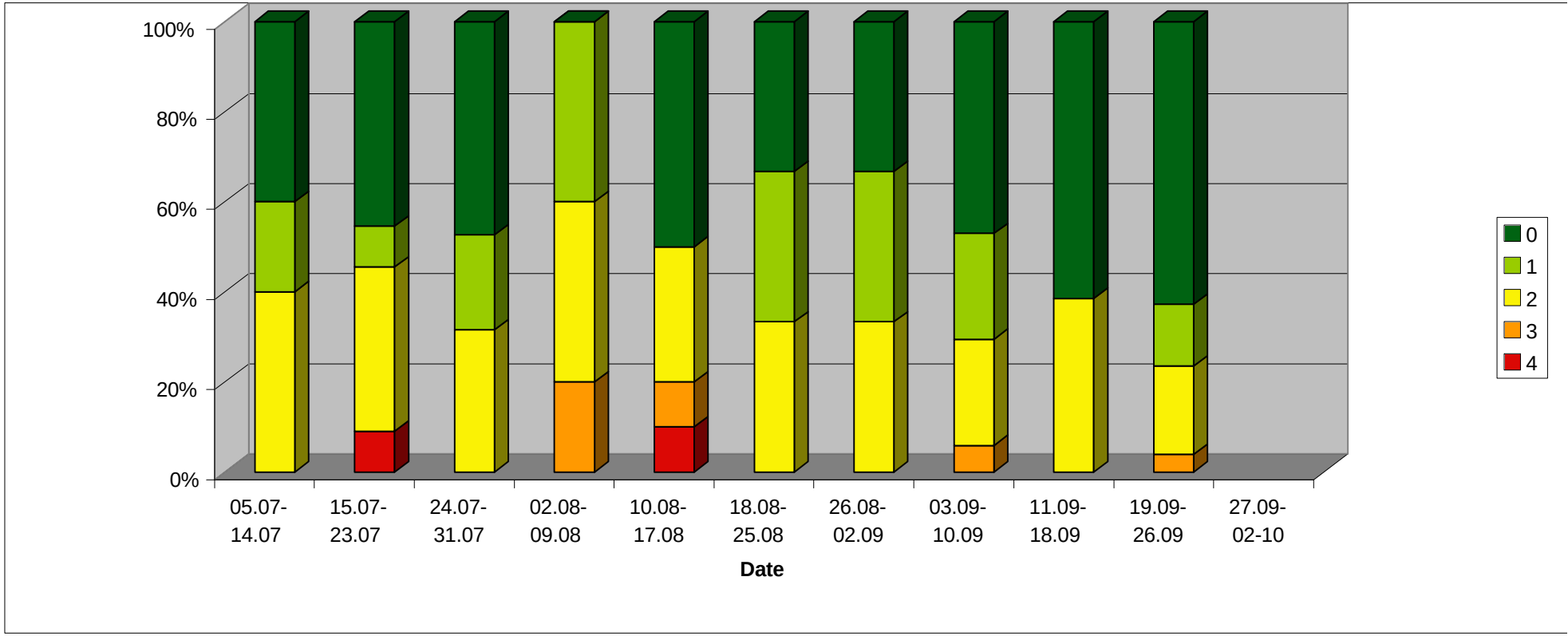
*Only data provided by the vessel-based photo-ID team were used in this section.

2.2.6.1 Body Weight

Starting in 2003, whales were assigned body condition (BC) classes based upon their physical condition using visual assessment (please see Volume 1 Chapter 3.5 of Background and Methods for details). In 2005, we had our first opportunity to observe individual whales with body weight deviations over an extended period of time. The body condition of most of the underweight whales was observed to improve over the course of the season (Yakovlev and Tyurneva, 2006; Yakovlev et al. 2007).

Data on the changes in body conditions over the course of the 2009 field season are given in Figure 3.

Figure 3. Percentage of Photo-identified Gray Whales within Each Body Condition (BC) Class Relative to the Total Number of Whales Sighted Offshore Sakhalin Island Averaged over 7-day Periods during the 2009 Field Season Offshore Sakhalin Island.



From 5 July to 2 October, 21 whales showed improvements in their BC class (Table A7 of Appendix, Figure 3).

A summary of the body condition data collected over the entire study period is given in Table 11.

Table 11. Body Condition (BC) Classes for the Whales Sighted offshore Sakhalin, 2003-2009.

BC Class	Number of Whales in Each BC Class in 2003	% Relation of Whales in Each BC Class in 2003	Number of Whales in Each BC Class in 2004	% Relation of Whales in Each BC Class in 2004	Number of Whales in Each BC Class in 2005	% Relation of Whales in Each BC Class in 2005	Number of Whales in Each BC Class in 2006	% Relation of Whales in Each BC Class in 2006	Number of Whales in Each BC Class in 2007	% Relation of Whales in Each BC Class in 2007	Number of Whales in Each BC Class in 2008	% Relation of Whales in Each BC Class in 2008	Number of Whales in Each BC Class in 2009	% Relation of Whales in Each BC Class in 2009
0	61	74.39	70	72.92	101	84.87	88	69.84	101	77.86	55	56.12	73	65,76
1	6	7.32	15	15.63	8	6.72	18	14.28	15	11.45	23	23.47	19	17,12
2	12	14.63	8	8.33	5	4.2	19	15.08	9	6.87	16	16.33	16	14,41
3	2	2.44	3	3.13	2	1.68	1	0.79	4	3.05	4	4.09	2	1,80
4	1	1.22	0	0	3	2.52	0	0	1	0.76	0	0	1	0,90

Note that temporary whales in the catalogue are included in the number of whales in each body class. Classes 2, 3 and 4, highlighted in green, correspond to underweight animals.

If an animal was observed with a higher BC class during the first sightings and the parameters improved during the subsequent sightings, we used the most recent data in calculating the total number of underweight whales.

In 2009, 19 underweight animals were identified, totalling 17.1% of the total number of identified whales (111) and including 4 nursing cows. All the calves sighted during all years had normal body condition and were assigned class 0 (Table A7 of Appendix).

In 2009, we were able to track the body condition of animals that were identified in 2008 as cows with calves. The comparative data are presented in Table 12.

Table 12. Inter-year Comparison of the Body Condition of Cows and Calves offshore North-Eastern Sakhalin, 2008-2009.

	Number of Cows/calves in 2008	Number of Underweight Cow/calves in 2008	Number of 2008 Cows/calves in 2009	Changes in BC from 2008 to 2009	
				Improvement in BC	Deterioration in BC
Cows	3	3	3	3	0
Calves	5(2)*	0(0)*	1(0)*	0	1(0)*

** Values in parentheses are given for calves identified as "possible calves".*

All cows with poor BC in 2008 that were sighted in 2009 showed improvement in their body condition from 2008 to 2009 (Table A7 of Appendix).

Of all calves that were observed in pairs in 2008, one was sighted in offshore Sakhalin in 2009 (Table A7 of Appendix).

2.2.7 Skin Sloughing

Skin sloughing on WGWs was observed for the first time during processing of the 2003 photo-ID data (Table A7 of Appendix).

Whales that have been photographed with skin sloughing continue to be monitered for any other obvious changes in external appearance or physical condition. To date, annual visual assessment of the photographs of these whales has not found any atypical physical condition to report.

In 2009, no whales with skin sloughing were observed.

2.2.8 Other Skin Condition Impairments

All four whales sighted in previous years with skin sloughing were encountered in 2009. These whales are continued to be visually monitored and photographed, but to date the white patches do not appear to have any obvious effect upon the whale's normal activity. (Table A7).

2.3 Photo Identification of Gray Whales Offshore Eastern Kamchatka Peninsula

2.3.1 Scope of Work

In 2009, activities were conducted in Vestnik and Olga Bays (plase refer to Volume I, Chapter 3 Photo ID for details of the protocols used).

Photographing in Vestnik Bay started on May 30 and continued until June 14. Six photo identification days were worked.

The first photographic surveys in the Olga Bay were conducted on 11 July, with the last surveys on 02 September. During this period, 10 photo identification missions were made, of which 2 were stopped due to deterioration of weather conditions (sea state of 3 points on the Beaufort scale).

Whales were observed at depths from 5 to 16 metres (average value 10.7 m). The water temperature near the surface was 12-15 °C.

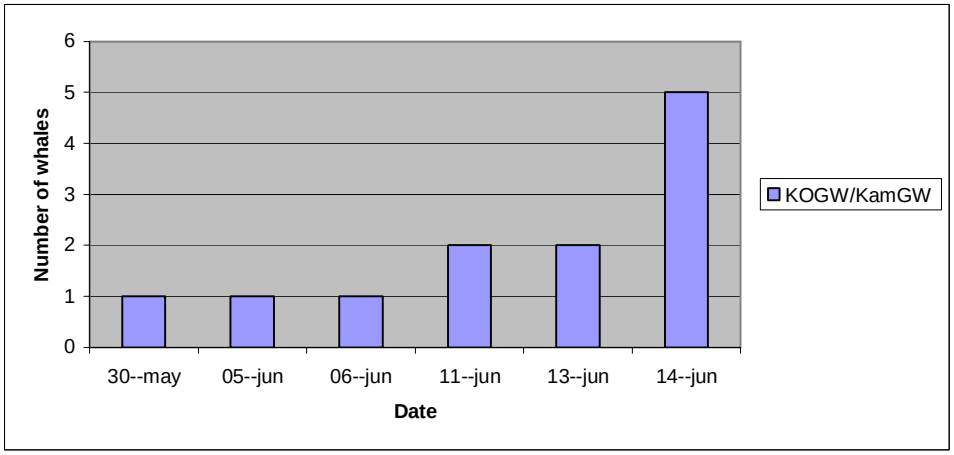
During the whole period of research on the shelf of the Kamchatka Peninsula in 2004 and 2006-2008, no duplicate encounters with gray whales were recorded among the three surveyed areas. For example, whales encountered in the Khalaktyrsky Beach area were not encountered in Olga Bay or in Vestnik Bay, and vice versa either during the same or during different years. However, in 2009, data were obtained for the first time that showed whales visited both Olga and Vestnik bays in different years (Table A10).

2.3.1.1 Identification and the Number of Whales

During five days of work in 2008, 117 sightings of gray whales were recorded in Olga Bay, out of which 89 whales were identified, including repeat sightings of animals. The total number of individual whales excluding repeated sightings was 50 whales (Table A8 of Appendix).

In 2009, during six days of photographing in Vestnik Bay, 6 missions were conducted, during which 1,435 photos were made. Over this period, 12 sightings (encounters) with 11 identified whales were recorded (Table A10, Figure 4, 5). All of the whales identified in Vestnik Bay are known from Sakhalin catalogue and have double identification numbers (KOGW/KamGW).

Figure 4. Gray Whales Identified in Vestnik Bay (Kamchatka) for Each Day of Research during the 2009 Field Season.



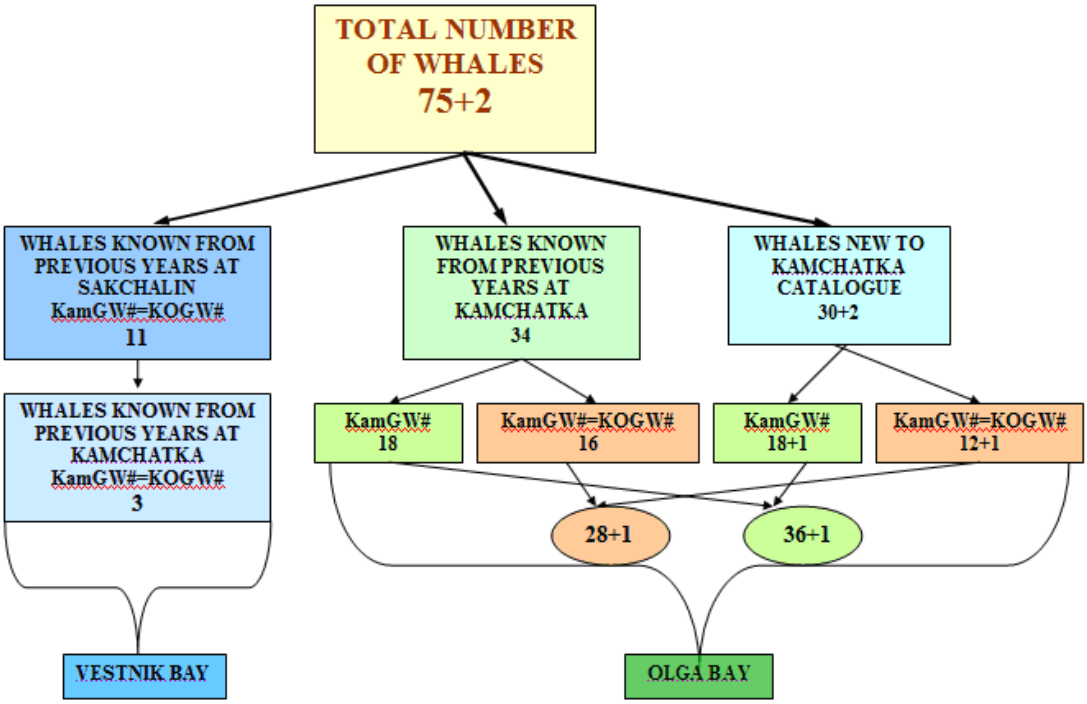
*All of the whales identified in Vestnik Bay are known from Sakhalin catalogue and have double identification numbers (KOGW/KamGW).

As can be seen from Figure 4, the maximum number of identified whales was recorded on 14 June. Only one whale was encountered twice (Table A10); all other animals were encountered once. According to the observers, all whales were transiting and entered Vestnik Bay only for a short period of time.

15,644 photos were taken in Olga Bay in the course of eight missions (on 8 days). 142 sightings with 206 whales were recorded taking into account duplicate encounters. In all, 64 whales and two whales that were assigned temporary numbers (TEMP##) were identified. Four missions were performed in July, three missions in August and one mission in September.

Among 64+2 TEMP whales, both already known individuals previously encountered in the Olga Bay (34 whales) and new animals for this area (30 + 2 TEMP whales) were encountered. Twenty-eight + 1 TEMP out of these 64 whales are already known from the catalogue of gray whales recorded on the shelf of Sakhalin Island (Figure 5).

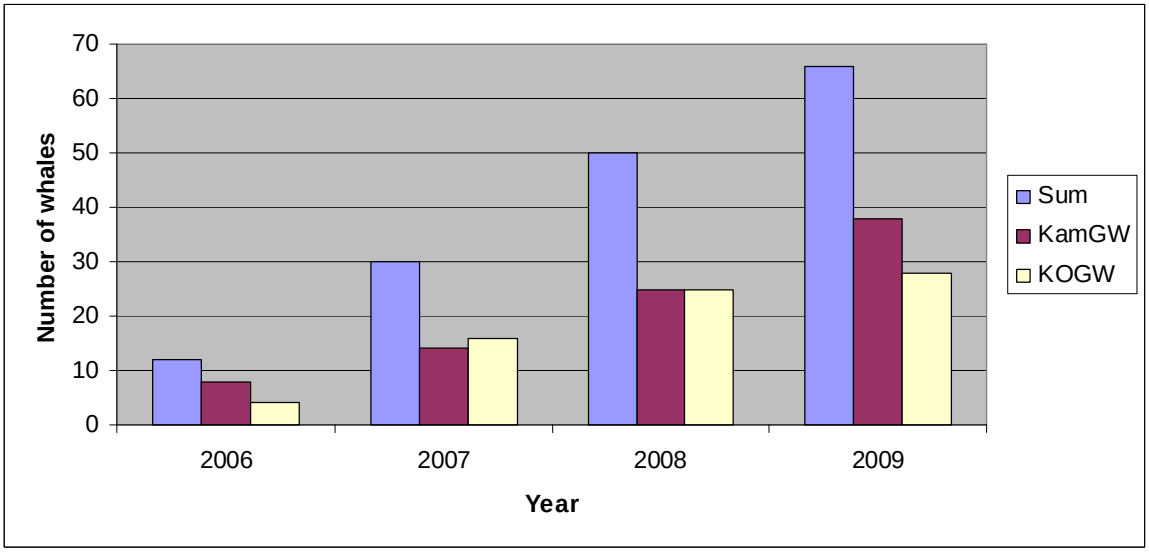
Figure 5. Gray Whales Identified in Vestnik and Olga Bays in 2009.



KamGW are the whales observed off the Kamchatka coast, and KOGW is the indication of the whales seen off Sakhalin. The left part of Figure 6 shows whales sighted in the Vestnik Bay and encountered on the northeastern shelf of Sakhalin Island in previous years. The right side shows whales observed in the Olga Bay.

Figure 6 shows the number of whales photographed in the Olga Bay that were also recorded offshore Sakhalin in various years of studies (KOGW/KamGW) compared to the number of whales not sighted anywhere but offshore Kamchatka (KamGW).

Figure 6. Annual Number of Identified Gray Whales in Olga Bay (Kamchatka).



**Whales marked as KamGW were identified only offshore Kamchatka, whales marked as KOGW were also identified offshore Sakhalin Island*

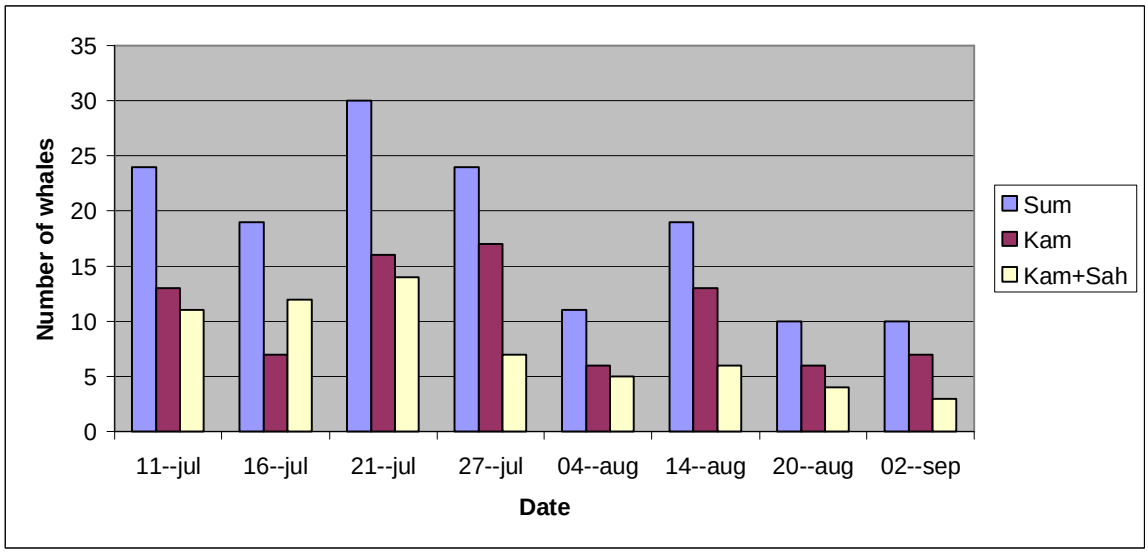
The number of whales identified in the Olga Bay has been observed to increase each year (Figure 6) which corresponds to the amount of field effort which has also increased each year since the onset of the study (Table 13).

Table 10. Number of Identified Gray Whales and Time of Work for the Whole Research Period in the Olga Bay (Kamchatka).

Time of Work		Number of Identified Whales
from to	21_08_2006 22_08_2006	12
from to	02__08_2007 05__08_2007	30
from to	19__08_2008 28__08_2008	50
from to	11__07_2009 02__09_2009	64 +2

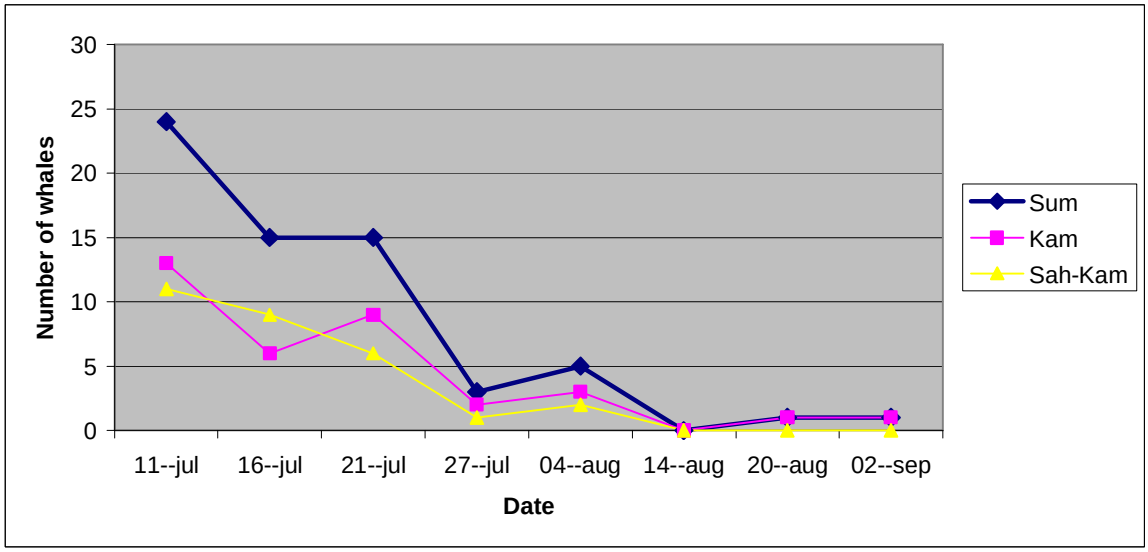
As can be seen from Figure 7, the number of identified whales in Olga Bay is strongly linked to survey timing with a ramp up in the number of whales prior to 21st of July and a decline in whale counts through from that point onwards to 2nd of September. New whale sightings (sightings of whales encountered for the first time during the current season) in Olga Bay in 2009 were also highly dependent on the date of observations (Figure 8), with fewer new whales being photographed as the season progressed.

Figure 7. Number of Identified Whales in the Olga Bay (Kamchatka) per Day of Research in the 2009 Field Season. "Kam" means whales only identified in the Kamchatka catalogue, "Sak+Kam" means whales identified in both the Sakhalin and Kamchatka catalogues, and 'Sum" means all whales identified in Olga Bay.



The 2009 surveys in Olga Bay give a much broader picture of the dynamics of the area. Understanding when peak numbers of whales are using the bay as well as the rate at which new individuals were discovered entering the bay helps shed light on what may have been happening in previous seasons. It's very likely that shorter field seasons as well as later survey start dates are at least part of the reason for the lower numbers of identified gray whales in Olga Bay in the first couple years of the study.

Figure 8. Recording of New Whales in the Olga Bay (Kamchatka) in 2009. "Kam" means whales only identified in the Kamchatka catalogue, "Sak-Kam" means whales identified in both the Sakhalin and Kamchatka catalogues, and 'Sum" means all whales identified in Olga Bay.



As can be seen from figure 8, the recording of new whales drastically declined after 21 July.

At present it is unknown whether all of the gray whales recorded in Olga Bay belong to the western gray whale population, or if some of them belong to the eastern population.

2.3.1.2 Kamchatka Catalogue Assessment: Photographic Coverage of Four Standard Body Aspects

With each subsequent year, we obtain a more complete description of each individual area as well as a more complete catalogue of the Kamchatka gray whale population. This annual updating of the catalogue allows us to improve the process of matching gray whales with earlier identified individuals from the Kamchatka and Sakhalin catalogues. The number of whales in the Kamchatka catalogue increases with every year of research. Among 116 whales recorded in Kamchatka over the entire research period, nine animals were described only by one (left or right) side of the body. If the Sakhalin catalogue contained the full description of an animal, then, even in the absence of the right side image, it was assigned an identification number in the Kamchatka catalogue. If a whale was new for both catalogues and lacked high-quality image of the right side, it was assigned a temporary number (TEMP ##). The sole exception is individual TEMP01=KOGW015 that was defined by the head and front region based on the data obtained by researchers on the shelf of Sakhalin Island in

2009 and had no images of the aspects required for placement in the Kamchatka catalogue. The data on the completeness of documenting four standard photographed aspects of identified gray whales are given in Table A9.

2.3.1.3 Cow/Calf Pairs

During the 2004, 2006 and 2007 surveys, no cow/calf pairs were sighted offshore Kamchatka. In 2008, a cow and a calf were recorded in Olga Bay. They stayed in the shallow waters (4.5-8.0 meters) while the study work was being conducted. The mother had been recorded offshore Sakhalin in 2002-2006, and in the Olga Bay in 2007. She had already been reported as a mother with a calf in 2003. The calf was in body condition (BC) Class 1.

In 2009, the early start date of the research allowed more comprehensive data on the cow/calf pairs in Olga Bay to be collected. After processing the photographs, seven pairs were identified which are in agreement with the observations that were made by the field team (Table 14).

Table 13. Occurrence of Cow/calf Pairs and Calves Encountered without Mothers on the South-Eastern Shelf of the Kamchatka Peninsula with the Assigned Reliability Grades.

Calf	Date of Observance	Cow	Date of Observance	Reliability Grade and Criteria is used	Total Grade
Kam/KoGW		Kam/KoGW			
85	2009_07_11	84/110	2009_07_11	A1.2,3	A
	2009_07_21	84/110	2009_07_21		
	2009_08_20				
	2009_09_02				
86	2009_07_11	001/090	2009_07_11	A1.2,3	A
	2009_07_21	001/090	2009_07_21		
	2009_08_04	001/090	2009_08_04		
	2009_08_14	001/090	2009_08_14		
	2009_08_20				
	2009_09_02				
88/174	2009_07_11	087/103	2009_07_11	A1,2,4	A
100	2009_07_16	57	2009_07_16	A1.2,3	A
	2009_07_21	57	2009_07_21		
	2009_07_27	57	2009_07_27		
	2009_08_20				
102	2009_07_21	101	2009_07_21	A1,2,4	A
	2009_07_27		2009_07_27		
104/177	2009_07_21	temp1/015	2009_07_21	A1.2,3+D3	A
105	2009_07_21	106	2009_07_21	A1,2,4	A
	2009_08_14				
	2009_08_20				
	2009_09_02				

Four of the mothers were encountered on the Sakhalin Island shelf in previous years, one of them was also photographed in the Piltun area in 2009 and was encountered there with a calf in 2007 (Table A7). The three other females had never been recorded as mothers.

Of the three mothers recorded only in the Kamchatka catalogue, one animal was encountered in Olga Bay in 2008, while two others were new for the catalogue.

As can be seen from Table 14 calves started being recorded without mothers in calf groups from 27 July. This means that if the researchers encountered these calves late in August as single whales, their identification as calves would be difficult and uncertain.

Three cow/calf pairs were recorded only in July 2009, though subsequently one of these pairs was first encountered on the shelf of Sakhalin Island on 25 August of the same year, after which its was encountered there many times during the 2009 feeding season. One calf was also photographed in the Sakhalin Island area on 19 and 20 August together with another calf known only from the Sakhalin catalogue (Table 10). The third calf was also recorded as a transiting whale in the Vestnik Bay in November 2009 during pilot research. The place where it spent the feeding season remained unknown.

2.4 Body Condition

2.4.1 Body Weight

The body condition (BC) data for gray whales identified offshore Kamchatka in 2009 are presented below in Table 15.

Table 14. Body Condition (BC) Classes for the Whales Sighted off South-Eastern Kamchatka, 2009.

Classes PCB	Number of whales in Vestnik Bay	Number of whales in Olga Bay
0	3	23
1	2	4
2	6	26
3	0	7
4	0	5

Note that temporary whales are included in the number of whales in each body class. Classes 2, 3, and 4, highlighted in yellow, correspond to underweight animals.

In 2009, 38 underweight animals were photographed in Olga Bay totalling 58.46% of the total number of identified whales for that area and including 7 nursing cows. All the calves sighted during 2009 had normal body condition and were assigned to class 0. In Vesnik Bay, 6 underweight animals were photographed, totalling 66% of the identified whales for that area.

A high proportion of gray whales recorded on the Kamchatka Peninsula with inadequate physical body condition can be partially explained by the early date when they were first identified in the field season. As can be seen from Figure 8 and Table A8, most whales in Olga Bay were identified early in the season.

2.5 The Total Number of Whales Identified by the Two 2009 Expeditions Offshore Sakhalin Island ND Kamchatka Peninsula

In 2009, out of the 177 individuals contained in the western gray whale catalogue of the Marine Biology Institute of the MBI FEB RAS, 138 were sighted on the shelves of Sakhalin Island and Kamchatka Peninsula. (The total number of the Kamchatka and Sakhalin whales identified in 2009 was 174+1 TEMP individuals, among which 100 whales were recorded only on Sakhalin, 56 + 1 TEMP whales—only on the shelf of the Kamchatka Peninsula (out of which, 21 whales were recorded in the Sakhalin catalogue in previous years).

2.6 Movement of Gray Whales Between the South-east Coast of Kamchatka, the Offshore Waters of North-east Sakhalin and Other Areas

Of the greatest biological interest are the data pertaining to whales identified offshore both Kamchatka and north-east Sakhalin Island, as they provide for a more complete and accurate picture of a particular animal's movement among the summer feeding areas.

Out of 11 whales identified in the Vestnik Bay in 2009, 10 animals were encountered on the shelf of Sakhalin Island in the same year.

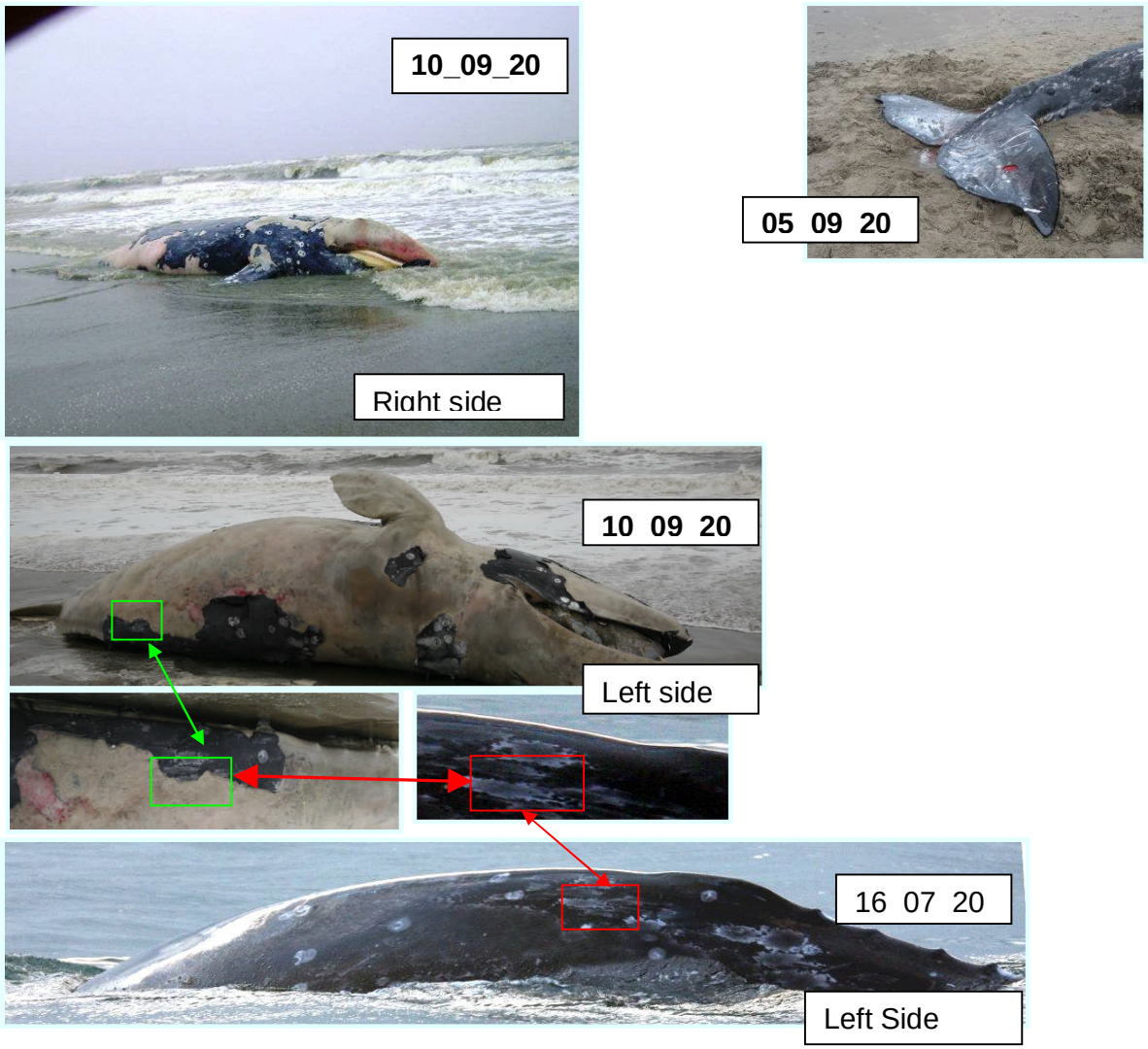
Out of all the whales that have been identified offshore both Kamchatka and Sakhalin:

- KamGW008 (KOGW095) was recorded as a calf in 2004 in the Piltun area and was not sighted offshore Sakhalin in the subsequent years,
- KamGW010 (KOGW077) and KamGW026 (KOGW075) were recorded as calves in 2003 in the Piltun area and were not sighted offshore Sakhalin in the subsequent years,
- KamGW035 (KOGW124) was recorded as a calf in 2005 and then was sighted offshore Sakhalin in 2006 and 2007,
- eight whales that had been recorded offshore Sakhalin as calves in 2007 were sighted in 2008 offshore Kamchatka in Olga Bay, and
- among five calves recorded on the shelf of Sakhalin Island in 2008, three were encountered in Olga Bay in 2009.

2.6.1 Stranded Dead Gray Whale

On 5 September 2009, a team of shore-based observers found a dead gray whale on the sandy beach in the Chayvo Bay. The body was photographed, and the photos were delivered to the photo identification laboratory of A.V. Zhirmunskiy IBM FEB RAS for identification (Figure 9).

Figure 9. Identification of the Gray whale Stranded Onshore of the Beach in the Chayvo Bay in 2009.



The first positive match for this whale was made by a photo of the left side flank taken on 10 September. At that time, the catalogues did not contain images of the ventral surface of fluke.

The whale was identified as KOGW126 = KamGW078 according to the Sakhalin and Kamchatka catalogues of the A.V.Zhirmunsky IBM FEB RAS.

2.6.2 Brief History of the Whale

Whale KOGW126 was first recorded on the Sakhalin Island shelf in the Piltun area and identified as a calf of mother KOGW037 (Table A7). It was encountered twice during the 2005 field season, though it was never sighted in Piltun in subsequent years.

In 2008, this whale was identified in Olga Bay (Tables A8, A10).

In 2009, it was encountered once in Olga Bay on 16 July in a group of gray whales and had a physical body condition of class 2, which is rather common early in the feeding season. An image of the ventral surface of fluke was obtained at this time, which allowed the match to be confirmed (Tables A8, A9).

In 2009, KOGW126 was not recorded alive on the shelf of Sakhalin Island by either the vessel or shore-based behavior teams.

2.7 Discussion

2.7.1 Whales Movement Among Feeding Areas

Long-term photo-identification of resident populations is used to passively track known individuals as they utilize the habitat around them. For foraging gray whales, tracking these movements can give a glimpse into the ecology of feeding whales. As the whales move between regions they target the prey in each specific area. By following these whales through the seasons, patterns of habitat use can be established which can be useful for management and planning decisions.

The analyses of the 2002-2009 Photo ID data indicate that inter- and intra-year movements of gray whales occur both within the Piltun and Offshore areas and between these areas. We have also discovered movement to areas to the north and to the south off the Piltun region as well as to offshore Kamchatka (Yakovlev and Tyurneva 2008, Tyurneva et al. 2010). Continuous monitoring of the whales and their movement is needed to track these spatial patterns (Meier et al. 2007; Vladimirov 2005, 2006, 2007, 2008a, b). As shown above, information about the whales' movement among areas over the course of a single season can only be provided by repeat sightings with individually recognized whales in that season. Similarly, individual gray whale sightings in one area during a season with re-sightings of the same animal in other areas in subsequent years provides information about inter-year movements.

The frequency of sightings over the entire survey period is an important factor in studying whale movement among different areas. In general, sample sizes for observational studies of cetaceans tend to be small due the the challenging, costly, and time-consuming nature of this type of science. The benefit of a long-term monitoring program is such that, as the duration of the study increases from one year to the next, and photographic re-capture of the same individuals continues over time, more data are accumulated and stronger inferences can be made regarding patterns of whale movement and feeding area utilization.

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

2.7.2 Whale Movement Between Southeastern Kamchatka and Sakhalin

According to the 2004, 2006 to 2009 photo-ID data, a total of 116 + 2 TEMP gray whales were identified in the surveyed areas offshore SE Kamchatka. 53 + 1 TEMP of these gray whales identified offshore Kamchatka in 2004 and 2006-2009 were also photographed offshore Sakhalin in different areas and years, and were therefore classified as western gray whales. The question as to affiliation (to western or eastern gray whales) of the other 63 + 1 TEMP animals sighted offshore Kamchatka but not listed in the catalogue of the Sakhalin whales remains open.

In 2004 and 2006, observations offshore Kamchatka photographed five individuals that were known Sakhalin whales. Four of these were sighted in Olga Bay during 2 days of surveys, in 2006. The fifth whale was photographed opportunistically in Vesnik Bay from the ship deck. A sixth whale was photographed in 2004 near Khalakryrsky Beach and was later identified in the Chayvo Bay area of Sakhalin, in 2006. Two additional whales photographed off Kamchatka in 2006 were later identified in Sakhalin (Tables A4 and A6 of Appendix). Data on all Kamchatka gray whales sightings are presented in Table A10.

In 2007 in Olga Bay, 30 whales were identified, 14 of these were known Sakhalin whales. Seven of these whales were sighted later offshore Sakhalin that same season (Tables A8, A10 of Appendix). In 2007 in Vesnik Bay, seven whales were identified, six

of which were known Sakhalin whales. All of these whales were also later sighted offshore Sakhalin that same season (Tables A8, A10 of Appendix).

In 2008 in Olga Bay, 50 whales were identified, 25 of these were known Sakhalin whales. Out of the 25 known Sakhalin whales one whale was also recorded off Sakhalin that same season.

Comparing 2007 to 2008, ten whales total with two-part ID numbers (KOGW/KamGW) that had been recorded offshore Kamchatka in 2007 were later sighted offshore Sakhalin in 2008 (Tables A8, A10 of Appendix).

In 2009, in Olga Bay, 64 + 2 TEMP whales were identified, eight of these were also seen off Sakhalin in the same season, including one that was photographed after being stranded ashore on Sakhalin (Tables A4, A6, A8, A10 in the Appendix). The 2009 stranded and deceased whale was recorded for the first time swimming off of on the Khalaktyrsky Beach in Nalychev Bay (Kamchatka) in 2004 and wasn't seen again until 2009. As discussed earlier, of seven calves recorded in the Olga Bay in 2009, two were sighted in the Piltun area of Sakhalin Island during the same season, and one of them was encountered there as a pair with its mother (Table 10).

2.7.3 Whale Movement between Other Areas and Sakhalin

In 2006 in the Kekurny Bay and Babushkin Bay in the north of the Sea of Okhotsk, three whales were identified and were assigned catalogue ID numbers NOGW (Vladimirov et al, 2007). Later, in 2007, one of these, whale NOGW003 was sighted in Piltun (five sightings) and was given catalogue ID number KOGW160 (Tables A5, A6, A8 of Appendix).

In 2008, in the Zakatny Bay offshore Shiashkotan Island (Kurile chain) a joint survey from TIBOX and MBI FED RAS identified one whale that had been recorded previously in Olga Bay off Kamchatka in 2007. This whale was also later sighted in Olga Bay during the same season (Figure A4 of Appendix). Off Medny Island (Commander Islands) one whale was identified that had previously been recorded in Olga Bay and offshore Sakhalin in 2007. This whale was also later sighted in the Olga Bay in August 2008. Offshore of Karaginsky Island four new whales were identified and have not been sighted in any other location. (Figure A4 of Appendix).

Every year, whales are recorded as visiting both the Sakhalin and Kamchatka areas during the same season and/or during previous years. In 2006, for example, two whales were observed both offshore Sakhalin Island and Kamchatka during the same feeding season. In 2008, 10 whales previously recorded offshore the Kamchatka Peninsula in 2007 were later photographed recorded in the area of Sakhalin Island. This proves that whales relocate between NE Sakhalin and Kamchatka both within one feeding season and between the summer and autumn seasons.

The reasons that induce some animals from the small western stock of gray whales to leave the known feeding grounds and, crossing the Sea of Okhotsk, to move northward toward the areas in the immediate vicinity of the northwestern feeding borders of the eastern (California-Chukotka) gray whale population are still unclear. Seasonal variability in the distribution of cetaceans has been extensively reported and is believed to be a response to seasonal habitat fluctuations and to the distribution constituting whales' prey (Payne et al. 1986, Calambokidis et al. 1989, Calambokidis et al. 1990, Calambokidis and Quan 1997, Weinrich et al.1997, Wilson et al. 1997, Forney and Barlow 1998, Karczmarski et al.1999). For example, eastern gray whales feeding along the west coast of Vancouver Island, Canada, rotate feeding grounds and prey types both within and between the summer feeding seasons as a function of the distribution and abundance of their prey (Bass 2000; Dunham and Duffus 2001, 2002; Meier 2003, Nelson et al. 2008). The distribution of eastern gray whales along the west coast of North America is variable both within and between years with whales using areas from northern California to south-eastern Alaska from spring to autumn, involving significant interchange of animals between areas within and between years (Calambokidis et al. 2002). Over recent years, gray whales have also been more frequently seen in the Beaufort Sea, where they were rarely sighted about two decades ago (Stafford et al. 2007).

Some researchers believe that climate warming, causing earlier ice melting, has led to changes in the food chain in the historic whale foraging areas, such as the Bering Sea. These changes are likely to cause early phytoplankton bloom and to introduce fish species into the area that compete with the whales for food. As a result, the whales migrate further north, where temperatures are still lower and food is more abundant. It is possible that similar considerations apply to the western gray whale population, which would in turn affect the timing of the western gray whales' presence in their historic feeding areas and their potential expansion to the new feeding areas. In this context,

the western gray whale population may serve as a good indicator of the changing environmental conditions in the region (Moore 2008).

Northeastern Sakhalin and Kamchatka are two parts of the historical feeding range of the western gray whale population. According to historical records, the range of the western population in the Sea of Okhotsk included Sakhalin Bay (at the west side of the north-west tip of the island), the Akademiya and Tugursk Bays south of the Shantar Islands (at the far west side of the Sea of Okhotsk, west of the north-west edge of Sakhalin Island), offshore North-East Sakhalin, the Shelikhov Bay, Gizhiga Gulf and Penzhina Gulf in the farthest north-east corner of the sea, as well as waters offshore western Kamchatka (Sleptsov 1955; Krupnik 1984; Yablokov and Bogoslovskaya 1984; Reeves et al. 2008).

Sokolov and Arseniev (1994) and Jones and Swartz (2002) present a map showing the gray whale range encompassing the entire Far Eastern basin where the western population inhabits waters along eastern shores of Asia from the Korean Peninsula all the way to the Sea of Okhotsk and marking paths of migration of the species toward the southeastern shores of Kamchatka. The current state of both gray whale populations and ranges of their distribution are covered in an exhaustive review (Swartz et al. 2006).

The affiliation of whales sighted along Kamchatka shores with one or the other population has almost never been discussed. It was always believed that the vast spaces of the northwestern part of the Pacific Ocean separating the Chukchi and Bering seas from the Seas of Okhotsk and the Sea of Japan were sufficient to consider these whale populations as totally separate entities (Vladimirov 1994). Our data indicate that this common perception may need to be revised, although the degree to which the two populations may mix remains to be investigated.

2.7.4 Cow/Calf Pairs

Our observations support the hypothesis put forward by Weller et al. (2000) that calves are weaned in the period from July to September. According to the data obtained by Bogoslovskaya (1966) for gray whales in the offshore waters of the Chukotka Peninsula, demographic grouping starts in July and August, when calves leave their mothers and gather in groups in the shallowest waters that are rich in prey. Shore-based distribution surveys conducted in 2005 (Vladimirov et al. 2006) indicated that separation of mother and calf pairs had been completed by early September, with the last cow/calf pair

observed from the shore on 11 September. In 2009, data provided by the vessel-based and shore-based photo identification teams indicate that the last pair recorded on the shelf of Sakhalin Island was encountered on 19 September.

Before 2008, the shallow-water Piltun area on the shelf of Sakhalin Island was considered to be the only feeding ground for the cow/calf pairs. But in 2008 the first cow/calf pair was found in Olga Bay of the southeastern shelf of Kamchatka Peninsula. This mother was recorded with calves on the northeastern shelf of Sakhalin Island in previous years (Tyurneva et al., 2010). Research conducted offshore Kamchatka Peninsula in 2009 earlier in the season compared to previous years demonstrated that mothers with calves also used Olga Bay for feeding. These identified females included both individuals known from the Sakhalin catalogue and those not encountered on the shelf of Sakhalin Island. Two cow/calf pairs were observed to relocate from Olga Bay to the Piltun area on the shelf of Sakhalin Island.

2.7.5 Body Condition

The presence of abnormally emaciated whales remains unexplained. The causes of emaciation in both Pacific gray whale populations are not clear, but a rather extensive body of evidence suggests that over-exploitation of the available food supply and/or possible large-scale climatic/oceanographic shifts affecting the productivity in the North Pacific region have been at least partially responsible for emaciation observed in eastern gray whales (LeBoeuf et al. 2000; Moore et al. 2001, 2003, Brownell and Weller 2001).

As the population of eastern gray whales increases to levels estimated to exceed the levels prior to the period of commercial whaling, intraspecific competition pressures in the subarctic feeding grounds may be increasing (LeBoeuf et al. 2000; Moore et al. 2001, 2003).

Other authors believe that changes in the extent and consolidation of sea ice in the Arctic Ocean, triggered by the climate change of the past 10 or 15 years, may affect the seasonal distribution and geographic boundaries of habitats, migration routes, the body condition or the reproductive status of whales (Tynan and DeMaster 1997; Perryman et al. 2002, Burek et al. 2008), which has potentially led to more intensive use of sub-Arctic zones.

Grebmeier and Barry (Grebmeier and Barry 1991) state that due to global warming, primary production in surface waters may be depressed resulting in a reduced availability of benthic prey. LeBoeuf et al. (2000) suggested that reduced availability of prey caused by a decline in productivity in North Pacific regions may be a limiting factor of gray whale feeding in subarctic areas. It is conceivable that these large-scale climatic and/or oceanographic events may have affected the entire North Pacific region and thus may have had simultaneous and similar impacts on both the western and the eastern gray whale populations (Brownell and Weller 2001).

Western gray whale prey studies have identified the Piltun area and particularly the offshore feeding area to be rich prey sources (Fadeev 2002, 2003, 2004, 2005, 2007, 2007, 2008, 2009), Benthic data acquired as part of this program also indicate that year-to-year variations in food biomass exist; however, this topic requires further study It as also possible that some other factor(s), such as diseases or anthropogenic impacts, during winter migration and/or the summer feeding period may have simultaneously and similarly affected both gray whale populations.

Some whales that had shown signs of emaciation in the previous years did not show such signs in the subsequent years. The ability of 'skinny' whales to recover to good body condition within one feeding season has been observed (Yakovlev and Tyurneva 2003, 2004, 2005b, 2006, 2007, 2008, 2009; Yakovlev et al. 2007; Weller et al., 2004). The feeding energy patterns of gray whales, in combination with the starvation and feeding cycles related to migration, feeding and reproduction is a dynamic process. At this point, recovery and deterioration of the body condition of both nursing and non-nursing whales do not fall into the framework of any relevant theory. The time frame of this process is different for each individual whale and demographic group, so, understanding of these processes requires a solid basis of information to be accumulated in the course of long-term observations.

In addition to the unexplained appearance of thin animals, skin sloughing was observed in some animals in 2003 for the first time. Upon repeated observations of these whales in 2004–2009, it appears that, according to the results of studying photographs, skin sloughing recorded in 2003 did not have any permanent noticeable influence on the external body condition of the whales' skin. So far, the phenomenon of skin sloughing remains unexplained, but it may be a result of several factors including suppressed immunity, diseases caused by bacteria, viruses, fungi (Gaydos et al. 2004), internal or

external parasites (Dailey et al. 2000), pollution, or excessive exposure to fresh water. The examples of skin sloughing recorded by us showed that the skin recovers relatively quickly after sloughing, and no subsequent pathological consequences are observed on the whale's skin (Tyurneva and Yakovlev, 2005c, Tombach Wright et al. 2007).

Organic pollutants have been shown to be responsible for the high incidence of tumours and skin ulcers in marine mammals by causing the hormonal balance in the body to change (Béland et al. 1992). Similar skin peeling has been reported in blue whales (Sears et al. 2000) and the Arctic whales (Pettis et al. 2004), but has been previously unreported in the eastern or western gray whale populations.

Further study is required to understand the duration and meaning of the skin sloughing phenomena before any conclusions can be drawn about the factors that cause it. It is especially important to document whale skin sloughing among those whales that were found to have skin sloughing in previous years, in order to continue observations of such a whale group with the aim of tracing changes or creating a long-term model. Further photography of the whales' skin, as well as biological skin samples from the affected areas could be collected for histological study and analysis to determine the presence of pathogenic viruses, microbes or fungi.

Appearance of white patches, observed on some gray whales since 2005, has yet to be explained. Continued photo-id monitoring of these individuals has not resulted in any obvious conclusions about the affect of white skin patches on gray whales. To date no obvious short-term health effects have been photographed but as this phenomenon is not well understood, it is essential to continue observation of all known afflicted individuals.

2.8 Conclusions

During the feeding season in 2009, photo-identification of gray whales took place on the northeastern shelf of Sakhalin and in Olga and Vestnik Bays in southeastern Kamchatka.

2.8.1 Catalogue Overview

The Sakhalin WGW Catalogue now contains 177 fully identified individual gray whales. Some of these whales were registered repeatedly over several years, whereas others are new to the catalogue or were not sighted again for a long time.

The catalogue of gray whales photo-identified on the Kamchatka shelf consists of photographs of animals observed in three areas: (Khalaktyrsky Beach, Vestnik and Olga Bays) during 2004 and 2006-2009. At present, this catalogue contains 116 fully identified animals. Fifty three of these whales were also observed in different areas of the Sakhalin shelf during various years, and are most likely western gray whales. It is yet unclear which population the other 63 animals belong to that were photographed near Kamchatka peninsula, but are not identified in the Sakhalin catalogue.

2.8.2 Whales Identified in 2009 on Both the Sakhalin and Kamchatka Shelves

In 2009, 117 whales were observed off the shore of Sakhalin (not including temporary whales). This number is higher than in 2008 (98 whales), but lower than in 2006 (121) and 2007 (125). This might have been due to shorter observation periods during the last two years because of unfavourable weather conditions.

In 2009, we identified 12 new gray whales including 8 calves that were not seen before in the shelf waters off Sakhalin. However, one of the adult animals was first identified in 2004 off of Khalaktyrsky Beach (Kamchatka). Another adult whale was first observed in Olga Bay (Kamchatka). The other two adult whales had not previously been observed.

From May 30 to June 14 of 2009, a total of 11 whales were identified off the Kamchatka peninsula in Vestnik Bay. All of them had been registered in previous years in the Sakhalin catalogue. The observation showed that the animals stayed in the bay for a short period of time (from several hours to two days) and then left the region.

From July 11 to September 2, 2009, 64 + 2 Temp whales were observed in Olga Bay, Kamchatka. Thirty four of them were already included in the Kamchatka catalogue, having been observed previously in Olga Bay. The other 30 + 2 Temp whales were new to the region. 28+1 Temp whales out of these 64 whales were registered in the Sakhalin catalogue, one whale remains a temporary because non-standard aspects (i.e. head shots) were used to match this whale between catalogues.

Since 2006, the number of identified whales in Olga Bay has grown every year. However, this could be attributed to the start day and increased duration of the field seasons. In 2009, the number of new whales that were identified for the first time in Olga Bay also strongly depended on the observation dates. After July 21, on which the maximum number of whales (30) was registered, sightings dropped, By the beginning of

September the number of whales in the bay was considerably smaller (10 whales) compared to the beginning of the survey season (25 whales).

Since the start of the surveys in Olga Bay (Kamchatka) in 2006, researchers have identified some whales that had been registered as calves in Piltun area (Sakhalin) in the previous year. In 2009, three of the five calves registered in the Sakhalin shelf in 2008 were identified in Olga Bay.

In 2009, 138 of 177 animals contained in the A.V. Zhirmunskiy IBM DVO RAN Sakhalin catalogue of western gray whales have been observed in both Sakhalin and Kamchatka. The total number of identified gray whales in Kamchatka and Sakhalin catalogues in 2009 alone was 174 +1 TEMP, 100 of them being registered only on Sakhalin shelf and 56 + 1 TEMP – only off the shore of Kamchatka (21 of which have been registered in the Sakhalin catalogue in the previous years) and 18 + 1 TEMP was soon in both locations. At present, it is unknown whether all of the animals observed in the Olga Bay, Kamchatka belong to the western stock, or whether some of them belong to the eastern gray whale population.

2.8.3 Dead Gray Whale

On September 5, 2009, a dead male gray whale was discovered on a sandy beach near Chayvo Bay (Sakhalin). This whale was identified as KOGW126 from the Sakhalin catalogue and KAMGW078 from the Kamchatka catalogue. He was first observed as a calf with his mother in the Piltun area on the Sakhalin shelf in 2005. Later, in 2008, he was identified in Olga Bay (Kamchatka). On July 16, 2009 the same animal was observed in Olga Bay and looked normal for early in the feeding season (BC 2). The cause of death of this whale could not be determined. Examination of photographs taken in Kamchatka of this individual did not reveal anything out of the ordinary.

2.8.4 Migration of Gray Whales Between Sakhalin Feeding Areas in 2009

In 2009, at the northeastern shore of Sakhalin in the Offshore region, 39 individuals were identified; 24 of these whales were observed only in this region. In the Piltun area 79 whales were identified, 60 of which were observed only in this region. Fourteen individual whales were photographed in Chayvo Bay, 6 of which were not observed anywhere else during this season.

During the length of the study, (2002-2009), 88 whales were identified in both the Piltun and Offshore feeding areas both during one year and over several years. In addition, 71 individual whales were sighted only in the Piltun area and four used only the Offshore area. It seems that the use of the monitored feeding areas on the Sakhalin shelf by gray whales is a normal event , linked with food availability. During all these years, cow-calf pairs were registered only in the Piltun area.

In 2009, 10 out of 11 whales photographed in Vestnik Bay (Kamchatka) were registered off the Sakhalin shore later in the season.

Eight out of 64 +2 TEMP whales identified in Olga Bay (Kamchatka) were spotted near Sakhalin later in the season. One of them was found dead there.

2.8.5 Body Condition

Since 2005, we collected data indicating the improvement of gray whales' body condition (BC) within a feeding season. In 2009, such improvement of BC was also recorded. In 2009, 19 whales with poor BC were identified, including 4 nursing females. This constitutes 17.12% of the total number of identified animals (111 individuals)*. All calves observed during this years were physically normal (BC 0).

If the BC of a particular whale improved upon subsequent observation, then the data used in calculations of the number of malnourished animals was based on the latest observation.

According to our observations, 21 whales* improved their BC during the period of July 5 to October 2.

**Note: BC data was only based on vessel-based photo-id surveys and doesn't include photographs of the onshore behavior teams.*

In Vestnik Bay (Kamchatka shelf) six out of the 11 identified whales (66%) were malnourished. In Olga Bay, 38 out of 64 + 2 TEMP whales (58.46%) showed high BC. Seven of these were nursing females.

The high percentage of gray whales with poor body conditions recorded near Kamchatka versus the Sakhalin can be explained by the early photo-identification survey period, as whales have just arrived to the feeding grounds from their winter-long fast and have not had time to accumulate body fat stores.

2.8.6 Cow-calf Pairs

In 2009, 6 cow-calf pairs and 2 calves without presence of mothers were registered on the Sakhalin shelf. Separation of the pairs started in the end of August and lasted until the middle of September, which is consistent with the long-term observations. One of the photo- identified mothers was registered with calves in 2004 and 2006. Two other females identified as mothers in 2009 were registered in 2007. Three females were observed with calves for the first time. Two calves were observed without mothers, but identified in calf groups. All registered calves were well nourished without any signs of malnutrition.

In 2008, a mother-calf pair was registered in Olga Bay (Kamchatka) for the first time. The mother with a calf was registered earlier on the Sakhalin shelf in 2003. The early start of the 2009 survey season in Olga Bay allowed us to collect more complete data about mother-calf pairs in this region. During data processing, we identified seven pairs. Four cows out of these pairs were observed in previous years on the Sakhalin shelf and one of them was photo-identified in Piltun area during the 2009 season. This animal was identified as mother with a calf in 2007 on the Sakhalin shelf for the first time. The remaining three females were observed only in Olga Bay and never before registered as mothers; one of them was observed in the Olga Bay during previous years, the two others were new to the catalogue.

Three of the mother-calf pairs were registered near the Kamchatka shore in July only. However, one of the pairs was later observed near Sakhalin on August 25 of the same season and since then was seen there many times. One of the calves was also photographed near Sakhalin on August 19 and 20 together with another calf that was registered in Sakhalin catalogue. The third one was registered as a transient whale in Vestnik Bay in November during pilot surveys. Its whereabouts during the feeding season are still unknown.

Starting around the middle of August, calves near the Kamchatka shores began to appear without mothers in calf groups. If these calves had not been previously identified as such with their mothers earlier in the season, identification of these whales as first-year calves would have been difficult. The timing of the field season in 2009 allowed for early surveys and photographic capture of the pairs prior to separation for the first time in the Kamchatka region.

Two out of the seven calves registered in Olga Bay in 2009 were observed in Piltun area during the same season, one of them being with his mother. Thus, 10 calves with mothers registered in Sakhalin catalogue were observed in two distant regions, i.e., near northeastern shores of Sakhalin Island and eastern shores of Kamchatka in 2009.

It is worth mentioning that only the early start of the survey season allowed us to identify mother-calf pairs in Olga Bay in 2009. It is quite possible that the pairs were present in this area before 2008, but they were not identified as such because the calves had already separated from their mothers. The obtained data suggests that the Piltun area of the Sakhalin shelf is not the only feeding area for mother-calf pairs and that at least a second “nursery ground” for foraging whales is located in Olga

2.9 Acknowledgements

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2.11 Appendices

Table A1. Time spent at each gray whale sighting from the Zodiac, Sakhalin 2009

N	Date	Area	Number of missions per day	Duration of each sighting in minutes														Total
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	09.07.13	Piltun	3	0:23	0:30	0:22	0:39											1:54
2	09.07.16	Piltun	1	0:30	0:18													0:48
3	09.07.17	Piltun	1	0:26	0:27	0:18												1:11
4	09.07.24	Offshore	1	0:20	0:09	0:14	0:09	0:08	0:18	0:30	0:30							2:18
5	09.08.08	Piltun	3	0:11	0:05	0:15	0:11	0:25	0:26									1:33
6	09.08.09	Piltun	1	0:07	0:08	0:08												0:23
7	09.08.10	Piltun	1	0:18														0:18
8	09.08.11	Piltun	3	0:08	0:08	0:07	0:25	0:48	0:06	0:27	0:07	0:25	0:12	0:17	0:07	0:04		3:21
9	09.08.25	Piltun	2	0:12	0:13	0:24	0:17	0:15	0:23	0:03	0:05	0:09	0:11	0:09				2:21
10	09.08.26	Chaivo	1	0:24	0:37													1:01
11	09.08.28	Piltun	1	0:11	0:21	0:04	0:09	0:26										1:11
12	09.09.04	Piltun	2	0:13	0:08	0:32	0:14	0:10	0:07	0:11	0:05	0:02	0:09	0:12	0:23	0:07		2:33
13	09.09.13	Piltun	2	0:08	0:16	0:20	0:07	0:14										1:05
14	09.09.14	Piltun	1	0:08	0:07	0:12	0:07	0:06										0:40
15	09.09.18	Piltun	2	0:18	0:19													0:37
16	09.09.19	Piltun/Chaivo	1	0:21	0:10	0:17	0:46	0:08	0:23	0:08	0:03							2:16
17	09.09.20	Piltun	3	0:13	0:13	0:06	0:15	0:09	0:24	0:35	0:13	0:07	0:33	0:28	0:07	0:21	1:26	5:10
18	09.09.21	Offshore	2	0:26	0:22	0:07	0:18	0:07	0:06	0:10	0:13	0:08	0:10	0:13	0:04	0:16	0:12	2:52
	Total		**31**															**31:32:00**

Table A2. Gray whale group size at each sighting in the course of photo-ID efforts from the Zodiac, Sakhalin 2009

N	Date	Area	Number of whales registered from Zodiac at each sighting														Number of whales in Piltun area	Number of whales in offshore area	Number of whales in Chaivo area
			1	2	3	4	5	6	7	8	9	10	11	12	13	14			
1	09.07.13	Piltun	4	2	3	2											11		
2	09.07.16	Piltun	3	3													6		
3	09.07.17	Piltun	1	3	3												7		
4	09.07.24	Offshore	4	4	3	3	3	3	3	11								34	
5	09.08.08	Piltun	1	1	3	1	5	1									12		
6	09.08.09	Piltun	3	1	1												5		
7	09.08.10	Piltun	1														1		
8	09.08.11	Piltun	2	1	1	3	4	2	1	3	2	1	3	2	1		26		
9	09.08.25	Piltun	2	3	2	2	3	2	1	2	3	2	2				24		
10	09.08.26	Chaivo	5	4															9
11	09.08.28	Piltun	2	1	3	1	3										10		
12	09.09.04	Piltun	4	3	1	1	1	1	3	1	1	3	3	4	1		27		
13	09.09.13	Piltun	2	3	2	1	1										9		
14	09.09.14	Piltun	1	2	3	2	3										11		
15	09.09.18	Piltun	1	2													3		
16	09.09.19	Piltun/Chaivo	1	2	1	1	2	3	2	4							11		5
17	09.09.20	Piltun	1	1	1	1	1	3	2	1	1	3	3	1	1	5	25		
18	09.09.21	Offshore	1	1	1	3	4	3	3	2	2	2	2	1	3	3		31	
	Total																**188**	**65**	**14**

Table A3. Depths recorded in the course of photo-ID efforts from the Zodiac, Sakhalin 2009

N	Date	Area	Depth at each sighting, m														Mean depth in Piltun area	Mean depth in Offshore area	Mean depth in Chaivo area
			1	2	3	4	5	6	7	8	9	10	11	12	13	14			
1	09.07.13	Piltun	29.0	28.0	37.0	37.0											32.8		
2	09.07.16	Piltun	31.0	30.0													30.5		
3	09.07.17	Piltun	13.5	5.0	9.0												9.2		
4	09.07.24	Offshore	63.0	60.0	61.0	60.0	62.0	63.0	64.0	65.0								62.3	
5	09.08.08	Piltun	29.0	30.0	31.0	33.0	28.0	10.0									26.8		
6	09.08.09	Piltun	11.0	12.0	12.0												11.7		
7	09.08.10	Piltun	14.0														14.0		
8	09.08.11	Piltun	12.0	11.0	13.0	9.0	4.0	23.0	23.0	12.0	5.5	8.0	14.0	16.0	16.0		12.8		
9	09.08.25	Piltun	13.0	12.5	20.0	30.0	25.0	26.0	26.0	24.0	24.0	24.0	24.0				22.6		
10	09.08.26	Chaivo	15.0	17.0															16
11	09.08.28	Piltun	14.0	14.0	26.0	26.0	26.0										21.2		
12	09.09.04	Piltun	28.0	28.0	25.0	27.0	26.0	26.0	26.0	26.0	25.0	25.0	25.0	25.0	25.0		25.9		
13	09.09.13	Piltun	16.0	21.0	16.0	17.0	17.0										17.4		
14	09.09.14	Piltun	12.0	18.0	22.0	20.0	6.0										15.6		
15	09.09.18	Piltun	19.0	15.0													17.0		
16	09.09.19	Piltun/Chaivo	17.0	15.0	12.0	8.0	15.0	15.0	15.0	15.0							13.0		15
17	09.09.20	Piltun	12.0	10.0	15.0	15.0	15.0	15.0	5.5	12.0	12.0	7.0	4.0	10.0	12.0	28.0	12.3		
18	09.09.21	Offshore	56.0	64.0	64.0	64.0	64.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0		61	
	Total																**18.9**	**61.6**	**15.5**

Table A 4.A Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2002					2003					2004					2005				
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF	
KOGW001	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW002	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW003	Y	Y	Y	Y	Y															
KOGW004	Y	Y			Y	Y	Y	Y	Y	Y										
KOGW005	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW006	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW007	Y	Y	Y	Y	Y			Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y
KOGW008	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW009	Y	Y	Y	Y	Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW010	Y	Y			Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW011	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW012	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y
KOGW013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW014	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y
KOGW016	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y
KOGW017		Y			N											Y	Y			Y
KOGW018	Y	Y	Y	Y	Y		Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW019	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW020	Y				N	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW022	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW023	Y	Y			Y						Y	Y	Y	Y	Y					
KOGW024	Y				N											Y	Y	Y	Y	Y
KOGW025	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				Y	Y	Y	Y		Y
KOGW026	Y	Y			Y	Y	Y			Y						Y	Y			Y
KOGW027		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW028	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y
KOGW029	Y	Y			Y	Y	Y			Y	Y	Y			Y	Y	Y			
KOGW030	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW031	Y				N		Y	Y	Y	Y	Y		Y		Y					
KOGW032	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW033	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y			Y
KOGW034	Y	Y			Y							Y			Y	Y	Y			Y
KOGW035	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y
KOGW036	Y				N	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
KOGW037	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW038	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y					
KOGW039	Y				N	Y	Y		Y	Y						Y	Y			Y
KOGW040	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y			Y

Table A 4.A Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2002					2003					2004					2005				
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF	
KOGW041	Y	Y			Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW042	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW043		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW044	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y		Y
KOGW045	Y	Y	Y		Y		Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW046						Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
KOGW047						Y	Y	Y	Y	Y										
KOGW048						Y	Y			Y	Y	Y		Y	Y	Y	Y			Y
KOGW049						Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
KOGW050						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW051						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW052						Y	Y			Y										
KOGW053						Y	Y	Y	Y	Y						Y	Y	Y	Y	Y
KOGW054						Y	Y	Y	Y	Y			Y	Y	N	Y	Y	Y	Y	Y
KOGW055						Y	Y	Y	Y	Y						Y	Y	Y	Y	Y
KOGW056						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW057						Y	Y	Y	Y	Y										
KOGW058						Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
KOGW059						Y	Y			Y						Y	Y	Y	Y	Y
KOGW060						Y	Y	Y	Y	Y	Y	Y			Y	Y	Y			Y
KOGW061						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW062						Y	Y			Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW063						Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW064						Y	Y	Y		Y	Y	Y			Y	Y	Y	Y	Y	Y
KOGW065						Y	Y			Y										
KOGW066						Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
KOGW067						Y	Y			Y		Y	Y	Y	Y	Y	Y			Y
KOGW068						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y
KOGW069						Y	Y			Y	Y	Y			Y	Y	Y			Y
KOGW070						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y
KOGW071						Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW072						Y	Y			Y	Y	Y			Y	Y	Y			Y
KOGW073						Y	Y			Y										
KOGW074						Y	Y	Y	Y	Y			Y		N			Y		Y
KOGW075						Y	Y			Y										
KOGW076						Y	Y			Y	Y	Y			Y	Y	Y			Y
KOGW077						Y	Y			Y										
KOGW078						Y	Y			Y	Y	Y	Y		Y	Y	Y	Y		Y
KOGW079						Y	Y			Y						Y	Y	Y		Y
KOGW080						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y					
KOGW081						Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
KOGW082						Y	Y			Y	Y	Y			Y	Y	Y			Y

Table A 4.A Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2002					2003					2004					2005				
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF	
KOGW083						Y	Y			Y	Y	Y			Y	Y	Y	Y	Y	Y
KOGW084						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y					
KOGW085						Y				N	Y	Y	Y	Y	Y	Y	Y			Y
KOGW086						Y	Y			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
KOGW087							Y			N	Y	Y	Y	Y	Y	Y	Y			Y
KOGW088						Y	Y	Y	Y	Y										
KOGW089							Y			N										
KOGW090							Y			N							Y	Y	Y	N
KOGW091						Y				N										
KOGW092							Y			N	Y	Y			Y		Y	Y		Y
KOGW093											Y	Y			Y	Y	Y	Y		Y
KOGW094											Y	Y	Y	Y	Y	Y	Y	Y		Y
KOGW095											Y	Y	Y	Y	Y					
KOGW096											Y	Y			Y	Y	Y			Y
KOGW097											Y		Y	Y	Y					
KOGW098											Y	Y			Y					
KOGW099											Y	Y			Y	Y	Y	Y		Y
KOGW100											Y	Y			Y					
KOGW101											Y	Y			Y					
KOGW102											Y	Y			Y	Y	Y			Y
KOGW103											Y	Y	Y	Y	Y	Y	Y	Y		Y
KOGW104											Y	Y	Y	Y	Y	Y	Y			Y
KOGW105											Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW106											Y	Y			Y	Y	Y			Y
KOGW107											Y				N	Y	Y			Y
KOGW108											Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW109											Y	Y			Y					
KOGW110											Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KOGW111											Y	Y	Y	Y	Y	Y	Y			Y
KOGW112											Y	Y			Y	Y				Y
KOGW113											Y	Y			Y	Y	Y	Y	Y	Y
KOGW114											Y	Y			Y	Y	Y	Y	Y	Y
KOGW115												Y		Y	N	Y	Y			Y
KOGW116												Y		Y	N	Y	Y	Y		Y
KOGW117																Y	Y	Y	Y	Y
KOGW118																Y	Y	Y	Y	Y
KOGW119																Y	Y			Y
KOGW120																Y	Y			Y
KOGW121																Y	Y	Y	Y	Y
KOGW122																Y	Y	Y	Y	Y
KOGW123																Y	Y	Y	Y	Y
KOGW124																Y	Y			Y

Table A 4.A Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2002					2003					2004					2005				
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF	
KOGW125																Y	Y			Y
KOGW126																Y	Y			Y
KOGW127																Y	Y			Y
KOGW128																Y	Y			Y
KOGW129																Y	Y			Y
KOGW130																Y	Y			Y
KOGW131																Y	Y			Y
KOGW132																Y	Y			Y
KOGW133																Y	Y			Y
KOGW134																Y	Y	Y	Y	Y
KOGW135																				
KOGW136											Y	Y	Y	Y	Y					
KOGW137																				
KOGW138																				
KOGW139																				
KOGW140																				
KOGW141																				
KOGW142																				
KOGW143																				
KOGW144																				
KOGW145																				
KOGW146																				
KOGW147																				
KOGW148																				
KOGW149																				
KOGW150																				
KOGW151																				
KOGW152																				
KOGW153																				
KOGW154																				
KOGW155																				
KOGW156																				
KOGW157																				
KOGW158																				
KOGW159																				
KOGW160																				
KOGW161																				
KOGW162																				
KOGW163																				
KOGW164																				
KOGW165																				
KOGW166																				

Table A 4.A Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2002					2003					2004					2005				
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF	
KOGW167																				
KOGW168																				
KOGW169																				
KOGW170																				
KOGW171																				
KOGW172																				
KOGW173																				
KOGW174																				
KOGW175																				
KOGW176																				
KOGW177																				
TEMP01	Y				N							Y			N					
TEMP02							Y			N		Y			N		Y			N
TEMP03																				
TEMP04																				
TEMP05																				
TEMP06																				
TEMP07																				
TEMP08																				
TEMP09																				
TEMP10																				
TEMP11																				
TEMP12																				
TEMP13																				
TEMP14																				

Table A 5.B Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2007					2008					2009					Qas for
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		02-09
KOGW001	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	4
KOGW002	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						4
KOGW003																4
KOGW004																4
KOGW005	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW006	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW007	Y	Y	Y	Y	Y											4
KOGW008	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y	4
KOGW009	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW010	Y	Y	Y	Y	Y							Y			Y	4
KOGW011	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW012	Y	Y			Y	Y				Y	Y	Y	Y	Y	Y	4
KOGW013	Y	Y	Y	Y	Y				Y	N				Y	Y	4
KOGW014	Y	Y	Y	Y	Y	Y		Y	Y	Y						4
KOGW015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	4
KOGW016	Y	Y			Y	Y	Y			Y	Y	Y			Y	4
KOGW017	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	4
KOGW018																4
KOGW019	Y	Y	Y	Y	Y						Y		Y	Y	Y	4
KOGW020	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y			Y	4
KOGW021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	4
KOGW022	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW023											Y	Y	Y		Y	4
KOGW024	Y	Y	Y	Y	Y	Y				Y	Y	Y	Y	Y	Y	4
KOGW025	Y	Y	Y		Y						Y		Y		Y	4
KOGW026						Y	Y	Y		Y	Y	Y			Y	3
KOGW027	Y	Y			Y	Y	Y	Y	Y	Y						4
KOGW028	Y	Y	Y	Y	Y						Y	Y			Y	4
KOGW029	Y	Y			Y	Y	Y	Y		Y	Y	Y			Y	3
KOGW030	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW031	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y			Y	4
KOGW032	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						4
KOGW033	Y		Y	Y	Y		Y			Y	Y	Y			Y	4
KOGW034	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y			Y	4
KOGW035	Y	Y			Y	Y	Y	Y	Y	Y		Y			Y	4
KOGW036	Y	Y	Y	Y	Y		Y			Y						4
KOGW037	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW038	Y	Y	Y	Y	Y	Y				Y	Y				Y	4
KOGW039	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW040			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	4

Table A 5.B Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2007					2008					2009					Qas for
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		02-09
KOGW041	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW042	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW043	Y	Y	Y	Y	Y	Y	Y			Y						4
KOGW044	Y	Y	Y		Y	Y	Y			Y		Y		Y	Y	4
KOGW045	Y	Y	Y	Y	Y						Y	Y			Y	4
KOGW046	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW047	Y	Y		Y	Y	Y	Y			Y	Y	Y			Y	4
KOGW048	Y	Y	Y	Y	Y						Y	Y			Y	4
KOGW049	Y	Y			Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW050	Y	Y			Y	Y	Y	Y	Y	Y	Y				Y	4
KOGW051	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	4
KOGW052																2
KOGW053	Y	Y	Y	Y	Y						Y	Y		Y	Y	4
KOGW054	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW055	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y	4
KOGW056	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW057	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW058	Y	Y			Y	Y	Y	Y	Y	Y						4
KOGW059	Y	Y	Y	Y	Y						Y	Y			Y	4
KOGW060	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW061	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW062	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW063	Y	Y			Y	Y	Y	Y	Y	Y						4
KOGW064	Y	Y			Y						Y	Y	Y	Y	Y	4
KOGW065																2
KOGW066		Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW067	Y	Y	Y	Y	Y											4
KOGW068	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y	4
KOGW069	Y	Y			Y	Y	Y			Y	Y	Y			Y	2
KOGW070	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	4
KOGW071	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			Y	4
KOGW072	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y			Y	4
KOGW073	Y	Y	Y	Y	Y						Y	Y			Y	4
KOGW074	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW075											Y	Y			Y	2
KOGW076						Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW077																4
KOGW078	Y	Y	Y	Y	Y		Y			Y	Y	Y	Y	Y	Y	4
KOGW079																3
KOGW080	Y	Y	Y	Y	Y	Y				Y	Y	Y	Y	Y	Y	4
KOGW081	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW082	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4

Table A 5.B Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2007					2008					2009					Qas for
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		02-09
KOGW083																4
KOGW084	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW085	Y	Y			Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW086	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW087	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW088																4
KOGW089	Y	Y	Y		Y	Y				Y	Y	Y			Y	3
KOGW090																3
KOGW091	Y	Y	Y		Y	Y	Y			Y						3
KOGW092	Y	Y			Y	Y	Y			Y	Y	Y			Y	2
KOGW093	Y	Y	Y		Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW094	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	4
KOGW095																4
KOGW096	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW097	Y	Y			Y	Y	Y	Y	Y	Y	Y				Y	4
KOGW098																2
KOGW099	Y	Y			Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	3
KOGW100																2
KOGW101																2
KOGW102		Y		Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	3
KOGW103	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						4
KOGW104											Y		Y	Y	Y	4
KOGW105	Y	Y	Y		Y	Y		Y		Y	Y	Y	Y	Y	Y	4
KOGW106																2
KOGW107	Y	Y	Y	Y	Y											4
KOGW108	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW109																4
KOGW110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				Y	4
KOGW111						Y	Y	Y		Y	Y				Y	4
KOGW112	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW113	Y	Y	Y	Y	Y		Y			N	Y	Y	Y	Y	Y	4
KOGW114	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y				Y	4
KOGW115	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	4
KOGW116	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	4
KOGW117	Y	Y	Y	Y	Y	Y				Y	Y	Y	Y	Y	Y	4
KOGW118	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW119	Y	Y	Y		Y	Y				Y						4
KOGW120																2
KOGW121																4
KOGW122																4
KOGW123	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW124	Y	Y			Y						Y	Y	Y	Y	Y	4

Table A 5.B Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2007					2008					2009					Qas for
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		02-09
KOGW125	Y	Y	Y		Y						Y	Y			Y	3
KOGW126											DEAD					2
KOGW127	Y	Y			Y						Y	Y			Y	2
KOGW128																2
KOGW129	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	4
KOGW130																2
KOGW131											Y		Y	Y	Y	4
KOGW132	Y	Y			Y											2
KOGW133																3
KOGW134																4
KOGW135	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW136	Y	Y	Y		Y											4
KOGW137	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW138	Y	Y	Y	Y	Y											4
KOGW139						Y			Y	Y	Y	Y			Y	3
KOGW140																3
KOGW141																2
KOGW142																2
KOGW143																2
KOGW144	Y	Y			Y	Y	Y			Y	Y	Y	Y	Y	Y	4
KOGW145	Y	Y	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	4
KOGW146	Y	Y			Y						Y				Y	2
KOGW147	Y	Y	Y	Y	Y											4
KOGW148	Y	Y	Y	Y	Y											4
KOGW149	Y	Y			Y											2
KOGW150	Y	Y			Y											2
KOGW151	Y	Y			Y											2
KOGW152	Y	Y			Y											2
KOGW153	Y	Y	Y	Y	Y											4
KOGW154	Y	Y			Y											2
KOGW155	Y	Y			Y											2
KOGW156	Y	Y			Y											2
KOGW157	Y	Y			Y											2
KOGW158	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW159	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	4
KOGW160	Y	Y	Y	Y	Y						Y	Y			Y	4
KOGW161						Y	Y			Y						2
KOGW162						Y	Y			Y		Y			Y	2
KOGW163						Y	Y			Y						2
KOGW164						Y	Y		Y	Y						3
KOGW165						Y	Y			Y						2
KOGW166											Y	Y			Y	2

Table A 5.B Aspects photographed of gray whale individuals off the NE coast of Sakhalin Island in 2002-2009 (5 Pages)

№ KOGW	2007					2008					2009					Qas for
	RS	LS	DF	VF		RS	LS	DF	VF		RS	LS	DF	VF		02-09
KOGW167											Y	Y			Y	2
KOGW168											Y	Y			Y	2
KOGW169											Y	Y			Y	2
KOGW170											Y	Y			Y	2
KOGW171											Y	Y			Y	2
KOGW172											Y	Y	Y	Y	Y	4
KOGW173											Y	Y			Y	2
KOGW174											Y	Y			Y	2
KOGW175											Y	Y			Y	2
KOGW176											Y	Y			Y	2
KOGW177											Y	Y			Y	2
TEMP01																done
TEMP02																done
TEMP03																done
TEMP04																1
TEMP05																1
TEMP06																1
TEMP07																1
TEMP08																1
TEMP09		Y			N											done
TEMP10	Y				N											done
TEMP11		Y			N											1
TEMP12		Y			N											1
TEMP13		Y			N											1
TEMP14																done

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
ID	P	O	C	P	O	C	P	O	C	P	O	C	Oha	El	P	O	C	Oha	P	O	C	P	O	C	P	O	C
001		Y						Y		Y					Y				Y	Y		Y	Y			Y	
002		Y			Y		Y			Y					Y	Y			Y	Y	Y		Y				
003		Y																									
004		Y		Y																							
005		Y		Y			Y			Y					Y		Y		Y	Y		Y			Y		
006		Y								Y	Y						Y		Y	Y		Y			Y		
007	Y			Y			Y			Y					Y		Y		Y	Y							
008		Y		Y			Y			Y			Y		Y	Y				Y			Y			Y	
009		Y					Y			Y					Y				Y	Y			Y			Y	
010		Y					Y			Y					Y				Y	Y	Y				Y		
011		Y			Y		Y			Y		Y			Y				Y	Y			Y			Y	
012		Y		Y	Y		Y			Y		Y			Y	Y			Y	Y			Y	Y		Y	
013		Y			Y		Y			Y					Y	Y				Y			Y		Y		
014		Y								Y					Y	Y				Y			Y				
015		Y			Y					Y					Y				Y	Y		Y	Y				
016		Y			Y		Y			Y						Y			Y			Y			Y		
017		Y			Y		Y			Y					Y	Y			Y	Y						Y	
018	Y			Y			Y			Y					Y												
019		Y			Y			Y		Y	Y					Y				Y						Y	
020		Y			Y		Y			Y		Y			Y	Y	Y		Y	Y		Y	Y				
021		Y			Y		Y			Y					Y					Y		Y	Y			Y	
022	Y			Y			Y			Y					Y		Y		Y			Y					Y
023	Y						Y								Y		Y									Y	
024	Y									Y					Y		Y		Y	Y			Y		Y		
023	Y	Y		Y	Y		Y			Y	Y					Y			Y	Y						Y	
026	Y			Y						Y		Y			Y							Y			Y		
027	Y			Y			Y										Y		Y			Y					
028		Y					Y			Y					Y				Y						Y		

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
029	Y			Y			Y			Y					Y				Y	Y		Y	Y		Y		
030	Y			Y			Y			Y					Y				Y	Y		Y	Y		Y	Y	
031	Y				Y		Y								Y				Y				Y		Y		
032		Y					Y			Y					Y				Y	Y			Y				
033		Y			Y		Y			Y					Y				Y							Y	
034		Y					Y			Y									Y			Y			Y		
035		Y		Y	Y		Y			Y					Y				Y	Y		Y	Y		Y		
036		Y			Y		Y			Y					Y	Y			Y	Y			Y				
037		Y		Y			Y			Y	Y				Y				Y	Y		Y	Y		Y		
038		Y		Y			Y			Y		Y			Y			Y	Y			Y			Y		
039		Y		Y						Y					Y		Y		Y	Y		Y			Y	Y	
040		Y		Y						Y										Y			Y			Y	
041		Y					Y			Y						Y			Y	Y		Y			Y		Y
042	Y		Y				Y			Y						Y			Y	Y		Y				Y	
043		Y		Y	Y		Y			Y		Y				Y			Y				Y				
044		Y		Y		Y				Y					Y		Y		Y			Y			Y		Y
045		Y			Y			Y		Y							Y			Y						Y	
046					Y		Y			Y					Y	Y			Y				Y			Y	
047				Y						Y					Y				Y		Y	Y			Y		
048							Y			Y					Y				Y	Y					Y		
049				Y			Y			Y		Y	Y		Y	Y			Y	Y		Y			Y		
050				Y			Y			Y					Y				Y			Y			Y		
051					Y		Y			Y									Y	Y			Y				Y
052				Y																							
053				Y						Y					Y				Y						Y		
054					Y		Y			Y						Y			Y	Y		Y	Y		Y		
055				Y						Y	Y				Y				Y	Y		Y			Y	Y	
056				Y			Y			Y					Y				Y			Y			Y	Y	
057				Y											Y	Y			Y	Y			Y				

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
058				Y			Y			Y		Y					Y		Y		Y		Y				
059				Y	Y					Y		Y			Y	Y			Y	Y					Y		
060				Y			Y			Y					Y					Y		Y	Y		Y		
061				Y			Y			Y							Y		Y		Y	Y		Y	Y		
062				Y				Y		Y					Y	Y			Y	Y		Y	Y			Y	Y
063				Y			Y			Y		Y			Y				Y			Y	Y				
064				Y			Y			Y		Y			Y				Y		Y				Y		Y
065				Y																							
066					Y		Y			Y					Y		Y		Y				Y		Y		
067				Y			Y			Y					Y	Y			Y								
068				Y			Y			Y					Y				Y			Y			Y		
069				Y	Y		Y			Y					Y	Y	Y		Y		Y	Y	Y		Y	Y	
070					Y		Y			Y					Y		Y			Y			Y		Y	Y	
071				Y			Y			Y					Y				Y		Y	Y			Y		
072				Y			Y			Y					Y						Y	Y	Y		Y		
073				Y											Y				Y						Y		
074				Y			Y			Y					Y		Y		Y			Y			Y		
075				Y						Y															Y		
076				Y			Y			Y					Y	Y				Y			Y		Y	Y	
077				Y																							
078				Y			Y			Y					Y				Y	Y	Y		Y		Y		
079				Y						Y																Y	Y
080				Y			Y								Y		Y		Y	Y	Y		Y		Y		
081				Y			Y			Y					Y		Y		Y		Y	Y					
082				Y											Y		Y		Y			Y			Y		
083				Y			Y			Y					Y												
084					Y		Y				Y					Y				Y			Y			Y	
085					Y		Y			Y						Y			Y	Y						Y	
086					Y		Y			Y										Y			Y		Y	Y	

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
087				Y			Y			Y					Y					Y			Y			Y	
088					Y																						
089				Y			Y			Y					Y		Y		Y		Y		Y				Y
090				Y			Y			Y																	
091				Y			Y			Y					Y				Y			Y					
092				Y			Y			Y					Y				Y		Y	Y			Y		
093		Y					Y			Y					Y		Y		Y	Y	Y	Y			Y		
094							Y			Y					Y				Y			Y			Y		
095							Y																				
096							Y			Y					Y				Y		Y	Y	Y			Y	
097							Y	Y											Y			Y	Y		Y		
098							Y																				
099							Y			Y					Y				Y			Y			Y		Y
100							Y																				
101							Y																				
102							Y			Y					Y				Y			Y	Y			Y	
103							Y			Y					Y				Y	Y			Y			Y	
104								Y		Y													Y			Y	
105							Y			Y		Y			Y		Y		Y			Y			Y		
106							Y			Y					Y												
107							Y			Y					Y				Y								
108	Y						Y			Y					Y		Y		Y	Y			Y			Y	
109							Y								Y												
110							Y			Y	Y					Y				Y		Y					
111							Y			Y												Y			Y		
112										Y					Y				Y		Y	Y			Y		
113							Y			Y					Y				Y			Y			Y		
114							Y			Y						Y				Y		Y	Y		Y	Y	
115							Y			Y					Y		Y			Y					Y	Y	

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
116							Y			Y					Y				Y	Y		Y	Y		Y		
117										Y					Y		Y		Y		Y		Y		Y	Y	
118										Y					Y					Y		Y		Y		Y	
119										Y					Y	Y				Y			Y				
120										Y																	
121										Y					Y												
122														Y													
123										Y			Y			Y				Y			Y		Y		
124										Y					Y				Y	Y					Y	Y	
125										Y					Y				Y						Y		
126										Y																	
127										Y					Y				Y								Y
128										Y																	
129										Y					Y				Y	Y					Y		
130										Y																	
131										Y															Y		
132										Y					Y				Y		Y						
133										Y					Y		Y										
134										Y																	
135							Y			Y					Y				Y	Y		Y	Y		Y		
136															Y		Y		Y		Y						
137															Y	Y			Y		Y	Y	Y		Y		
138															Y				Y								
139	Y														Y								Y		Y		
140															Y												
141															Y												
142															Y												
143															Y												
144															Y				Y			Y					Y

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
145															Y				Y	Y			Y		Y		
146															Y				Y								
147															Y				Y								
148																			Y								
149																			Y								
150																			Y								
151																			Y								
152																			Y								
153																			Y								
154																			Y								
155																			Y								
156																			Y								
157																				Y							
158															Y		Y		Y	Y			Y				
159																			Y			Y					
160																			Y								
161																						Y					
162																						Y					
163																						Y					
164																						Y					
165																						Y					
166																									Y		
167																									Y		
168																									Y		
169																									Y		
170																									Y		
171																									Y		
172																									Y		Y
173																									Y		

Table A 6. Locations of encounters with identified gray whales off NE Sakhalin Island by all expeditions 2002-2009. (7 Pages)

	2002			2003			2004			2005					2006				2007			2008			2009		
174																									Y		
175																									Y		
		P - Piltun			O - Offshore			C - Chaivo				Oha - Okha				El - Elisaveta cape											

Table A7. Number of encounters with identified gray whales by area off NE Sakhalin Island during the 2009 expedition. (3 Pages)

KOGW000	Piltun	North Piltun	Offshore	West Offsh	Chaivo	Arkutun	SKam+Kuril	Total
KOGW001	0	0	1	0	0	0		1
KOGW005	2	0	0	0	0	0		2
KOGW006	1	0	0	0	0	0		1
KOGW008	0	0	2	0	0	0		2
KOGW009	0	0	1	0	0	0		1
KOGW010	2	0	0	0	0	0		2
KOGW011	0	0	3	0	0	0		3
KOGW012	0	0	2	0	0	0		2
KOGW013	1	0	0	0	0	0		1
KOGW016	3	0	0	0	0	0		3
KOGW017	0	0	1	0	0	0		1
KOGW019	0	0	3	0	0	0		3
KOGW021	0	0	1	0	0	0		1
KOGW022	0	0	0	0	2	0		2
KOGW023	0	0	3	0	0	0		3
KOGW024	3	0	0	0	0	0		3
KOGW025	0	0	2	0	0	0		2
KOGW026	1	0	0	0	0	0		1
KOGW028	2	0	0	0	0	0		2
KOGW029	2	0	0	0	0	0		2
KOGW030	4	1	4	0	0	0		9
KOGW031	1	0	0	0	0	0		1
KOGW033	0	0	1	0	0	0		1
KOGW034	4	0	0	0	0	0		4
KOGW035	1	0	0	0	0	0		1
KOGW037	4	3	0	0	0	0		7
KOGW038	3	0	0	0	0	0		3
KOGW039	3	0	2	0	0	0		5
KOGW040	0	0	1	0	0	0		1
KOGW041	1	0	0	0	1	0		2
KOGW042	0	0	2	0	0	0		2
KOGW044	1	0	0	0	1	0		2
KOGW045	0	0	3	0	0	0		3
KOGW046	0	0	2	0	0	0		2
KOGW047	1	0	0	0	0	0		1
KOGW048	5	0	0	0	0	0		5
KOGW049	7	1	0	0	0	0		8
KOGW050	1	0	0	0	0	0		1
KOGW051	0	0	0	0	2	0		2
KOGW053	0	0	0	0	2	0		2
KOGW054	3	0	0	0	0	0		3
KOGW055	1	0	0	0	0	0		1
KOGW056	1	0	0	1	0	0		2
KOGW057	3	0	2	0	0	0		5
KOGW059	3	0	0	0	0	0		3
KOGW060	1	0	0	0	0	0		1
KOGW061	3	0	0	0	0	0		3
KOGW062	0	0	5	0	1	0		6
KOGW064	1	0	0	0	2	0		3

Table A7. Number of encounters with identified gray whales by area off NE Sakhalin Island during the 2009 expedition. (3 Pages)

KOGW000	Piltun	North Piltun	Offshore	West Offsh	Chaivo	Arkutun	SKam+Kuril	Total
KOGW066	3	0	0	0	0	0		3
KOGW068	2	0	0	0	0	0		2
KOGW069	2	0	2	0	0	0		4
KOGW070	1	0	2	0	0	0		3
KOGW071	2	0	0	0	0	0		2
KOGW072	2	0	0	0	0	0		2
KOGW073	1	0	0	0	0	0		1
KOGW074	2	0	0	0	0	0		2
KOGW075	0	1	0	0	0	0		1
KOGW076	3	0	2	0	0	0		5
KOGW078	3	0	0	0	0	0		3
KOGW080	0	0	4	0	2	0		6
KOGW081	2	0	0	0	0	0		2
KOGW082	2	0	0	0	0	0		2
KOGW084	0	0	2	0	0	0		2
KOGW085	0	0	1	0	0	0		1
KOGW086	0	1	1	0	0	0		2
KOGW087	0	0	4	0	0	0		4
KOGW089	0	0	0	0	2	0		2
KOGW092	2	0	0	0	0	0		2
KOGW093	3	0	0	0	0	0		3
KOGW094	7	0	0	0	0	0		7
KOGW096	0	0	1	0	0	0		1
KOGW097	2	0	0	0	0	0		2
KOGW099	6	0	0	0	1	0		7
KOGW102	0	0	8	0	0	0		8
KOGW104	0	0	1	0	0	0		1
KOGW105	3	0	0	0	0	0		3
KOGW108	0	0	5	0	0	0		5
KOGW111	2	0	0	0	0	0		2
KOGW112	6	0	0	0	0	0		6
KOGW113	3	0	0	0	0	0		3
KOGW114	1	0	1	0	0	0		2
KOGW115	2	3	2	0	0	0		7
KOGW116	3	0	0	0	0	0		3
KOGW117	1	0	1	0	0	0		2
KOGW118	0	0	2	0	0	0		2
KOGW123	1	1	0	0	0	0		2
KOGW124	3	0	5	0	0	0		8
KOGW125	1	0	0	0	0	0		1
KOGW127	0	0	0	0	1	0		1
KOGW129	2	0	0	0	0	0		2
KOGW131	2	0	0	0	0	0		2
KOGW135	1	0	0	0	2	0		3
KOGW137	2	0	0	0	0	0		2
KOGW139	2	1	0	0	0	0		3
KOGW144	0	0	0	0	2	0		2
KOGW145	2	1	0	0	0	0		3
KOGW158	0	0	3	0	0	0		3
KOGW159	1	0	1	0	0	0		2

Table A7. Number of encounters with identified gray whales by area off NE Sakhalin Island during the 2009 expedition. (3 Pages)

KOGW000	Piltun	North Piltun	Offshore	West Offsh	Chaivo	Arkutun	SKam+Kuril	Total
KOGW160	1	0	0	0	0	0		1
KOGW162	1	0	0	0	0	0		1
KOGW166	3	0	0	0	0	0		3
KOGW167	2	0	0	0	0	0		2
KOGW168	4	0	0	0	0	0		4
KOGW169	1	0	0	0	0	0		1
KOGW170	1	0	0	0	0	0		1
KOGW171	2	0	0	0	0	0		2
KOGW172	1	0	0	0	1	0		2
KOGW173	1	0	0	0	0	0		1
KOGW174	2	0	0	0	0	0		2
KOGW175	1	0	0	0	0	0		1

Table A8. Sighting of gray whales by year, recorded sightings of cows with calves, physical body condition (PCB) class and skin condition, 2002-2009

№ whale KOGW	Year		cow/calf	PCB	Skin condition	Year	cow/calf	PCB	Skin condition	Year	cow/calf	PCB	Skin condition	Year		cow/calf	PCB	Skin condition	Year	cow/calf	PCB	Skin condition	Year	cow/calf	PCB	Skin condition	Year	cow/calf	PCB	Skin condition
	2002	2003				2004				2005				2006					2007				2008				2009			
1	x			0	0	x		0	0	x		0	0	x	1		1		x		1-0		x		1		x			
2	x	x		1	0	x		1	0	x		0	0	x	1		2		x		2-1		x							
3	x																													
4	x	x		0	0																									
5	x	x	cow	2-3	0	x		0	0	x	cow	4	0	x	1				x				x		3-2-1		x		3	
6	x	x		0	0	x		2	0	x		0	0	x	1		1		x				x		1		x			
7	x	x		0	0	x		0	0	x		0	0				1-4		x		1-0									
8	x	x		3	0	x		0	0	x		0	0	x	1		2		x		1-0		x				x		1	
9	x					x		0	0	x		0	0	x	1				x		2	1	x				x			
10	x					x		1	0	x		1	1	x	1				x		1-0						x			
11	x	x		1	0	x		0	0	x		0	0	x	1				x		1-0		**x**				x		2	
12	x	x		1	0	x		1	0	x		1	0	x	1				x		1-0		x				x		2	
13	x	x		2	0	x		0	0	x		2	0	x	1				x								x			
14	x					x		1	0	x		0	0	x	1				x				x							
15	x	x		0	0					x		0	0	x	1				x	cow	4-3		x		1		x	cow	4	
16	x	x		0	0	x		0	0	x		0	0	x	1				x		2-0	?	x		2		x			
17	x	x		0	0	x		1	0	x		0	0	x	1		2-1-0		x		1-0						x			
18	x	x	cow	2	0	x		0	0	x		0	0	x	1		2-1													
19	x	x		2	0	x		0	0	x		3	0	x	1		3-2		x		1						x		2-1	
20	x	x		0	0	x		0	0	x		0	0	x	1		1-0		x		1-0		x				x	cow	4	

21	x	x		0	0	x		2	0	x		0	0	x	1	cow	2-3		x				x	cow	4-3		x		1	
22	x	x			0	x		0	0	x		0	0	x	1				x		2		x		4-2=1		x			
23	x					x		0	0				0	x	1		2-0										x			
24	x									x		0	0	x	1				x				x				x			
25	x	x		1	0	x		0	0	x		0	0	x	1				x		2-0						x		1	
26	x	x	cow	2	2					x		0	0	x	1		2						x				x		1	
27	x	x	cow	4	2	x		2	0	x	cow	3-4	0	x	1		2		x	cow	4-3		x		2					
28	x	x		0	от 1 до 3	x		0	0	x		0	0	x	1		2		x		2	1-2					x			
29	x	x		0	0	x		1	0	x		0	0	x	1		1-0		x		1-0	1	x				x		1	
30	x	x		0	0	x		0	0	x		0	0	x	1				x				x				x		2-0	
31	x	x		0	0	x		0	0					x	1				x		2-0	1	x				x	cow	3	
32	x	x		0	1	x		1	0	x		0	0	x	1				x		2-0		x				x			
33	x	x		0	0	x		0	0	x		0	0	x	1		2		x				x				x			
34	x					x		0	0	x		0	2	x	1		2-0		x		2-0	1	x		2		x		2-1	
35	x	x		0	0	x		0	0	x		0	0	x	1		1		x		2-1-0		x				x			
36	x	x		0	0	x		0	0	x		1	0	x	1		2		x				x							
37	x	x	cow	2	0	x		0	0	x	cow	3	0	x	1		1		x				x		3		x		3-0	
38	x	x		0	0	x		0	0	x				x	1				x		2-0		x				x			
39	x	x	cow	3	0					x		0	0	x	1		3-0		x		2-1-0	1	x				x		1-0	
40	x	x		2	0	x		0	0	x		0	0						x				x				x		2	
41	x					x		0	0	x		0	0	x	1				x		2-0		x		2		x		2	
42	x					x		0	1	x		0	1	x	1		1-0		x		1-		x				x		1	

																					0										
43	x	x		1	0	x		0	0	x		1	0	x	1		1-0		x		2		x								
44	x	x		2	0	x		3	0	x		4	0	x	1				x		4-3		x		4-2		x		1		
45	x	x		0	0	x		0	0	x		0	0	x	1				x								x				
46		x		0	0	x		2	0	x		0	0	x	1		2-1-0		x		1	1	x				x				
47		x		0	1	x		0	0	x		0	0	x	1				x				x		3		x				
48		x		0	0	x		0	0	x		0	0	x	1		4-1		x		1-0						x				
49		x		2	2	x		0	0	x		0	0	x	1		2		x		2-0		x				x				
50		x		0	2	x	cow	3	1	x		0	0	x	1	cow	2		x		2-1-0		x		2-0		x	cow	1		
51		x		0	0	x		2	0	x		0	0	x	1		2		x				x		1		x				
52		x	calf	0	0																										
53		x		0	0					x		0	0	x	1		1		x		2-1-0						x		1		
54		x		0	0	x		0	0	x		0	0	x	1		1-0		x		2-0		x		1		x		1		
55		x		0	0					x		0	0	x	1				x		1-0	1	x				x				
56		x		0	от 1 до 3	x		1	0	x		0-1	0	x	1		2-0		x		2-1	1	x		2		x				
57		x		0	0									x	1		1		x		2-0		x				x		3-0		
58		x		0	0	x		0	0	x		1	0	x	1				x		2-1-0		x		2						
59		x		0	0					x		0	0	x	1		1		x		3-0	1					x		2-0		
60		x		0	0	x		0	0	x		0	0	x	1		2-0		x		1-0		x				x		2		
61		x		0	0	x		0	0	x		0	0	x	1		2-0		x		1-0	2	x				x				
62		x		0	0	x		0	0	x	cow	2	0	x	1		1-0		x	cow	4-3		x		2		x				
63		x	cow	2	0	x		1	0	x		0	0	x	1				x	cow	2-0		x								

64		x		0	0	x	cow	2	0	x		2	0	x	1				x	cow	3						x			
65		x		0	0																										
66		x		0	0	x		0	0	x		0	0	x	1		1-0		x				x				x		2	
67		x		0	0					x		0	0	x	1		2-1		x		2-1									
68		x		2	1	x		0	0	x		0	0	x	1		2		x		1-0	1-2-3	x		1		x		2	
69		x	calf	0	0	x		1	0	x		0	0	x	1		1-0		x				x				x		2-0	
70		x		2	0	x		1	0	x		0	0	x	1		1-0		x				x				x		2-0	
71		x		0	0	x		0	0	x		1	0	x	1				x		2	1	x		2-1		x		2-0	
72		x		0	0	x		0	0	x		0	0	x	1				x		1		x		1		x		2-0	
73		x	calf	0	0														x	?	2-1						x			
74		x		0	0	x		0	0	x		0	0	x	1				x		1-0	1	x				x			
75		x	calf	0	0																						x		1	
76		x	calf	0	0	x		0	0	x		0	0	x	1				x				x				x			
77		x	calf	0	0																									
78		x	calf	0	0	x		0	0	x		0	0	x	1				x		1-0		x				x		1	
79		x	calf	0	0					x		0	0																	
80		x	calf?	0	0	x		1	0					x	1		1-0		x		1-0		x				x		1	
81		x	calf	0	0	x		0	0	x		0	0	x	1		2-0		x		2-1-0		x				x		2	
82		x	calf	0	0	x		0	0			0	0	x	1				x		2		x				x			
83		x	calf?	0	0	x		0	0	x		0	0	x	1															
84		x		1	0	x		0	0	x				x	1		2		x				x				x			
85		x		0	0	x		1	0	x		0	0	x	1				x		2-1		x				x			
86		x		0	0	x		0	0	x		0	0						x				x				x		2-0	

87		x		0	0	x		0	0	x		0	0	x	1				x				x				x		2-0	
88		x		0	0			0	0																					
89		x	calf?	0	0	x		0	0	x		0	0	x	1		2-1-0		x		2-1-0		x				x		1	
90		x																												
90		x		0	0	x		0	0	x		0																		
91		x		0	0	x		0	0	x				x	1		1-0		x		1		x							
92		x		0	0	x		2	0	x			0	x	1		2		x		2-1		x		3-1		x	cow	4	
93						x		0	0	x		0	0	x	1		2-0		x		1-0		x		3-1		x			
94						x		0	0	x		0	0	x	1		1-0		x		1-0		x		2		x			
95						x	calf	0	0																					
96						x		1	0	x		0	0	x	1				x		1		x				x		1	
97						x		0	0										x	cow	4-2		x		3-2		x	cow	2	
98						x		0	0																					
99						x		0	0	x		0	0	x	1				x		2-1-0		x		1		x		2-0	
100						x		3	0																					
101						x	calf	0	0																					
102						x		0	0	x		0	0	x	1				x				x				x			
103						x		0	0	x		0	0	x	1				x		2		x							
104						x		0	0	x		1	0										x				x			
105						x		0	0	x		0	0	x	1		1-0		x		2-1-0		x		2		x			
106						x		0	0	x		0	0	x	1		1-0						x							
107						x		0	0	x		0	0	x	1		1		x											
108						x		1	0	x		0	0	x	1		2-1		x		2-0		x				x			
109						x		0	0	x				x	1															
110						x		2	0	x		0	0	x	1		1-0		x				x				x			
111						x		0	0	x		0	0										x		2		x			
112						x		0	0	x		0	0	x	1		2-1-0		x		2-1-		x				x		2-0	

																				0										
113						x		0	0	x		0	0	x	1				x		2		x				x			
114						x		0	0	x		0	0	x	1				x		1-0		x				x	x		
115						x		0	0	x		0	0	x	1				x		1						x		2-0	
116						x		0	0	x		0	0	x	1				x		2-0	1	x				x		1-0	
117										x		0	0	x	1				x		1-0		x				x			
118										x		0	0	x	1		1		x				x				x			
119										x		1	0	x	1		2-0		x				x							
120										x		2	0																	
121										x		0	0	x	1		1-2													
122										x		1	0																	
123										x		0	0	x	1				x				x				x		2	
124										x	calf	0	0	x	1				x		1						x		1	
125										x	calf	0	0	x	1		1		x		2-1-0						x		2	
126										x	calf	0	0																	
127										x	calf	0	0	x	1		2		x			2					x			
128										x		0	0																	
129										x		0	0	x	1		1		x		2-0						x		1-0	
130										x		0	0																	
131										x		0	0														x		1	
132										x		2	0	x	1				x		1									
133										x		0	0	x	1															
134										x		0	0																	
135										x		0	0	x	1				x				x				x		2-0	
136														x	1		1-0		x		1									
137														x	1		1-0		x		1-0		x				x			
138														x	1		2-0		x		1-0									
139														x	1		2		x								x		2	
140														x	1		1-0													
141														x	1	calf														
142														x	1	calf														
143														x	1	calf														

144														x	1	calf ?			x				x		1		x		2	
145														x	1				x				x				x			
146														x	1	calf ?			x		1-0	2-1					x			
147														x	1		1-2		x		1									
148																			x	calf										
149																			x	calf										
150																			x	calf										
151																			x	calf										
152																			x	calf										
153																			x	calf										
154																			x	calf										
155																			x	calf ?										
156																			x		1									
157																			x		1									
158																			x		1		x		2		x		2	
159																			x		2-1-0		x		2		x		1-0	
160																			x								x		1	
161																							x	calf						
162																							x	calf			x		2	
163																							x	calf						
164																							x	calf ?						
165																							x	calf ?						
166																											x		2-0	
167																											x	calf		
168																											x	calf		
169																											x	calf		
170																											x			
171																											x			
172																											x		2	
173																											x	calf		
174																											x	calf		
175																											x	calf		
176																											x	calf		

177																											x	calf		
TEMP 1	x																													
TEMP 2						x		0	0	x		0	0	identified as KOGW135																
TEMP 3	x	identified as KOGW108																												
TEMP 4														x																
TEMP 5														x																
TEMP 6														x																
TEMP 7														x																
TEMP 8														x																
TEMP 9																			identified as KOGW129											
TEMP 10																			x	c al f?										
TEMP 11																			x											
TEMP 12																			x											
TEMP 13																			x											
TEMP 14																			identified as KOGW158											

Обозначения: мать - cow, детеныш - calf, норма - 0.

Number of whales		
Whales seen in Piltun and offshore	6	
Были недостаточной ФК, но их состояние улучшилось.	12/6	2
Были нормальной ФК,но их состояние ухудшилось	7/2	
Были недостаточной ФК, их состояние не изменилось	1	
Состояние кожных покровов не было нормальным в 2003г.	6/2	
Состояние кожных покровов было нормальным и изменилось	1	
Состояние кожных покровов не было нормальным и не изменилось	1	

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
KamGW001 cow			2006_08_21	1			2008_08_22	1	2009_07_11	1	KOGW090
							2008_08_28	1	2009_07_21	1	
							2008_08_29	1	2009_08_04	1	
									2009_08_14	1	
KamGW002			2006_08_21	1	2007_08_02	1	2008_08_29	1	2009_07_16	1	KOGW132
									2009_07_21	1	
KamGW003			2006_08_22	1	2007_08_05	1	2008_08_19	1	2009_07_11	1	
									2009_07_27	1	
									2009_08_14	1	
									2009_09_02	1	
KamGW004			2006_08_22	2	2007_08_02	1	2008_08_22	1	2009_07_21	1	
KamGW005			2006_08_22	1			2008_08_19	1	2009_07_27	1	
							2008_08_28	1	2009_08_04	1	
							2008_08_29	1	2009_08_20	1	
									2009_09_02	1	
KamGW006			2006_08_22	1							
KamGW007			2006_08_22	1	2007_08_02	2	2008_08_22	1	2009_07_16	1	
					2007_08_05	1	2008_08_23	1			
KamGW008			2006_08_22	1	2007_08_02	1	2008_08_29	1			KOGW095
KamGW009			2006_08_22	1	2007_08_02	1			2009_08_14		
KamGW010			2006_08_22	1	2007_08_02	1	2008_08_28	1	2009_07_21	1	KOGW077
					2007_08_05	1					
KamGW011			2006_08_22	1	2007_08_02	1			2009_08_14	1	
KamGW012			2006_08_22	1	2007_08_02	1			2009_08_14	1	
					2007_08_05	1					
KamGW013			2006_07_05	1							KOGW047

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
KamGW014	2004_07_22	1									
	2004_08_11	1									
KamGW015	2004_07_22	1									KOGW166
KamGW016	2004_08_11	1									KOGW136
KamGW017					2007_08_02	1					
					2007_08_05	1					
KamGW018					2007_08_02	1	2008_08_22	1	2009_07_11	1	KOGW160
									2009_07_16	1	
									2009_07_21	1	
									2009_07_27	1	
KamGW019					2007_08_02	1			2009_06_05	1	KOGW022
KamGW020					2007_08_02	1	2008_08_22	1	2009_07_11	1	
					2007_08_05	1	2008_08_29	1	2009_07_27	1	
									2009_08_14	1	
KamGW021					2007_08_02	1					
KamGW022					2007_08_02	1					
					2007_08_05	1					
KamGW023					2007_08_02	1					
KamGW024					2007_08_02	1	2008_08_22	1	2009_07_16	1	NOGW001
					2007_08_05	1					
KamGW025					2007_08_02	1	2008_08_23	1	2009_08_04	1	
							2008_08_28	1	2009_08_14	1	
							2008_08_29	1			
KamGW026					2007_08_02	1					KOGW075
KamGW027					2007_08_02	1					
KamGW028					2007_08_02	1					KOGW142
					2007_08_05	1					
KamGW029					2007_08_02	1			2009_08_04	1	

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
					2007_08_05	1					
KamGW030					2007_08_02	1	2008_08_28	1	2009_07_21	1	
							2008_08_29	1	2009_08_04	1	
KamGW031					2007_08_02	1	2008_08_23	1	2009_07_16	1	KOGW018
					2007_08_05	1					
KamGW032					2007_08_02	1			2009_07_16	1	KOGW140
					2007_08_05	1			2009_07_21	1	
KamGW033					2007_08_02	1					KOGW066
KamGW034											KOGW159 NOGW03
					2007_08_02	1					
KamGW035					2007_08_05	1	2008_08_19	1			KOGW124
KamGW036					2007_08_05	1					
KamGW037					2007_08_05	1	2008_08_22	1	2009_07_21	1	KOGW133
							2008_08_29	1	2009_08_04	1	
KamGW038					2007_06_05	1					KOGW092
KamGW039					2007_06_05	1					KOGW019
KamGW040					2007_06_05	1					
					2007_06_08	1					
KamGW041					2007_06_08	1					KOGW105
					2007_06_11	1					
KamGW042					2007_06_11	1			2009_06_11	1	KOGW137
KamGW043					2007_06_11	1					KOGW039
KamGW044					2007_06_11	1					KOGW033
KamGW045							2008_08_19	1			KOGW028
							2008_08_29	1			
KamGW046							2008_08_19	1			
KamGW047							2008_08_19	1			
							2008_08_23	1			

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
							2008_08_28	1			
KamGW048							2008_08_19	1	2009_07_11	1	KOGW149
							2008_08_28	1	2009_07_27	1	
							2008_08_29	1	2009_08_04	1	
									2009_08_14	1	
									2009_09_02	1	
KamGW049							2008_08_19	1	2009_07_11	1	
									2009_07_27	1	
KamGW050							2008_08_19	1			KOGW152
							2008_08_28	1			
KamGW051							2008_08_19	1			
							2008_08_23	1			
							2008_08_28	1			
KamGW052							2008_08_19	1	2009_07_11	1	KOGW154
							2008_08_28	1	2009_07_21	1	
									2009_07_27	1	
									2009_08_14	1	
									2009_08_20	1	
									2009_09_02	1	
KamGW053							2008_08_19	1	2009_07_11	1	KOGW148
							2008_08_22	1	2009_07_16	1	
									2009_07_21	1	
KamGW054							2008_08_19	1	2009_07_16	1	KOGW153
							2008_08_22	1	2009_07_21	1	
							2008_08_23	1	2009_07_27	1	
							2008_08_29	1			
KamGW055							2008_08_22	1	2009_07_11	1	
							2008_08_23	1	2009_07_21	1	

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
									2009_07_27	1	
									2009_08_14	1	
KamGW056							2008_08_22	1	2009_07_11	1	KOGW151
							2008_08_29	1	2009_07_16	1	
KamGW057 cow							2008_08_22	1	2009_07_16	1	
							2008_08_29	1	2009_07_21	1	
									2009_07_27	1	
									2009_08_14	1	
KamGW058							2008_08_22	1			
							2008_08_29	1			
KamGW059							2008_08_22	1			
KamGW060							2008_08_22	1			KOGW064
KamGW061							2008_08_22	1			
KamGW062							2008_08_22	1			KOGW053
KamGW063							2008_08_22	1	2009_07_11	1	KOGW107
							2008_08_29	1			
KamGW064							2008_08_22	1			KOGW127
							2008_08_29	1			
KamGW065							2008_08_22	1			KOGW131
							2008_08_29	1			
KamGW066							2008_08_22	1	2009_07_11	1	
							2008_08_23	1	2009_07_27	1	
KamGW067							2008_08_28	1			
KamGW068							2008_08_22	1	2009_06_14	1	KOGW045
KamGW069							2008_08_22	1			KOGW067
							2008_08_29	1			
KamGW070							2008_08_22	1			KOGW084
							2008_08_28	1			

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
KamGW071							2008_08_22	1			KOGW048
							2008_08_28	1			
							2008_08_29	1			
KamGW072							2008_08_22	1			
							2008_08_28	1			
KamGW073							2008_08_22	1	2009_07_16	1	
							2008_08_29	1	2009_07_21	1	
									2009_07_27	1	
KamGW074							2008_08_22	1	2009_07_16	1	KOGW150
									2009_08_20	1	
									2009_09_02	1	
KamGW075							2008_08_23	1			
KamGW076							2008_08_23	1	2009_07_11	1	
							2008_08_28	1	2009_07_27	1	
							2008_08_29	1	2009_08_14	1	
KamGW077							2008_08_29	1			KOGW073
KamGW078							2008_08_29	1	2009_07_16	1	KOGW126
KamGW079									2009_07_11	1	
KamGW080									2009_07_11	1	KOGW164
									2009_07_27	1	
									2009_08_14	1	
									2009_08_20	1	
									2009_09_02	1	
KamGW081									2009_08_04	1	
KamGW082									2009_07_11	1	
KamGW083									2009_07_11	1	KOGW163
									2009_07_27	1	
KamGW084									2009_07_11	1	KOGW110

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
cow									2009_07_21	1	
KamGW085 calf									2009_07_11	1	
									2009_07_21	1	
									2009_08_20	1	
									2009_09_02	1	
KamGW086 calf									2009_07_11	1	
									2009_07_21	1	
									2009_08_04	1	
									2009_08_14	1	
									2009_08_20	1	
									2009_09_02	1	
KamGW087 cow									2009_07_11	1	KOGW103
KamGW088 calf									2009_07_11	1	KOGW174
KamGW089									2009_05_30	1	KOGW061
KamGW090									2009_06_06	1	KOGW091
KamGW091									2009_06_11	1	KOGW145
KamGW092									2009_06_13	1	KOGW111
									2009_06_14	1	
KamGW093									2009_06_13	1	KOGW016
KamGW094									2009_06_14	1	KOGW089
KamGW095									2009_06_14	1	KOGW038
KamGW096									2009_06_14	1	KOGW139
KamGW097									2009_07_16	1	KOGW157
									2009_07_21	1	
									2009_07_27	1	
KamGW098									2009_07_16	1	KOGW121
									2009_08_04	1	

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
KamGW099									2009_07_16	1	KOGW058
KamGW100 calf									2009_07_16	1	
									2009_07_21	1	
									2009_07_27	1	
									2009_08_14	1	
									2009_08_20	1	
KamGW101 cow									2009_07_21	1	
									2009_07_27	1	
KamGW102 calf									2009_07_21	1	
									2009_07_27	1	
KamGW103									2009_07_21	1	KOGW125
KamGW104 calf									2009_07_21	1	KOGW177
KamGW105 calf									2009_07_21	1	
									2009_07_27	1	
									2009_08_14	1	
									2009_08_20	1	
									2009_09_02	1	
KamGW106 cow									2009_07_21	1	
KamGW107									2009_07_21	1	
KamGW108									2009_07_21	1	
KamGW109									2009_07_11	1	
									2009_07_16	1	
									2009_07_21	1	
									2009_07_27	1	
KamGW110									2009_07_21	1	
									2009_07_27	1	
									2009_08_14	1	

Table A 9. Number of encounters with gray whales off Kamchatka Peninsula during the 2004, 2006-2009. (8 Pages)

ID (KamGW _	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	Date	Number of encounters	KOGW000
KamGW111									2009_07_27	1	KOGW161
									2009_08_14	1	
KamGW112									2009_08_14	1	
									2009_09_02	1	
KamGW113									2009_08_14	1	KOGW040
KamGW114									2009_08_20	1	
KamGW115									2009_07_11	1	
KamGW116									2009_07_16	1	

TABLE A10. Views from which individual gray whales were photographed off kamchatka Peninsula, all years (3 Pages)

ID	Views				Number of views described
	RS	LS	DF	VF	
KamGW001	Yes	Yes	Yes	Yes	4
KamGW002	Yes	Yes	Yes	Yes	4
KamGW003	Yes	Yes	No	No	2
KamGW004	Yes	Yes	No	No	2
KamGW005	Yes	Yes	No	No	2
KamGW006	Yes	Yes	No	No	2
KamGW007	Yes	Yes	No	No	2
KamGW008	Yes	Yes	Yes	Yes	4
KamGW009	Yes	Yes	Yes	Yes	4
KamGW010	Yes	Yes	Yes	Yes	4
KamGW011	Yes	Yes	No	No	2
KamGW012	Yes	Yes	Yes	Yes	4
KamGW013	Yes	Yes	Yes	Yes	4
KamGW014	Yes	Yes	Yes	Yes	4
KamGW015	Yes	Yes	Yes	Yes	4
KamGW016	Yes	Yes	Yes	Yes	4
KamGW017	Yes	Yes	No	No	2
KamGW018	Yes	Yes	No	No	1
KamGW019	Yes	No	Yes	Yes	3
KamGW020	Yes	Yes	No	No	2
KamGW021	Yes	Yes	No	No	2
KamGW022	Yes	Yes	да	нет	3
KamGW023	Yes	Yes	No	No	2
KamGW024	Yes	Yes	Yes	Yes	4
KamGW025	Yes	Yes	Yes	Yes	4
KamGW026	Yes	No	No	No	1
KamGW027	Yes	No	No	No	1
KamGW028	Yes	Yes	No	No	2
KamGW029	Yes	Yes	Yes	Yes	4
KamGW030	Yes	Yes	Yes	Yes	4
KamGW031	Yes	Yes	No	No	2
KamGW032	Yes	Yes	No	No	2
KamGW033	Yes	No	No	Yes	2
KamGW034	Yes	No	No	No	1
KamGW035	Yes	No	No	No	1
KamGW036	Yes	Yes	Yes	Yes	4
KamGW037	Yes	Yes	Yes	Yes	4
KamGW038	Yes	Yes	Yes	Yes	4
KamGW039	Yes	Yes	Yes	Yes	4
KamGW040	Yes	Yes	No	No	2
KamGW041	Yes	Yes	No	No	2
KamGW042	Yes	Yes	No	No	2
KamGW043	No	Yes	No	No	1
KamGW044	Yes	Yes	No	No	2
KamGW045	Yes	Yes	No	No	2

TABLE A10. Views from which individual gray whales were photographed off kamchatka Peninsula, all years (3 Pages)

KamGW046	Yes	Yes	Yes	No	3
KamGW047	Yes	Yes	No	No	2
KamGW048	Yes	Yes	да	No	3
KamGW049	Yes	Yes	No	No	2
KamGW050	Yes	Yes	No	No	2
KamGW051	Yes	Yes	No	No	2
KamGW052	Yes	Yes	No	No	2
KamGW053	Yes	Yes	No	No	2
KamGW054	Yes	Yes	No	No	2
KamGW055	Yes	Yes	No	No	2
KamGW056	Yes	Yes	No	No	2
KamGW057	Yes	Yes	Yes	Yes	4
KamGW058	Yes	Yes	No	No	2
KamGW059	Yes	Yes	Yes	Yes	4
KamGW060	Yes	Yes	No	No	2
KamGW061	Yes	Yes	No	No	2
KamGW062	Yes	Yes	No	No	2
KamGW063	Yes	Yes	Yes	Yes	4
KamGW064	Yes	Yes	No	No	2
KamGW065	Yes	Yes	No	No	2
KamGW066	Yes	Yes	No	No	2
KamGW067	Yes	No	No	No	1
KamGW068	Yes	Yes	No	No	2
KamGW069	Yes	Yes	No	No	2
KamGW070	Yes	Yes	No	No	2
KamGW071	Yes	Yes	No	No	2
KamGW072	Yes	Yes	No	No	2
KamGW073	Yes	Yes	Yes	Yes	4
KamGW074	Yes	Yes	Yes	нет	3
KamGW075	Yes	Yes	No	No	2
KamGW076	Yes	Yes	No	No	2
KamGW077	Yes	No	No	No	1
KamGW078	Yes	Yes	No	Yes	3
KamGW079	Yes	Yes	No	No	2
KamGW080	Yes	Yes	No	No	2
KamGW081	Yes	Yes	No	No	2
KamGW082	Yes	No	No	No	1
KamGW083	Yes	Yes	No	No	2
KamGW084	Yes	Yes	No	No	2
KamGW085	Yes	Yes	No	No	2
KamGW086	Yes	Yes	No	No	2
KamGW087	Yes	Yes	No	No	2
KamGW088	Yes	Yes	No	No	2
KamGW089	Yes	Yes	Yes	Yes	4
KamGW090	Yes	Yes	No	No	2
KamGW091	Yes	Yes	No	No	2
KamGW092	Yes	Yes	No	No	2
KamGW093	No	Yes	No	No	2
KamGW094	Yes	Yes	No	No	2
KamGW095	Yes	Yes	No	No	2
KamGW096	Yes	Yes	No	No	2

TABLE A10. Views from which individual gray whales were photographed off kamchatka Peninsula, all years (3 Pages)

KamGW097	Yes	Yes	No	No	2
KamGW098	Yes	Yes	No	No	2
KamGW099	Yes	No	No	No	2
KamGW100	Yes	Yes	Yes	Yes	4
KamGW101	Yes	Yes	Yes	нет	3
KamGW102	Yes	Yes	Yes	нет	3
KamGW103	Yes	Yes	No	No	2
KamGW104	Yes	Yes	No	No	2
KamGW105	Yes	Yes	No	No	2
KamGW106	Yes	Yes	No	No	2
KamGW107	Yes	Yes	Yes	Yes	4
KamGW108	Yes	Yes	Yes	Yes	4
KamGW109	Yes	Yes	No	No	2
KamGW110	Yes	Yes	No	No	2
KamGW111	Yes	Yes	No	No	2
KamGW112	Yes	Yes	No	No	2
KamGW113	No	Yes	No	No	2
KamGW114	Yes	Yes	No	No	2
KamGW115	Yes	Yes	No	No	2
KamGW116	Yes	Yes	No	No	2

TABLE A11. Number of encounters with identified gray whales off Kamchatka Peninsula 2004, 2006 - 2009 and off Sakhalin Island 2002-2009. (4 Pages)

Whale ID Kamchatka	Year of encounter Kamchatka	Area of encounter	Whale ID Sakhalin	Year of encounter Sakhalin	Number of encounters	Area of encounter
KamGW001	2006	Olga Bay	KOGW090	2003	1	pil
	2008			2005	2	pil
	2009					
KamGW002	2006		KOGW132	2005	1	pil
	2007			2006	1	pil
	2008			2007	1	pil/chay
	2009				1	
KamGW008	2006		KOGW095	2004	6	pil
	2007					
	2008					
KamGW010	2006		KOGW077	2003	1	pil
	2007					
	2008					
	2009					
KamGW013	2006	Vestnik Bay	KOGW047	2003	2	off
	2008			2004	1	off
				2005	4/1	pil/off
				2006	1	pil
				2007	3	pil/chay
				2008		pil
				2009	1	pil
KamGW016	2004_08_11	Khalaktyrsky beach	KOGW136	2006_09_13	1	Chay
				2006_09_30	1	pil
				2006_10_01	1	pil
				2007	6	pil/chay
KamGW015	2004_08_11		KOGW166	2009		pil
KamGW018	2007	Olga Bay	KOGW160	2007		pil
	2008			ë		
	2009				2	
KamGW019	2007_08_02		KOGW022	2007	1	pil
				2008	6	pil
				2009		
KamGW026	2007		KOGW075	2003	1	pil
				2009		
KamGW028	2007_08_02		KOGW142	2006	3	pil
KamGW031	2007		KOGW018	2002-2006	16	pil
	2008					
	2009					
KamGW032	2007		KOGW140	2006		
	2009					
KamGW033	2007_08_02		KOGW066	2003,2005-2008	9	pil/off/chay
				2009	1	off
KamGW034	2007_08_02		KOGW159	2007	5	pil
				2008	4	pil

TABLE A11. Number of encounters with identified gray whales off Kamchatka Peninsula 2004, 2006 - 2009 and off Sakhalin Island 2002-2009. (4 Pages)

Whale ID Kamchatka	Year of encounter Kamchatka	Area of encounter	Whale ID Sakhalin	Year of encounter Sakhalin	Number of encounters	Area of encounter
				2009		
KamGW035	2007 2008		**KOGW124**	2005 2006 2007 2009	2 2 4 4	pil pil pil/off
KamGW037	2007		**KOGW133**	2004-2006	8	pil/chay
	2008					
	2009					
KamGW038	2007	**Vestnik Bay**	**KOGW092**	2004-2008 2009	18 7	pil/chay pil
KamGW039	2007_06_05		**KOGW019**	2002-2007 2009	17	pil/off
KamGW041	2007		**KOGW105**	2005-2008 2009	18 1 1 1	pil/chay pil
KamGW042	2007 2009		**KOGW137**	2007-2008 2009	11 2	pil/off/chay pil/off
KamGW043	2007		**KOGW039**	2002-2007 2008	16 4	pil/off/chay pil
KamGW044	2007		**KOGW033**	2002-2008 2009	9 1	pil/off/chay off
KamGW045	2008	**Olga bay**	**KOGW028**	2002-2008 **2009**	17	pil/off
KamGW048	2008 2009		**KOGW149**	**2007**		**pil**
KamGW050	2008		**KOGW152**	2007	5	pil

TABLE A11. Number of encounters with identified gray whales off Kamchatka Peninsula 2004, 2006 - 2009 and off Sakhalin Island 2002-2009. (4 Pages)

Whale ID Kamchatka	Year of encounter Kamchatka	Area of encounter	Whale ID Sakhalin	Year of encounter Sakhalin	Number of encounters	Area of encounter
KamGW052	2008 2009		**KOGW154**	2007	2	**pil**
KamGW053	2008 2009		**KOGW148**	2007	6	**pil**
KamGW054	2008 2009		**KOGW153**	2007	3	**pil**
KamGW056	2008 2009		**KOGW151**	2007	6	**pil**
KamGW060	2008		**KOGW064**	2005-2007 2009	8	**pil/chay**
KamGW062	2008		**KOGW053**	2003-2007 2009	19 KamGW048	**pil**
KamGW063	2008 2009		**KOGW107**	2005-2007	10	**pil**
KamGW064	2008		**KOGW127**	2005-2007 2009	5	**pil**
KamGW065	2008		**KOGW131**	2005 2009	1	**pil**
KamGW068	2008 2009		**KOGW045**	2002-2007 2009	11	**pil/off**
KamGW069	2008		**KOGW067**	2003-2007	15	**pil/off**
KamGW070	2008		**KOGW084**	2003-2008 2009	9 1	off off
KamGW071	2008		**KOGW048**	2003-2007 2009	10	pil/off
KamGW074	2008 2009		**KOGW150**	2007		pil
KamGW077	2008		**KOGW073**	2003.201 2009	7	pil
KamGW078	2008 2009		**KOGW126**	2005 whale found dead in 2009	2	pil
KamGW080	2009		**KOGW164**	2008		pil
KamGW083	2009		**KOGW163**	2008		pil
KamGW084	2009		**KOGW110**	2004-2008		pil
KamGW087	2009		**KOGW103**	2004-2008		pil
KamGW088	2009		**KOGW174**	2009		pil
KamGW089	2009	**Vestnik Bay**	**KOGW061**	2003-2009		
KamGW090	2009		**KOGW091**	2003,2006-2008		
KamGW091	2009		**KOGW145**	2006-2009		
KamGW092	2009		**KOGW111**	2004,2006,2008, 2009		
KamGW093	2009		**KOGW016**	2002-2009		
KamGW094	2009		**KOGW089**	2003,2006-2009		

TABLE A11. Number of encounters with identified gray whales off Kamchatka Peninsula 2004, 2006 - 2009 and off Sakhalin Island 2002-2009. (4 Pages)

Whale ID Kamchatka	Year of encounter Kamchatka	Area of encounter	Whale ID Sakhalin	Year of encounter Sakhalin	Number of encounters	Area of encounter
KamGW095	2009		**KOGW038**	2002-2009		
KamGW096	2009		**KOGW139**	2006,2008-2009		
KamGW097	2009	**Olga Bay**	**KOGW157**	2007		
KamGW098	2009		**KOGW121**	2005-2006		
KamGW099	2009		**KOGW058**	2003-2008		
KamGW103	2009		**KOGW125**	2005-2007,2009		
KamGW104	2009		**KOGW177**	2009		
KamGW111	2009		**KOGW161**	2008		
KamGW113	2009		**KOGW040**	2002-2009		

TABLE A12. Occurence of gray whale from Sakhalin Catalog off Sakhalin Island and Kamchatka Peninsula in 2002-2009 (4 Pages)

KOGW###	2002	2003	2004	2005	2006	2007	2008	2009	KamGW###
1	Y		Y	Y	Y	Y	Y	Y	
2	Y	Y	Y	Y	Y	Y	Y	Y	
3	Y								
4	Y	Y							
5	Y	Y	Y	Y	Y	Y	Y	Y	
6	Y	Y	Y	Y	Y	Y	Y	Y	
7	Y	Y	Y	Y	Y	Y			
8	Y	Y	Y	Y	Y	Y	Y	Y	
9	Y		Y	Y	Y	Y	Y	Y	
10	Y		Y	Y	Y	Y		Y	
11	Y	Y	Y	Y	Y	Y	Y	Y	
12	Y	Y	Y	Y	Y	Y	Y	Y	
13	Y	Y	Y	Y	Y	Y	Y	Y	
14	Y		Y	Y	Y	Y	Y		
15	Y	Y		Y	Y	Y	Y	YY	Temp1
16	Y	Y	Y	Y	Y	Y	Y	YY	93
17	Y			Y	Y	Y		Y	
18	Y	Y	Y	Y	Y	Y	Y	Y	31
19	Y	Y	Y	Y	Y	YY		Y	39
20	Y	Y	Y	Y	Y	Y	Y	Y	
21	Y	Y	Y	Y	Y	Y	Y	Y	
22	Y		Y	Y	Y	YY	Y	YY	19
23	Y		Y		Y			Y	
24	Y			Y	Y			Y	
25	Y	Y	Y	Y	Y	Y		Y	
26	Y	Y		Y	Y	Y		Y	
27	Y	Y	Y	Y	Y	Y	Y		
28	Y	Y	Y	Y	Y	Y	Y	Y	45
29	Y	Y	Y	Y	Y	Y	Y	Y	
30	Y	Y	Y	Y	Y	Y	Y	Y	
31	Y	Y	Y		Y	Y	Y	Y	
32	Y	Y	Y	Y	Y	Y	Y		
33	Y	Y	Y	Y	Y	YY	Y	Y	44
34	Y		Y	Y	Y	Y	Y	Y	
35	Y	Y	Y	Y	Y	Y	Y	Y	
36	Y	Y	Y	Y	Y	Y	Y		
37	Y	Y	Y	Y	Y	Y	Y	Y	
38	Y	Y	Y		Y	Y	Y	YY	95
39	Y	Y		Y	Y	YY	Y	Y	43
40	Y	Y	Y	Y		Y	Y	YY	40
41	Y		Y	Y	Y	Y	Y	Y	
42	Y		Y	Y	Y	Y	Y	Y	
43	Y	Y	Y	Y	Y	Y	Y		
44	Y	Y	Y	Y	Y	Y	Y	Y	
45	Y	Y	Y	Y	Y	Y	Y	YY	68

TABLE A12. Occurence of gray whale from Sakhalin Catalog off Sakhalin Island and Kamchatka Peninsula in 2002-2009 (4 Pages)

KOGW###	2002	2003	2004	2005	2006	2007	2008	2009	KamGW###
46		Y	Y	Y	Y	Y	Y	Y	
47		Y			YY	Y	Y	YY	13
48		Y	Y	Y	Y	Y	Y	Y	71
49		Y	Y	Y	Y	Y	Y	Y	
50		Y	Y	Y	Y	Y	Y	Y	
51		Y	Y	Y		Y	Y	Y	
52		Y							
53		Y		Y	Y	Y	Y	Y	62
54		Y	Y	Y	Y	Y	Y	Y	
55		Y		Y	Y	Y	Y	Y	
56		Y	Y	Y	Y	Y	Y	Y	
57		Y			Y	Y	Y	Y	
58		Y	Y	Y	Y	Y	Y	Y	99
59		Y		Y	Y	Y		Y	
60		Y	Y	Y	Y	Y	Y	Y	
61		Y	Y	Y	Y	Y	Y	YY	89
62		Y	Y	Y	Y	Y	Y	Y	
63		Y	Y	Y	Y	Y	Y		
64		Y	Y	Y	Y	Y	Y	Y	60
65		Y							
66		Y	Y	Y	Y	YY	Y	Y	33
67		Y	Y	Y	Y	Y	Y		69
68		Y	Y	Y	Y	Y	Y	Y	
69		Y	Y	Y	Y	Y	Y	Y	
70		Y	Y	Y	Y	Y	Y	Y	
71		Y	Y	Y	Y	Y	Y	Y	
72		Y	Y	Y	Y	Y	Y	Y	
73		Y				Y	Y	Y	77
74		Y	Y	Y	Y	Y	Y	Y	
75		Y				Y		Y	26
76		Y	Y	Y	Y		Y	Y	
77		Y			Y	Y	Y	Y	10
78		Y	Y	Y	Y	Y	Y	Y	
79		Y		Y					
80		Y	Y		Y	Y	Y	Y	
81		Y	Y	Y	Y	Y	Y	Y	
82		Y	Y	Y	Y	Y	Y	Y	
83		Y	Y	Y	Y				
84		Y	Y		Y	Y	YY	Y	70
85		Y	Y	Y	Y	Y	Y	Y	
86		Y	Y	Y		Y	Y	Y	
87		Y	Y	Y	Y	Y	Y	Y	
88		Y							
89		Y			Y	Y	Y	YY	94
90		Y		Y	YY		Y	Y	1
91		Y			Y	Y	Y	Y	90

TABLE A12. Occurence of gray whale from Sakhalin Catalog off Sakhalin Island and Kamchatka Peninsula in 2002-2009 (4 Pages)

KOGW###	2002	2003	2004	2005	2006	2007	2008	2009	KamGW###
92		Y	Y	Y	Y	YY	Y	Y	38
93			Y	Y	Y	Y	Y	Y	
94			Y	Y	Y	Y	Y	Y	
95			Y		Y	Y	Y		8
96			Y	Y	Y	Y	Y	Y	
97			Y			Y	Y	Y	
98			Y						
99			Y	Y	Y	Y	Y	Y	
100			Y						
101			Y						
102			Y	Y	Y	Y	Y	Y	
103			Y	Y	Y	Y	Y	Y	87
104			Y	Y				Y	
105			Y	Y	Y	YY	Y	Y	41
106			Y						
107			Y	Y	Y	Y	Y	Y	63
108			Y	Y	Y	Y	Y	Y	
109			Y		Y				
110			Y	Y	Y	Y	Y	Y	
111			Y	Y			Y	YY	92
112			Y	Y	Y	Y	Y	Y	
113			Y	Y	Y	Y	Y	Y	
114			Y	Y	Y	Y	Y	Y	
115			Y	Y	Y	Y		Y	
116			Y	Y	Y	Y	Y	Y	
117				Y	Y	Y	Y	Y	
118				Y	Y	Y	Y	Y	
119				Y	Y	Y	Y		
120				Y					
121				Y	Y			Y	99
122				Y					
123				Y	Y	Y	Y	Y	
124				Y	Y	YY	Y	Y	35
125				Y	Y	Y		YY	103
126	whale found dead in 2009			Y			Y	Y	78
127				Y	Y	Y	Y	Y	64
128				Y					
129				Y	Y	Y		Y	
130				Y					
131				Y			Y	Y	65
132				Y	YY	Y	Y	Y	2
133				Y	Y	Y	Y	Y	37
134				Y					
135		Y	Y		Y	Y	Y	Y	
136			Y		Y	Y			16
137					Y	YY	Y	YY	42

TABLE A12. Occurence of gray whale from Sakhalin Catalog off Sakhalin Island and Kamchatka Peninsula in 2002-2009 (4 Pages)

KOGW###	2002	2003	2004	2005	2006	2007	2008	2009	KamGW###
138					Y	Y			
139					Y		Y	YY	96
140					Y	Y		Y	32
141					Y				
142					Y	Y			28
143					Y				
144					Y	Y	Y	Y	
145					Y	Y	Y	YY	91
146					Y	Y			
147					Y	Y			
148					Y		Y	Y	53
149						Y	Y	Y	48
150						Y	Y	Y	74
151						Y	Y	Y	56
152						Y	Y		50
153						Y	Y	Y	54
154						Y	Y	Y	52
155						Y			
156						Y			
157						Y		Y	97
158						Y	Y	Y	
159						YY	Y	Y	34
160						YY	Y	YY	18
161							Y	Y	111
162							Y	Y	
163							Y	Y	
164							Y	Y	
165							Y		
166			Y					Y	
167								Y	
168								Y	
169								Y	
170								Y	
171								Y	
172								Y	
173								Y	
174								YY	88
175								Y	
176								Y	
177								YY	104

Note

Y	whale seen off sakhalin
Y	whale seen off kamchatka
YY	whale seen off sakhalin and kamchatka during one season

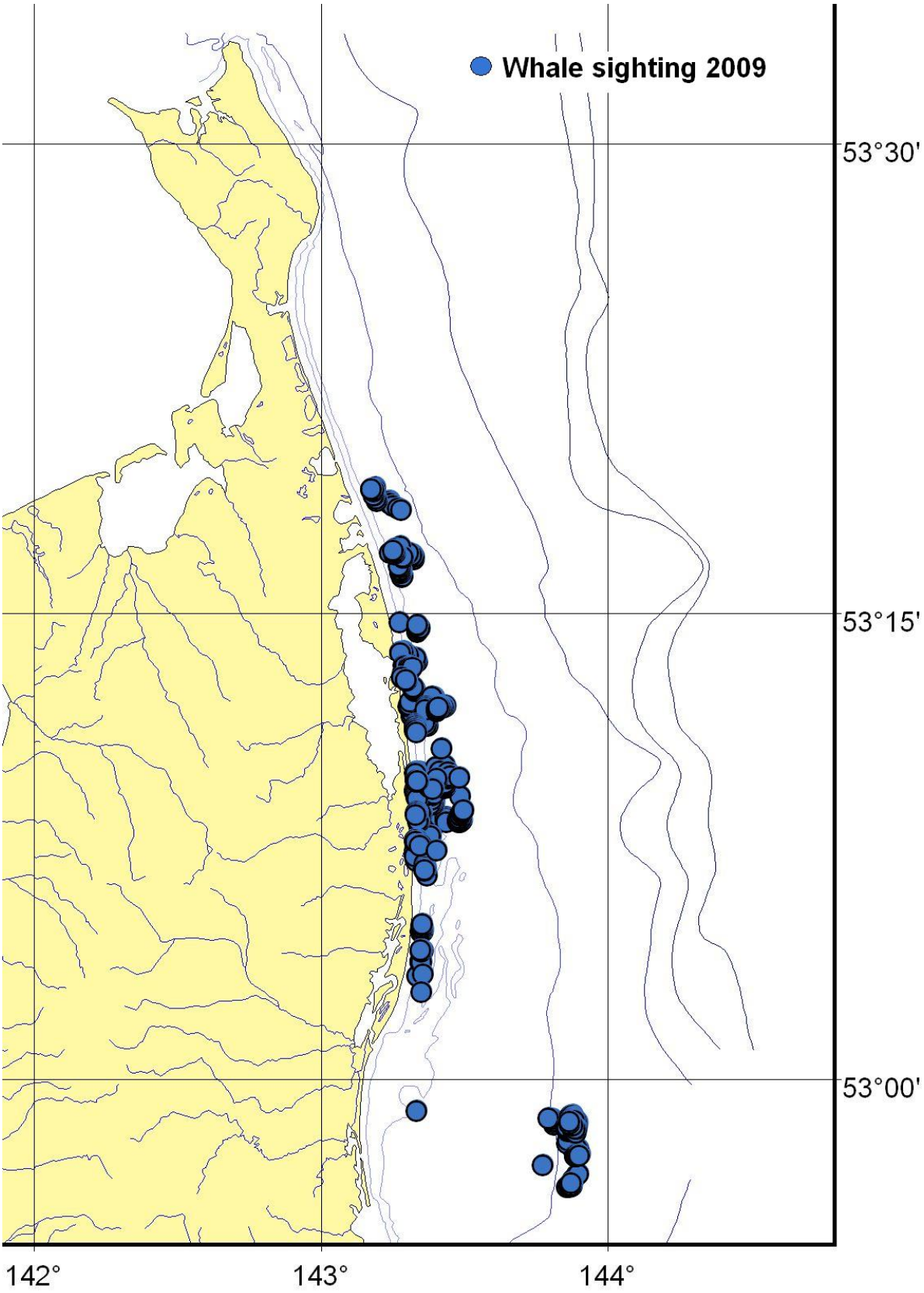

Figure A1. Gray whale photo-ID sites along the NE coast of Sakhalin Island, 2009.

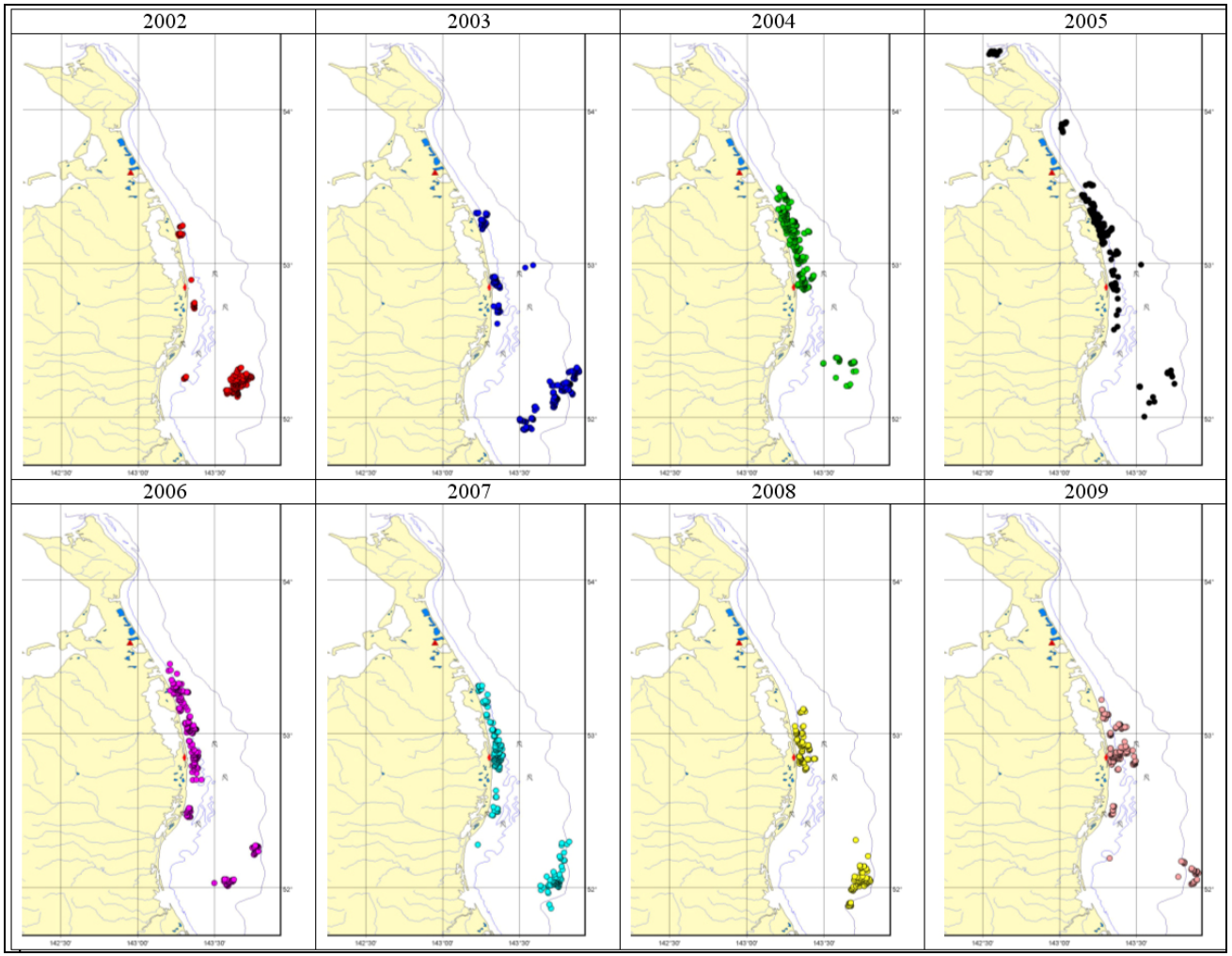

Figure A2. Gray whale photo-ID locations along the NE coast of Sakhalin Island in September throughout the study years, 2002 to 2009.

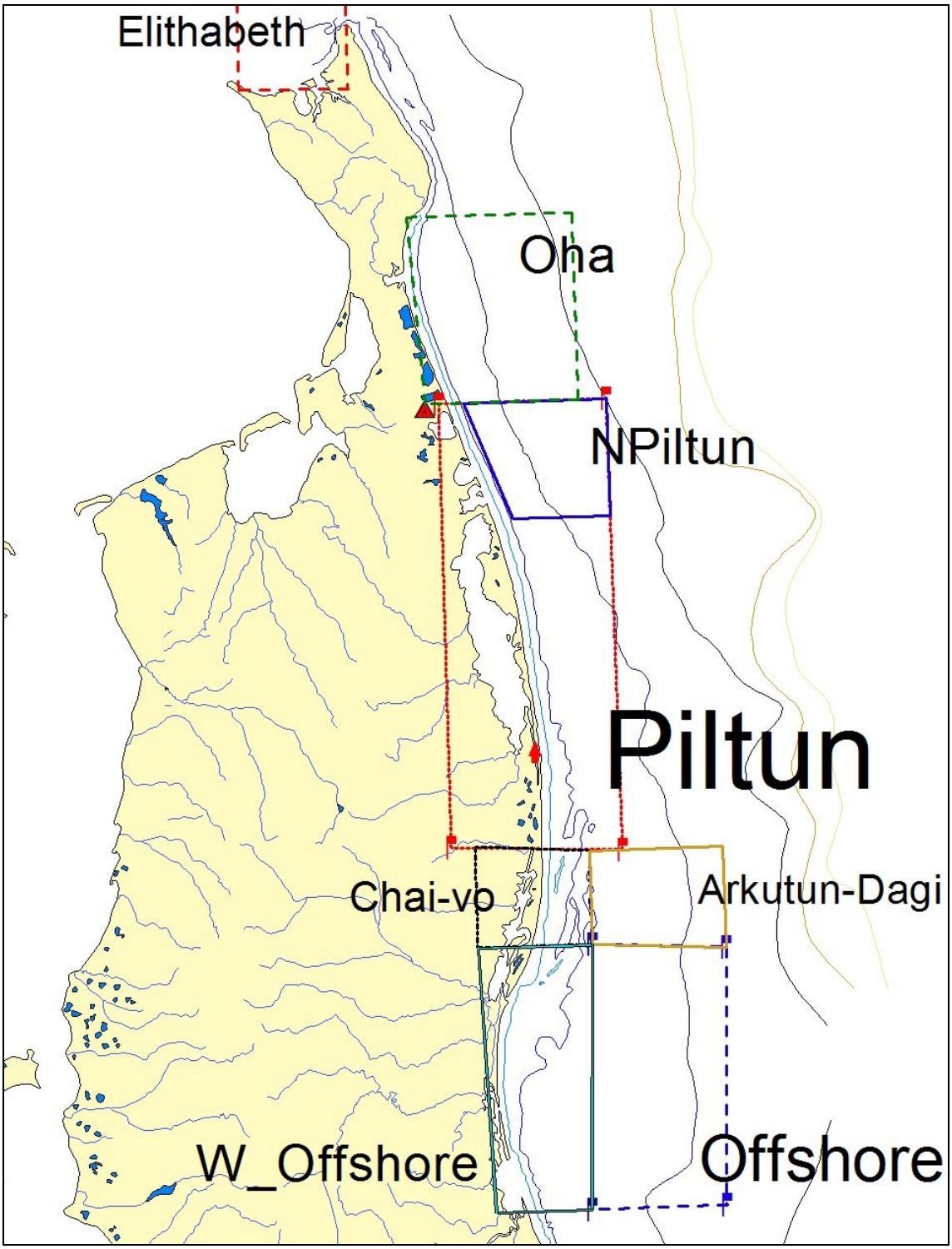

Figure A3. Boundaries of zones described in Appendix Table A6.

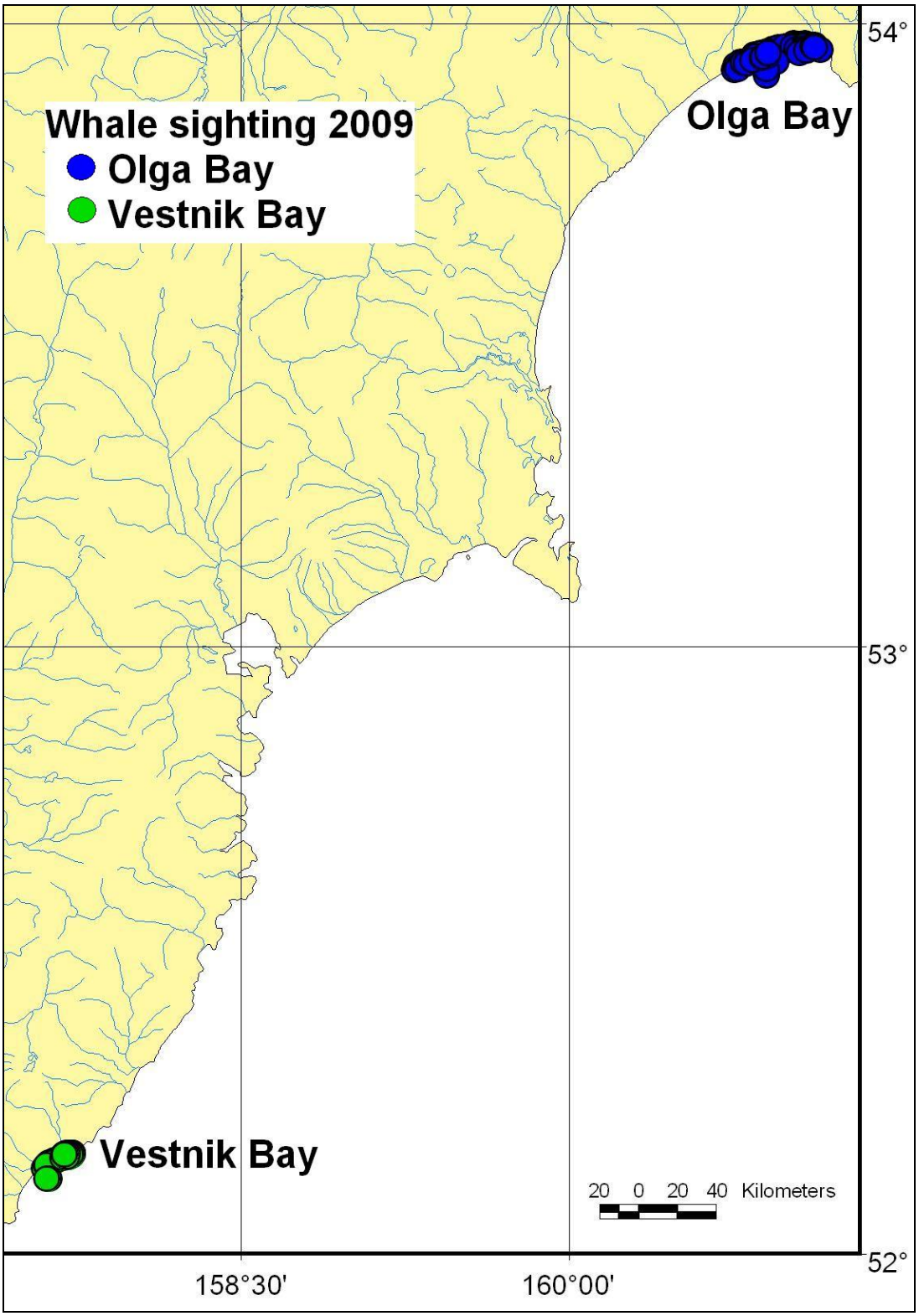

Figure A4. Locations of photo-identified gray whales off SE Kamchatka, Vestnik and Olga bays, 2009.

CHAPTER 3

BENTHOS STUDIES IN FEEDING GROUNDS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2009 RESULTS AND DISCUSSION[4]

Photo taken by Y.M. Yakovlev

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VLADIVOSTOK
March 2010

[4] Chapter 3 *In:* 2010. Western gray whale research and monitoring program in 2009, Sakhalin Island, Russia. Volume II Results and Discussion

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Academician of the Russian Academy of Sciences
_____ A.V.Adrianov

REPORT
ON THE RESEARCH PROJECT

BENTHOS STUDIES IN FEEDING GROUNDS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2009

RESULTS AND DISCUSSION

Research Supervisor,
V.I.Fadeev
Laboratory Director, Candidate of Biological Sciences

VLADIVOSTOK
2010

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LIST OF TABLES

Table 1. Organochlorine pesticide concentrations (ng/g) in bottom sediments at 4 stations in the Piltun area in 2005 and 2008-2009. 239
Table 2. Heavy metal concentrations in the area of the Piltun – Astokh field based on published data and the data collected in the study area. 240
Table 3. Concentrations of petroleum hydrocarbons, α- and γ-isomers of hexachlorocyclohexane ($\sum$HCH) and DDT and its metabolites ($\sum$DDT), in bottom sediments of different areas of the Gulf of Peter the Great (Sea of Japan) and the study area. 240
Table 4. Macrobenthos Biomass (g/m^2) in the Piltun Area. 245
Table 5. Composition of benthos complexes of the Piltun area. 257
Table 6. Frequency of occurrence of benthos taxonomic groups in the Offshore area. 260
Figure 7. Diagram of station locations in the Offshore area in 2009. 261
Table 8. Macrobenthos biomass (g/m^2) in the Offshore area, 2008-2009. 262
Table 9. Quantitative characteristics (B, g/m^2) of macrobenthos complexes in the Offshore area. 265
Table 10. Distribution of macrobenthos biomass (g/m^2) in the Intermediate area (2007-2009 data). 269

LIST OF FIGURES

Figure 1. Classification of stations by 10-fraction sediment composition in the areas based on 2002-2009 data. 236
Figure 2. Locations of stations in the Piltun area in 2009. 243
Figure 3. Variation in biomass (A, g/m^2) and variation in the proportions (B, %) of 5 benthos groups by depth in the Piltun area in 2007-2009. 247
Figure 4. Isopod biomass distribution (g/m^2) in the Piltun area in 2009. 247
Figure 5. Amphipod biomass spatial distribution (g/m^2) in the Piltun feeding area. 251
Figure 6. Sand lance biomass distribution in the Piltun area in 2004-2005, 2007-2009. 256
Figure 7. Distribution of complexes in the Piltun area based on 2002-2009 data. 258
Figure 8. Dendrogram of the similarity of stations in the Piltun area based on collections from 2002-2009. 259
Figure 9. Dendrogram of the similarity of Offshore area stations in regard to benthos structure. 261
Figure 10. Distribution of benthic complexes in the Offshore area in 2004-2009. The numbers of the complexes are given in Table 12. 267
Figure 11. Ampeliscid amphipod biomass distribution (g/m^2) in the Offshore area. The number next to each station indicates station depth. 267
Figure 12. Locations of stations in the Intermediate area in 2009. 270

Figure 13. The faunal complexes of the Intermediate area 2007-2009 data. 270
Figure 14. Chart of gray whale feeding sites studied in 2002-2009. 274
Figure 15. Chart of gray whale feeding sites in the Chayvo Bay area in 2006-2009 275
Figure 16. Amphipod biomass (g/m^2) in the Chayvo subarea in 2001, 2006-2009 275
Figure 17. Distribution of average depths of whale feeding sites in the Offshore area by years. 277
Figure 18. Chart of the distribution of biomass of the amphipod *Ampelisca eschrichti* (g/m^2) and whale feeding sites in the Offshore area in 2002, 2006-2009. 277
Figure 19. Locations of ice fields according to satellite monitoring data during the first ten days of June 2004-2009 of northeastern Sakhalin (http://www.aari.nw.ru). 281

CHAPTER 3: BENTHIC STUDIES

3.1 Characteristics of Water Column and Bottom Sediments

3.1.1 Water Temperature

Surface and bottom water temperature and salinities were measured at benthos stations during the period from July 8 to September 22, 2009. However, the most complete multi-annual time series of observations is available for the month of September; thus, it is these data that are presented below.

Water temperature. In September 2009, the surface water temperature in the Piltun Area ranged from 3.0 to 11.7°C, and the bottom water temperature ranged from 1.5 to 11.7°C. Bottom water temperature averaged 6.4±0.5°C (m±SE) in the Piltun Area, which was higher than temperatures in the Offshore Area (5.3±0.2°C). Bottom water temperatures in the Piltun area were consistent between 2006-2008 (Table 11). In 2009 bottom temperature was lower than in 2006-2008 both in the Piltun and Offshore Areas. The same results were obtained by hydrologists from POI DVO RAN during analysis of hydrologic profiles in the Piltun and Offshore Areas (Borisov et al., 2010).

Table 11. Bottom Water Temperatures (°C) in the Areas.

Characteristic	Piltun area				Offshore area			
	Sep. 2009	Sep. 2008	Sep. 2007	Sep. 2006	Sep. 2009	Sep. 2008	Sep. 2007	Sep. 2006
Average	6.4	11.0	11.1	11.03	5.3	7.9	11.2	10.5
Std error	0.5	0.43	0.3	0.16	0.21	0.32	0.31	0.18
Minimum	1.5	6.7	5.8	6.8	3.2	4.5	5.6	8.5
Maximum	10.7	13.5	13.7	14.4	6.6	10.6	13.5	13.04
Observations	29	42	44	60	19	37	38	48

The occurrence of colder surface water observed in the northern part Piltun Area (Odoptu region) in 2001–2006 may be due to upwelling of deeper water in the area (Krasavtsev et al. 2000; Rutenko 2006). Colder sea surface temperatures were also recorded in this area in 2006-2009. It is thought that upwelling plays a significant role in primary productivity of phytoplankton in some parts of the Sea of Okhotsk (Shuntov 2001).

During the summer, upwelling has been observed on the northeastern shelf when winds are from the south (Borisov et al. 2008) and/or southeast. Hydrological

observations indicate that durational upwelling can occur over large areas of the northeast Sakhalin shelf, and for prolonged periods in some parts (Krasavtsev et al. 2000).

3.1.2 Particle Size Distribution of Bottom Sediments

Particle size distribution of bottom sediments in 2009 was based on analyses of 168 samples taken at benthos stations and whale feeding sites. The bottom sediments at most stations throughout the area are characterized by predominance of sandy (psammite) fractions. Of the 168 stations, 85% are predominately sands, while 15% have gravel–pebble soils containing some sands of various grain sizes. The proportion of the fine sand fraction exceeds >70% at most stations.

Piltun Area. Data for 2002–2009 showed that fine, sandy soils predominate at depths up to 10–15 m throughout the area. With increasing depth, these are replaced by medium- and coarse-grained sands and areas with gravel–pebble soils containing some sands of varying grain size.

The 2009 data reconfirmed this spatial distribution. Fine sands predominated at >70% of the entire set of the stations taken in the Piltun area, with medium sands predominating at >20% of the stations. Gravel–pebble bottoms, often containing some sands of various grain sizes, occur in patches at depths greater than 15–20 m. The highest proportion (more than 15%) of silt–pelite fraction in the sediment was observed in a local area at depths <20 m in the channel area of Piltun Lagoon. The active hydrodynamics of the area probably promotes the transfer of fine soil fractions to greater depths. Areas with elevated silt-pelite content are found both north and south of the lagoon outlet. This is consistent with hydrology data indicating that during low tides and upwelling, the current direction along the shoreline in the coastal zone of the Piltun Area can change from south to north.

Offshore Area. The depths in the Offshore area increase gradually from 20 to 70 m. The proportion of silt-pelite in the soil increases with water depth. Overall, fine sands predominate at >85% of the stations in the Offshore area. Gravel soils and coarse-grained sands occur in patches.

3.1.3 Classification of Stations According to Similarity of Particle Size Distribution

Data on the 10-fraction compositions of bottom sediments at stations in the Piltun and Offshore areas and at whale feeding sites have been grouped by cluster analysis procedures. Dendrograms are shown in Figure 9.

It follows from the dendrograms that three groups of stations (A, B, C) can be distinguished according to particle size distribution. Table 2 provides average characteristics for each sediment group for the Piltun and Offshore areas based on data from 2005–2009.

Group A consists of stations where the 0.1–0.25 mm fraction (fine sand) predominates. According to 2002–2009 data, the proportion of this fraction varies from 60 to 96% of dry sediment weight in sediments of the Piltun area. The normalized entropic index of sediment sorting averages 0.35 and varies from 0.17 to 0.47 (an ideally sorted sediment has a value of 0). The average depth at which this sediment group occurs in the Piltun area is 19 m. ***Group B*** includes stations where the soil is predominately medium and fine-grained sand with up to < 20% coarse sand and minor amount of gravel. The normalized entropic index of sorting averages 0.61 and varies from 0.44 to 0.73. The average depth of the sediments of this group in the Piltun area is 22 m. ***Group C*** comprises stations without clear dominance[5] of any one fraction. The soil is medium and fine-grained sand fractions mixed with (>40%) coarse sand and gravel fractions. The major fractions are 0.5–1.0 mm (coarse sand) and 1.0–2.0 mm (small gravel). The defining feature of ***Group C*** is a substantial (usually >10%) presence of coarse fraction (gravel and pebble). The normalized entropic index of sorting average 0.84 and varies from 0.79 to 0.88 (absolutely ungraded sediment has a value of 1). The average depth of this group of stations in the Piltun area is 26 m.

Whereas ***group A*** is well-sorted fine-grained sands, ***group B*** comprises medium-sorted sands of varying grain size (a mixture of fine and medium sands), and ***group C*** includes poorly sorted sands and is characterized by the admixture of some gravel of varying grain size, pebbles, and shell detritus. The characteristics of the different sediment groups in the Piltun area from 2009 data are in good agreement with the

[5] Dominance is defined as comprising > 50% of the total weight of the sample.

sediment analysis based on the 2005–2008 data (Table 12), and data from 2002-2004 (Fadeev 2006).

Table 12. Characteristics of Sediment Groups in Piltun and Offshore Areas.

Sediment group	Sediment fractions (% Total)						H_s	H_s/H_{max}	Code
	Peb	Grav	Sand coarse	Sand med	Sand fine	Aleu+Pel			
Piltun area, 2009 data									
A	0.39	1.21	0.77	11.41	**84.52**	1.7	0.57	0.32	Sf
B	0.26	8.11	9.64	47.81	32.64	1.54	1.23	0.68	Smf
C	1.05	37.28	14.81	17.49	25.96	3.41	1.47	0.82	Gr+Sfmc
Piltun area, 2008 data									
A	0	0.75	0.75	7.9	**83.3**	7.3	0.63	0.39	Sf
B	0	3.8	5	32.68	**52.77**	5.75	1.01	0.63	Sf
C	4.42	36.1	17.5	16.88	21.7	3.4	1.58	0.88	Gr+Sc
Piltun area, 2007 data									
A	0	0.74	0.49	5.40	**83.92**	9.45	0.61	0.35	Sf
B	0	4.71	7.51	45.95	39.54	2.29	1.2	0.7	Sfm
C	3.52	41.1	23.23	15.66	14	2.49	1.42	0.81	Gr+Sc
Piltun area, 2006 data									
A	0	0.7	0.71	3.84	**90.36**	4.39	0.42	0.26	Sf
B	0	6.73	9.17	34.97	47.84	1.29	1.18	0.73	Sfm
C	1.88	38.83	24.98	18.13	15.5	0.68	1.42	0.79	Gr+Sc
Piltun area, 2005 data									
A	0	4.1	5.07	12.25	**74.48**	4.1	0.89	0.35	Sf
B	0	9.75	4.72	**54.2**	29.04	2.29	1.15	0.71	Smc
C	6.1	36.15	22.02	20.48	11.68	3.57	1.57	0.87	Gr+Scm
Offshore area, 2009 data									
A	0.71	2.74	2.4	15.65	**75.4**	3.1	0.83	0.47	Sf
B	0.31	3.49	5.41	**52.03**	37.55	1.21	1.05	0.59	Smf
C	0.44	18.49	21.83	36.69	20.66	1.89	1.44	0.8	Gr+Scmf
Offshore area, 2008 data									
A	0	0,64	1,16	5,43	**85,88**	6,93	0,53	0,32	Sf
B	0	1,42	4,94	44,76	42,34	6,61	0,88	0,5	Smf
C	4,85	31,1	19,78	23,6	12,43	8,55	1,59	0,87	Gr+Scm
Offshore area, 2007 data									
A	0	0.62	1.00	7.18	**83.61**	7.65	0.55	0.33	Sf
B	0	2.55	8.81	**68.1**	13.46	7.19	0.95	0.5	Sm
C	2.3	34.13	20.48	27.43	13.71	2.54	1.52	0.82	Gr+Scm
Offshore area, 2006 data									
A	0	0.39	0.5	1.96	**94.39**	2.76	0.27	0.17	Sf
B	0	0.71	1.14	2.84	**76.56**	18.75	0.71	0.44	Sf+Al
C	3.28	22.72	14.34	28.8	29.96	0.9	1.49	0.83	Sfc+Gr
Offshore area, 2005 data									
A	0	0.75	1.01	10.38	**82.67**	5.19	0.63	0.39	Sf
B	0	2.87	2.6	19.31	**66**	9.22	1.01	0.63	Sfc
C	5.32	30.93	11.73	18.32	29.38	4.32	1.58	0.88	Gr+Sfmc

Notes for Tables 2 and 3: for abbreviations of sediment fractions, see Table 3. H_s is the entropic index of sediment sorting, and H_s/H_{max} is the normalized entropic index of sorting. ***Boldface*** *indicates the dominant sediment fractions (dominance is defined as comprising > 50% of the total weight of the sample).*

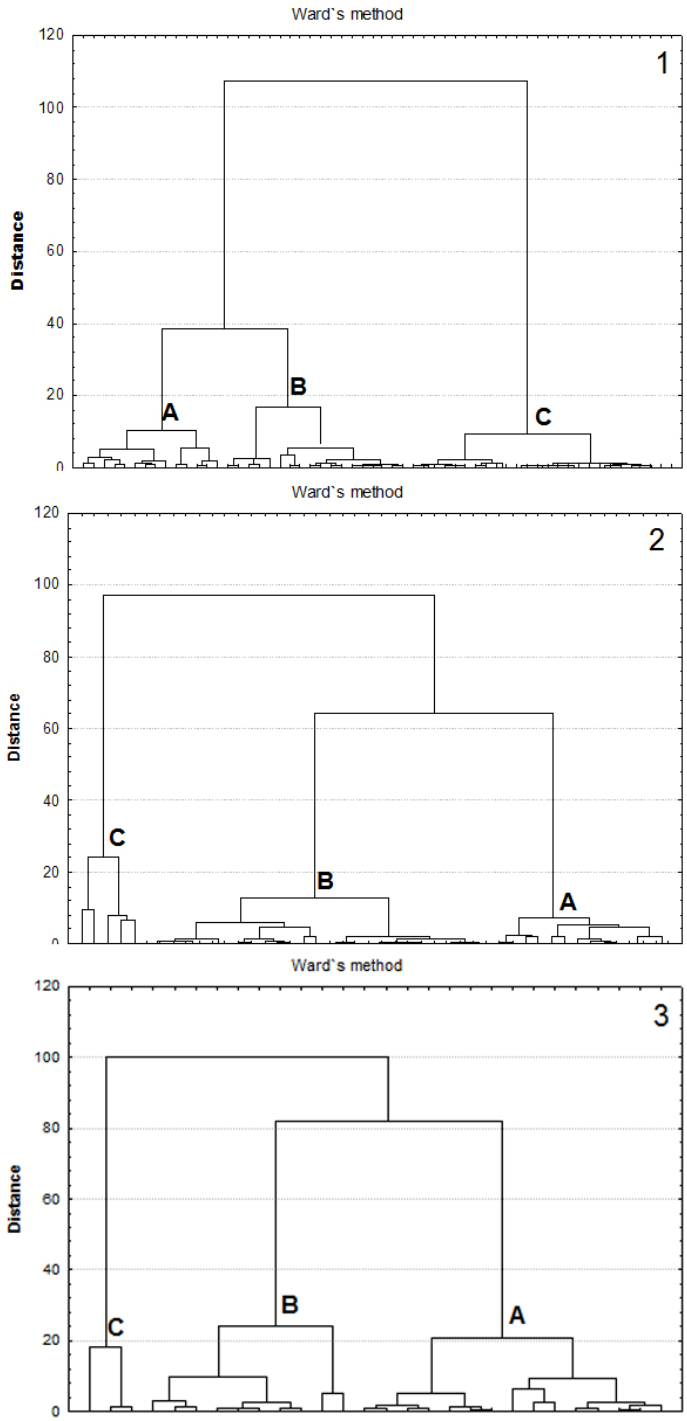

Figure 9. Classification of stations by 10-fraction sediment composition in the areas based on 2002-2009 data.

1 – Piltun Area;
2 – Offshore Area;
3 – Stations at gray whale feeding sites;
A, B, C – sediment groups.

3.1.4 Particle Size of Bottom Sediments at Gray Whale Feeding Sites

The sediment composition at gray whale feeding sites in the Piltun and Offshore areas was studied using data obtained in 2001–2009 (Fadeev 2002, 2003, 2004, 2006, 2009, present study).

Table 3 presents data on the characteristics of sediments at whale feeding sites in 2006-2009. In 2006-2009, medium sands and mixed fine–medium sands predominated at 36% of the whale-feeding sites, while 12% of the sites were dominated by fine and coarse sands.

Well-sorted fine sands (sediment group A) were prevalent at all gray whale feeding sites in both the Piltun and Offshore feeding areas in 2009. Only about 20% of the whale feeding sites had medium-sorted mixed sandy soils (medium and fine sands).

Table 13. Characteristics of Sediment Groups at Whale Feeding Sites.

Sediment group	Sediment fractions						H_s	H_s/H_{max}	Code
	Peb	Grav	Sand coarse	Sand med	Sand fine	Aleu+Pel			
Whale feeding sites (2009 stations)									
A	0.85	1.07	1.48	4.62	**85.02**	6.96	0.87	0.38	Sf
B	0.34	1.28	3.37	22.91	**66.61**	5.49	1.37	0.59	Sf+Sm
C	0	11.82	22.52	44.58	18.89	2.19	1.47	0.68	Sm+Scf
Whale feeding sites (2008 stations)									
A	0	0.64	1.31	7.25	**84.57**	6.23	0.74	0.37	Sf
B	0	2.39	5.05	48.52	39.23	4.81	1.21	0.57	Smf
C	0	10.04	18.82	48.98	19.27	2.89	1.47	0.68	Smcf
Whale feeding sites (2007 stations)									
A	0	0.23	0.77	5.28	**87.55**	6.16	0.43	0.31	Sf
B	0	1.69	8.85	**71.66**	10.4	7.4	0.74	0.46	Sm
C	0	7.37	12.13	44.81	26.67	9.01	1.42	0.85	Smfc
Whale feeding sites (2006 stations)									
A	0	0.44	0.35	1.32	**90.48**	7.41	0.37	0.23	Sf
B	0	0	0.59	**87.7**	11.45	0.3	0.41	0.3	Sm
C	0	11.45	9.1	48.05	31.3	0.1	1.19	0.74	Smf+Gr

3.1.5 Concentrations of Key Pollutants in Sediments

The first studies of key of pollutants in the Piltun Area were conducted in 2001, when sediment samples were collected in the vicinity of locations where whales were observed to feed intensely (i.e., feeding points). Concentrations of petroleum

hydrocarbons and 10 heavy metals (copper, aluminium, arsenic, barium, cadmium, chromium, iron, mercury, lead and zinc) were found to be low, and no significant effect of pollutants on benthos was observed (Fadeev, 2002).

More detailed assessments of key pollutants were carried out in 2004, 2005 and 2008[6].

Petroleum hydrocarbons. In 2009, concentrations of petroleum hydrocarbons in the sediments of the Piltun Feeding Area ranged from 0 to 0.08 mg/g dry sediment and averaged 0.048±0.006 (m±SE) mg/g dry sediment. In the sediments of the Offshore Feeding Area, petroleum hydrocarbons averaged 0.053±0.008 mg/g dry sediment; and at places where the whales fed, 0.051±0.008 mg/g dry sediment. All of these values are lower than the natural background concentrations of petroleum hydrocarbons in Sakhalin shelf sediments (Status of the Environment, 1996, 1997; Multidisciplinary Studies… 1997). Similar patterns are noticeable for 2005 and 2008-2009 data (Table 2); lower petroleum hydrocarbon concentrations in the sediments were measured closer to shore.

Organochlorine pesticides. It is thought that organochlorine hydrocarbons in the waters of the northeastern Sakhalin shelf have two possible sources: 1) the Amur River flow and 2) the waters flowing out of coastal lagoons.

[6] 60 bottom sediment samples were collected each year: 42 samples in the Piltun area and 18 in the Offshore feeding area. Samples were taken at 2001 sampling points on three transects to assess possible year-to-year changes in the pollutant distribution. In the Piltun Area in 2005 and 2008-2009, 4 samples were taken at depths of 10-15 m to study the concentration of organochlorine pesticides in the bottom sediments. Samples were taken in the same depth range in 2001.

Table 1. Organochlorine pesticide concentrations (ng/g) in bottom sediments at 4 stations in the Piltun area in 2005 and 2008-2009.

Station	Depth	DDT	DDE	DDD	∑DDT	∑HCH
2-2N	15	1.0 (0.8/0.6)*	0.3 (0.2/0.2)	0.4 (0.4/0.2)	1.7 (1.4/1.7)	0.3 (0.2/0.2)
2-3M	16	0.6 (0.9/0.7)	0.2 (0.2/0.2)	0.2 (0.2/0.2)	1.0 (1.3/1/4)	0.2 (0.4/0.4)
2-4M	15	1.3 (1.4/1/5)	0.2 (0.2/0.2)	0.2 (0.2/0.2)	1.7 (1.8/1/8)	0.4 (0.4/0.4)
4-1S	16	1.1 (1.1/1/0)	0.2 (0.2/0.2)	0.3 (0.2/0.1)	1.6 (1.6/1.5)	0.2 (0.3/0.3)

*Note: *data correspond to values in 2005 (2008/2009).*

Table 4 indicates that the concentration of DDT as well as the sum concentration of DDT and its metabolites, vary only slightly and do not exceed background values for the northeastern Sakhalin region (Status of the Environment, 1996, 1997).

Heavy metals. Concentrations of heavy metals in marine sediments depend on a number of factors. In some situations, the mineralogical composition and particle size distribution of sediments influence heavy metal concentrations. Sandy bottoms, due to their lower sorption capacity, typically have lower concentrations of heavy metals than aleurite-pelite deposits. Hydrodynamic conditions, physical and chemical processes, and biological activity all affect the accumulation and distribution of microelements. Concentrations of heavy metals in NE Sakhalin shelf sediments are presented in Table 5.

Concentration values of heavy metals in the deposits in the study area in 2009 did not exceed the background values registered for the deposits of northeast Sakhalin shelf prior to the beginning of active industrial activities (Status of the Environment 1996, 1997; Multidisciplinary studies 1997; Kot 1998); they were substantially below the values of the Probable Active Concentration of toxic metals (PAC) at which negative influence on ground organisms is expected.

Table 2. Heavy metal concentrations in the area of the Piltun – Astokh field and NE Sakhalin shelf based on published data and the data collected in the study area.

Elements	Concentration, µg/g					
	Published[1]	Published[2]	PAC[3]	2001[4]	2005[4]	2009[4]
As(µg/g)	2,5 - 14,8	–	-	1.25 – 4.8	0 – 2.20	0.2 – 3.9
Ba (µg/g)	268 - 763	–	-	46.7 – 89.6	0.9 – 20.42	-
Cd (µg/g)	<0.01 – 0.13	0.12	4.2 – 9.6	0.001 – 0.006	0 – 0.27	0
Cr (µg/g)	0.6 – 121	42	160 – 370	1.32 – 8.91	1.6 – 33.20	7.9 – 41.0
Cu (µg/g)	0.6 – 6.7	32	108 – 270	0.23 – 1.46	0.79 – 6.60	0 – 2.5
Hg (µg/g)	0.001 – 0.047	0.19	–	0.013 – 0.125	0.0002 – [illegible]	0 – 0.01
Pb (µg/g)	5.1 – 19.5	30.5	112 – 218	0.17 – 0.39	0 – 1,90	0
Zn (µg/g)	3.1 – 29.1	21.1	271 – 410	2.0 – 7.18	1.98 – 15.10	2.5 – 14.0

Note: [1] - published data for Piltun – Astokh field (Status of the Environment 1996, 1997).
[2] - published data for NE Sakhalin shelf (Kot 1998). PAC[3] – probable active concentration of toxic metals (Belan 2001). [4]- study area (grab samples along the grid and at feeding points collected in the Piltun and Offshore feeding areas.

Table 3. Concentrations of petroleum hydrocarbons, α- and γ-isomers of hexachlorocyclohexane (∑HCH) and DDT and its metabolites (∑DDT), in bottom sediments of different areas of the Gulf of Peter the Great (Sea of Japan) and the study area.

Area	Petroleum hydrocarbons, mg/g dry weight[1]	∑HCH, ng/g dry weight[2]	∑DDT, ng/g dry weight[3]
Zolotoi Rog Bay (Sea of Japan)	5.4–16.7	<0.2–5.5 (1.66)	0.8–22.7 (9.01)
Amur Bay (Sea of Japan)	0.03–2.72	<0.2–1.3 (0.58)	4.4–14.8 (7.59)
Ussuriysk Gulf (Sea of Japan)	0.03–0.25	<0.2–1.1 (0.32)	4.4–9.1 (6.01)
Piltun area, 2001[3]	0–0.03 (0.02)	<0.1– 0.6 (0.29)	1.3–4.8 (2.31)
Piltun area, 2004[3]	0–0.05 (0.02)	<0.1– 0.4 (0.23)	1.0–3.9 (1.91)
Piltun area, 2005[3]	0-0.04 (0.02)	<0.1- 0.4 (0.32)	1.0-1.6 (1.5)
Piltun area, 2008[3]	0-0.08 (0.06)	<0.1– 0.5 (0.21)	1.1–3.7 (1.81)
Piltun area, 2009[3]	0-0.08 (0.05)	<0.1– 0.5 (0.21)	1.1–3.7 (1.81)
Offshore area, 2004[3]	0–0.05 (0.03)	–	–
Offshore area, 2005[3]	0-0.06 (0.03)	–	–

Area	Petroleum hydrocarbons, mg/g dry weight[1]	∑HCH, ng/g dry weight[2]	∑DDT, ng/g dry weight[3]
Offshore area, 2008[3]	0-0.14 (0.08)	–	–
Offshore area, 2009[3]	0-0.11 (0.05)	–	–

Note: [1] - According to: Belan, 2001 (concentration range given); [2] - According to: Tkalin, 2001 (concentration range given and in parentheses - average values); [3] - our data.

Table 6 compares pollutant data from Piltun and Offshore areas with data from the Gulf of Peter the Great, in the Sea of Japan. Sediment concentrations of petroleum hydrocarbons, α- and γ-isomers of hexachlorocyclohexane (∑HCH) and DDT and its metabolites (∑DDT) were lower (and in some cases substantially lower) offshore Sakhalin than in the Sea of Japan. Therefore, analysis of the concentrations and distribution of the main pollutants – petroleum hydrocarbons, heavy metals and organochlorine pesticides – in the bottom sediments of the Piltun and Offshore feeding areas makes it possible to conclude that pollutants levels would not have any significant effect on benthos observed during the study period. These low pollutant levels in Sakhalin water might have been promoted by the active hydrodynamic conditions of the waters in question and the movement of waters of the eastern Sakhalin Current along the coast, which prevent the accumulation of pollutants in sandy sediment.

3.2 Benthos Composition and Quantitative Distribution in the Areas

Benthos studies were conducted in the Piltun and Offshore feeding areas in 2002–2009, in the Intermediate area in 2002 and in 2007-2009, and in the Chayvo subarea in 2001 and in 2006-2009.

3.3 Piltun Area

The station locations in 2009 consisted of 71 bottom grab stations (213 samples), as indicated in Figure 2. The locations of stations in previous years have been reported in previous annual reports (Fadeev, 2002-2009).

3.3.1 Quantitative Distribution

Total benthos biomass. The 2001 and 2002 data showed an increase in total benthos biomass with depth throughout the Piltun area (from 507.4 g/m^2 at a depth of 11 m to 1153 g/m^2 at 30 m in 2001, and from 274 g/m^2 in the range 11 – 15 m to 755 g/m^2 at 30 m in 2002 (Fadeev 2003), mainly due to increasing biomass of the sand dollar *Echinarachnius parma*, which comprised 61-70% of the total biomass of the study area, and increased to 85–95 % at depths of 25–30 m. The proportion of other groups in the total biomass was significantly lower: crustaceans, 9–17%; bivalve molluscs, 8–13%; and isopods, 4–5%; and amphipods, 4-9% (Fadeev 2003). The proportion of key WGW forage benthos (amphipods and isopods) to the total biomass decreased with depth: from 40–59% at 5–15 m to 1–4% at 20–30 m.

In 2003 and 2004, the average benthos biomass in the Piltun area at depths of 8–30 m was more than 500 g/m^2, with a colony density of more than 6000 individ./m^2. Once again, the sand dollar *E. parma* comprised the largest proportion (70%) of the benthos biomass; the proportion of sand dollars in the total benthos biomass increased with depth, from 20% at 15 m to 95% at 25–30 m. The biomass of amphipods decreased from 146 g/m^2 (74% of total benthos biomass) at depths of 8–11 m to 9 g/m^2 (1.2% of total benthos biomass) at >26 m. The sharpest changes in the quantitative abundance of benthos were observed between 15 and 20 m.

In 2005, average benthos biomass in the Piltun feeding ground was 392.4±63.3 g/m^2, which was not significantly (t-test, $p>0.05$) different from the 2004 data (501.2±93.8) (Fadeev 2005, 2006). In 2006, the average benthos biomass in the Piltun area was 434.3± 64.5 g/m^2, which was not significantly different from 2004 and 2005. The average total benthos biomass in the Piltun Area in 2008 was 415.6±148.2 g/m^2 and showed no statistically significant (t-test, $p>0.05$) differences from 2007 data (448.5±87.1 g/m^2).

In 2008-2009, as in previous years, sand dollars accounted for most of total biomass (on average, >75% in of each sample), and the proportion was as high as >95% at depths greater that 20 m. The quantitative abundance of the principal WGW forage benthos (amphipods and isopods) decreased from 75 g/m^2 (69% of total benthos biomass) in samples taken at 11-15 m, to 28 g/m^2 (<4%) at depths of 26-30 m.

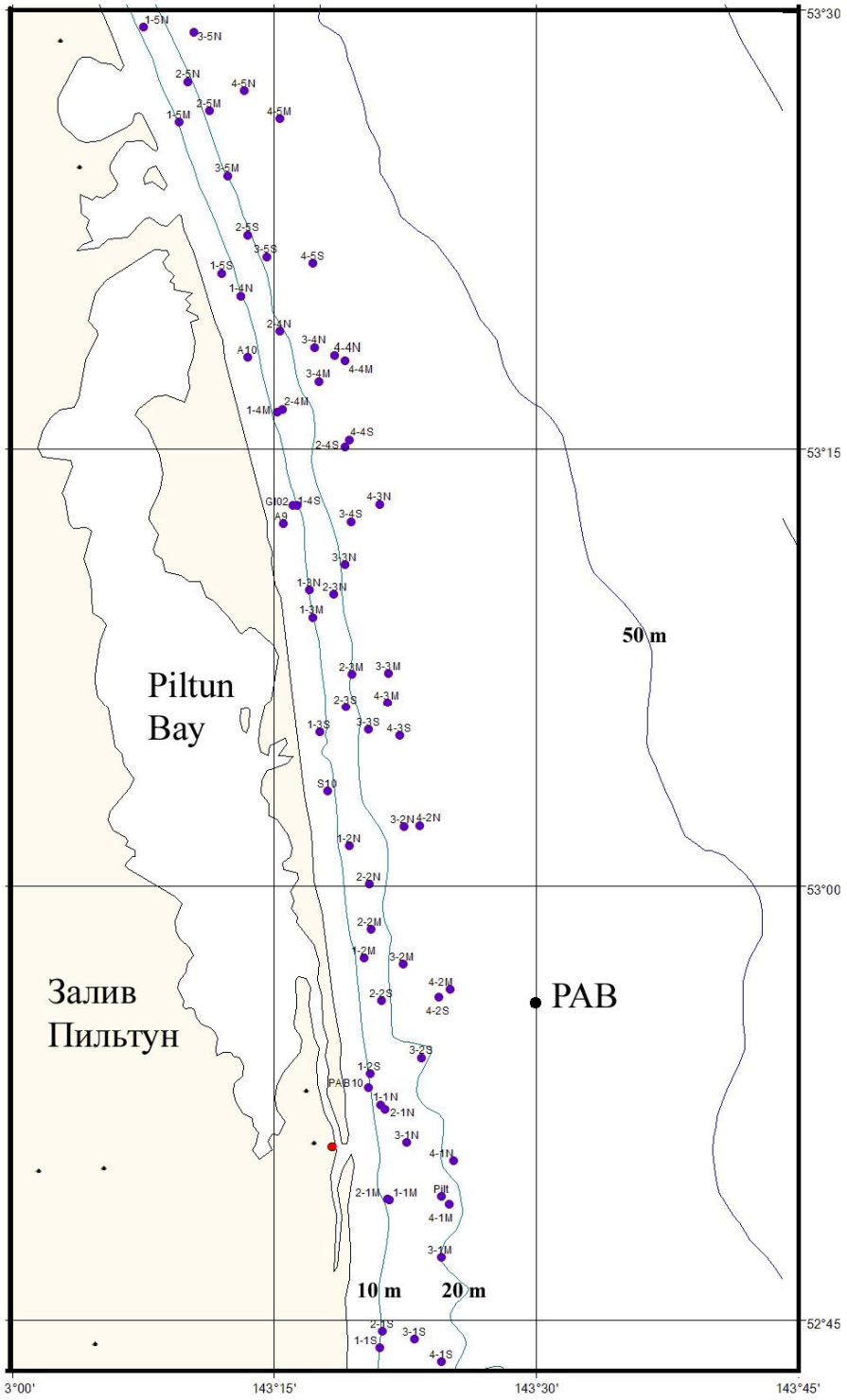

Figure 1. Locations of stations in the Piltun area in 2009.

Biomass of basic taxonomic groups and common benthos species. Crustaceans (amphipods and isopods) are believed to be the most important food resource for WGW food.

Crustaceans (*Crustacea*). The main crustacean groups had high frequencies of occurrence in 2008-2009, with amphipods occurring in >90% of the samples and isopods in >60%; these frequencies were not substantially different from those in 2006-2007. Despite the frequent occurrence of crustaceans in the Piltun area, the percentage of these animals in total benthos biomass varied considerably, mainly with depth. Based on data from 2002–2009, the overall proportion of crustaceans in the macrobenthos biomass in Piltun feeding area was 40–75% at depths of 5–10 m and only 3–10% at 26–30 m.

Various orders within the crustacean group were distributed differently with respect to depth; three patterns were noticed: (1) amphipods and isopods had a maximum biomass at 5–15 m, decreasing sharply at depths greater than 20 m; (2) cumacean biomass reflected the opposite pattern: lower biomass in shallower depths, and increasing in biomass in depths greater than 20 m; and (3) decapod biomass was low at all depths and varied only slightly.

In 2009, as in 2007-2008, the proportion of crustaceans in the overall biomass was 65% at depths of 11–15 m, decreasing to 4% at 26–30 m. Spots of high biomass at depths greater than 20 m consist of cumaceans and large *Saduria entomon* isopods, an important WGW food source. Amphipods had the strongest proportional decreasing trend with depth (Table 7; Figure 3). Some patchy areas of high crustacean biomass were observed in the coastal zone at depths not greater then 15-20 m. (Fig 4B). These shallow-water accumulations consist mainly of amphipods and isopods.

Table 4. Macrobenthos Biomass (g/m^2) in the Piltun Area.

Depth	Depth[1]								Entire area		
	11–15 m		16–20 m		21–25 m		26–30 m				
	2009	2008	**2009**	2008	**2009**	2008	**2009**	2008	**2009**	2008	2007
Amphipoda	76.7	65.5	24.1	33.3	11.2	21.1	13.7	14.5	31.4±5.2	36.1±9.2	32.1±4.8
Isopoda	30.6	9.4	9.6	10.6	19.5	15.9	23.2	15.5	20.7±4.3	12.9±3.7	6.8±3.8
Bivalvia	26.5	22.3	88.7	21	49.2	34.1	65.8	27.7	57.6±13.1	28.8±4.2	35.9±5.6
Cumacea	1.7	0.7	1.2	0.92	1.1	11.3	12.6	15.8	5.6±3.3	6.9±2.3	7.3±3.9
Echinoidea	18.9	4.5	367.8	135.7	543.7	554.6	496.8	582.3	356.8±118	319±146	334±84
Polychaeta	2.2	5.7	6.1	7.5	14.4	7.7	33.4	9.2	14.1±3.4	7.5±0.7	8.7±3.2
Rest	5.6	0.55	13.2	6.2	23.3	19.4	17.1	23.6	8.8±3.7	12.9±5.4	27.7±12.1
Totals	163.9	108.6	490.7	215.2	623.3	645.1	666.4	693.6	486.3±118	415.6±148	448.5±87.1

Notes: [1] Biomass values represent averages calculated from different sample sets. For simplicity of presentation, mean±SD are included only for overall (entire area) calculations.

Isopods. The small isopod *Synidotea cinerea* (average body weight 0.02 g) was the most significant component of benthos biomass in the Piltun area. In 2002-2009 it had the highest frequency of occurrence (>80%) of all macrobenthos species. Maximum biomass values for this species were observed in depths less than 15 m; only a few individuals of *S. cinerea* were encountered in deeper waters. Results of diving works show that the largest colony of *S. cinerea* (up to 5000 individ./m^2) was associated with tube mats of the sea worm *Onuphis shirikishinaiensis* (Fadeev 2007).

A larger isopod, *Saduria entomon* (body weight up to 5 g, average weight 2.1 g), was encountered much less frequently in the Piltun area. However, this species can form large local accumulations that, together with other crustaceans, can provide potential prey for gray whales. In contrast to *S. cinerea*, the biomass of *S. entomon* increases with depth.

The spatial distribution of isopods in 2009 was distinctly patchy. Distinct accumulation of isopod biomass was observed near the mouth of the Piltun lagoon (Fig 4). In 2008 larger accumulations were recorded in the northern portion of the area.

Both isopods do not seem to provide a substantial, constant food resource for WGW in the Piltun Area. The average isopod biomass in 2007 (6.8±3.8 g/m^2) was lower than in 2002 and in 2006 (11.6±1.6 and 18.9±4.6 g/m^2, respectively). This decrease was attributed to the prevalence of young *Saduria entomon* (size class up to 25 mm) during the 2007 survey.

In 2009, the average biomass of isopods was 20.7±4.3 g/m^2, higher than in 2008 and 2007. During 2002-2009, the highest biomass of *Saduria entomon* was observed within local accumulations at depths greater than 20 m. In 2007-2009, maximum biomass of this species reached levels >75 g/m^2 at some sampling stations.

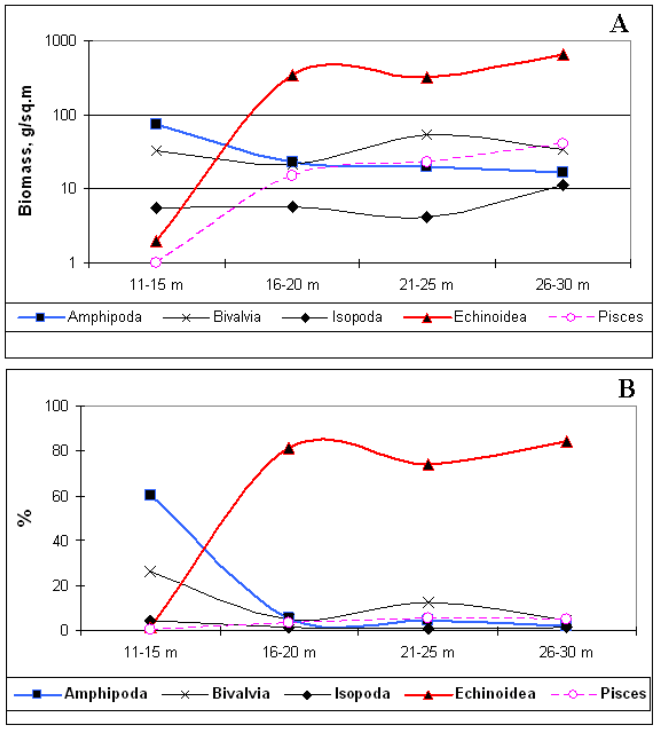

Figure 2. Variation in biomass (A, g/m2) and variation in the proportions (B, %) of 5 benthos groups by depth in the Piltun area in 2007-2009.

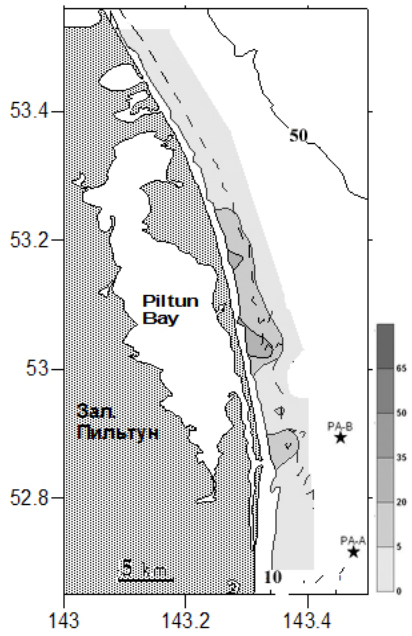

Figure 3. Isopod biomass distribution (g/m2) in the Piltun area in 2009.

Amphipods. In 2002-2003, 37 amphipod species were recorded. Of these, six species had frequencies of occurrence (P) 50%: *Eohaustorius eous eous (100%), Monoporeia affinis* (98%), *Grandifoxus longirostris* (86%), *Eogammarus schmidti* (81%), *Anisogammarus pugettensis* (78%), *and Westwoodilla sp*. (65%). The average amphipod biomass levels for the entire area were similar in 2002 and 2003 (42.7±9.6 g/m^2 and 54.6±8.7 g/m^2, respectively – compared to 35.9 g/m^2 observed in 2001).

The average amphipod biomass in the Piltun area in 2005 was 38.8±7.2 g/m^2, which was lower than 2004 values of 47.4±7.7 g/m^2.

In 2006, average amphipod biomass in the overall Piltun area decreased compared with 2005 to 28.5±3.8 g/m^2, due to a decrease in amphipod biomass at depths greater than 25 m (18.1 g/m^2 in 2005 and 9.4 g/m^2 in 2006); however, WGW do not commonly feed at depths >25m because amphipods comprise on average less than 2% of benthos biomass at these depths and do not form significant accumulations.

In September 2006, the average amphipod biomass in 11-15 m depth in the southern Piltun area was 33.5±11.8 g/m^2. In July 2005, in the same area in similar depths, the average amphipod biomass reached 69.4±18.3 g/m^2. The 2006 decline may have been due to various factors. For instance, in 2005, sampling in the southern Piltun area was performed in July, i.e., at the beginning of the feeding season, while in 2006 samples were collected in September, i.e., at the end of the feeding season. Notwithstanding the different months of sample collection, the average size of mature *M. affinis* individuals, the dominant WGW food species, was 11.62±0.14 mm (max = 15.9 mm) in 2005 and 12.66±0.18 mm (max = 15.8 mm) in 2006. Another causal factor for the 2006 decline in biomass may have been temperature. Benthic water temperatures in the southern part of the Piltun area were lower in 2006 than in 2004 and 2005. In addition, satellite data indicated that coastal sea ice cover remained later in 2006 than in 2004 and 2005 (Figure 19). Thus, lower bottom temperatures and longer sea ice cover might have limited amphipod production during 2006 in the Piltun area.

In 2007, the average amphipod biomass was 32.1±4.8 g/m^2, which is higher than that in 2006. As in 2005-2006, the average amphipod biomass in 2007 was about

9% of the total benthos biomass. More than 95% of amphipod biomass was due to two species: *Monoporeia affinis* (more than 60% of the total amphipod biomass) and *Eogammarus schmidti* (more than 30%). In 2007, amphipods accounted for 58% of benthos biomass at depths less than 15 m, and the proportion decreased to 1.5% at depths greater than 20 m.

In 2008 and 2009, the average amphipod biomass for the entire Piltun area was 36.1±4.8 g/m^2 and 41.4±5.2 g/m^2, respectively.

A comparison of amphipod biomass spatial distribution among years is presented in Figure 5. Although data for 2005 are not included in Figure 5, amphipod biomass was more evenly distributed in 2006 than in 2005 (Fadeev 2006). In 2006, local spots of elevated biomass (about 120 g/m^2) were recorded in the northern parts of the area; these northern concentrations were of *Eogammarus schmidti*, which is usually the second-most predominant amphipod species in the overall Piltun feeding area. Another notable change in the spatial distribution of amphipods was the re-emergence of elevated amphipod biomass near the mouth of the Piltun lagoon in 2007 and in 2008 after a decline in 2006. Historically, concentrations of amphipod biomass have typically been highest in the southern Piltun area adjacent to the mouth of Piltun lagoon (Fig. 5).

<u>Characteristics of the dominant amphipod species.</u> The amphipod *Monoporeia affinis* (= *Pontoporeia affinis*) is a brackish-water, Pan-Arctic, circumpolar species represented by relict populations in the boreal zone. It inhabits the northern Arctic seas and lakes of Northern Europe and North America. It has been recorded in the northern Pacific along the littoral of the Komandorskiye Islands, in freshened areas and relict lakes of the western part of the Bering Sea (the mouth of the Kamchatka River, the Anadyr liman, and lakes near the mouth of the Kamchatka River) and in the Amur liman and the Sea of Okhotsk.

In the Baltic Sea, it lives at depths of 0.5-300 m with salinity of 1.5-18‰ and temperatures up to 12.8ºC (Yarvekyulg 1979). Females are benthic forms and are submerged in the sediment throughout their life cycle. Males are pelagic forms during the mating season. In cold waters, the species reaches sexual maturity in the second year of life, while in warmer waters, it has a one-year life cycle (Segerstrale

1967). Mating occurs in October-December, and young appear in March or April. The males die soon after mating, and the females die after the young emerge from the incubating sac.

They are burrowing deposit feeders that turnover significant amounts of sediment during feeding, and thus affect bivalve mollusk juveniles (Segestrale 1973), meiobenthic animals (Olafsson and Elmgren 1991) and even zooplankton (Albertsson and Leonardsson 2001). In the Baltic Sea, *M. affinis* is among the most highly productive benthic species (Andersin et al. 1984).

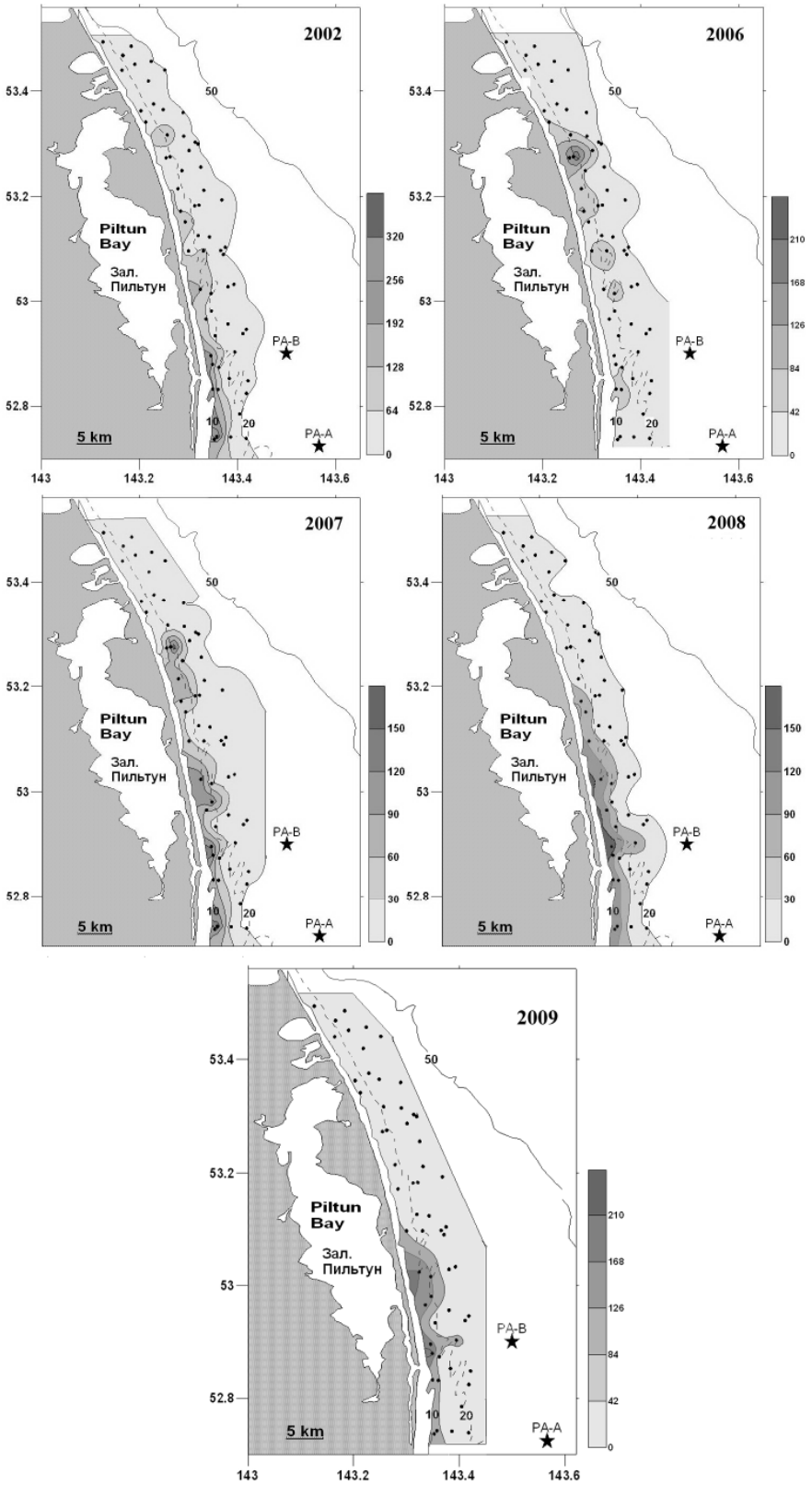

Figure 4. Amphipod biomass spatial distribution (g/m^2) in the Piltun feeding area.

Year-to-year changes in amphipod biomass. The data used for analysis of year-to-year changes in amphipod biomass consisted of data collected in 2002-2009 from 184 grid and feeding point stations located in the Piltun feeding area. These stations represent a subset of the entire set of grid stations and are located in the Piltun coastal area at depths of up to 15 m, i.e. depths of maximum amphipod concentration (Figure 3).

All these stations are classified as high-calorie Crustacea – amphipods and isopods, and located in summer-autumn feeding areas for gray whales. Over 50-65% of the total benthic biomass is comprised of five species: *Monoporeia affinis*, *Eogammarus schmidti*, *Anisogammarus pugettensis, Anonyx nugax,* and *Eohaustorius eous.* These species have large body size (more than 5-6 mm) and high frequency of occurrence (60-90%) in summer. Results of single-factor dispersion analysis allow us to reject a hypothesis on homogeneity of groups, i.e. they show presence of statistically significant differences in mean total amphipod biomass throughout years (one-way ANOVA: df=7; F=7.79; p=0.0014). Figure 6 shows differences in mean total amphipod biomass. As follows from the picture, the amphipod biomass decreased from the maximum values in 2002 (115.5 ±19.6 g/m^2; mean±SE) and in 2003 (113.8 ±14.2 g/m^2) to minimum values in 2006 (52.6±7.4 g/m^2) to rise up to 79.2±5.8 g/m^2 in 2009.

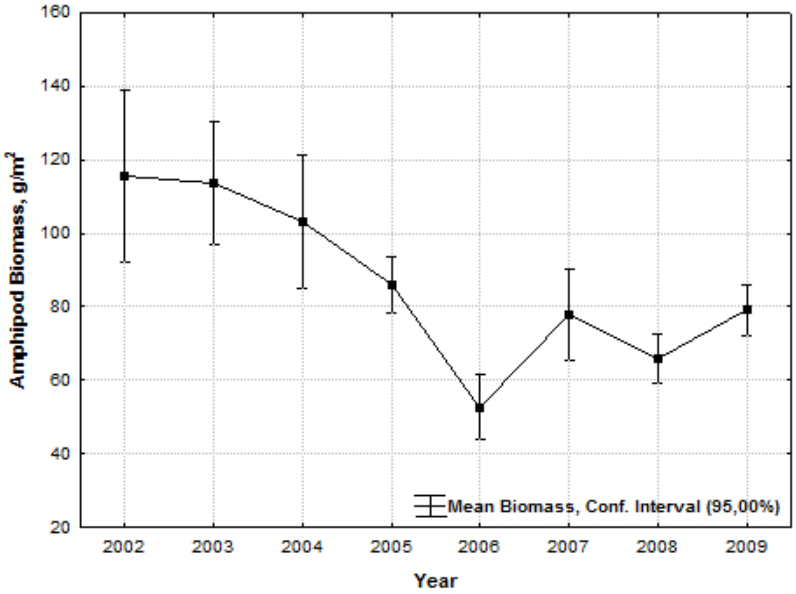

Figure 6. 2002–2009 changes in mean total amphipod biomass in Piltun area at depths < 15m.

Fisher LSD Test and Mann-Whitney U-test were used to confirm yearly differences in mean biomass (Borovikov, 2001). Calculations in both tests show practically identical results; principal deviations refer to assessment of difference significance levels (Table 8). The key results of the statistical analysis are as follows:

1) There was not a statisitically significant difference in mean amphipod biomass between years 2002 to 2005 (LSD multiple comparison, P>0.05).
2) Mean amphipod biomass in 2006 was significantly lower compared to 2002-2005, 2007, and 2009 and was not statistically significantly different from the 2008 values.
3) Mean amphipod biomass in 2007 and 2009 was significantly lower compared to 2002-2003; amphipod biomass in 2008 was significantly lower compared to 2002-2005.

There is only one difference in the results of the Fisher LSD Test and Mann U test: The Mann-Whitney U-test shows 2009 mean amphipod biomass to be higher than in 2008 (p=0.016), whereas Fisher LSD Test suggests there is no statistically significant difference between 2008 and 2009 (p>0.05). However, if we correct the Mann-U alpha level for the number of analyses conducted on a single dataset (i.e., Bonferonni correction to alpha = 0.05/7 = 0.007; a standard procedure to guard against committing a Type I error in multiple comparisons), we conclude the Mann-U comparison between 2008 and 2009 is not statistically significant. Note, the Fisher LSD test does not need an alpha correction factor because it essentially acts as a single test (i.e, alpha = 0.05). Other year-to-year comparisons that the Mann-U test found to be marginally significant (i.e., 0.05 > P > 0.007) will also become non-significant if we correct alpha (despite the LSD test continuing to show them as significant), a result that is symptomatic of non-parametric tests like Mann U being less powerful than parametric tests like ANOVA and Fisher LSD (Zar 1984). In short, statistical inference should be based on the Fisher LSD results shown in Table 8; significant Mann-U results that align with significant Fisher LSD results gives confidence that these results indicate a true effect.

Thus, based on the analysis results, multi-year changes in amphipod biomass in the shallow waters of Piltun area represent a statistically significant biomass decrease in 2006 compared to 2002-2005. The rise in amphipod biomass observed in 2007-2009 has not yet reached the maximum biomass values of 2002-2003 (statistically significant differences still remain). In 2009, amphipod biomass, which constitutes the main feeding component for gray whales in the Piltun area, reached the level of 2004-2005 (no statistically significant differences in biomass values).

Possible causes of the statistically significant drop of amphipod biomass in 2006 in the Piltun feeding area are described below in Item 2.5 «Comments for assessing year-to-year changes in forage benthos in the Piltun and Offshore feeding areas».

Table 8. Fisher LSD Test and Mann-Whitney U-test results showing mean total amphipod biomass broken down by years

Year	2002	2003	2004	2005	2006	2007	2008	2009
2002		**ns**	**ns**	**ns**	***	*	*	*
2003	**ns**		**ns**	**ns**	***	**	***	**
2004	**ns**	**ns**		**ns**	***	**ns**	**	**ns**
2005	**ns**	**ns**	**ns**		**	**ns**	**	**ns**
2006	***	***	***	***		*	**ns**	***
2007	*	*	**ns**	**ns**	**		**ns**	**ns**
2008	***	***	*	*	**ns**	**ns**		*
2009	*	*	**ns**	**ns**	**	**ns**	**ns**	

*Legend: Top triangle – Mann-Whitney U-test results (alpha=0.007), bottom triangle –LSD test (alpha=0.05; one-way ANOVA: df=7; F=7.79; p=0.0014). Significance levels: ns = p>0.05, * = p<0.05, **= p<0.01, *** = p<0.001.*

<u>Pisces.</u> Sand lance have been identified as food resources for gray whales (Zimushko and Lenskaya 1970). The sand lance is a temporary component of biota at depths of ≤40 m, where it breeds. The densest accumulations of *A. hexapterus* in the Piltun area were associated with areas with sandy bottoms and mixed gravel, at depths greater than 20 m.

In 2002-2003, the frequency of occurrence of the sand lance <u>*Ammodytes hexapterus*</u> in samples from the Piltun area was 5-8%, with an average biomass of 4.6-6.2 g/m^2. The frequency of occurrence of sand lance in 2004 was higher (15%), with an average biomass of 14.8±4.8 g/m^2. Within local accumulations, the sand lance

biomass varied from 68 to 166 g/m^2, which amounted to 25 to 48% of the total macrobenthos biomass in the samples.

Sand lance was encountered in small numbers throughout the Piltun area in 2004-2005, with the densest accumulations recorded in the northern and middle parts of the area. In 2005, when frequency of occurrence was 15% throughout the area, the frequency in the northern part was as high as 40-60%. Average biomass in 2005 was 16.3±4.4 g/m^2 for the Piltun area and reached 150 – 236 g/m^2 within local accumulations.

The average sand lance biomass in the Piltun area was lower in 2009 and 2008 (8.8±3.7 g/m^2 and 12.9±5.4 g/m^2) than in 2007 (27.7±12.1 g/m^2). In the northern part of the Piltun area, a substantial decrease in sand lance frequency of occurrence was observed, from 40-60% in 2005 to 20-25% in 2006-2007, and 8-12% in 2008-2009. The causes for this decline are unknown, but are likely related to a natural decline in numbers. Changes in the spatial distribution of sand lance biomass during the period 2004-2005 and 2007-2009 are illustrated in Figure 6.

The most distinct increase in frequency of occurrence and biomass of sand lance in the northern Piltun area was observed during 2004-2005. The high numbers of sand lance in the northern Piltun area (in 2004-2005) was concurrent with a decrease in the number of whales feeding in the Offshore area, and increase in the number of gray whales feeding at depths greater than 20 m in the northern Piltun area (Vladimirov et al. 2006; Yakovlev and Tyurneva 2006). Simultaneously, the number of whales feeding at depths greater than 20 m in the northern Piltun area was higher in 2004-2005 than in 2007-2009, and the number of individual whales observed in the Offshore feeding area, based on the photo-ID data, was lower in 2004-2005 (7 and 7 whales, resp.) than in 2007-2009 (about 30-70 whales each year) (Vladimirov et al. 2006; Yakovlev and Tyurneva 2006; Yakovlev et al. 2010). Thus, the appearance of an additional, accessible food resources may have attracted feeding whales to the northern Piltun area, away from other feeding areas.

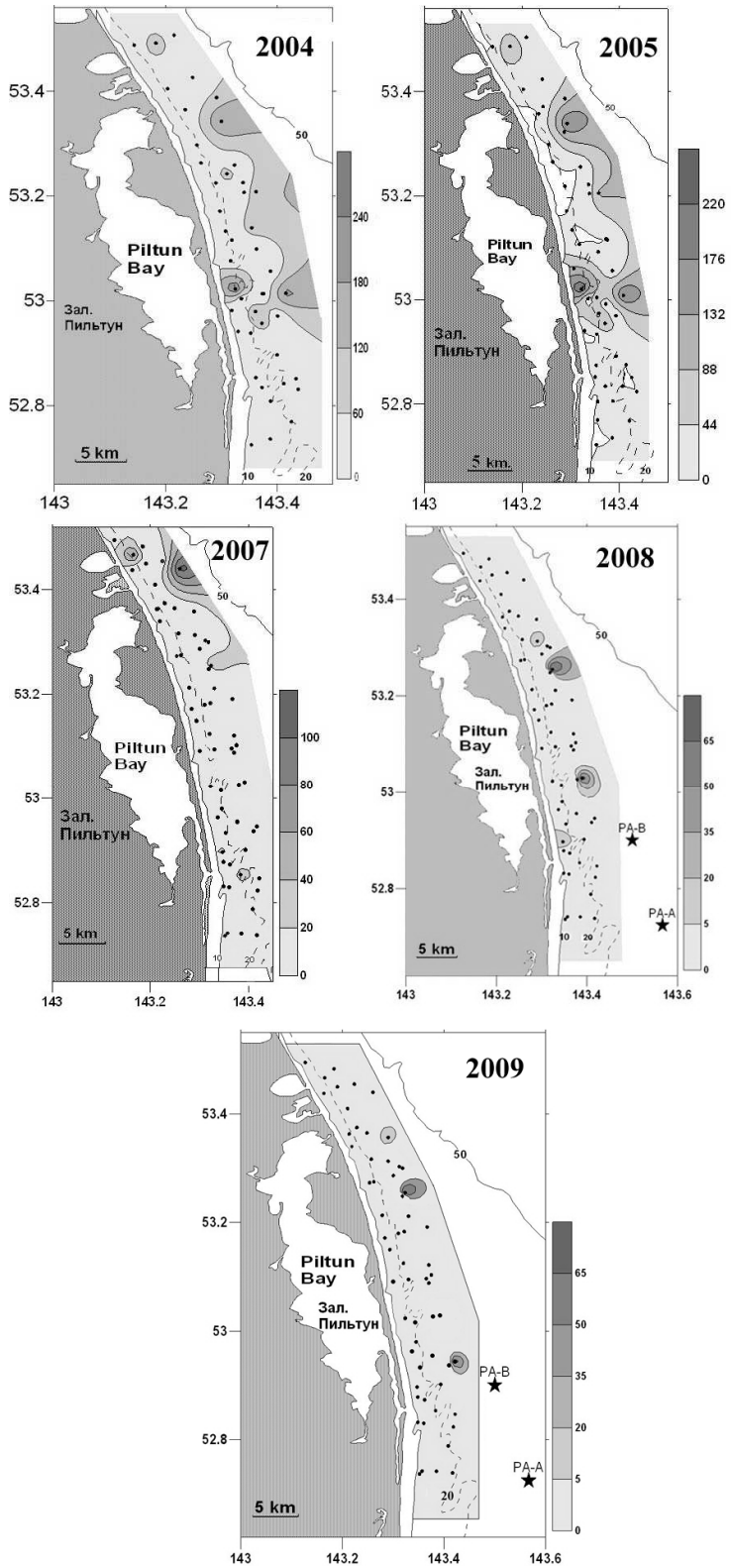

Figure 5. Sand lance biomass distribution in the Piltun area in 2004-2005, 2007-2009.

3.4 Composition and Distribution of Benthos Complexes

The locations of stations assigned to each benthos complex in the Piltun area are presented in Figure 8, and the classification results benthic stations are presented in Figure 9. The benthos complexes differ both in the composition and the quantitative abundance of the taxonomic groups (Table 8).

Table 5. Composition of benthos complexes of the Piltun area.

Taxonomic Group	Amphipoda complex		Bivalvia complex		Echinoidea complex	
	A, spec./m^2	B, (g/m^2)	A, spec./m^2	B, (g/m^2)	A, spec./m^2	B, (g/m^2)
Amphipoda	5027	**89.5**	222	14.9	54	8.4
Bivalvia	77	19.8	369	**131.2**	64	54.4
Cumacea	40	0.5	142	1.3	899	4.6
Decapoda	0	0	1	1.5	2	2.9
Echinoidea	0	0	10	34.9	74	**881.9**
Isopoda	296	17.2	***191***	11.2	12	17.3
Pisces*	0	0	2	9	3	22.1
Polychaeta	61	3.1	71	15.8	81	21.6
Totals	5501	130.1	1008	219.8	1189	1013.2

*Note: * - temporary community component.*

The Amphipoda complex includes 83 stations at depths of 5 to 23 m (average depth 15 m) in the fine- and medium-grained sand zone. The complex is distributed in a belt-like pattern along the coast in the Piltun area (Figure 8). The average biomass of the complex (130.1 g/m^2) is made up primarily of amphipods – 68%; isopods – 15%; and bivalve molluscs – 13%. The complex includes 34 amphipod species with a total biomass of 89.5 ±23.2 g/m^2 and a colony density of 5,027±800 individuals/m^2. The most abundant species were *Monoporeia affinis, Eogammarus schmidti, Eohaustorius eous eous* and *Anisogammarus pugettensis*; they accounted for 90% of the average biomass and colony density.

The Amphipoda complex is dominated by the amphipod *Monoporeia affinis*, which makes up 80% of biomass and 75% of colony density. Isopods *Synidotea cinerea* and *Saduria entomon* are the next most significant components of the Amphipoda complex; the dominant species, *S. cinerea,* has a frequency of occurrence in the

complex of >90%, and it accounts for 95% of the total isopod biomass. The Amphipoda complex also includes 10 species of molluscs, of which five species have a frequency of occurrence greater than 50%: *Tellina lutea, Siliqua alta, Tridonta borealis, Liocyma fluctuosum* and *Macoma lama.* These species account for more than 95% of the biomass of bivalve molluscs (19.8 g/m^2).

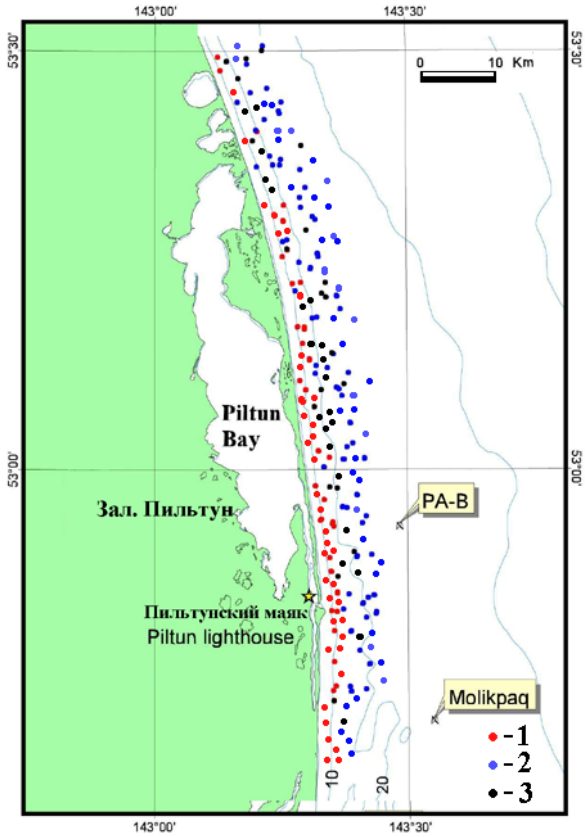

Figure 6. Distribution of complexes in the Piltun area based on 2002-2009 data.
Complex designations: 1 – amphipods; 2 – sand dollars; 3 – bivalve molluscs.

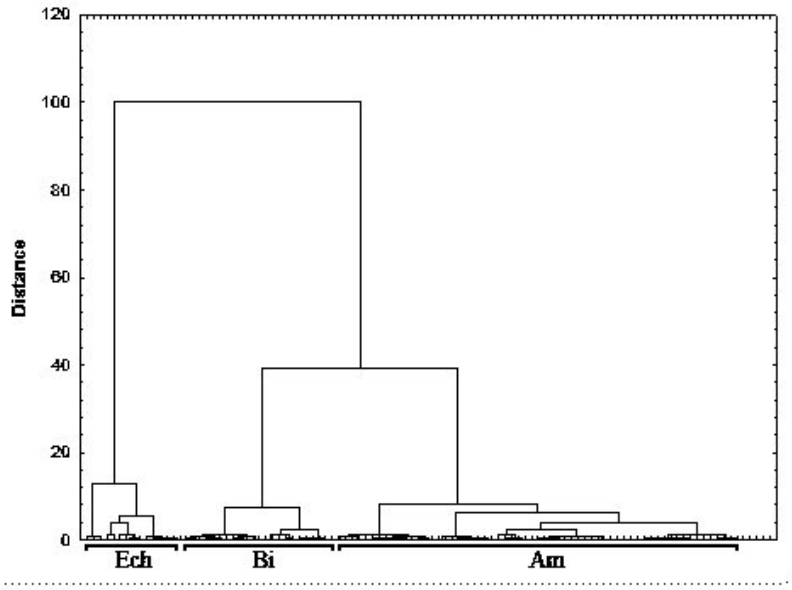

Figure 7. Dendrogram of the similarity of stations in the Piltun area based on collections from 2002-2009.

In dendrogram: Am – amphipod complex; Bi – bivalve mollusc complex; Ech –sand dollar complex.

The Bivalvia complex includes 56 stations at depths of 9 to 31 m (22 m on average) in fine sands and mixed gravel and sand bottoms. In contrast to the amphipod complex, it has a distinctly patchy distribution across the Piltun area (Figure 8). The composition of the complex includes 21 bivalve mollusc species, with a biomass of 131.262.45± 42.1 g/m^2 at an average complex biomass of 219.8 g/m^2. Seven mollusk species have the highest frequency of occurrence: *Tellina lutea, Astarte arctica, Macoma lama, Tridonta borealis, Siliqua alta, Mysella kurilensis, Liocyma fluctuosum* and *Mactromeris polynyma*. They account for more than 95% of the total biomass of the complex. The bivalve mollusc complex is not homogeneous: *Tellina lutea* is dominant in the shallow areas, while *Astarte arctica* is dominant in deeper waters (deeper than 20-25 m). Within the complex, the total amphipod and isopod (primarily *Saduria entomon*) biomass can reach 50% of the biomass of molluscs.

The sand dollar complex has been described in detail based on materials from 2001-2004 (Fadeev 2007) and, considering the low significance of *Echinarachnius parma* to food resources of WGW, it is not covered in this report.

Summarizing the analysis of the distribution of macrobenthos complexes, we note that most of the benthos in the Piltun area is occupied by two complexes: a shallow-

water, coastal amphipod complex with a high proportion of forage components, and a deeper-water sand dollar complex with an extremely low proportion of prey in its biomass. The provisional boundary between the complexes lies at depths of about 20 m.

3.5 Offshore Area

3.5.1 Quantitative Abundance and Distribution of Benthos

In 2008, 48 stations were sampled (144 bottom grab samples) in the Offshore area at depths from 18 to 62 m. The average depth in 2008 and 2007 was 42.5±1.7 m; 42.1±1.7 m (n=48) in 2006; 42.5±1.7 m (n=48) in 2005; and 49.3±2.3 m (n=32) in 2004. Station locations in the Offshore area are shown in Figure 10.

Most of the Offshore area has sandy sediments: well-graded fine sand was recorded at 40 stations and differently-grained sand with mixtures of gravel and pebbles at eight stations. The proportion of the silt-pelite fraction is more than 20-26% of the dry sediment weight at a number of stations. Seventeen taxonomic groups were identified for benthos of the Offshore area in 2008-2009; these groups differed substantially in their frequency of occurrence (Table 9).

Table 6. Frequency of occurrence of benthos taxonomic groups in the Offshore area.

Frequency of Occurrence (P, %) of Taxonomic Groups, n=48							
P>50%		P = 25-50%		P = 10-25%		P<10%	
Group	P,%	Group	P,%	Group	P,%	Group	P,%
Amphipoda	98	Gastropoda	44	Echinoidea	22	Bryozoa	7
Polychaeta	92	Holoturoidea	32	Isopoda	14	Pisces	5
Bivalvia	90	Decapoda	29	Caprellida	13	Ophiuroidea	5
Cumacea	87	Nemertinea	25	Hydroidea	11		
Actinia	77						
Sipunculida	67						

As in 2002-2008, the groups with a frequency of occurrence greater than 50% in 2009 were amphipods, cumaceans, bivalve molluscs, marine worms and sea anemones. Groups with lower frequencies of occurrence, such as sand dollars *E. parma* (P = 22%), nevertheless formed localized concentrations of biomass. For the Offshore area as a whole, these 17 taxonomic groups accounted for more than 95% of the average total benthos biomass during 2009. The biomass of benthos in the Offshore area in 2008-2009 is presented in Table 11.

The average total benthos biomass in the Offshore area was 598.6±134.7 g/m^2 in 2009, and 627.4±142.4 g/m^2 in 2008; these values were not statistically significant (t-test, p>0.05).

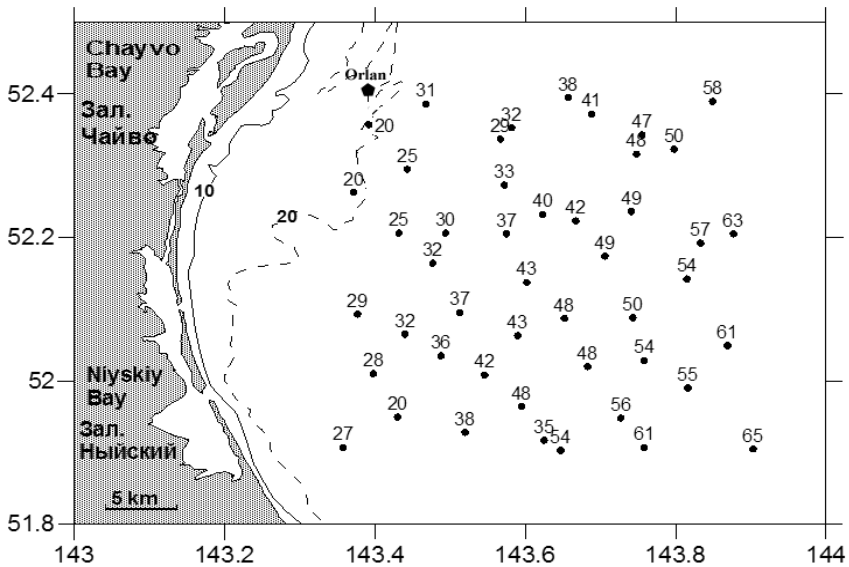

Figure 7. Diagram of station locations in the Offshore area in 2009. The numbers indicate station depth (m).

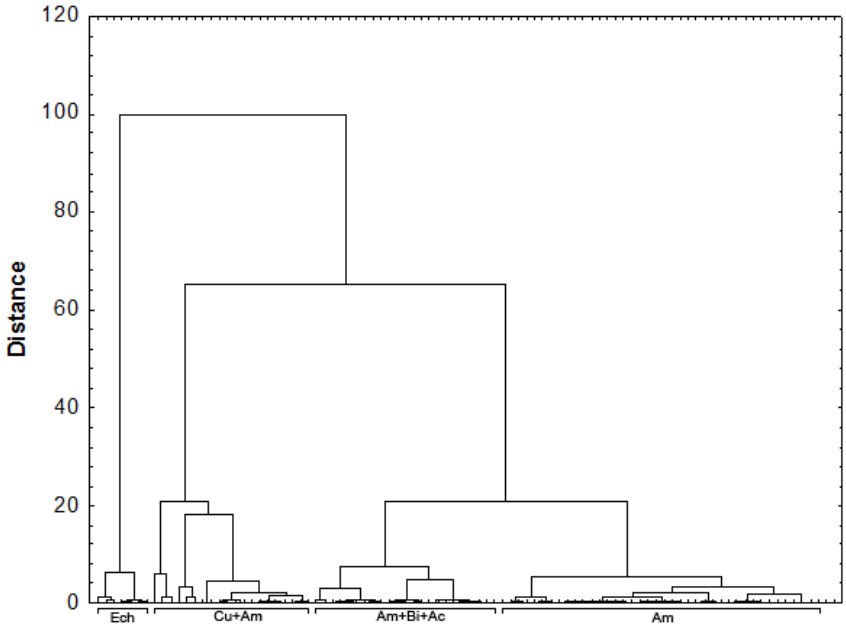

Figure 8. Dendrogram of the similarity of Offshore area stations in regard to benthos structure.

Table 8. Macrobenthos biomass (g/m^2) in the Offshore area, 2008-2009.

Indicator	Taxonomic Group								Entire Area (Bsumm)	
	Amphipoda		Actinia		Bivalvia		Echinoidea			
	2009	2008	**2009**	2008	**2009**	2008	**2009**	2008	**2009**	2008
Average Bsumm	183.9	213.9	139.5	117.3	102.5	67.3	72.2	111.7	598.6	627.4
Standard error	66.2	69.6	52.3	30.1	28.2	21.8	25.2	29.3	134.7	142.4
Proportion, % of Bsumm	31	34	23	18	17	10	12	17		

Notes: Average of 48 stations. ***Bsumm*** *is the average total benthos biomass, g/m^2*

The biomass of the main groups (amphipods, bivalve molluscs, sea anemones and cumaceans) in 2009 was comparable to the 2007-2008 data. The biomass of amphipods – the most important component in the diet of whales in the Offshore area – was 183.9±66.2 g/m^2 and 213.9±69.6 g/m^2 in 2009 and 2008, respectively. The year-to-year variations in the average amphipod biomass are statistically insignificant (t-test; $p>0.05$). Analysis of data from the central part of the Offshore area (20 stations), where benthic samples were taken in 2002-2004 and in 2006-2009, shows that the differences between the years in the total biomass of benthos and the total biomass of the main prey item - *Ampelisca eschrichti* - were statistically not significant.

The spatial distribution of benthos biomass in 2009 was similar to that in 2007-2008. The biomass and the proportion of amphipods in the total benthos biomass of the Offshore area eastwards increases from shore toward deeper water (Figures 13 and 14). A similar trend was observed in 2002-2006. There was also a gradual increase in the proportion of silt-pelite fractions in the seabed.

The other groups (sea anemones, bivalve molluscs, cumaceans and sand dollars) that make up most of the remainder of the biomass had a patchy distribution in the Offshore area. Higher-biomass patches of these groups were located on the edge of the amphipod mass development zone.

3.5.2 Composition and Distribution of Benthos Complexes

During 2002-2004 (118 stations), three macrobenthos complexes were distinguished in the Offshore area: the sand dollar complex, the cumacean and amphipod complex, and the ampeliscid amphipod complex. The latter occupied the largest part of the study area and is considered of greater importance to the feeding of gray whales (Fadeev 2005).

The classification results are illustrated in a dendrogram (Figure 11). Based on these data, four benthos complexes were distinguished in the Offshore area (Table 12).

Offshore Benthos Complex I. A complex dominated by sand dollars *Echinarachnius parma* was present mostly in the northern Offshore area (Figure 12). The average depth was 33.1±3.8 m (27 stations at depths of 18-52 m). Sand dollars are dominant at all stations, with an average biomass greater than 700 g/m^2 (71% of the total biomass of the complex).

A similar complex was described in the Piltun area at depths greater than 20 m (Fadeev 2007). According to Averintsev et al. (1979), there is a substantial subarctic-latitude occurrence of the sand dollar *E. parma* in the area of northeastern Sakhalin Island at depths of 15-120 m. This area comprises about 13,000 km^2, i.e., about 40% of the shelf area off eastern Sakhalin. The *E. parma* population is associated with shallow sandy bottoms and silted sands, where bottom currents with sufficiently high speeds are present (Koblikov 1983 a, b). As the current speed decreases southward along the eastern Sakhalin shelf and bottom silting increases, the sand dollars are replaced by other species, such as mobile seston-feeders. Sand dollars settle primarily on sands and coarse silts, with an organic matter content of 0.5-1.0% and a concentration of suspended matter in the seabed water of about 20 mg/l (Kuznetsov 1964). Significant bottom areas occupied by the *E. parma* community have been discovered on the western Kamchatka shelf (Neyman 1988), and, as researchers note, the northern boundary of the *E. parma* area has advanced more than 20 miles to the north. They connect the cause of such changes with an indirect human impact – over-harvesting of the Kamchatka crab and flounder (which feed on the sand dollars), which has resulted in a disruption of the balance in the “predator-prey” system.

Offshore Benthos Complex II. A complex dominated by cumacean *Diastylis bidentata* and amphipod *Ampelisca eschrichti.* The average depth for this complex was 24.1±1.6 m (40 stations at depths of 24-33 m). The average total biomass of the complex was 446.1±78.6 g/m^2 (mean±Sd), and the dominant species accounted for more than 80% of the biomass (cumaceans – 53; and amphipods – 31%). The complex occurred in patches at depths of 24 to 32 m in the western part of the area, on fine-grained and mixed sands. Amphipod *A. eschrichti* was a subdominant species with a biomass of 141.3±44.1 g/m^2.

Data collected in 2002 were used to examine relationships between the colony density of cumacean *D. bidentata* and amphipod *A. eschrichti* in the Offshore area. The amphipod colony density decreased, and the cumacean colony density increased, as depth increased (Fadeev 2003). Ampeliscid amphipods and cumaceans are seston-feeders and filter-feeders; i.e., both species obtain nutrition by filtering seabed water. In areas of greatest abundance, their densities become very large: for cumaceans, up to 87,000 individuals/m^2; and for amphipods, more than 31,000 individuals/m^2. Consequently, it could be expected that competition for food supplies might result in a spatial separation between accumulations of amphipod *A. eschrichti* and cumacean.

Analysis of benthos at gray whale feeding sites in the Offshore area in 2002 indicated that the whales fed in areas where the cumacean complex was dominant on a number of occasions (Fadeev 2003). Nevertheless, the significance of cumaceans in WGW diet remains uncertain. It is known that there is a threshold amphipod body size (6-8 mm, according to Rice and Wolman 1973; Nerini 1984), below which WGW cannot access them as a food source. If this value is valid for other crustaceans as well, it is worth noting that the cumaceans in the Offshore area are significantly smaller. Gray whales may prefer the high ampeliscid biomass content of this complex, selectively feeding the areas of this complex with ampeliscid pockets.

Table 9. Quantitative characteristics (B, g/m^2) of macrobenthos complexes in the Offshore area.

Parameter	Taxonomic Group					Average total biomass (**Bsumm**)
	Amphipoda	Actinia	Bivalvia	Echinoidea	Cumacea	
1. Complex *Echinarachnius parma* (Ech)						
Average biomass	47.2	91.5	58	**699.5**	50.6	947.4
Standard deviation	20.4	43.5	30.3	121.1	24.2	158.9
Proportion in **Bsumm**, %	5.5	9.4	6.5	71.7	4.9	100%
2. Complex *Diastylis bidentata* + Amphipoda (Cu+Am)						
Average biomass	**141.3**	20	21.1	23.1	**238.2**	446.1
Standard deviation	44.1	12.5	9.8	14.2	47.3	78.6
Proportion in **Bsumm**, %	31.5	4.1	4.5	4.8	53	100%
3. Complex *Ampelisca eschrichti* + Bivalvia + *Actinia* (Am+Bi+Ac)						
Average biomass	**291.3**	**199.9**	**182.3**	0	34.9	724.9
Standard deviation	41.1	48.7	43.4	0	9.5	87.2
Proportion in **Bsumm**, %	38.2	24.7	28.2	0	9.5	100%
4. Complex *Ampelisca eschrichti* (Am)						
Average biomass	**652.8**	167.1	124	3.1	26.8	967.2
Standard deviation	53.3	35.5	27.6	2	6	83.6
Proportion in **Bsumm**, %	67.7	16.8	12.4	0.3	2.4	100%

Note: Abbreviated names of complexes used in Figure 21 are given in parentheses.

Offshore Benthos Complex III. A complex dominated by amphipod *A. eschrichti*, bivalve molluscs, and sea anemones. The average depth of the occurrence of this complex was 43.5±2.4 m (58 stations in a range of 23-52 m). This complex occurred in patches on the edge of the ampeliscid complex, and had an average biomass of 724.9±87.2 g/m^2. Ampeliscids, bivalve molluscs, and sea anemones accounted for over 90% of the biomass of the complex. The complex included 19 recorded species of bivalve molluscs. Two species had the highest frequency of occurrence: *Serripes groenlandicus* (P>50%) and *Liocyma fluctuosum* (P>20%).

The dominant species in this complex – amphipod *Ampelisca eschrichti* and bivalve molluscs *S. groenlandicus* and *L. fluctuosum* – are seston-feeders and filter-feeders, and are associated with hydrodynamically active sections of the shelf. A high seston concentration near the seabed and steady bottom currents to facilitate seston transfer promote their development. Actinians, which are classed as predators, also

depend on currents to promote the transfer of larvae from existing sestonophage colonies to new areas, which lead to a patchy distribution.

Offshore Benthos Complex IV. A complex dominated by amphipod *Ampelisca eschrichti* was indentified at 78 stations with an average depth of 52.4±2.4 m (range 30-65 m). The complex occurred in the eastern part of the Offshore area. The average biomass was 967.2±83.6 g/m^2, and the biomass of the dominant group – amphipods – was more than **652.8** g/m^2 (>65% of total biomass). The complex comprised 35 amphipod species, of which 14 species were found only in the Offshore area. *A. eschrichti* was distinctly dominant in regard to frequency of occurrence, colony density and biomass. Its biomass made up 95-100% of the total amphipod biomass at some stations. The maximum ampeliscid biomass had similar values in 2002 – 1,312, 2003 – 1,237, 2004 –1094, 2005 – 1,334 and 2009 – 1,077 g/m^2, at 100% frequency of occurrence.

The ampeliscid colony density and biomass in the area are comparable to, and in some cases exceed, the benthic values of other highly productive areas of the North Pacific (Kuznetsov 1964; Koblikov 1983 a, b, 1986; Makarov 1937) and eastern gray whale feeding grounds (Stoker 1981; Nerini and Oliver 1983; Oliver et al. 1983; Dunham and Duffus 2001, 2002; Moore 2000; Moore et al. 2007). In contrast to the dominant species in the amphipod complex of the Piltun area, the ampeliscids live in tubes attached to the substrate in areas with significant bottom currents (Mills 1967; Wildish and Kristmans 1997).

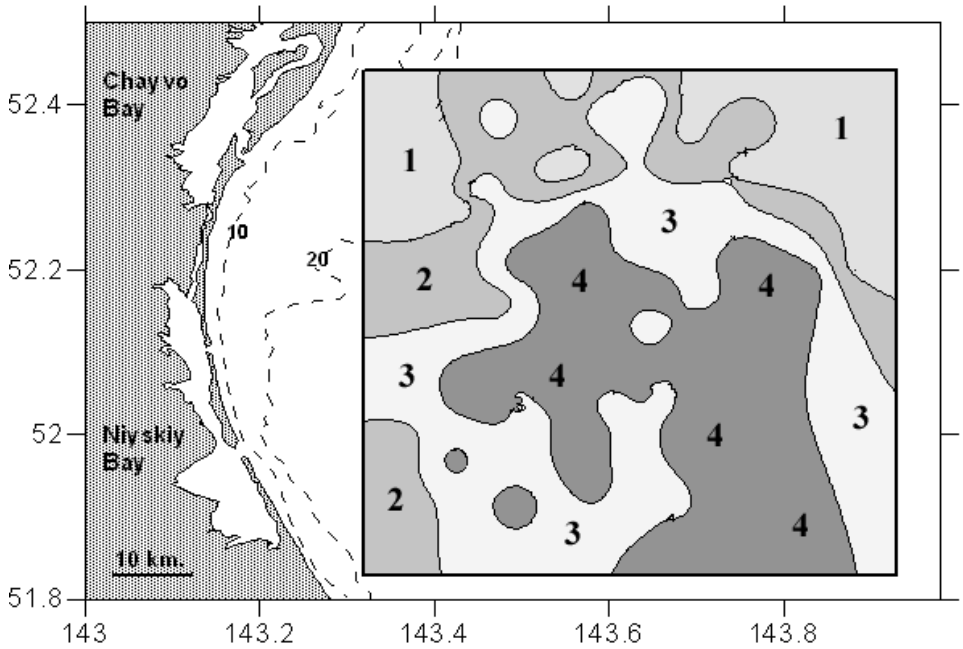

Figure 9. Distribution of benthic complexes in the Offshore area in 2004-2009. The numbers of the complexes are given in Table 12.

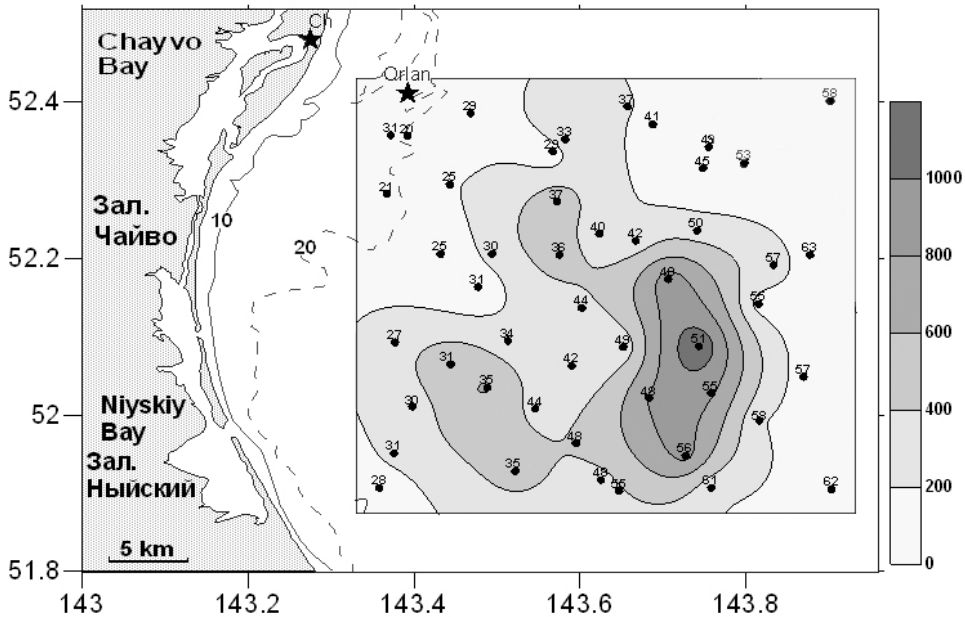

Figure 10. Ampeliscid amphipod biomass distribution (g/m2) in the Offshore area. The number next to each station indicates station depth.

3.6 Intermediate Area

3.6.1 Quantitative Abundance and Distribution of Benthos

Stations of the Intermediate area are located south of the Piltun area and cover waters from Chayvo Bay to the western boundary of the Offshore area. Bottom grab samples were collected at 15 stations (45 samples) in 2007-2008, at 13 stations (39 samples) in 2002 and in 2009 12 stations (36 samples) at depths from 8 to 24 m, with an average collection depth of 18.1±1.1 m. Figure 12 shows a chart of the stations sampled in 2009.

In 2007-2009, the average benthos biomass for the Intermediate area was 404.2±102.1 g/m^2 (mean±Sd). Similar to the pattern in the Piltun area, substantial variations in benthos biomass were recorded with depth in the Intermediate area (Table 13). The biomass of amphipods decreased sharply from 85.6±31.5 g/m^2 at depths of ≤15 m to 3.9±1.9 g/m^2 at 25 m. Sand dollar biomass increased with the depth and reached maximum values (as much as 480±218.5 g/m^2) at depths greater than 15 m.

3.6.2 Composition and Distribution of Benthos Complexes

Analysis of the benthos composition indicates significant variations. Classification of the Intermediate stations according to benthos composition and biomass of individual groups identified 3 benthos complexes (Figure 16):

Intermediate Benthos Complex I. A shallow-water complex (21 stations, average depth 13.8±2.6 m) with dominance of amphipods at an average biomass of 78.2±27.1 g/m^2. This complex included the same amphipod species as in the Piltun area at depths of ≤15 m, isopods *Synidotea cinerea* with biomass up to 60 g/m^2, and bivalve molluscs. Hence, 2002 and 2008-2009 data indicate that forage benthos also has a relatively high biomass south of Piltun Bay, as far as Chayvo Bay (Fadeev 2002). **Intermediate Benthos Complex II**. A complex dominated by ascidian *Pareugyrioides dalli* (8 stations, average depth 23±3.6 m). The complex occupied sections in the southern part of the Intermediate area, and is a boundary complex with the Offshore area. The biomass of the dominant species averaged 198,6±66.5 g/m^2, while cumaceans and polychaetes were found in small numbers.

Intermediate Benthos Complex III. A complex dominated by sand dollars *E. parma* was identified at 11 stations , at an average depth of 23±3.4 m. Sand dollar biomass averaged 344.7±165.1 g/m^2.

The latter two complexes are found in patches in areas with a complex bottom macrorelief and active hydrodynamics. Based on depth finder profiling data, the ascidian complex was associated with terrain elevations comprised of sand of varying grain size mixed with shell debris. The *E. parma* complex was more prevalent on flatter relief.

Sharp changes in the abundance of benthos were recorded in the coastal zone south of the Intermediate area (from Chayvo Bay to Niyskiy Bay). The average total benthos biomass to the south of the Intermediate area, according to 2002 data (three stations), was 90.9 g/m^2, and amphipod biomass decreases to 3.7 g/m^2, while isopod biomass decreased to 5.9 g/m^2. This reflects similar results obtained in 2001 (Fadeev 2002).

Table 10. Distribution of macrobenthos biomass (g/m^2) in the Intermediate area (2007-2009 data).

Group	Frequency of occurrence	Depth (m)			Average biomass	Standard error
		<15	16-20	21-25		
Amphipoda	100	85.6	13.7	3.9	39.8	11
Bivalvia	88	48.1	82.4	23.4	41.8	10.8
Polychaeta	84	4.1	6.9	22.5	13.2	4.9
Cumacea	81	4.6	7.5	5.2	5.7	1.5
Echinoidea	56	0	110.1	480.8	215.2	87.9
Isopoda	48	12.1	7.1	9.7	9.9	3.4
Ascidia	42	8.9	133.7	0	78.4	28
Total		162.8	361.4	545.5	404	

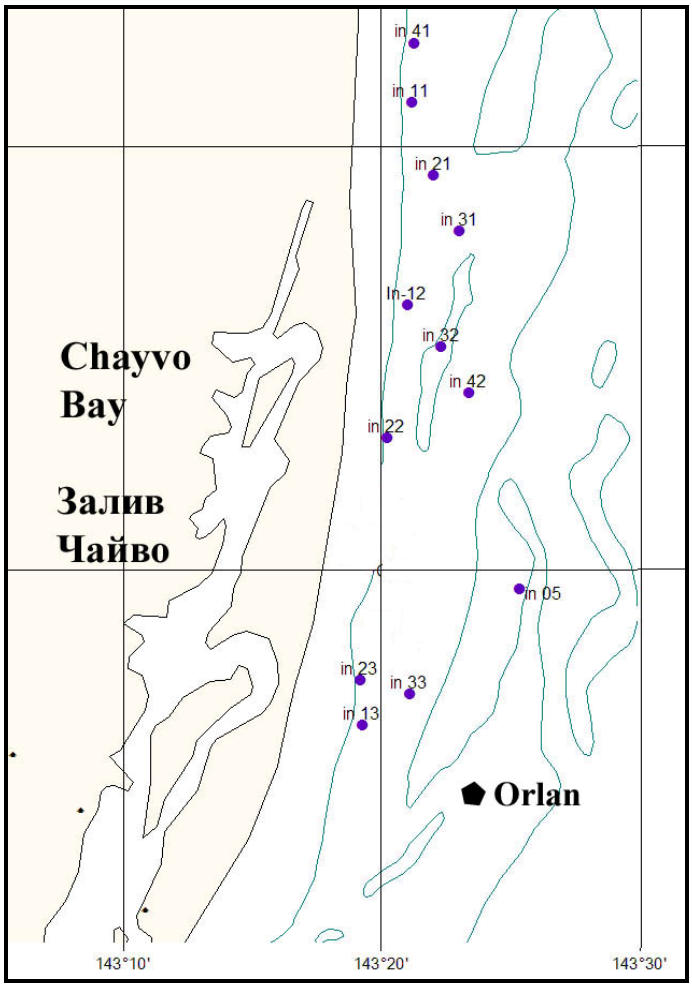

Figure 11. Locations of stations in the Intermediate area in 2009.

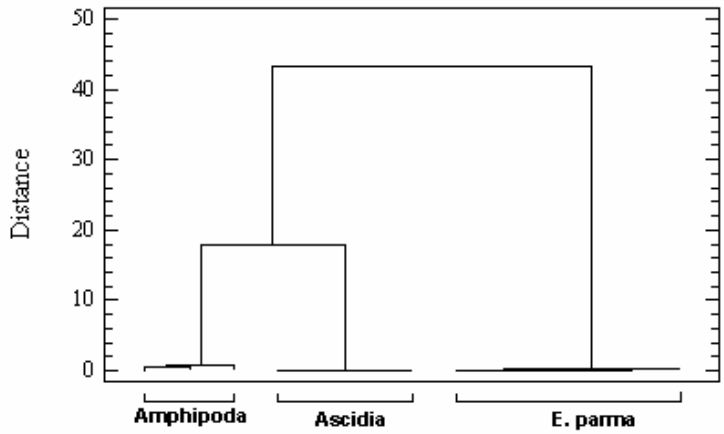

Figure 12. The faunal complexes of the Intermediate area 2007-2009 data.

3.7 Benthos at Gray Whale Feeding Sites

During 2009, 44 benthos stations (132 samples) at gray whale feeding sites[7] were sampled by grab: 17 in the Offshore area, 7 in the Chayvo area, and 20 in the Piltun area.

3.7.1 Whale Feeding Sites in the Piltun Area

Diving samples were first collected at 21 whale feeding sites (average depth of the stations 19.5±1.5 m) in the Piltun area in 2002. The average benthos biomass was 234.4 g/m^2. Forage benthos – amphipods and isopods – made up more than 50% of the total biomass.

Twelve sites (average depth 18.6±1,6 m) were studied in 2003. The average biomass of benthos at the feeding sites was 164.2 g/m^2, and amphipods and isopods made up 79% of the biomass. Most of the whales fed at depths of 20 m or less within the shallow-water amphipod complex in 2003 (Fadeev 2007).

In 2004, 50 whale feeding sites were studied in a depth range of 14-35 m (average depth 23.5±0.9 m was greater than previous years). The increase in the average feeding depth was due to the whales' foraging within the sand dollar complex at depths greater than 20 m in the northern part of the Piltun area.

In 2005, there were 74 whale feeding sites (average depth 18.5±1.1 m). Most of the whales fed at depths of 20 m or less within the coastal amphipod complex. In the northern Piltun area, however, whales were once again observed feeding in deeper waters. The number of "deeper-water" whales in 2005 was sometimes as high as 40% of the total number of whales in the northern Piltun area. Analysis of 2004-2005 samples showed that the sand lance *Ammodytes hexapterus*, the amphipod *Eogammarus schmidti* and the isopod *Saduria entomon* had the highest frequency of occurrence and biomass at deeper-water feeding sites (>20m) in the northern area.

The sand lance accumulations in the northern Piltun area (depth greater than 20 m) were located 5-7 km from the shallow-water areas of the coastal amphipod complex (depth less than 15-20 m); however, gray whales can cover this distance in 1-1.5

[7] As in previous years, data from photo-ID and WGW distribution surveys were used to guide observation for whale feeding sites in the feeding areas.

hours, and so coastal areas with amphipod dominance and the deeper-water areas with sand lance dominance could easily be foraged by the same whales within short periods of time.

The average sand lance biomass in the Piltun area was lower in 2009 and 2008 (8.8±3.7 g/m^2 and 12.9±5.4 g/m^2, respectively) than in 2007 (27.7±12.1 g/m^2). In the northern part of the Piltun area, a substantial decrease in sand lance occurrence was observed, from 40-60% in 2005 to 20-25% in 2006-2007, and 8-12% in 2008-2009.

In 2008 the average total biomass of benthos at the whale feeding sites in Piltun area was 57.9±7.5 g/m^2, of which amphipod biomass was 35.2±3.2 g/m^2 (60.7% of the total biomass). In 2009 the examined whale feeding sites were located mainly in southern and central part of the Piltun Area (Figure 17). All feeding sites were less than 20 m deep and were located in the area with amphipod biomass ranging from 50 to 120 g/m^2.

3.7.2 Whale Feeding Sites in the Chayvo Subarea

During 2006-2009, 39 benthos stations at gray whale feeding sites were sampled by grab in the Chayvo subarea. At these stations benthos and epibenthos samples were taken by grab, underwater video surveys of the water column and bottom surface were conducted, and plankton (Bongo net).

Stations at whale feeding sites were located in depths of 10 to 15 m (average depth – 13.5 m) on well-graded fine and medium sand. Video records did not reveal any accumulation of plankton animals in the water column. Copepods, euphausiids, cumaceans and planktonic amphipod-hyperiids were found in insignificant numbers in samples of plankton and epibenthos (epibenthos net).

Benthos at the whale feeding sites belonged to coastal amphipod complex, which is common at depths ≤20 m in the Piltun area; the species composition of this complex in the Intermediate area was the same as that in the Piltun area.

The occurrence of the amphipod complex to the south of Piltun Bay, as far as Chayvo Bay, has been known since 2001 (Fadeev 2002), when it was also noted that the biomass of amphipods is significantly lower there than in the Piltun area. This observation was confirmed by the data of 2002 benthos stations in the

Intermediate area. In 2001, the average amphipod biomass at whale feeding sites in the 10-15 m range was 35.7±9.8 g/m^2, in 2006[8] this was 41.1±7.9 g/m^2, in 2007 51.3±8.6 g/m^2, in 2008 the average amphipod biomass was 47.6±9.6 g/m^2 and in 2009 (this was 61.4±13.6 g/m^2, respectively, Fig. 19).

Vessel-based observation and photo-ID data during 2006-2009 recorded no more than 5-7 gray whales feeding in the area at any one time, indicating that this small area with relatively low prey biomass may be secondary to the prime feeding grounds.

[8] 2006-2008 samples were collected from the area between two transects, over 5-30m depth, that were sampled in 2001.

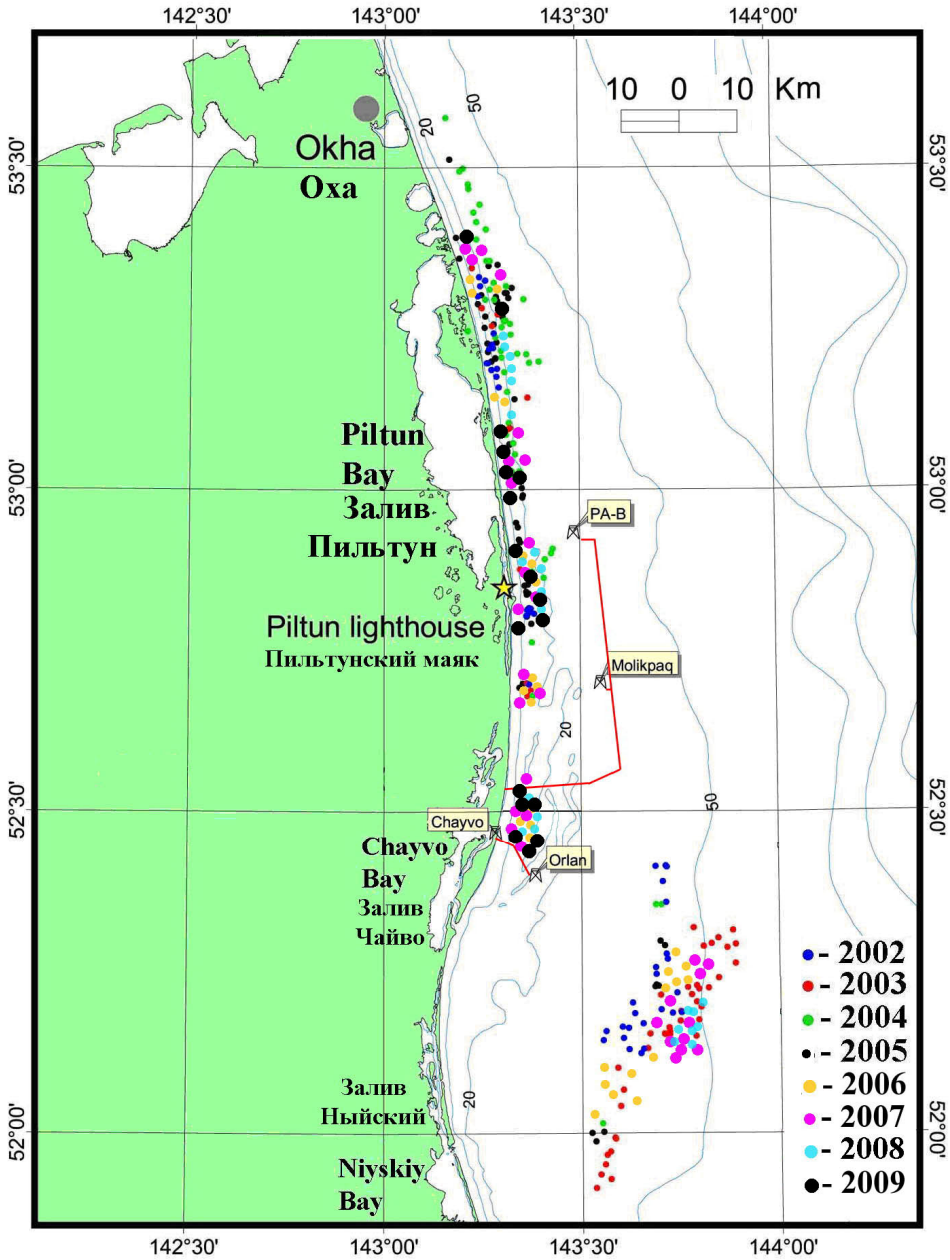

Figure 13. Chart of gray whale feeding sites studied in 2002-2009.

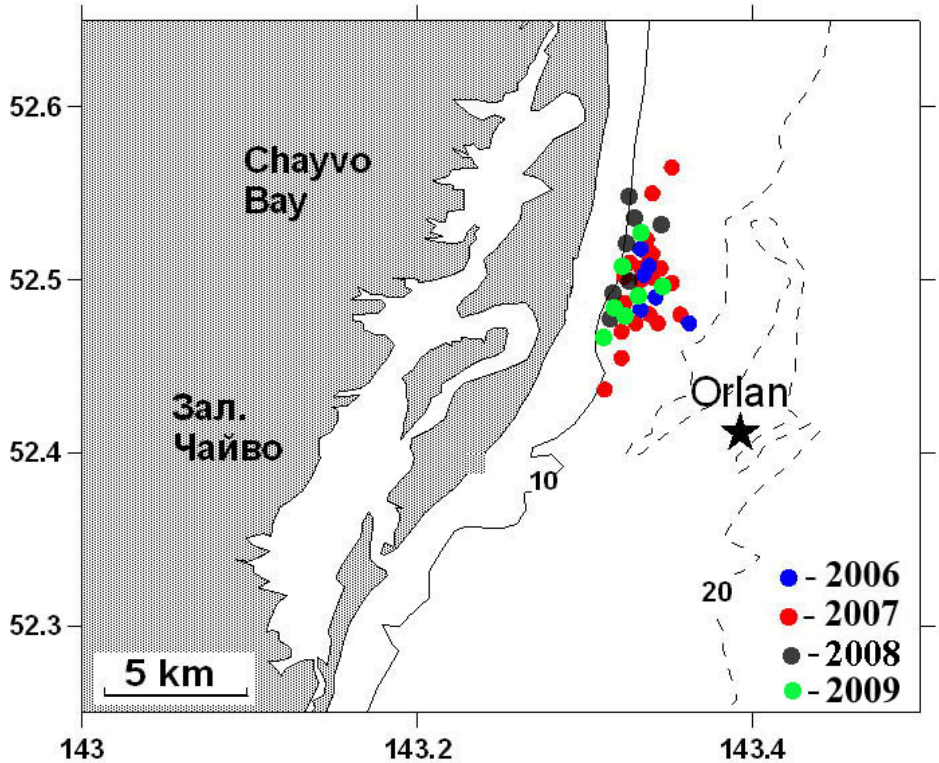

Figure 14. Chart of gray whale feeding sites in the Chayvo Bay area in 2006-2009.

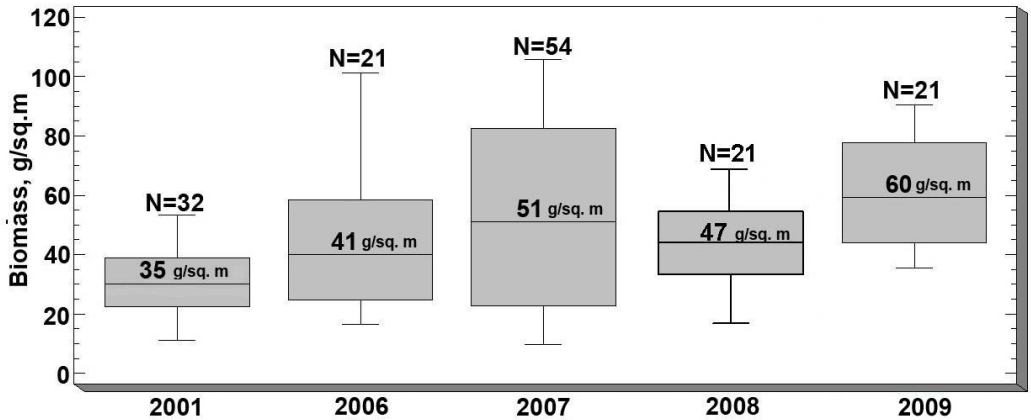

Figure 15. Amphipod biomass (g/m^2) in the Chayvo subarea in 2001, 2006-2009.

3.7.3 Whale Feeding Sites in the Offshore Area

In 2002-2003, 64 whale feeding sites were studied in the Offshore area; three sites were studied in 2004, eight sites in 2005, 14 sites in 2006, 30 sites in 2007, 9 sites in 2008 and 13 in sites 2009. During all these years, the whales fed in a rather narrow depth range, from 41 to 61 m, i.e., in a zone of high abundance of the amphipod *Ampelisca eschrichti* (Fig. 20). However, variation in densities of feeding whales in the Offshore area were not linked to variations in abundance of total benthos or the ampeliscid component.

The ampeliscid biomass at whale feeding sites averaged 366.3±168.3 g/m^2 in 2005, 329.4±143.8 g/m^2 in 2006, 516±140.1 g/m^2 in 2007 and 523±148.5 g/m^2 in 2008. The average ampeliscid biomass at whale feeding sites in 2009 was 507.7±59.3 g/m^2, indicating that gray whales forage in the Offshore area primarily at sites with ampeliscid biomass of more than 500 g/m^2 in 2007-2009 at depths greater than those recorded previously. It is possible that whales foraged at greater depths (51-53 m) in 2007-2009 due to increased abundance (and therefore resource pressure or competition) of whales (up to 70 individuals) in the Offshore feeding area.

In 2009, as in previous years, benthos at the feeding sites had composition and structure consistent with the *Ampelisca eschrichti* complex and the *A. eschrichti* + Bivalvia + Actinia complex. Whales were feeding at similar sites in the Offshore area in 2007-2009 and at different sites in 2002 and 2006 (Fig. 21).

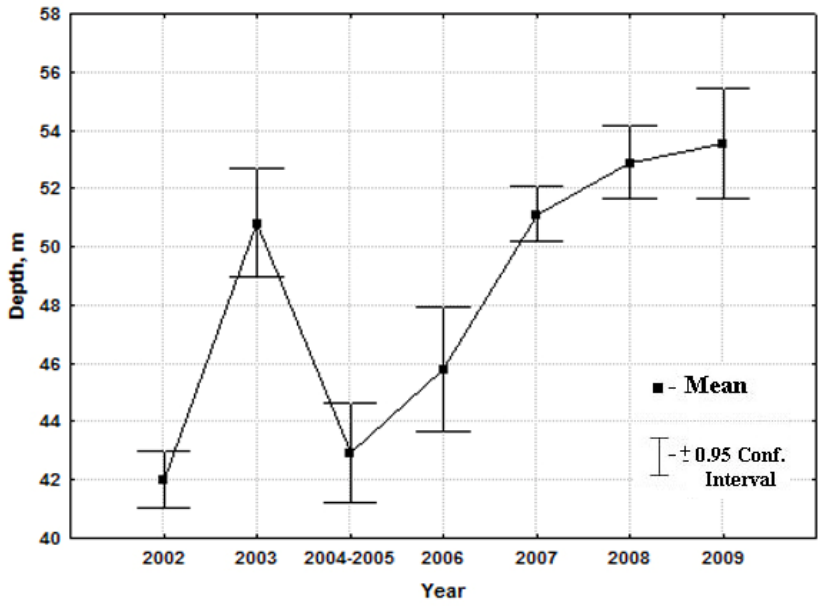

Figure 16. Distribution of average depths of whale feeding sites in the Offshore area by years.

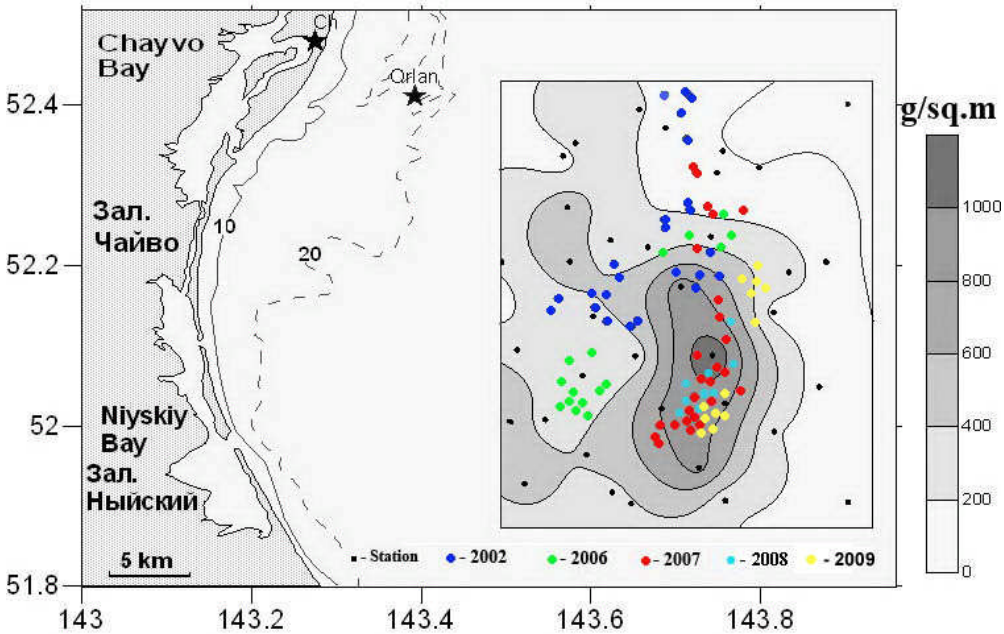

Figure 17. Chart of the distribution of biomass of the amphipod Ampelisca eschrichti (g/m2) and whale feeding sites in the Offshore area in 2002, 2006-2009.

3.8 Comments for Assessing Year-to-Year Changes in Forage Benthos in the Piltun and Offshore Feeding Areas

The purpose of this section is to compare the most notable trends in year-to-year changes in the distribution of foraging whales and forage benthos. This section is not intended to provide a detailed, cross-spectrum analysis of the relationships between benthos and foraging whales. That exercise would require special analysis within the framework of a unified GIS.

Principal trends in the distribution of whales in 2002-2009:

1) 2002-2003 – whales fed in both (Piltun and Offshore) feeding areas; most of the whales in the Piltun area fed in the shallow-water zone at depths ≤ 20 m in the northern and southern parts of the area.
2) 2004-2005 – whales fed primarily in the Piltun area; the number of photo-identified whales in the Offshore area was low– 8 (2004) and 7 (2005) individuals; whales fed in the Piltun area generally in the shallows at depths of ≤ 20 m, while in the northern part of the area, some whales (up to 40%) fed at depths greater than 20 m.
3) 2006 – whales fed in both the Piltun and Offshore areas; the number of photo-identified whales in the Offshore area increased to 33 individuals; whales in the Piltun area fed along the entire coastline; the number of foraging whales declined sharply in the southern part of the area, as did the proportion of whales feeding at depths >20 m in the north. A small number of foraging whales appeared in the Chayvo Bay area.
4) 2007-2009 – whales fed in both areas; the number of photo-identified whales in the Offshore area increased to 70; the number of foraging whales in the southern Piltun area increased relative to 2006, while the number of whales feeding at depths > 20 m in the northern part of the area was very low. The Chayvo subarea had a small number of foraging whales.

Principal trends in variation of forage benthos abundance in 2002-2009:

Offshore Area: Biomass of forage benthos was stable, and no major year-to-year variations were observed; whales fed in a depth range of 41-61m every year in a zone of high abundance of major prey: amphipods *Ampelisca eschrichti.*

Piltun Area:

1) 2004-2005 – areas with elevated amphipod biomass occur in the shallower-water part of the southern and northern Piltun area; *Monoporeia affinis* is dominant in biomass; there is an increase in the frequency of occurrence (to 40-60%) and biomass of the sand lance *Ammodytes hexapterus* in the northern part of the area.

   The appearance of the sand lance in waters >20 m in the northern part of the Piltun area coincided with a decrease in the number of whales in the Offshore area, and the appearance of foraging whales in the northern Piltun area at depths greater than 20 m.
2) 2006 – the proportion of the amphipod *M. affinis* in the total biomass of forage benthos in the shallow-water zone decreased, and the biomass of this species at shallow-water stations in the southern part of the Piltun Feeding area declined by 50% from the 2005 level; in the northern part of the Piltun Feeding area, the frequency of occurrence of the sand lance decreased from 40-60% to 20-25%.
3) The decrease in abundance of amphipods and sand lance coincided with the appearance of foraging whales in the Chayvo subarea and an increase in the number of whales in the Offshore area. It is notable that whales began feeding in the Chayvo subarea at sites with biomass of about 40 g/m^2 when the biomass of amphipods in the southern Piltun area dropped to approximately this level.
4) 2007-2009 – amphipod biomass increased in the shallow-water zone of the Piltun area. In 2008-2009 amphipod *M. affinis* was dominant in the southern and central part of the area Piltun area; its biomass there in 2007-2009 was higher than in 2006 but did not reach the maximum levels of previous years(see Figs 4-5).

5) Sand lance abundance in at deeper-water sites in the northern part of the area remained at the low level of 2006. In 2009, the frequency of occurrence, biomass and the spatial distribution of sand lance in the Piltun area were similar to those of 2008. There have been sporadic finds while the concentrations in the northern part of the area is absent (see Fig. 6).

An increase in the abundance of the amphipod *M. affinis* in the south Piltun area coincided with shore- and vessel-based observations of increases in the number of foraging whales in the southern section of the area; lone foraging whales were observed in deeper waters of the northern section.

Changes in hydrology and sea ice cover in the Piltun area:

An analysis of the year-to-year dynamics of the hydrological regime in the Piltun area showed that the lowest bottom temperatures for the period 2004-2009 occurred in 2009. Temperature is expected to affect amphipod breeding, growth, and feeding, resulting in changes to their life cycle duration. For example, the dominant species in the Piltun area, *Monoporeia affinis*, has a two-year life cycle in cold waters and a one-year life cycle in warmer waters (Segestrale 1967). The amphipod *Ampelisca macrocephala,* which inhabits the Offshore area, lives for 5-6 years in the cold waters of the Bering Sea, but for only 2-3 years in the temperate waters of Denmark (Kannewoff 1969; Highsmith and Coyle 1991). Whether the few degrees centigrade of temperature differences the Piltun area has affected amphipod life cycle is not known. The effect of hydrological features on the life cycle of mass amphipod species on the Sakhalin north-east shelf will be further assessed once current morphometric analysis of the 2007-2009 amphipod collections is completed.

Important Climate-parameters such as sea ice dynamics can also impact coastal biota. Ice conditions varied substantially in the Piltun area during 2004-2009. Figure 22 indicates the position of the ice edge during the first ten days of June each year. According to these satellite monitoring data, the northeastern Sakhalin coastal zone was free of ice in June 2004 and 2005. However, the area was covered in 10-point ice almost to the mouth of the Piltun lagoon in early June 2006. In June 2007-2009,

ice remained near the Chayvo lagoon, but there was open coastal water from the Piltun lagoon northward.

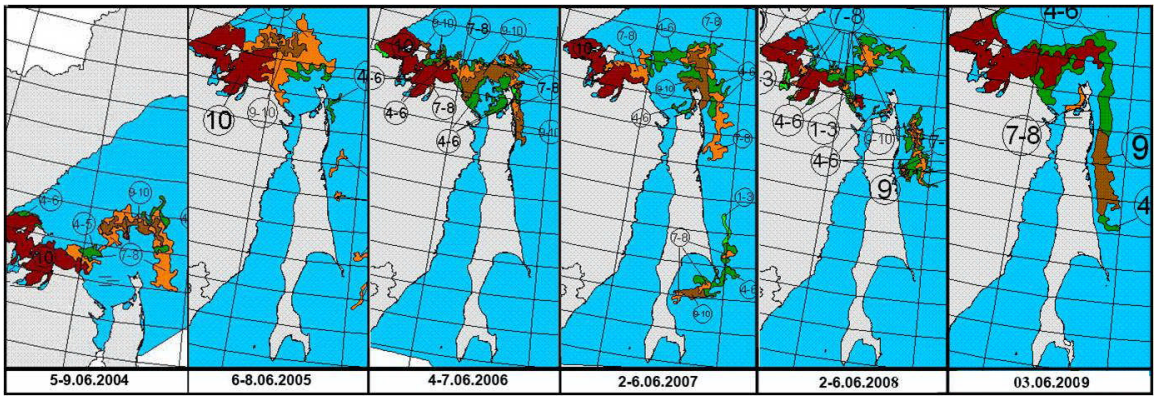

Figure 18. Locations of ice fields according to satellite monitoring data during the first ten days of June 2004-2009 of northeastern Sakhalin (http://www.aari.nw.ru).

Ice cover could affect the abundance of *Monoporeia affinis* through influence on hydrological processes and on primary production (i.e., food for benthos). Settled phytoplankton and detritus of phytoplanktonic origin have been reported to play an important role in the diet of this species (Sarvala 1991; Van de Bund at al. 2001). In an environment with an ice regime, such as the northeast Sakhalin shelf and associated coastal bays and lagoons, the intensity and duration of spring bloom of phytoplankton may, as in similar environments, be influenced in part by light conditions when the water surface is free of ice (Schell et al. 1982); persistence of ice conditions could delay the spring bloom of phytoplankton, and this in turn could affect zooplankton productivity and fish that feed on plankton (Boytsov and Orlova 2004), as well as benthos (Fleeger et al. 1989). A sharp increase in growth rates of *M. affinis* has been shown to follow the spring bloom of phytopolankton in the Baltic Sea, where nutrients availability affected growth to a greater degree than temperature (Lehtonen 1996; Lehtonen and Andersin 1998).

The lowest abundance of *M. affinis,* the most likely principal component of WGW diet, occurred in 2006. The distinguishing features of the hydrological and climatic conditions in 2006 were: (a) a decrease in the summer temperature of bottom waters, and (b) an anomalous ice cover duration (Figure 22). We note that the two phemonena may be related. There are available data on the observed cooling of the

climate of the Sea of Okhotsk (Volvenko 2004). Unfortunately, no data are available for phytoplankton productivity.

A slight and not statistically significant increase in *M. affinis* biomass in 2007-2009 coincided with an earlier clearing of ice cover (Figure 19).

3.9 Trophodynamics Using Stable Isotope and Fatty Acid Analyses

Isotopic ($\delta^{13}C$ and $\delta^{15}N$) and molecular (fatty acids, n-alkanes) biomarkers were analyzed in samples collected at seven stations in the Piltun and Offshore Feeding Areas, and at three stations in Piltun Lagoon (Fig. 3). Samples of benthic invertebrates belonging to 20 species of various taxonomic groups differing in their feeding types and bottom sediments were collected here in 2006–2008. Analysis methods and results of the analysis are described in detail in Fadeev (2009); however, the main results are briefly summarized here.

Figure 20 shows the results of the stable isotope analysis for mass benthos species samples taken from the Piltun Lagoon, Piltun feeding area and Offshore feeding area in coordinates of concentration values of $\delta^{13}C$ and $\delta^{15}N$ indicative of trophic levels. Figure 21 shows the results of the molecular analysis (composition of marker fatty acids) in the lipids of four amphipod species dominant in the food benthos of the Piltun and Offshore Areas.

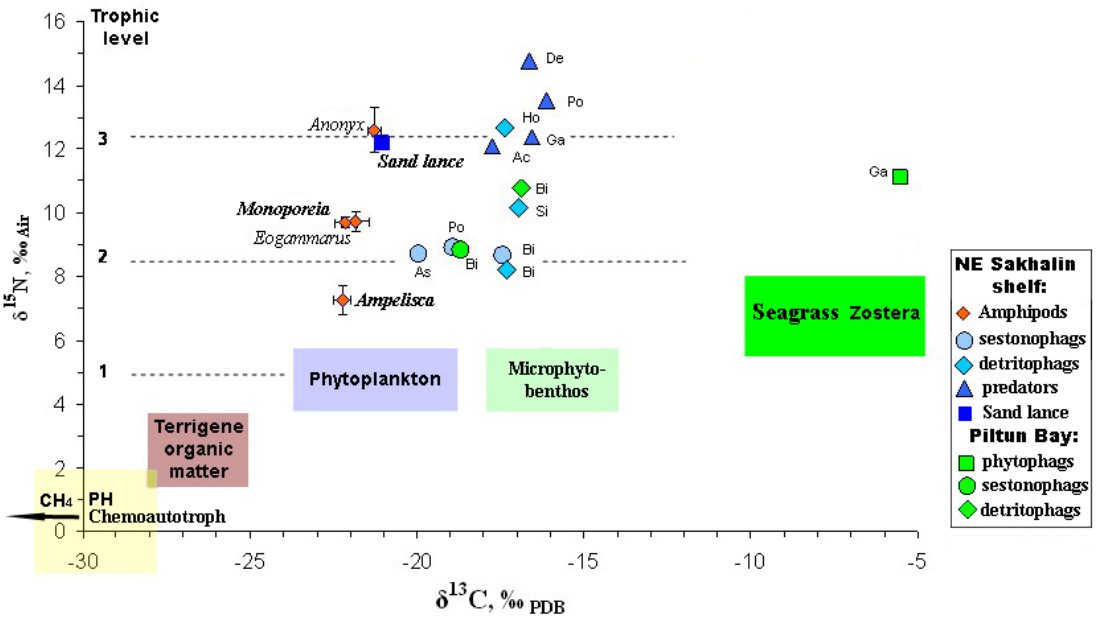

Figure 20. Distribution of mass benthos species of the Piltun (lagoon and nearshore) and Offshore areas in coordinates of concentration values of stable isotopes $\delta^{13}C$ and $\delta^{15}N$ (mean±SD[1]).

Ac – Actiniaria; As – Ascidiae; Bi – Bivalvia; De – Decapoda; Ga – Gastropoda; Ho – Holothuroidea; Po – Polychaeta; Si – Sipunculoidea.

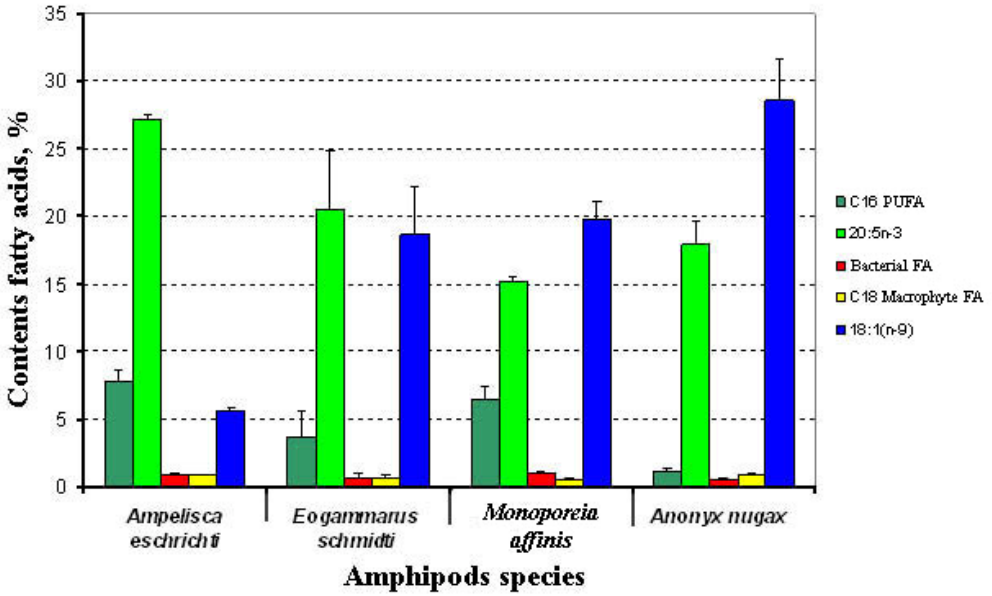

Figure 21. Composition of marker fatty acids in the lipids of four amphipod species dominant in the food benthos of the Piltun and Offshore Areas.

C16 PUFA – Diatom; 20:5n3 – Diatom; Bacterial FA – Bacteria; C18 Macrophyte FA – Macrophytes such as Seagrasses; 18:1(n-9) – Predation.

The third rank in terms of total biomass is occupied by the isopod *Synidotea cinerea*. Literature about the structure of its diet is absent. Fatty acids composition of *Synidotea cinerea* shows a decrease in the proportion of the fatty acid characteristic of phytoplankton (C16PUFA, 18:4 (n-3)). The relation of 16:1 (n-7)/16:0-0.9 is 0.8. Compared with amphipods *Monoporeia affinis* and *Eugammarus schmidti*, this isopod has much more Docosahexaenoic acid and arachidonic acid. One may assume that this isopod, along with feeding on sinking diatom phytoplankton, obtains a portion of its food from the detritus food chain via Protozoans.

In summary, the analysis of stable isotopes and molecular biomarkers shows the following (Fadeev, 2009):

I. The content of ^{13}C isotopes in amphipods is similar to that of phytoplankton.
II. The content of ^{15}N isotopes in amphipods is indicative of higher (2nd or 3rd) trophic levels.
III. Fatty acid markers indicative of contributions by bacteria, terrestrial vegetation or sea grasses were either not found in the amphipods' lipids (terrestrial vegetation) or very small (<1% for bacteria markers, <0.8% for sea grasses).
IV. Fatty acid markers indicative of diatoms were found in significant amounts in the amphipods' lipids.

From these results, the following conclusions can be drawn:

I. Amphipods and isopods in the Piltun and Offshore feeding areas feed mainly on diatom phytoplankton, or on organisms feeding on diatom phytoplankton.
II. Bacteria attached to suspended sediment exported from Piltun Lagoon into Piltun feeding ground do not provide a significant part of the food resource for amphipods. This is confirmed by the low level (<1%) of bacterial markers in fatty acids of amphipods lipids.
III. The gray whales' main food supply (mass species of amphipods and isopods) is mainly dependant on diatom phytoplankton.

3.10 Conclusion

1. In 2009, the average total biomass of benthos in the Piltun feeding area was 486.3±118.6 g/m2. As in previous years, sand dollars constituted the largest proportion of the total biomass (>70% of total biomass on average, and up to 95% at depths greater than 20 m).
2. For the entire depth range studied in 2009, the average biomass of amphipods was 31.4±5.2 g/m^2. More than 90% of the abundance of amphipods was due to two species: *Monoporeia affinis* (> 60% of total amphipod biomass) and *Eogammarus schmidti* (> 30%). The distribution of amphipod biomass along the coast of the Piltun feeding area showed similar trends in 2002-2009; zones of maximum biomass were associated with the coastal waters, and the amphipod distribution has a distinctly aggregated nature.
3. Multi-year changes in amphipod biomass in the shallow waters of Piltun area represent a statistically significant biomass decrease in 2006 compared to 2002-2005. Amphipod biomass rise observed in 2007-2009 has not yet reached the maximum biomass values of 2002-2003 (statistically significant differences still remain). In 2009 amphipod biomass, the main feeding component for gray whales in the Piltun area, reached the level of 2004-2005 (no statistically significant differences in biomass values).
4. In 2009 the examined whale feeding sites were located mainly in the southern and central part of the Piltun Area. All feeding sites were less than 20 m deep and were located in the area with amphipod biomass ranging from 50 to 120 g/m^2.
5. The average sand lance biomass in the Piltun area was lower in 2009 than in 2008 (8.8±3.7 g/m^2 and 12.9±5.4 g/m^2, respectively). In the northern part of the Piltun area, a substantial decrease in sand lance frequency of occurrence was observed, from 40-60% in 2005 to 20-25% in 2006-2007, and 8-12% in 2008-2009.
6. **Offshore feeding area.** The average benthos biomass in 2009 was 598.6±134.7 g/m^2 compared to 627.4±142.4 g/m^2 in 2008. The biomass of amphipods was 183.9±66.2 g/m^2 in 2009 compared to 213.9±69.6 g/m^2 in 2008. Year-to-year differences in average amphipod biomass were not

statistically significant. The spatial distribution of benthos biomass was similar in 2009 and 2006-2008. The proportion of amphipod biomass in total benthos biomass of the Offshore feeding area increased with distance from shore toward deeper waters. Like in previous years in the Offshore feeding area, in 2009 the whales fed in the areas with amphipod biomass from 200 g/m^2.

7. **Year-to-year variations in forage benthos in the Piltun and Offshore areas.** Forage benthos biomass in the Offshore feeding area was stable during 2002-2009, and no major year-to-year variations were observed; whales fed in a depth range of 41- 61m during all those years in a zone of high abundance of amphipods *Ampelisca eschrichti.* In the Piltun feeding area, the most notable changes in the abundance and spatial distribution of the dominant amphipod species, *Monoporeia affinis*, occurred in 2006 when the lowest biomass levels were observed. Hydrological and climatic conditions in summer 2006 were characterized by lower bottom temperatures compared to 2004-2005, and the anomalous duration of the ice cover.
8. **Trophodynamics.** Three species comprising the bulk of zoobenthic biomass in Piltun area, i.e. amphipods *Pontoporeia affinis, Eogammarus schmidti* and isopod *Synidotea cinerea*, obtain the main portion of their food from the settled diatom phytoplankton.

3.11 List of Citations

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Chapter 4

Patterns of Western Gray Whale Behavior, Movement, and Occurrence off Sakhalin Island, 2009: Results and Discussion[9]

Photo taken from shore, G. Gailey.

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Wildlife Fisheries and Sciences

Texas A&M University

March 2010

[9] Chapter 4 *In:* 2010. Western gray whale research and monitoring program in 2009, Sakhalin Island, Russia. Volume II Results and Discussion

LIST OF TABLES

Table 1. Total amount of effort during 11 July to 18 September 2009. Days represent the combination of research effort at both stations and actual days represent calendar days. 298

Table 2. Summary of scans conducted in 2009 at six shore-based stations off northeastern Sakhalin Island. 299

Table 3. Distance of western gray whales from shore at six shore-based stations. Sample size represents number of sightings of gray whales in 2009.2009 312

Table 4. Number of whales (A) and pods (B) detected at six shore-based stations. Sample size is represented by the number of scans per station. 315

Table 5. Relative abundance of western gray whales for July through September 2009. 316

Table 6. Summary of trackline information gathered in 2009 at six shore-based stations. 317

Table 7. Summary of trackline information gathered during July – September, 2009. 317

Table 8. Summary data for movement parameters of western gray whales during summer 2009 319

Table 9. Summary of focal behavior data gathered at six shore-based stations. 323

Table 10. Summary of focal behavior data gathered during July thru through September, 2009. 323

Table 11. Summary statistics for surface-respiration-dive parameters of individual western gray whales. 324

Table 12. Movement and respiration variables of western gray whales during feeding, feeding/traveling, and traveling behavioral states. Post-hoc significance is denoted by F (Feeding), FT (Feeding/Traveling), and T (Traveling). 327

Table 13. Western gray whale movement parameters in relation to whales observed closest to pile driving activity compared to other areas 338

Table 14. Western gray whale respiration parameters in relation to whales observed closest to the pile driving location compared to other areas. 339

Table 15. Summary of number of whales and pods per scan for 2001-2009. Stations proceed from highest latitude (North Station) to lowest latitude (South Station). Sightings between 0-20 and 160-180 where removed from 2004 - 2009 data sets to properly compare relative abundance of gray whales to the methods of 2001-2003 (see methods). Sightings from 2006-2007 were summarized from mid-July to September since this period was more typical of past field seasons. 348

Table 16. Summary statistics for movement and respiration data collected during 2001 - 2009. Dashes (-) separate numbers that indicate ranges; plus/minus (±) separate means and standard deviations, and numbers in parentheses are sample sizes. 355

LIST OF FIGURES

Figure 1. Geographic positions of sightings of western gray whales at six shore-based stations off Sakhalin Island for the summers of 2002 - 2009. 301

Figure 2. Distribution of western gray whales from six shore-based positions during the summer of 2009. Blue – red represents the kernel density probability contours. 302

Figure 3. Seasonal distribution of western gray whales from six shore-based positions from (A) July, (B) August, and (C) September of 2009. Blue – red represents the kernel density probability contours. 305

Figure 4. Density distribution of western gray whales from six shore-based stations during the summer of 2009. 306

Figure 5. Seasonal density distribution of western gray whales from six shore-based stations from (A) July, (B) August, and (C) September of 2009. 309

Figure 6. Frequency histograms of numbers of whales (A) and pods (B) detected per scan throughout the study period, and pod size (C). 311

Figure 7. Frequency distribution of distance of western gray whale sightings from shore off Sakhalin Island, summer 2009. 312

Figure 8. Western gray whale distance from shore at six geographic locations during July - September of 2009. 313

Figure 9. Mean number of whales per time of day at six shore-based stations 2009. 314

Figure 10. Mean number of western gray whales observed per scan for three months of observations at six shore-based locations in 2009. 316

Figure 11. Tracklines of western gray whales at six shore-based positions on Sakhalin Island during summer 2009 (N = 177). 318

Figure 12. Leg Speed for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. For each box-plot the whiskers represent the 10th and 90th percentile, the box represents the 25th and 75th percentile, the solid bar represents the 50th percentile, and dashed bars represent mean values. 320

Figure 13. Acceleration for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Negative values represent deceleration. Display as in Figure 22. 320

Figure 14. Reorientation rate for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 22. 321

Figure 15. Mean vector length for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 22. 321

Figure 16. Linearity index for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 22. 322

Figure 17. Ranging index for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 22. 322
Figure 18. Blow interval, surface time, and dive time parameters of western gray whales. Display as in Figure 22. 324
Figure 19. Number of blows per surfacing, dive-surface blow rate, and surface blow rate of western gray whales. Display as in Figure 22. 325
Figure 20. Speed of western gray whales during three behavioral states. Display as in Figure 22. 328
Figure 21. Reorientation rate of western gray whales during three behavioral states. Display as in Figure 22. 328
Figure 22. Linearity index of western gray whales during three behavioral states. Display as in Figure 22. 329
Figure 23. Mean vector length of western gray whales during three behavioral states. Display as in Figure 22. 329
Figure 24. Acceleration of western gray whales during three behavioral states. Display as in Figure 22. 330
Figure 25. Ranging index of western gray whales during three behavioral states. Display as in Figure 22. 330
Figure 26. Distance to shore of western gray whales during three behavioral states. Display as in Figure 22. 331
Figure 27. Respiration interval of western gray whales during three behavioral states. Display as in Figure 22. 331
Figure 28. Surface time of western gray whales during three behavioral states. Display as in Figure 22. 332
Figure 29. Dive time of western gray whales during three behavioral states. Display as in Figure 22. 332
Figure 30. Number of blows per surfacing of western gray whales during three behavioral states. Display as in Figure 22. 333
Figure 11. Dive-surface blow rate of western gray whales during three behavioral states. Display as in Figure 22. 333
Figure 32. Surface blow rate of western gray whales during three behavioral states. Display as in Figure 22. 334
Figure 33. Mean squared displacement of western gray whales during three behavioral states. The upper and lower 95% confidence intervals are represented by dashed and dotted lines,dotted lines, respectively. 334
Figure 34. Feeding, Feeding/Traveling and TravelingTraveling tracklines of western gray whales in the Piltun feeding area from July - September 2009. Contours represent the 90% kernel density probability. 336
Figure 35. Feeding activity (feeding + feeding/traveling behavioral states) observed for western gray whales in the nearshore Piltun feeding area during July, August, and September 2009. Contours represent the 90% kernel density probability. 337
Figure 36. Mean number of whales per scan day at six shore-based station during the summer of 2009. 340
Figure 37. Maximum number of whales per scan day at six shore-based stations during the summer of 2009. 341

Figure 38. Annual relative abundance of western gray whales at six shore based stations from 2001-2009. Sightings between 0-20 and 160-180 degrees were removed from 2004 - 2009 data sets to properly compare relative abundance of gray whales to the methods of 2001-2003 (see methods). Sightings from 2006-2007 were summarized from mid-July to September since this period was more typical of past field seasons. 349

CHAPTER 4: BEHAVIOR

4.1 Effort

Behavioral research started on 5 July and ended on 21 September 2009. There was a total of 33 observation days (412 hrs) of effort at six shore-based stations (see Chapter 5, Appendix 1) for the entire field season. Due to weather conditions, the first day of data collection was on 11 July at 2nd Station and Station 07. The last observation day of effort was 18 September at South and 1st Stations. Slightly more effort was conducted during the month of August (43% of the observation time) than during July (27%) and September (30%) (Table 1).

Table 1. Total amount of effort during 11 July to 18 September 2009. Days represent the combination of research effort at both stations and actual days represent calendar days.

Month	Days	Effort (hrs)	Actual days
July	18	103.9	9
August	28	179.4	14
September	19	128.9	10
Total	64	412.2	33

4.2 Scan Data

General – For each observation day, scan surveys were conducted to collect information on relative abundance and distribution of western gray whales in the study area. A total of 256 scans were conducted for the entire field season, which yielded 790 sightings of 1136 whales (Table 2). The average number of scans per day of effort was 4.7 with a range of 1 to 9 scans per day. As noted in the methods, the sampling design in 2009 differed from that of previous years. In 2009, more effort was spent at the two middle stations (Station 07 and 2nd Station) due to their proximity to construction activity.

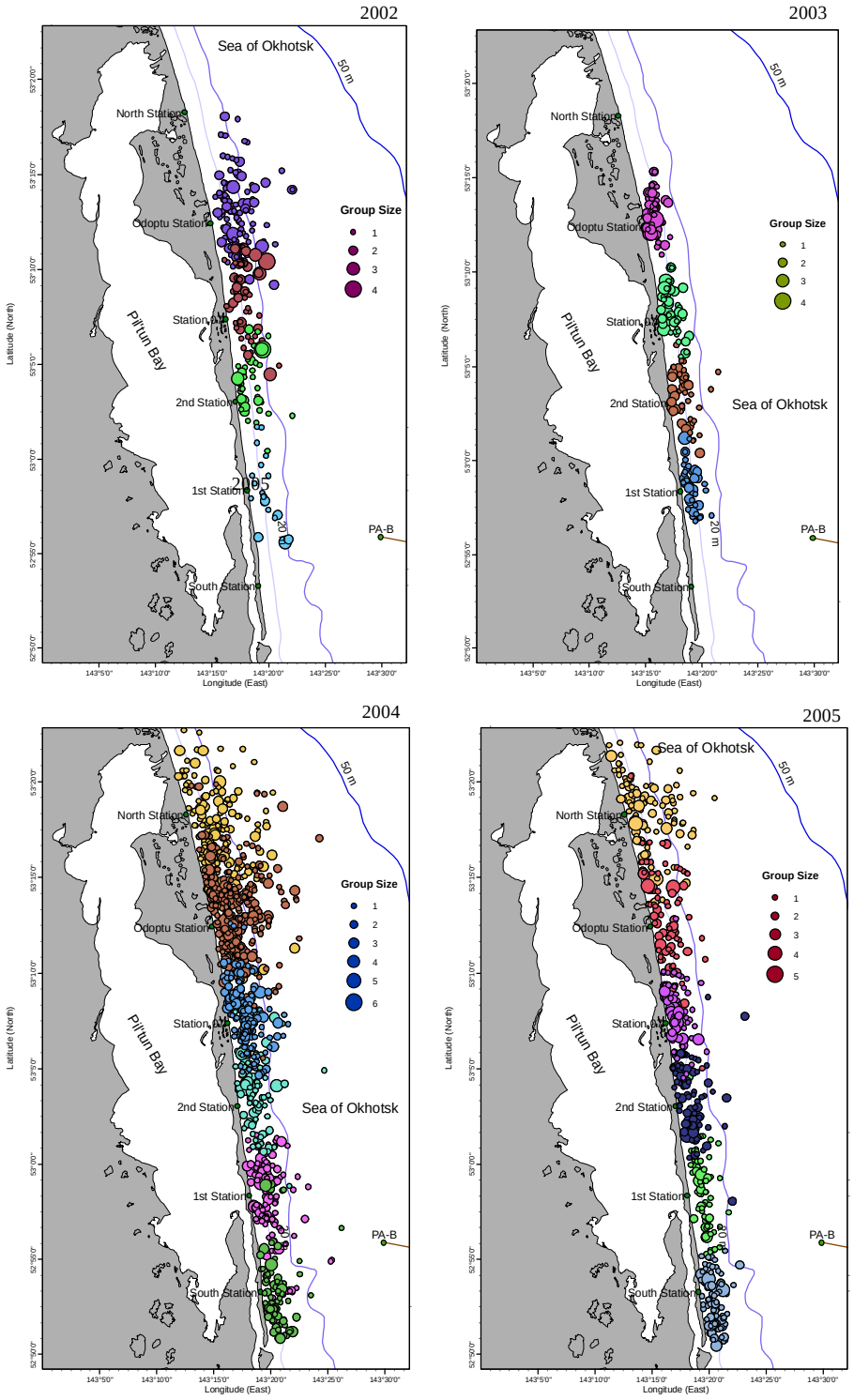
Distribution of gray whale sightings from the six stations are shown in Figures 1-5. These figures represent the kernel density of the sightings as well as the effort corrected density plots for both the whales observed for the entire field season and those whales observed during different months within the feeding season. Both the kernel and density estimates illustrate the same overall distributional pattern. Whales could potentially be sighted up to about 10 km distance from shore

depending on the observation height (distance-to-horizon ranges from ~ 9-16 km). However, whales were usually less than 5 km from shore (Figure 7; Table 3). Northern regions (North and Odoptu Stations) represented some of the highest elevations (approximately twice the observation height compared to other stations) and therefore observers could see whales at further distances. Despite the increased observation range, these regions had the lowest number of whales compared to other stations. In contrast, the most southern station (South Station) in the study area, which had the lowest observation height, had the highest density of whales throughout the field season.

The mean number of gray whales sighted per scan was 4.2 ± 4.20 SD (Median = 3, Range: 0-20, N = 256) whales. The mean number of pods detected during a scan was 2.9 ± 2.99 (2, 0-15, 256) pods. There was a range of 1-5 gray whales per pod for all sightings. The majority of sightings were of single whales with an overall mean of 1.4 ± 0.65 whales per pod (Figure 6).

Table 2. Summary of scans conducted in 2009 at six shore-based stations off northeastern Sakhalin Island.

Station	Days	# Scans	Mean Scans/Day	# Sightings	# Individuals
North Station	6	26	4.3	19	30
Odoptu Station	7	25	3.6	43	64
Station 07	14	82	5.9	201	283
2nd Station	11	53	4.8	139	211
1st Station	8	35	4.4	138	201
South Station	8	35	4.4	250	347
All Stations	54	256	4.7	790	1136



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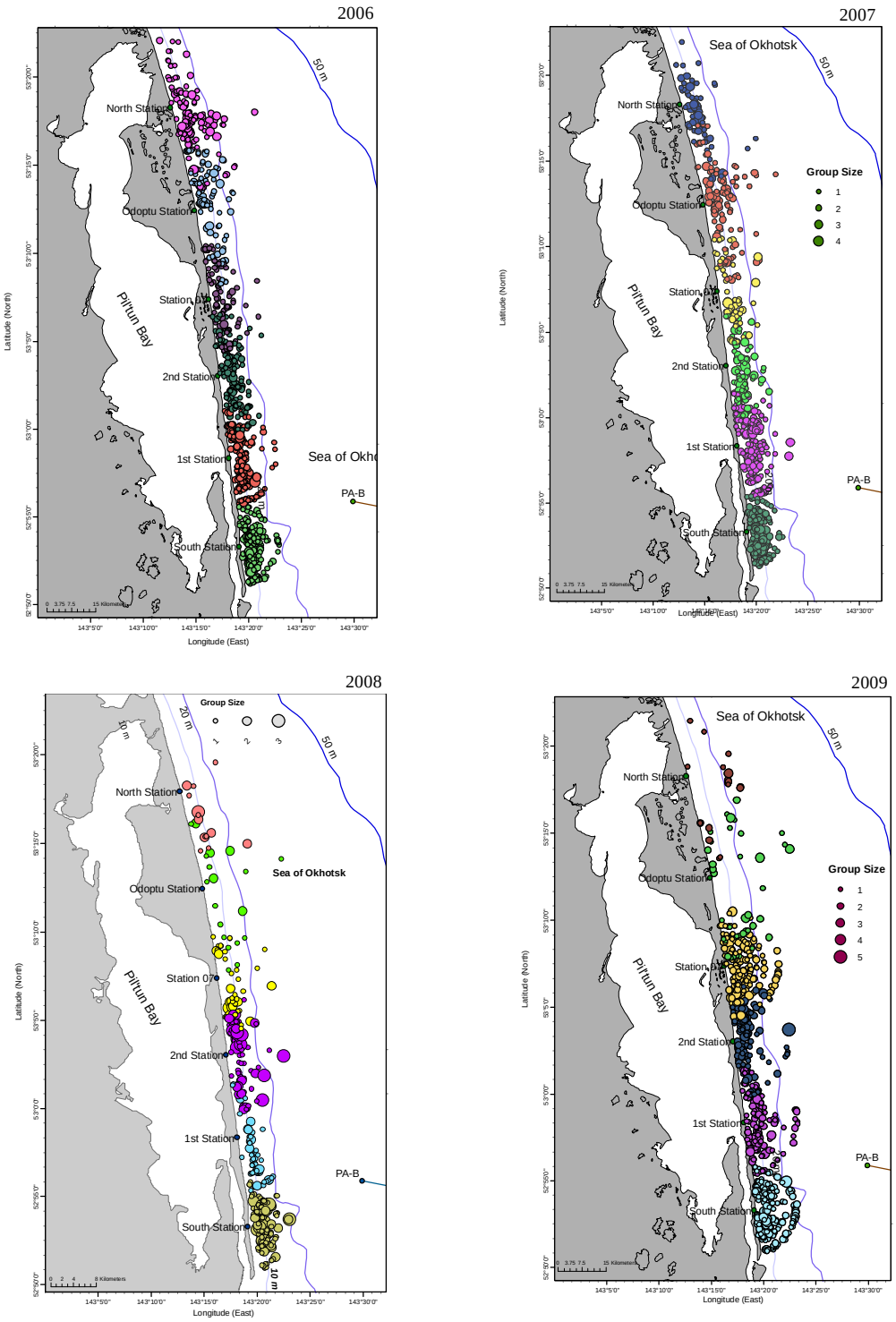


Figure 1. Geographic positions of sightings of western gray whales at six shore-based stations off Sakhalin Island for the summers of 2002 - 2009.

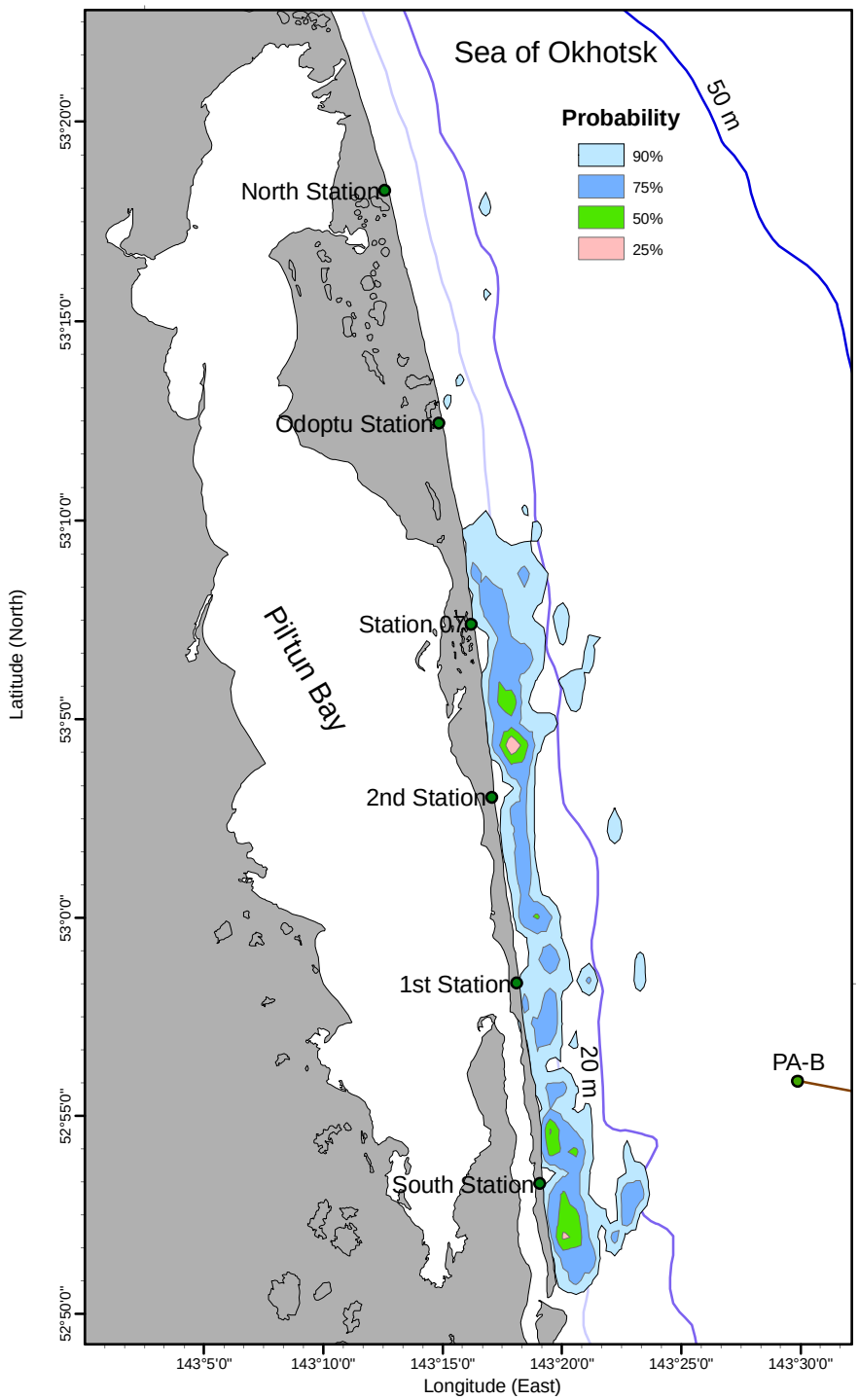
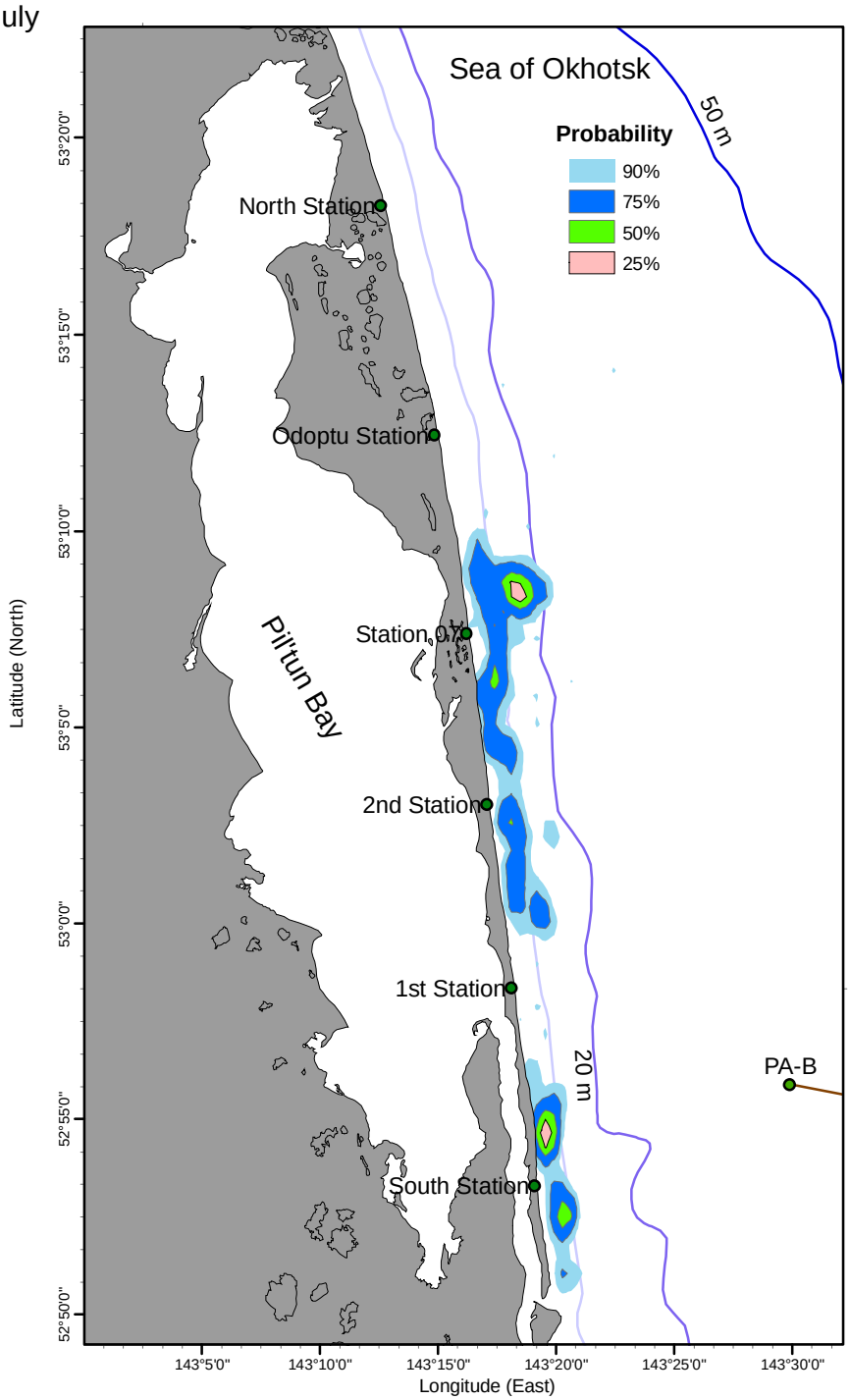


Figure 2. Distribution of western gray whales from six shore-based positions during the summer of 2009. Blue – red represents the kernel density probability contours.

A. July



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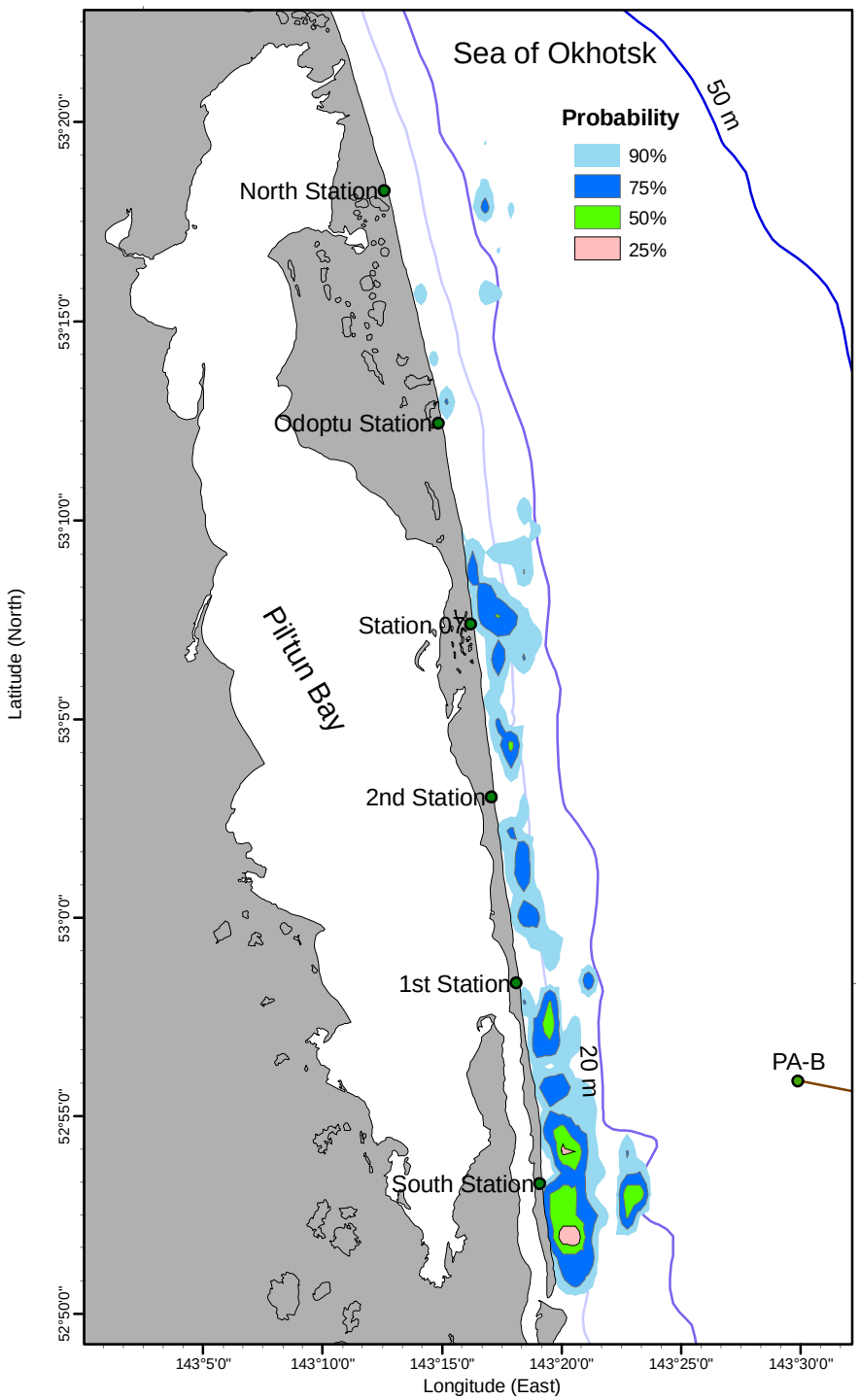
B. August



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C. September

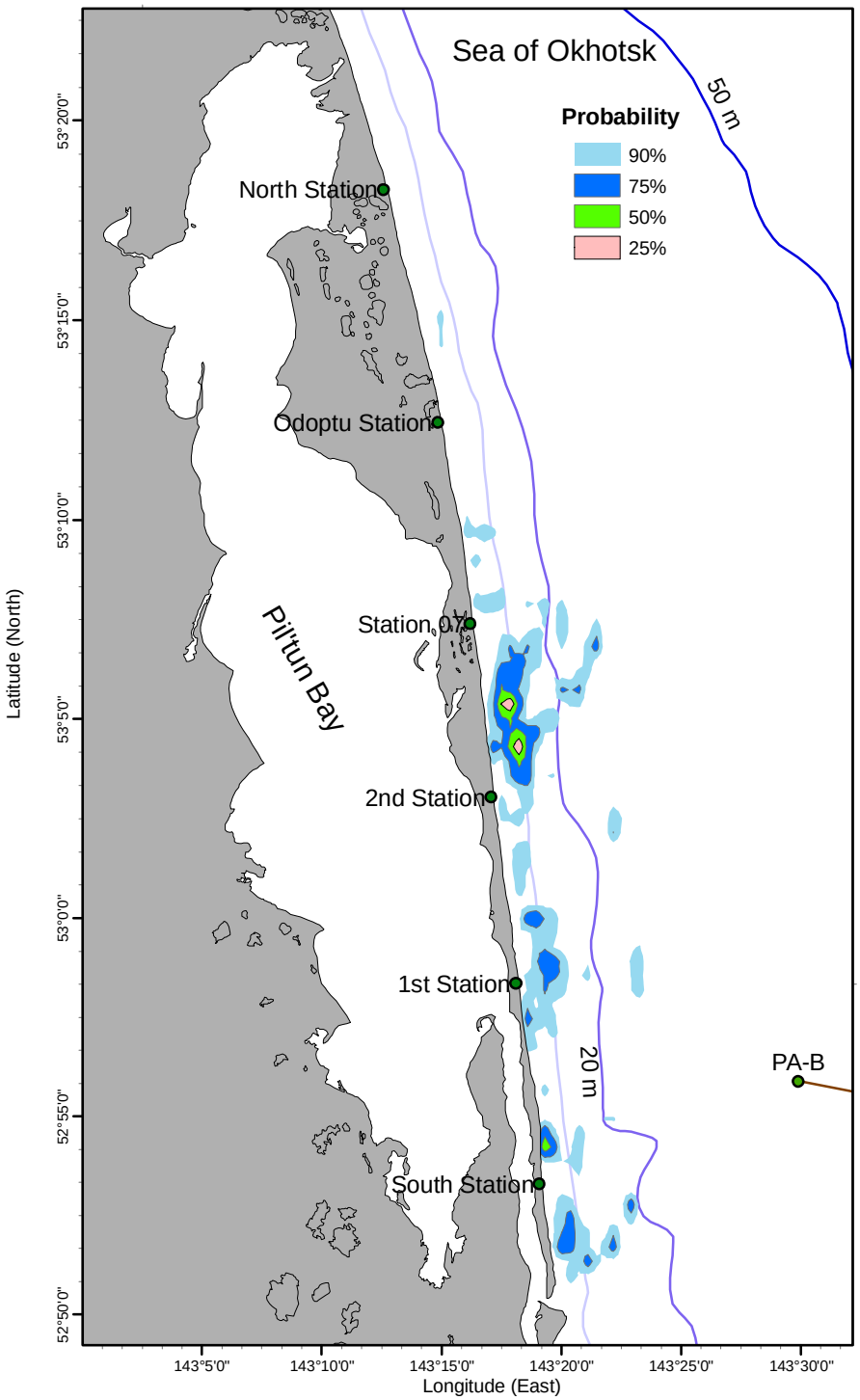


Figure 3. Seasonal distribution of western gray whales from six shore-based positions from (A) July, (B) August, and (C) September of 2009. Blue – red represents the kernel density probability contours.

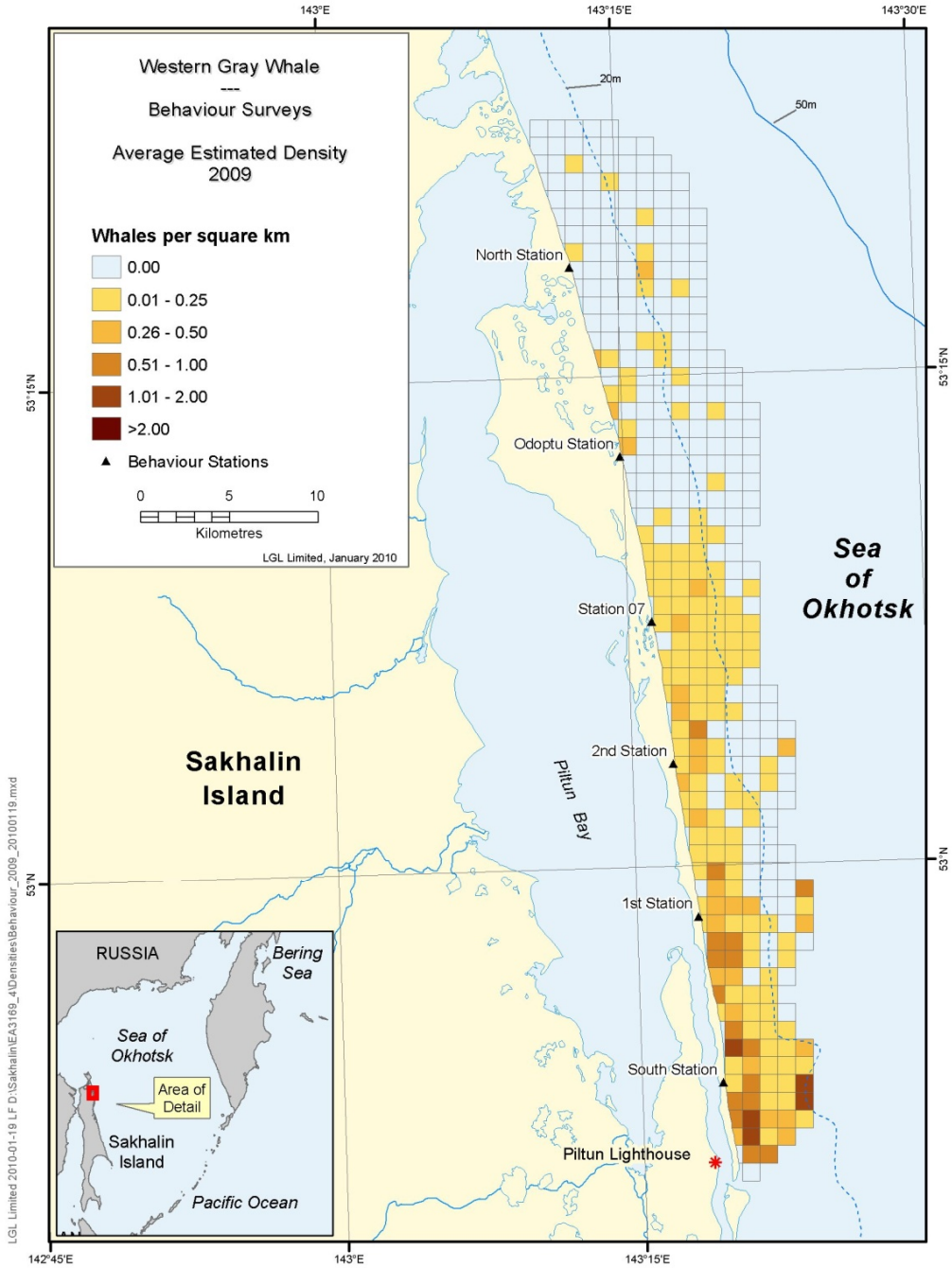
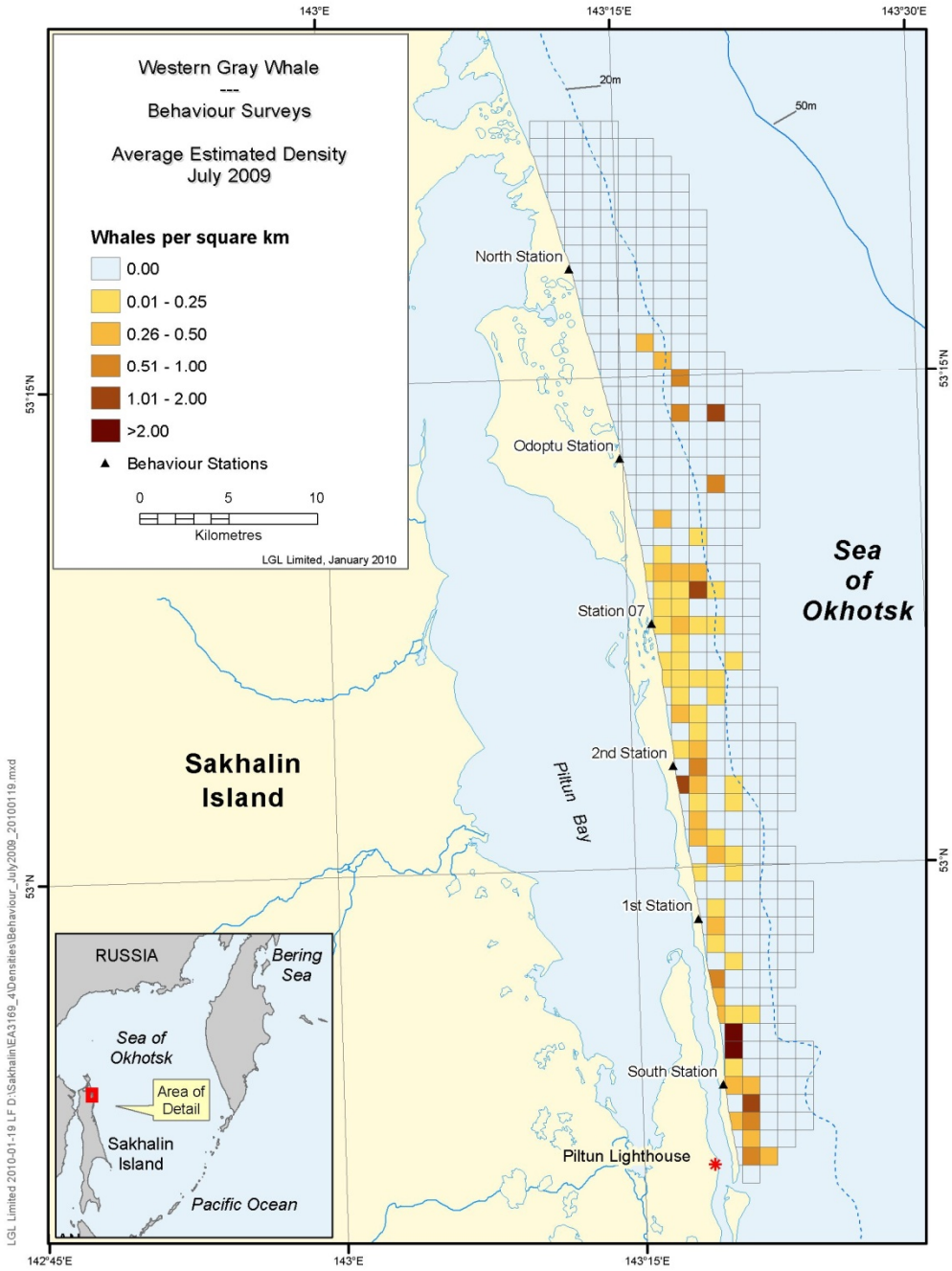


Figure 4. Density distribution of western gray whales from six shore-based stations during the summer of 2009.

A. July



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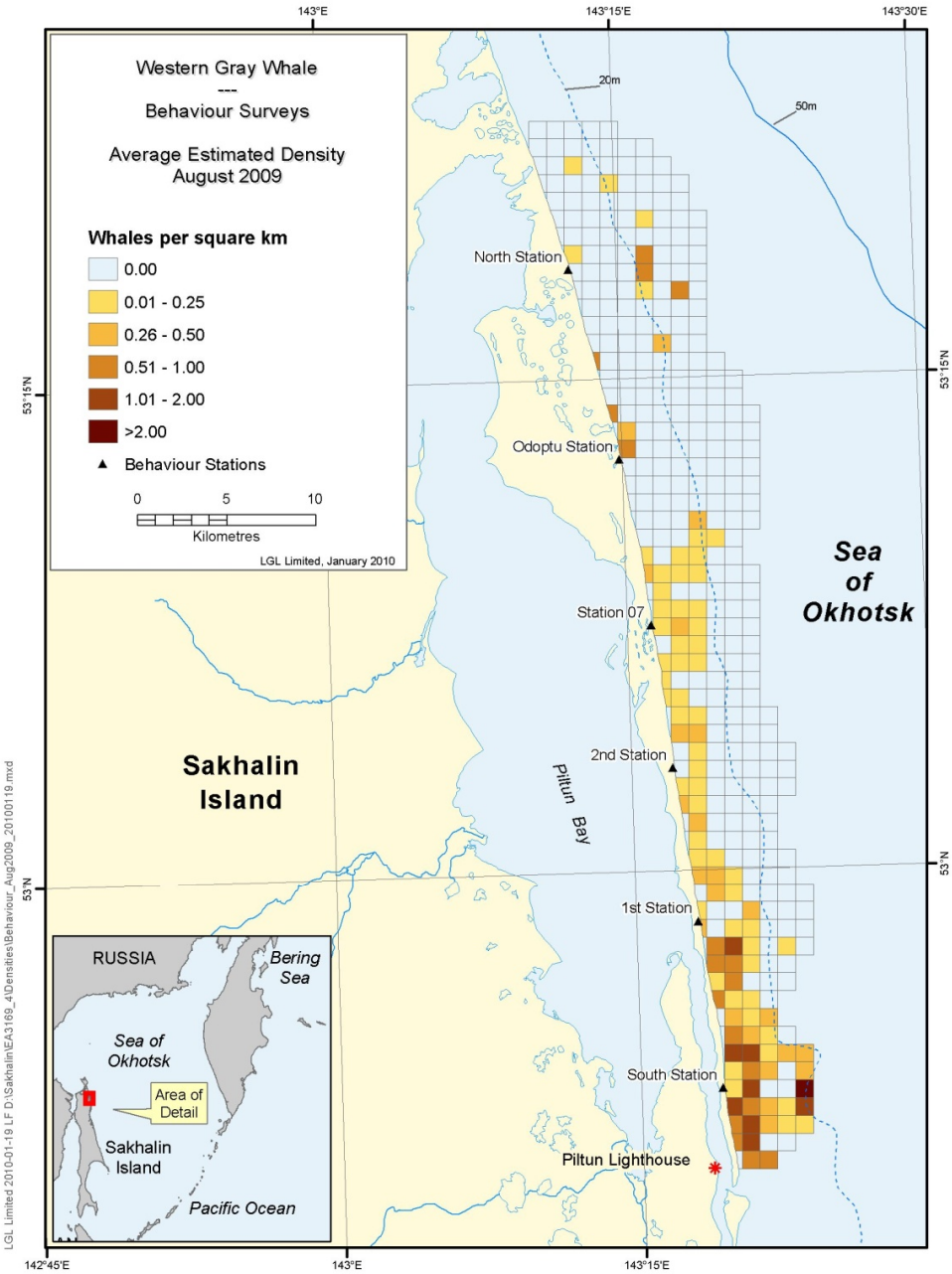
B. August



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C. September

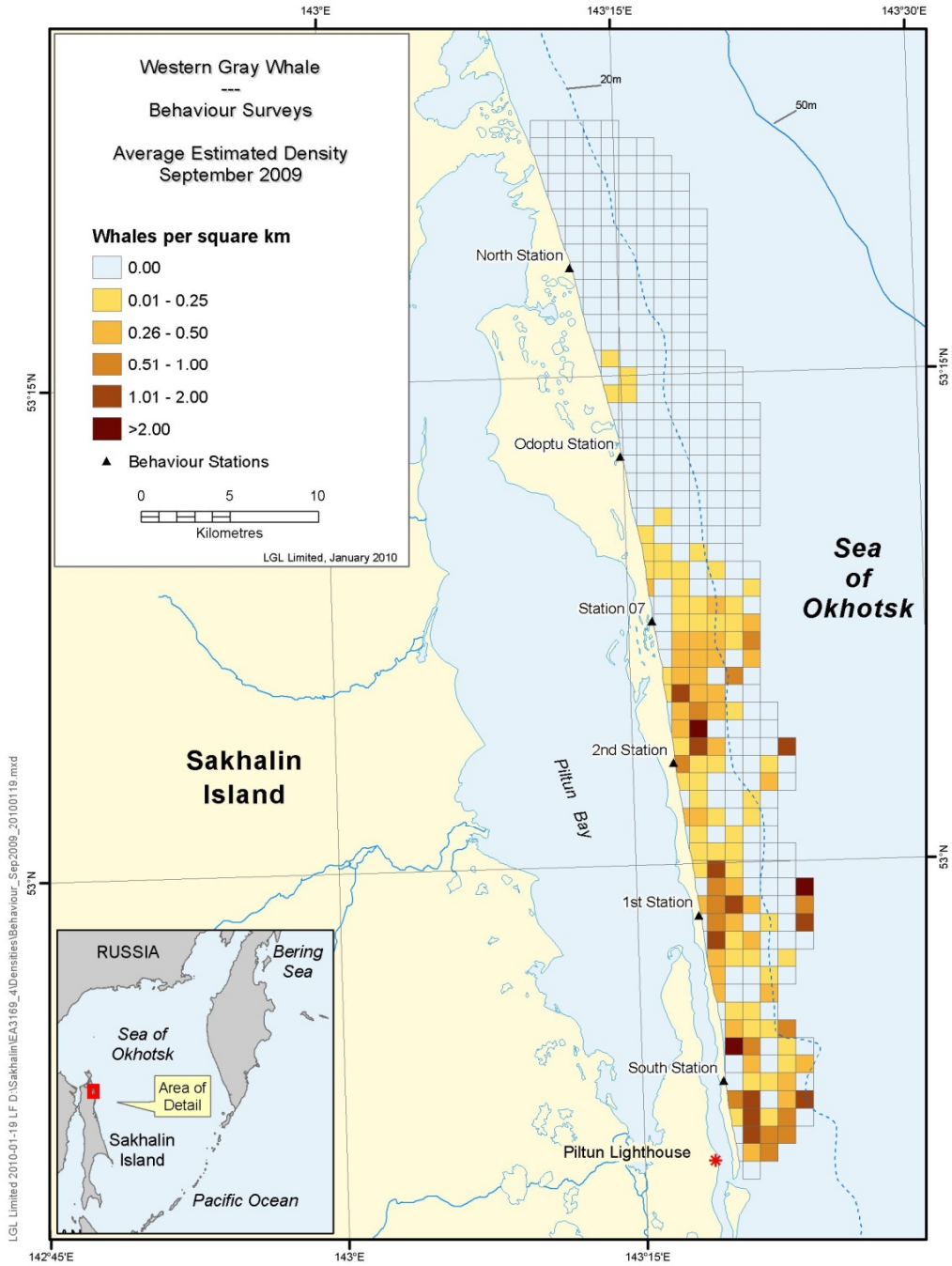
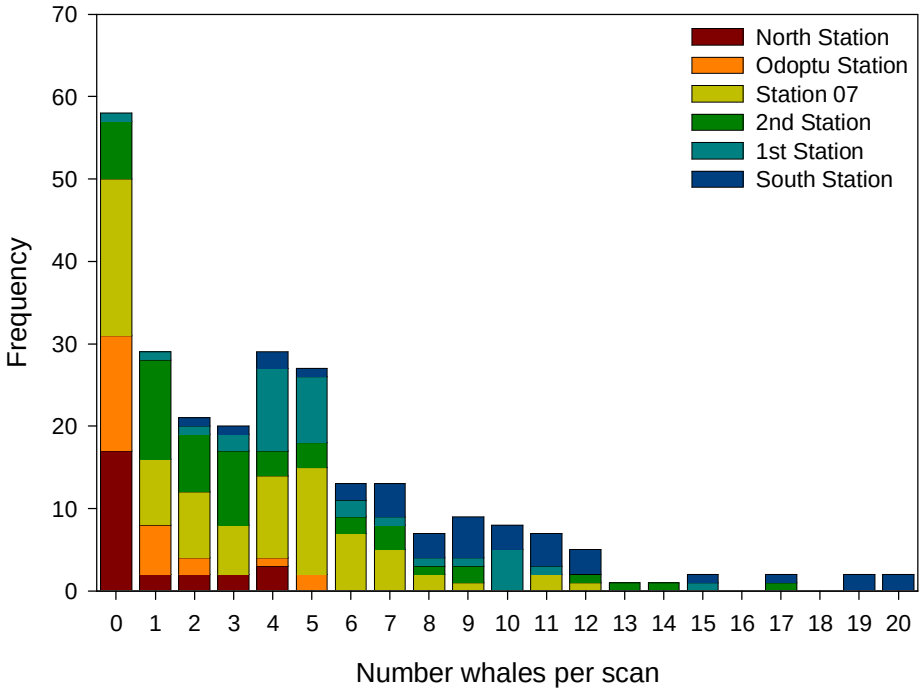


Figure 5. Seasonal density distribution of western gray whales from six shore-based stations from (A) July, (B) August, and (C) September of 2009.

A.



B.

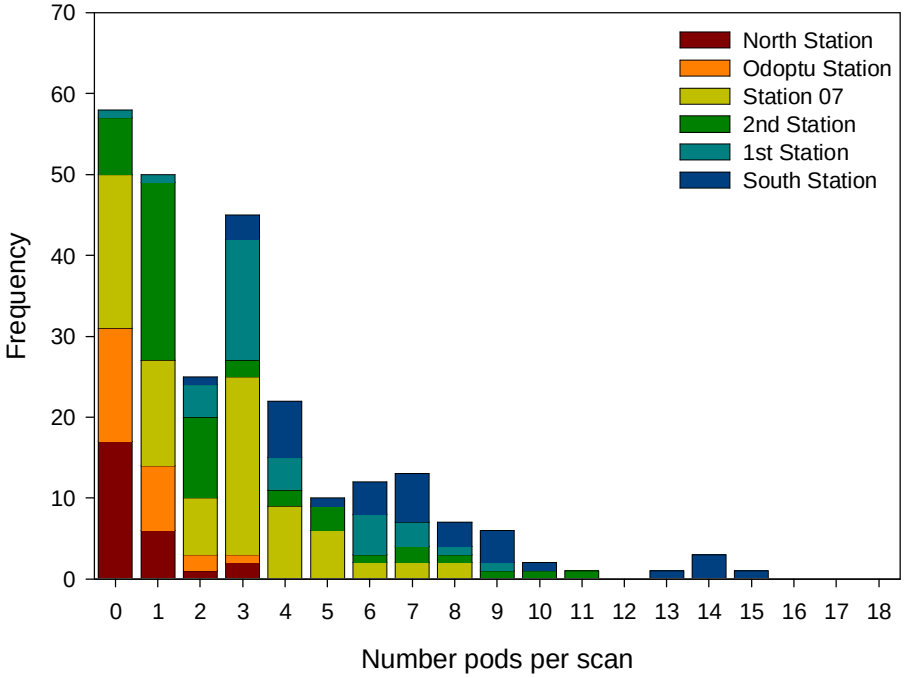


Figure 6…continued on next page…

C.

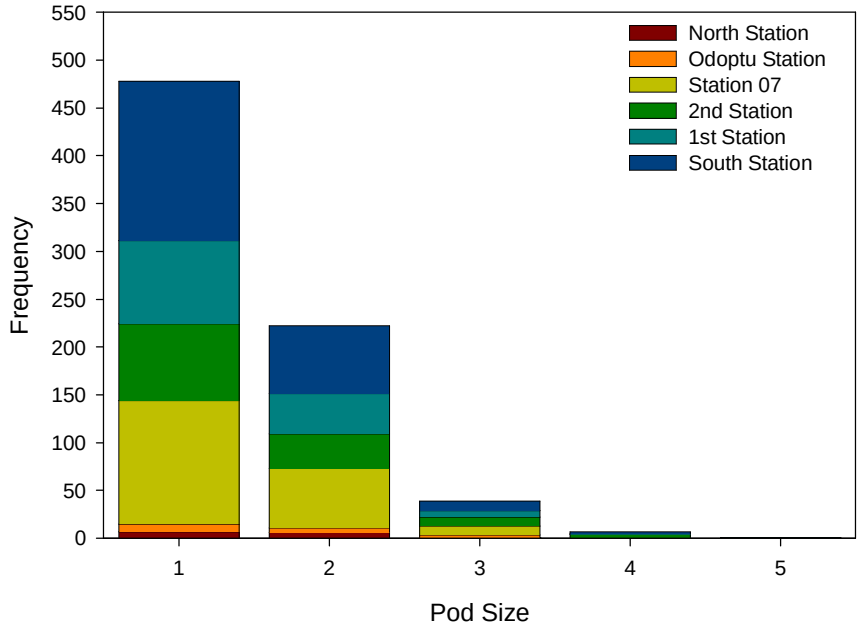


Figure 6. Frequency histograms of numbers of whales (A) and pods (B) detected per scan throughout the study period, and pod size (C).

Distance from shore – Western gray whales observed in the study area were on average 1.7 ± 1.38 km from shore (Table 3; Figure 7). Gray whales observed at the two most northern locations (North and Odoptu Stations) tended to be further from shore (2.9 and 2.7 km respectively). In fact, the whales observed in the north were significantly further from shore than those whales in the southern part of the study area (1st and South Station, F = 4.93, df = 5, P = 0.0002). The whales in the central region of the study area (2nd and Station 07) were at intermediate distances from shore compared to the northern and southern regions and, therefore, were non-significantly different when comparing these locations to other stations.

There were temporal differences in western gray whale's distance from shore. Whales were further from shore in the latter part of the season (September) compared to earlier observations (July; F = 4.69, df = 2, P=0.0094). At Station 07, whales were significantly closer to shore during August compared to September while whales at Odoptu station were further from shore in July than in September (Figure 8). For other stations, distance from shore was not found to significantly vary for the different months of observation.

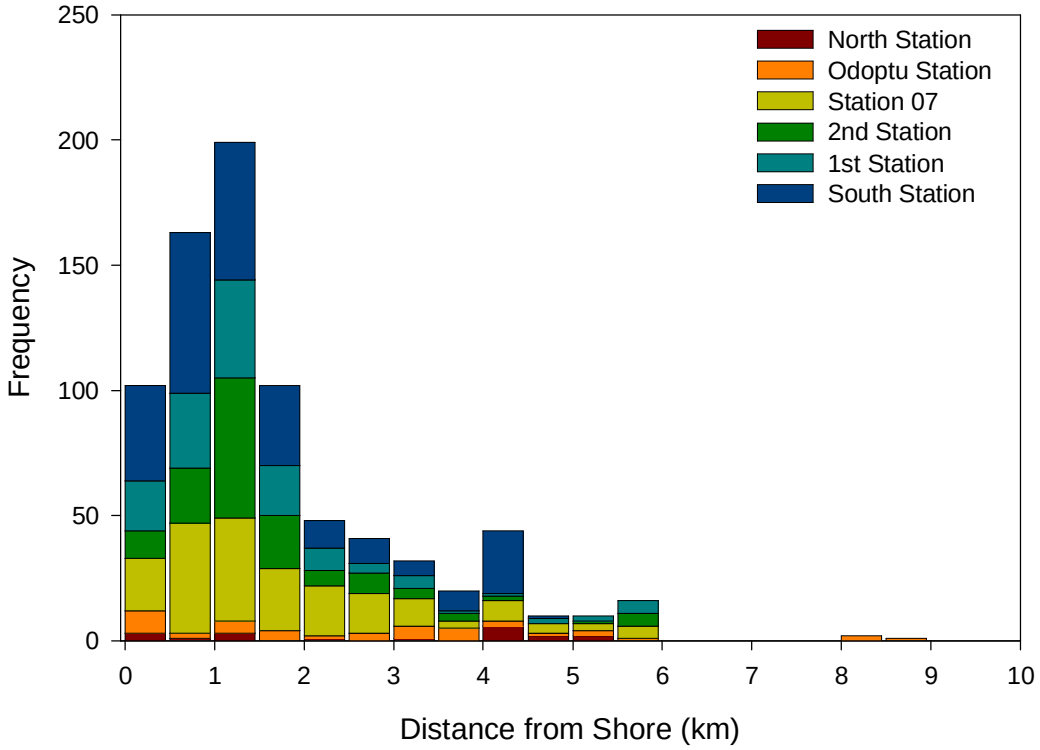


Figure 7. Frequency distribution of distance of western gray whale sightings from shore off Sakhalin Island, summer 2009.

Table 3. Distance of western gray whales from shore at six shore-based stations. Sample size represents number of sightings of gray whales in 2009.

Stations	Mean(km)	Median (km)	SD (km)	N	Min (km)	Max (km)
North Station	2.9	4	1.87	19	0.27	5.32
Odoptu Station	2.7	2.8	2.23	43	0.29	8.82
Station 07	1.8	1.4	1.34	201	0.04	5.74
2nd Station	1.6	1.3	1.18	139	0.21	5.98
1st Station	1.6	1.3	1.28	138	0.11	5.67
South Station	1.6	1.2	1.23	250	0.02	4.54
All Stations	1.7	1.3	1.38	790	0.02	8.82

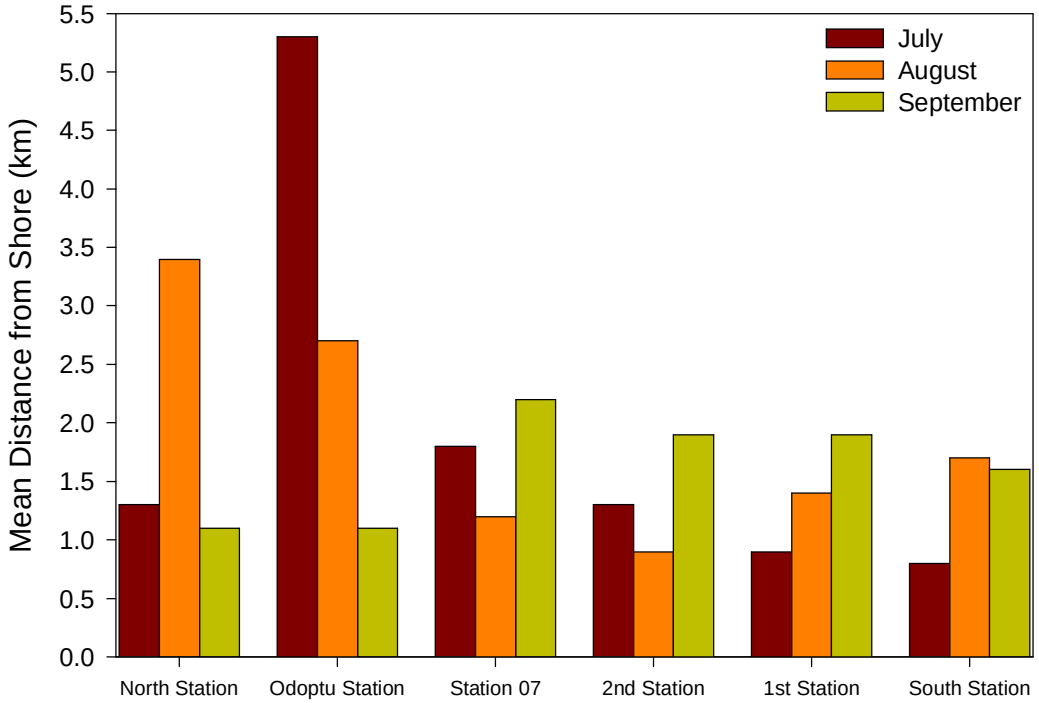


Figure 8. Western gray whale distance from shore at six geographic locations during July - September of 2009.

Morning vs. Afternoon - To evaluate daily variation in whale abundance, the number of whales sighted during a scan were categorized into morning and afternoon periods for each station. We found no significant daily patterns in the number of whales (F = 0.8763, df = 1, P = 0.3502) during the morning compared to the afternoon portions of each day (Figure 9). In the morning, the mean number of whales was 3.8 ± 4.07 SD (Median = 3, Range: 0-20, N = 125); and in the afternoon, mean number of whales was 3.8 ± 3.56 (3, 0-19, 131).

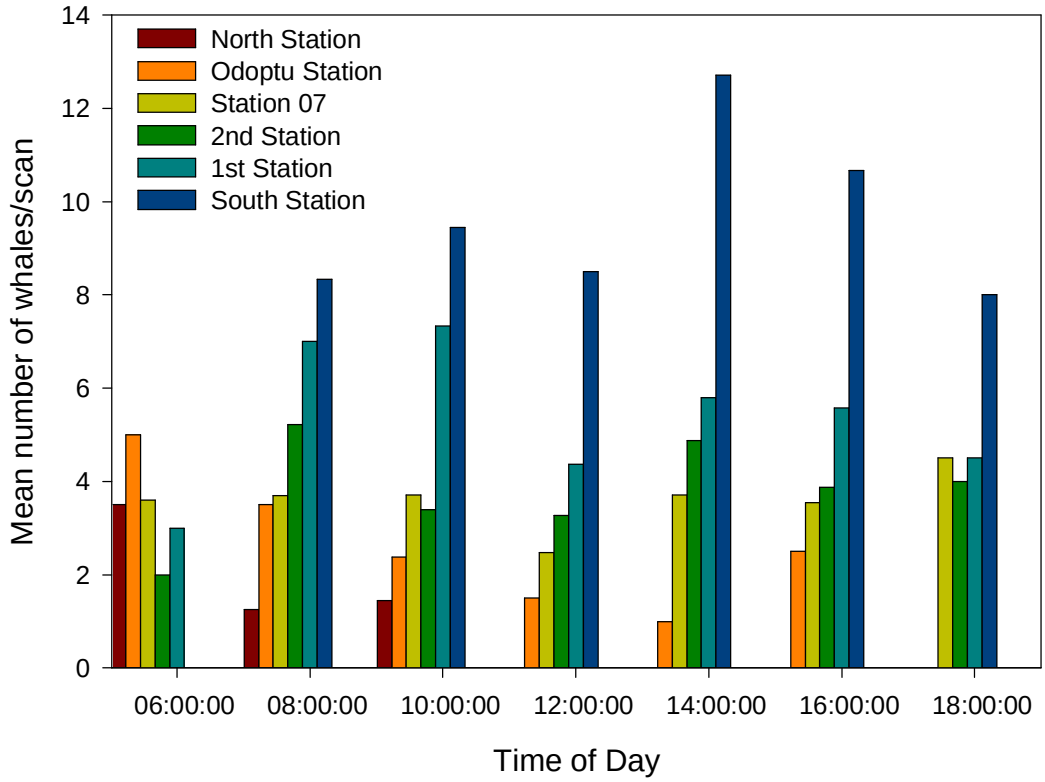


Figure 9. Mean number of whales per time of day at six shore-based stations 2009.

Stations – As seen in the distributional maps (Figures 1-5), western gray whales were not uniformly distributed in the nearshore feeding habitat. The mean numbers of whales for each station were significantly different (whales $F = 53.21$, $df = 5$, $P < 0.001$) with fewer whales at the two northern stations compared to all other stations (Table 4). These northern stations (Odoptu and North Station) had similarly low number of whales but were significantly different from all other stations. The middle stations (Station 07 and 2nd Stations) had similar whale abundance compared to one another, but significantly higher abundance compared to the northern stations and lower abundance values compared to the southern locations. Both southern stations (1st and South Stations) had significantly higher number of whales in the area than all other stations, with South Station having significantly higher abundance estimates compared to 1st Station.

Table 4. Number of whales (A) and pods (B) detected at six shore-based stations. Sample size is represented by the number of scans per station.

A

Station	Mean	Median	SD	Range	N
North Station	0.8	0	1.35	0-4	26
Odoptu Station	1.0	0	1.54	0-5	25
Station 07	3.5	4	2.93	0-12	82
2nd Station	3.7	3	3.85	0-17	53
1st Station	5.7	5	3.17	0-15	35
South Station	9.9	9	4.69	2-20	35
Total	4.2	3	4.2	0-20	256

B.

Station	Mean	Median	SD	Range	N
North Station	0.5	0	0.9	0-3	26
Odoptu Station	0.6	0	0.82	0-3	25
Station 07	2.5	3	2.04	0-8	82
2nd Station	2.4	1	2.68	0-11	53
1st Station	3.9	3	2.06	0-9	35
South Station	7.1	7	3.51	2-15	35
Total	2.9	2	3	0-15	256

The study area had significant variation in whale abundance for the different months (July – September) of observation ($F = 12.24$, $df = 2$, $P < 0.001$). Post-hoc analyses indicated that the number of whales seen in July and August were not significantly different, while the number of whales seen in the nearshore feeding grounds significantly increased in September. For a given station, the utilization of the area varied for the different periods of the whales' feeding season. At Station 07, there was a significant decrease in the number of whales observed during the month of August. At 2nd Station, there was an increase in the number of whales observed in September compared to July and August. The most northern station (North Station) significantly decreased in whale abundance in September compared to August. However, no significant differences in whale abundance were found for Odoptu, 1st Station, and South Stations for the different months of this study (Table 5; Figure 10).

Table 5. Relative abundance of western gray whales for July through September 2009.

Station	July	August	September
North Station	1.0 ± 0.00 (1)	2.0 ± 1.48 (12)	0.4 ± 0.96 (13)
Odoptu Station	4.0 ± 1.73 (3)	3.4 ± 3.11 (11)	1.4 ± 1.12 (11)
Station 07	4.1 ± 1.89 (20)	1.7 ± 1.96 (41)	6.3 ± 2.82 (21)
2nd Station	2.5 ± 2.22 (16)	1.9 ± 1.39 (23)	9.1 ± 3.86 (14)
1st Station	3.7 ± 1.38 (7)	5.7 ± 3.31 (15)	6.8 ± 3.31 (13)
South Station	6.4 ± 3.41 (7)	11.9 ± 5.31 (17)	9.0 ± 2.49 (11)
Total	3.8 ± 2.43 (54)	3.9 ± 4.53 (119)	5.7 ± 4.21 (83)

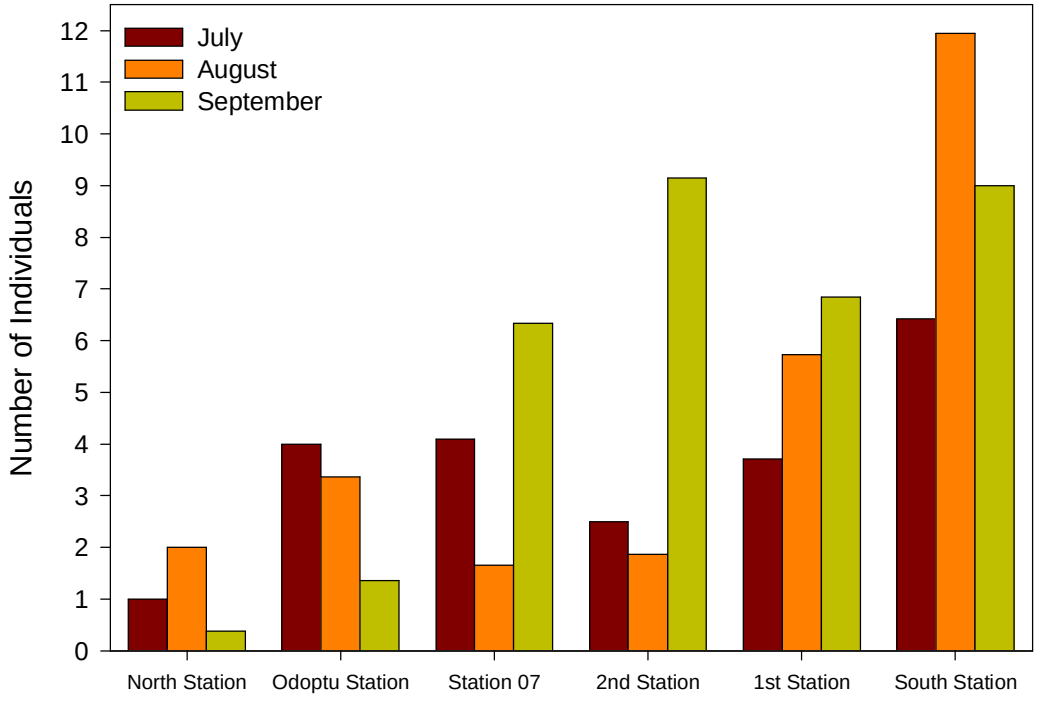


Figure 10. Mean number of western gray whales per scan for three months of observations at six shore-based locations in 2009.

4.3 Theodolite Tracklines

Effort - Western gray whales in the study area were tracked using theodolite surveying techniques. The movements of gray whales were monitored for a total of 201 hours with an average track duration lasting for 1.13 hrs (range from 6 min to 5.2 hrs) (Table 6). A total of 177 tracklines with over 10,300 geographic positions were recorded (Figure 11). The majority of the individuals tracked were collected in August (39%) and September (38%) compared to July (23%) (Table 7). This result was mainly due to less effort (due to weather conditions) in July compared to August and September.

Table 6. Summary of trackline information gathered in 2009 at six shore-based stations.

Station	# Tracks	Mean Duration (hr)	Range (hr)
North Station	5	0.86	0.3 - 1.4
Odoptu Station	11	1.41	0.1 - 3.8
Station 07	38	1.13	0.1 - 5.2
2nd Station	41	1.39	0.2 - 4.5
1st Station	38	1.00	0.1 - 4.0
South Station	44	0.97	0.1 - 2.7
All Stations	177	1.13	0.1 - 5.2

Table 7. Summary of trackline information gathered during July – September, 2009.

Month	# Tracks	Mean Duration (hr)	Range (hr)
July	40	1.31	0.1 - 5.2
August	69	1.11	0.1 - 3.8
September	68	1.05	0.1 - 4.5
Total	177	1.13	0.1 - 5.2

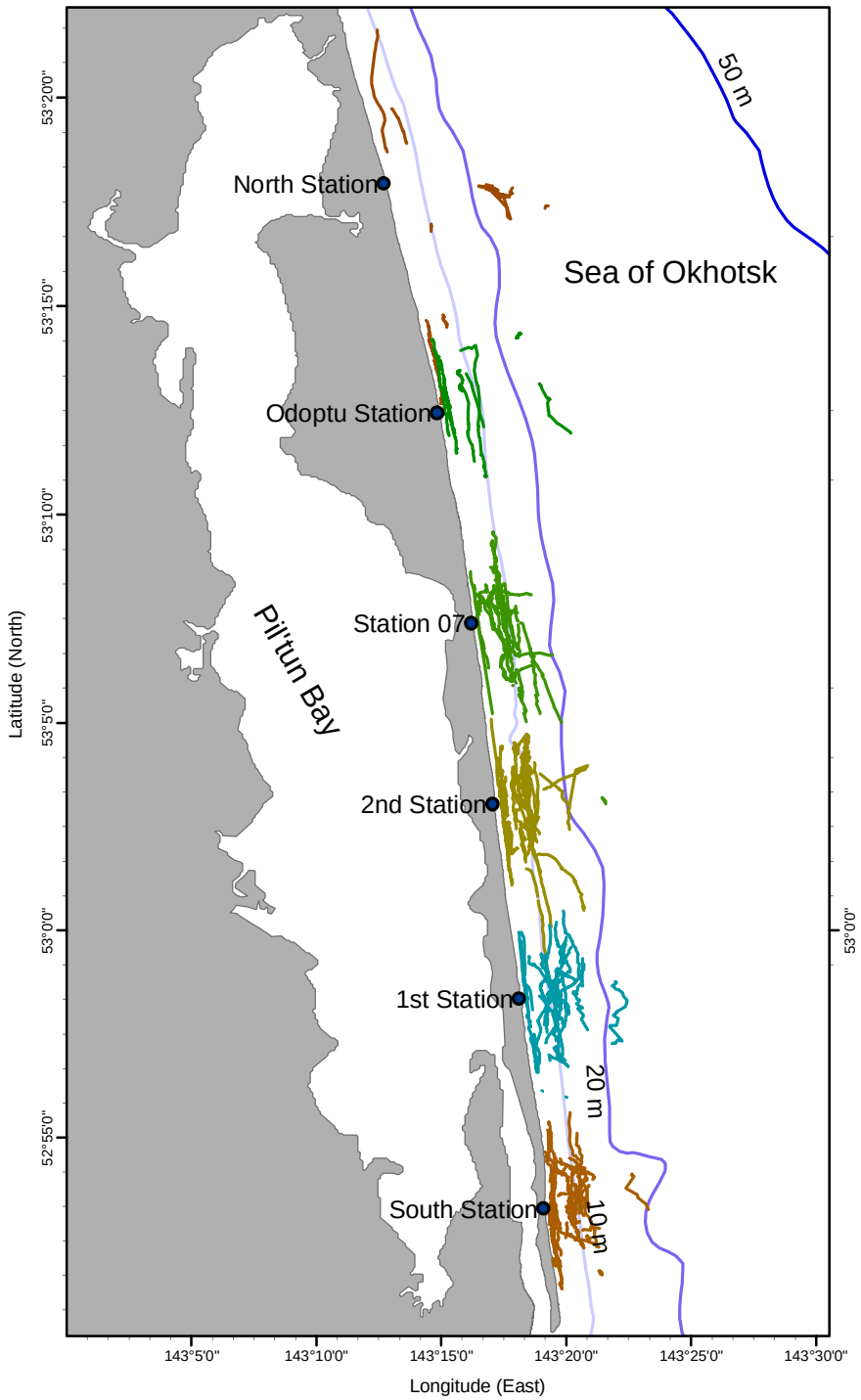


Figure 11. Tracklines of western gray whales at six shore-based positions on Sakhalin Island during summer 2009 (N = 177).

The analytical data set, consisting of only recognizable or single individuals, yielded 120 tracklines that were suitable for movement analyses (Table 8). In 2009, gray whales were observed to be moving 2.7 ± 2.03 SD km/h (Figure 12), accelerating 0.00 ± 0.205 km/h^2 (Figure 13), reorienting 16.8 ± 14.98 °/min (Figure 14), and ranging 41.4 ± 34.27 m/min (Figure 17). Directional indices (mean vector length and linearity index) were 0.81 ± 0.238 (Figure 15) and 0.84 ± 0.221 (Figure 16), respectively. Taken together, these movement parameters suggest a more straight-line path movement (traveling) as opposed to a non-directional feeding type behavior. As all behaviors were pooled together for these general assessments, the more straight-line result is likely a factor of having more representative traveling type tracklines in the dataset (see sample size in the Behavior section below).

Table 8. Summary data for movement parameters of western gray whales during summer 2009.

N = 120	Mean	Median	Min	Max	SD
Leg Speed (km/h)	2.7	2.0	0.1	9.2	2.03
Reorientation Rate (°/min.)	16.8	11.9	1.2	57.8	14.98
Acceleration (km/h^2)	0.00	0.01	-0.94	0.65	0.205
Mean Vector Length	0.81	0.92	0.08	1.00	0.238
Linearity Index	0.84	0.94	0.15	1.00	0.221
Ranging Index (m/min.)	41.4	29.9	1.4	152.9	34.27
Distance from shore (km)	0.989	1.107	0.036	3.269	0.650

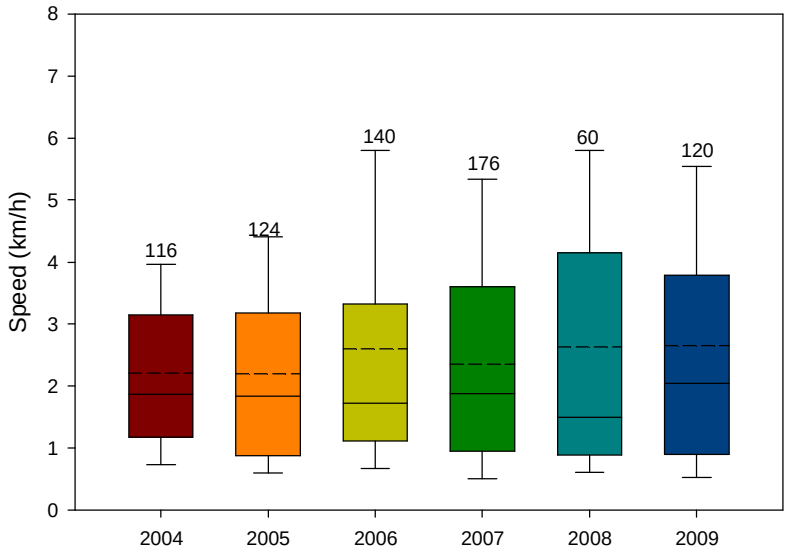


Figure 12. **Leg Speed for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. For each box-plot the whiskers represent the 10th and 90th percentile, the box represents the 25th and 75th percentile, the solid bar represents the 50th percentile, and dashed bars represent mean values.**

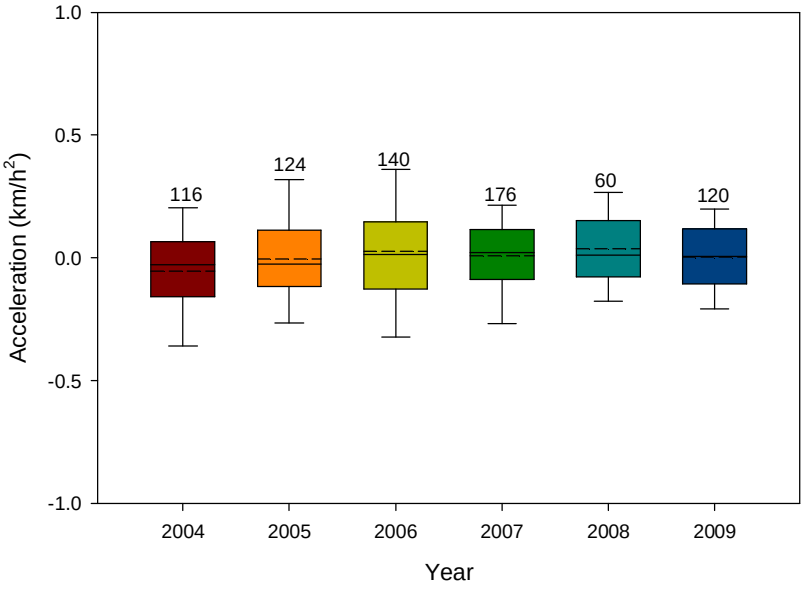


Figure 13. **Acceleration for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Negative values represent deceleration. Display as in Figure 12.**

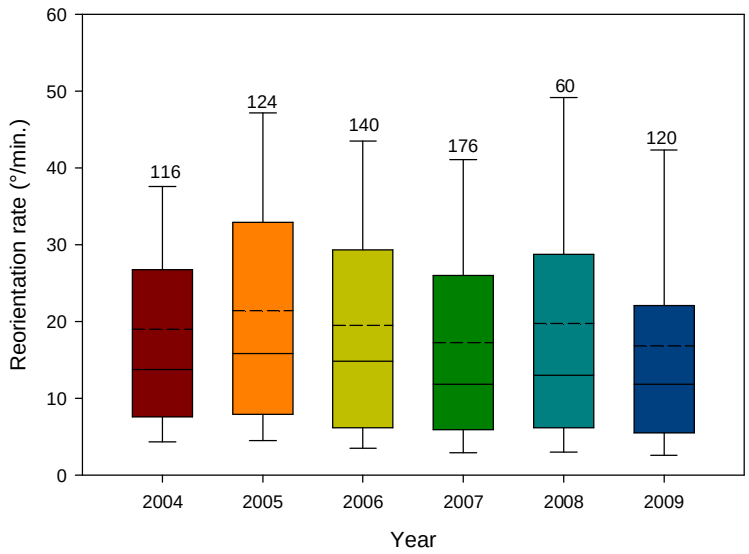


Figure 14. Reorientation rate for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 12.

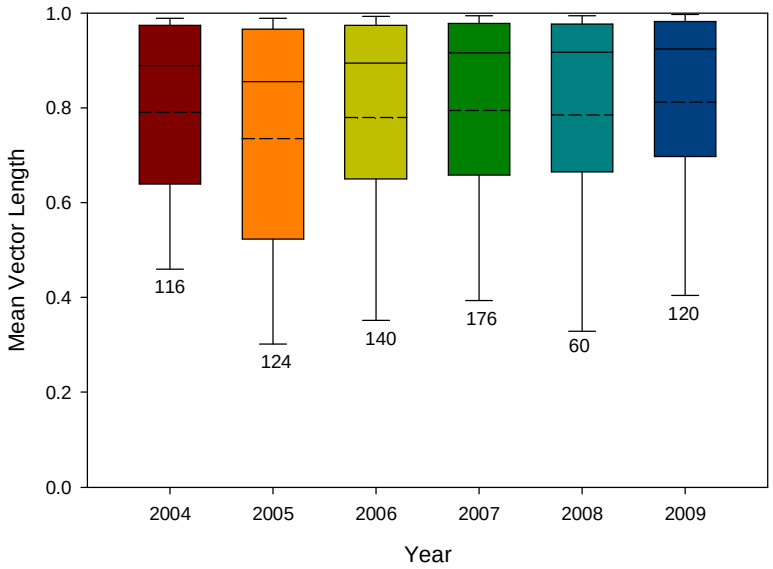


Figure 15. Mean vector length for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 12.

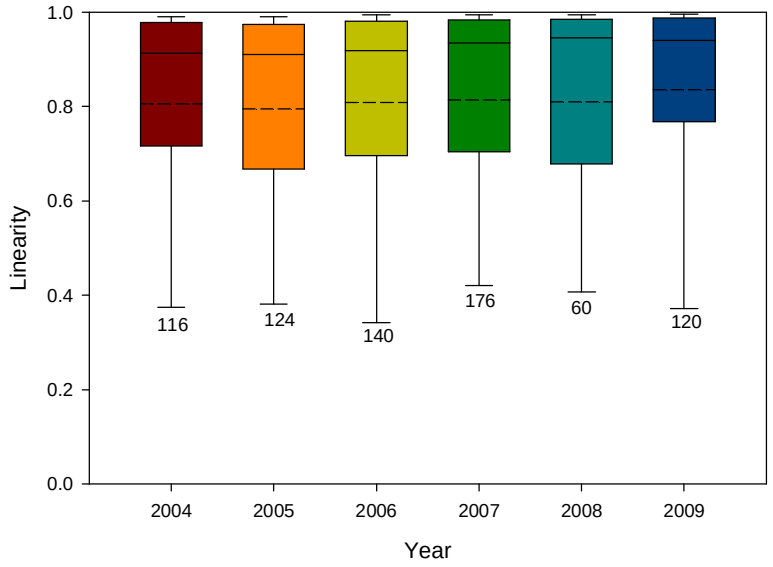


Figure 16. Linearity index for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 12.

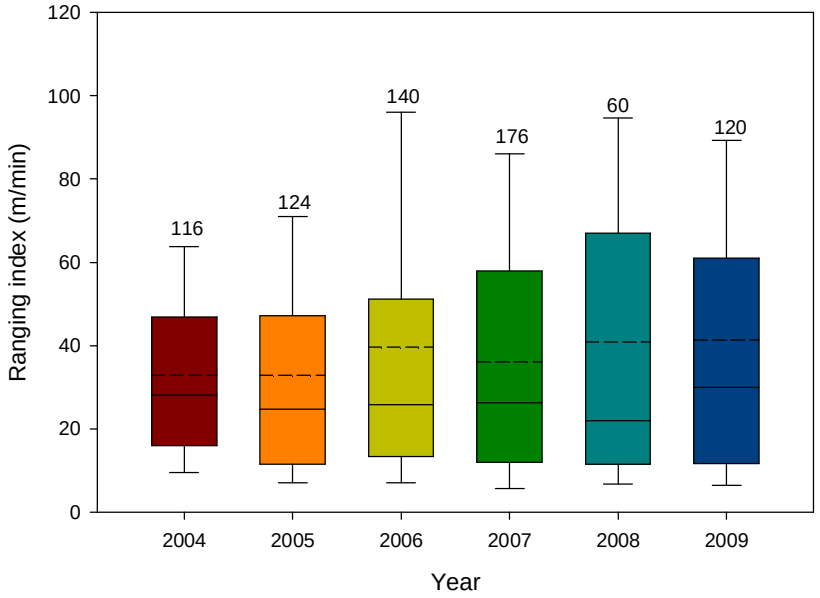


Figure 17. Ranging index for all single or recognizable individual gray whales observed at six (2004-2005 and 2007-2009) to nine (2006) shore-based stations. Display as in Figure 12.

4.4 Focal Behavior Observations

Focal follow observations were conducted to monitor behavioral events and respiration patterns of individual gray whales. A total of 63 focal sessions were conducted with 64 hrs of observation time from 11 July to 14 September 2009 (Table 9). The mean duration of a focal session lasted approximately 1.02 hours (range 0.2 – 4.0 hrs), with over 6,100 behavioral events being recorded. Approximately 25% of the focal follows were collected in July while 41% and 34% of the focal follow observations were recorded in August and September, respectively (Table 10).

Table 9. Summary of focal behavior data gathered at six shore-based stations.

Station	*# Focals*	*Events*	*Mean Duration(hrs)*	*Range (hrs)*
North Station	1	32	0.61	0.6 - 0.6
Odoptu Station	3	264	0.89	0.5 - 1.7
Station 07	16	1315	0.96	0.2 - 4.0
2nd Station	17	2249	1.23	0.3 - 3.1
1st Station	15	1457	1.07	0.3 - 3.9
South Station	11	789	0.78	0.3 - 1.9
All Stations	63	6106	1.02	0.2 – 4.0

Table 10. Summary of focal behavior data gathered during July through September, 2009.

Month	# Focals	Mean Duration (hr)	Range (hr)
July	16	1.25	0.2 - 3.9
August	26	0.76	0.2 - 2.5
September	21	1.14	0.2 - 4.0
Total	63	1.01	0.2 - 4.0

While individuals were at the surface, the mean duration between subsequent respirations was 25 ± 12.4 SD seconds (Figure 18), with a mean of 4.6 ± 3.15 blows per surfacing (Figure 19). The individuals monitored remained at the surface for 1.52 ± 1.849 minutes (Figure 18) and dove for a mean of 2.18 ± 0.866 minutes (Figure 18). The dive surface blow rate and surface blow rate were 1.17 ± 0.278 and 4.40 ± 1.953 blows per minute, respectively (Table 11 and Figure 19). The general surface-respiration-dive patterns observed in 2009 were similar to those observed in previous years.

Table 11. Summary statistics for surface-respiration-dive parameters of individual western gray whales.

N = 63	Mean	Median	Min	Max	SD
Blow Interval (min.)	0.41	0.35	0.18	1.00	0.207
Blows/Surfacing	4.57	4.00	1.13	17.00	3.150
Surface Time (min.)	1.53	0.88	0.17	9.55	1.849
Dive Time (min.)	2.18	2.02	1.08	4.68	0.866
Surface Blow Rate	4.40	4.36	1.58	8.94	1.953
Dive-Surface Blow Rate	1.17	1.12	0.61	2.05	0.278
% Time at Surface	36.04	28.89	6.19	98.10	23.475

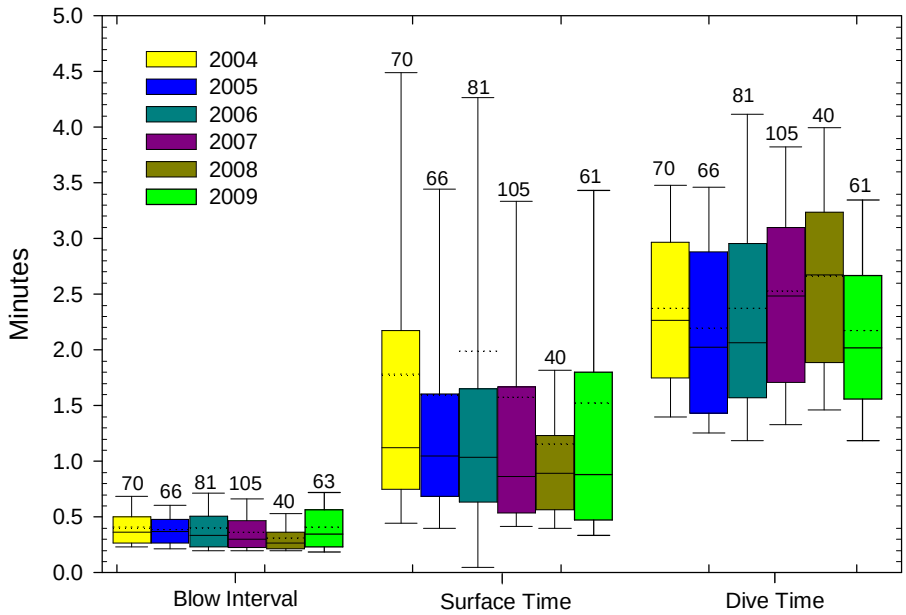


Figure 18. Blow interval, surface time, and dive time parameters of western gray whales. Display as in Figure 12.

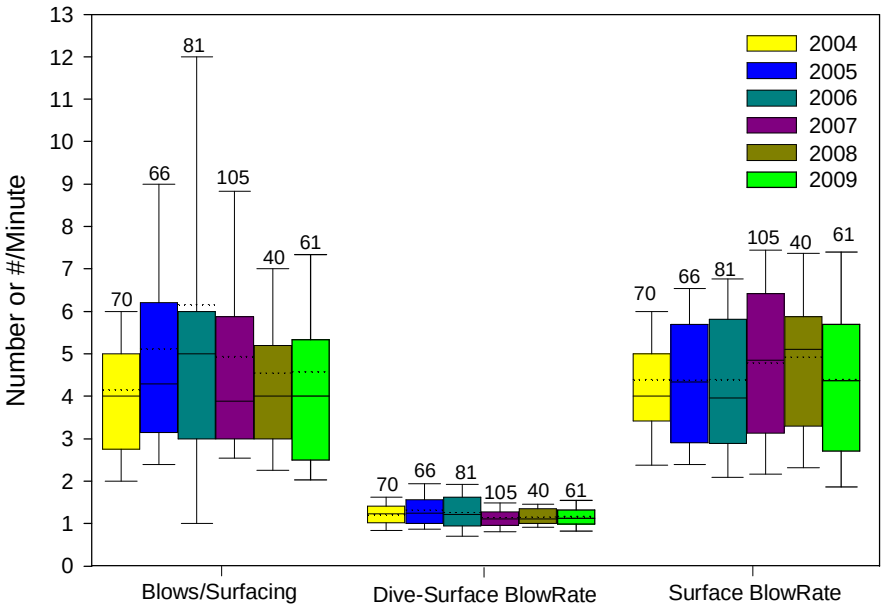


Figure 19. Number of blows per surfacing, dive-surface blow rate, and surface blow rate of western gray whales. Display as in Figure 12.

4.5 Behavioral States

Movement and respiration patterns are dependent on the activity of the animal. For each track or focal follow session, the general behavioral state of the whale was recorded. In 2009, there were three primary behavioral states observed: 1) Feeding – whale(s) generally remain in one localized area with non-directional movement and consistent periods of diving; 2) Feeding/Traveling – whale(s) swim in one general direction at relatively slow speeds with consistent periods of diving; and 3) Traveling – whale(s) swim in one general direction and often remain at the surface without consistent dives. Other behavioral states were observed, such as socializing, resting, and milling, however, there were too few occurrences to provide detailed analyses for these other states.

For the three primary behavioral states, western gray whales' reorientation rates (F = 141.02, df = 2, P <0.001), ranging index (61.13, 2, <0.001), speed (107.23, 2, <0.001), linearity (67.7, 2, <0.001) and mean vector length (68.82, 2, <0.001) were found to be significantly different when comparing movement parameters among the

behavioral states. When gray whales were traveling, they tend to have higher speeds, reorient directions less, with more directionality, and cover larger geographic ranges, compared to concentrated feeding and feeding/traveling activities.

Gray whales' respiration patterns were also found to be different among behavioral states. While gray whales were feeding or feeding/traveling, they had significantly longer dive durations (24.45, 2, < 0.001) compared to traveling behavior. Surface-blow rates, respiration interval, and surface time were also significantly different among the feeding states and that of traveling. However, there were no differences in any of the surface-respiration-dive patterns between the two different "modes" of feeding (i.e. concentrated feeding in a localized area compared to directional persistence in feeding/traveling activity). Acceleration, distance from shore, respiration interval, surface time, number of blows per surfacing, and dive-surface blow rate were all non-significant among the three behavioral states (Table 12; Figures 20-32).

The “displacement” (i.e. geographic movement from the initial observation) analysis indicated significant differences in movement for the three behavioral states. After 20 "steps" of movement (i.e. 30 minutes in duration), individuals displaced 0.05 km^2 (95% confidence interval: 0.03 – 0.08 km^2), 0.39 km^2 (0.22 – 0.56 km^2), and 3.09 km^2 (2.46 – 3.59 km^2) while they were feeding, feeding/traveling, and traveling, respectively (Figure 33). In 2009, the displacement values for whales feeding and feeding/traveling were within the same confidence intervals observed in 2002-2008. Displacement values while traveling were comparable to those observed in 2006-2008, but significantly higher compared to earlier observations (2002-2005).

Table 12. Movement and respiration variables of western gray whales during feeding, feeding/traveling, and traveling behavioral states. Post-hoc significance is denoted by F (Feeding), FT (Feeding/Traveling), and T (Traveling).

Variable	Feeding	Feeding/Traveling	Traveling	F (df = 2)	P	Post-hoc Significance
Speed (km/h)	0.8 ± 0.47 (35)	1.5 ± 0.86 (36)	3.9 ± 1.78 (83)	107.23	< 0.0001	F-T,FT-T,FT-F
Reorientation rate (°/min)	33.5 ± 13.82 (35)	21.5 ± 12.53 (36)	9.2 ± 7.01 (83)	141.02	< 0.0001	F-T,FT-T,FT-F
Linearity Index	0.6 ± 0.23 (35)	0.8 ± 0.16 (36)	1.0 ± 0.05 (83)	67.7	< 0.0001	F-T,FT-T,FT-F
Mean vector length	0.5 ± 0.23 (35)	0.8 ± 0.20 (36)	0.9 ± 0.09 (83)	68.82	< 0.0001	F-T,FT-T,FT-F
Ranging index (m/min)	10.1 ± 7.00 (35)	22.5 ± 14.54 (36)	62.6 ± 29.51 (83)	61.13	< 0.0001	F-T,FT-T,FT-F
Distance to shore	1.0 ± 0.54 (35)	1.0 ± 0.56 (36)	1.0 ± 0.72 (83)	0.13	0.874	
Acceleration $(km/h)^2$	0.0 ± 0.12 (35)	-0.1 ± 0.15 (36)	0.0 ± 0.30 (83)	0.9	0.409	
Respiration Interval (min)	0.23 ± 0.056 (15)	0.27 ± 0.060 (18)	0.54 ± 0.193 (43)	61.5	< 0.0001	F-T, FT-T
Blows/Surfacing	3.89 ± 1.063 (15)	4.38 ± 2.146 (18)	4.55 ± 2.912 (40)	0.14	0.872	
Surface Time (min)	0.65 ± 0.226 (15)	0.94 ± 0.757 (18)	1.86 ± 1.772 (40)	7.45	< 0.0001	F-T, FT-T
Dive Time (min)	2.74 ± 0.842 (15)	2.73 ± 0.863 (18)	1.75 ± 0.511 (40)	24.45	< 0.0001	F-T, FT-T
Surface Blow Rate	6.40 ± 1.403 (15)	5.28 ± 1.280 (18)	3.21 ± 1.225 (40)	38.75	< 0.0001	F-T, FT-T
Dive-surface Blow Rate	1.10 ± 0.225 (15)	1.16 ± 0.297 (18)	1.19 ± 0.302 (40)	0.34	0.711	

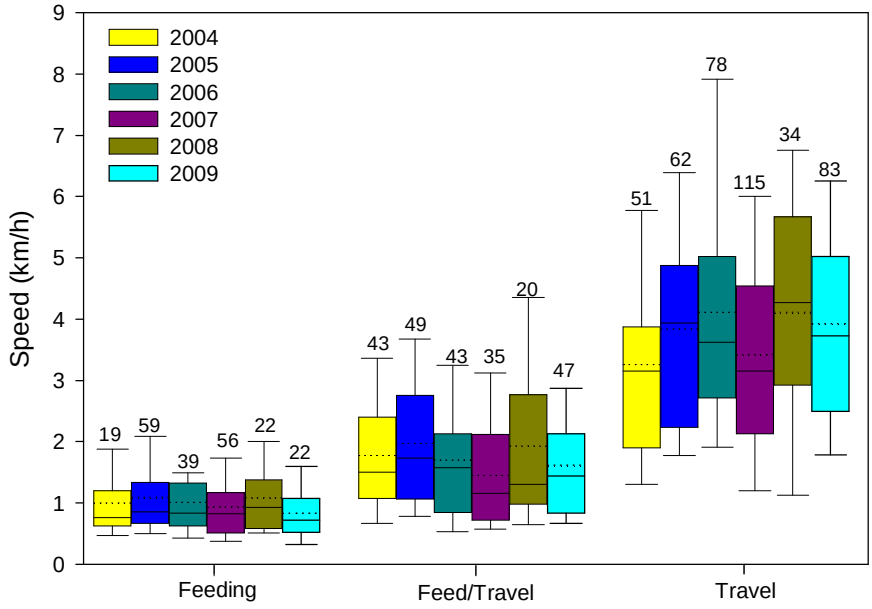


Figure 20. Speed of western gray whales during three behavioral states. Display as in Figure 12.

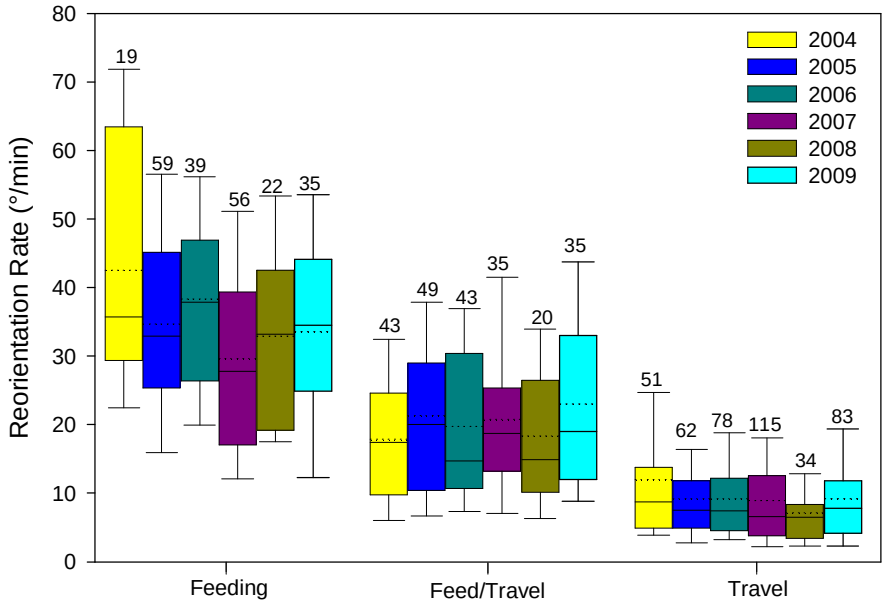


Figure 21. Reorientation rate of western gray whales during three behavioral states. Display as in Figure 12.

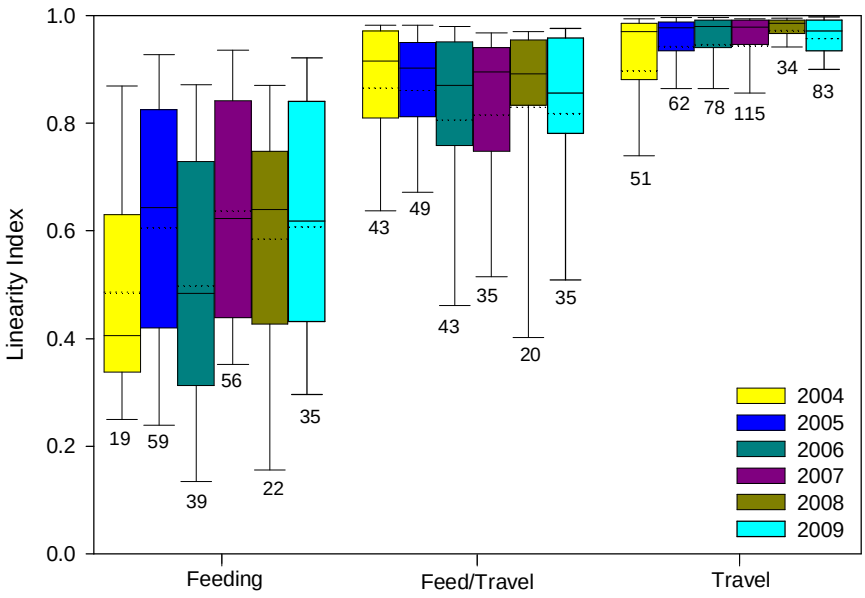


Figure 22. Linearity index of western gray whales during three behavioral states. Display as in Figure 12.

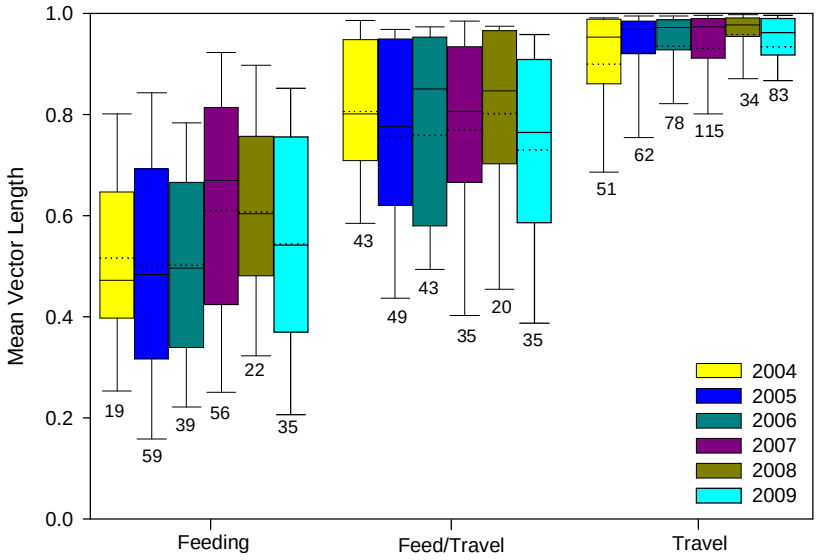


Figure 23. Mean vector length of western gray whales during three behavioral states. Display as in Figure 12.

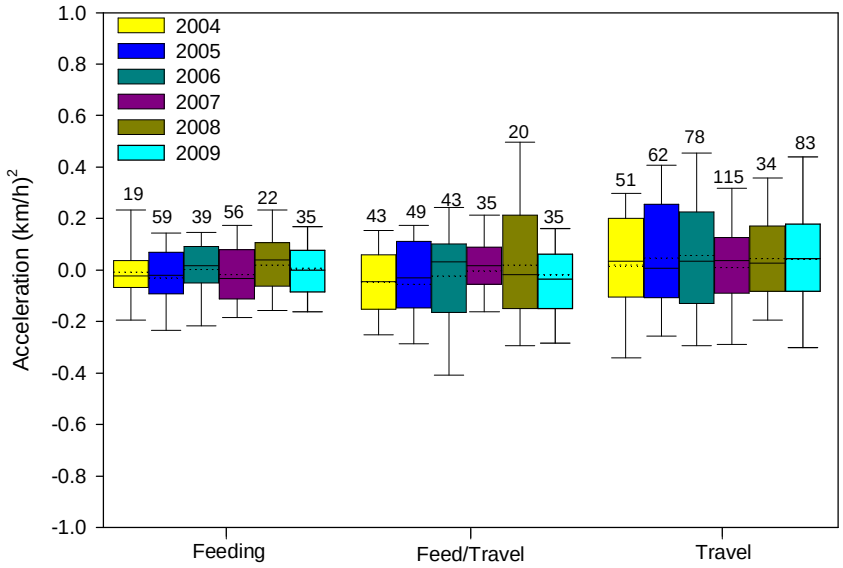


Figure 24. Acceleration of western gray whales during three behavioral states. Display as in Figure 12.

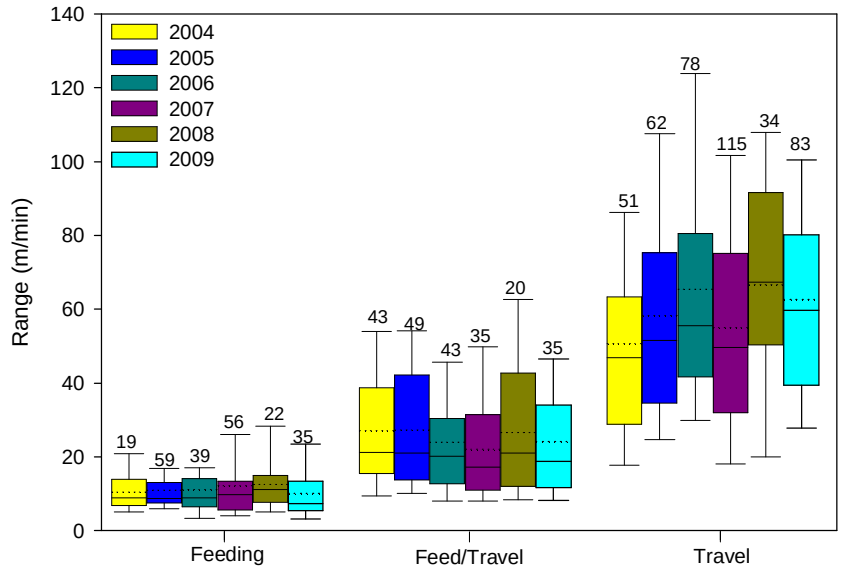


Figure 25. Ranging index of western gray whales during three behavioral states. Display as in Figure 12.

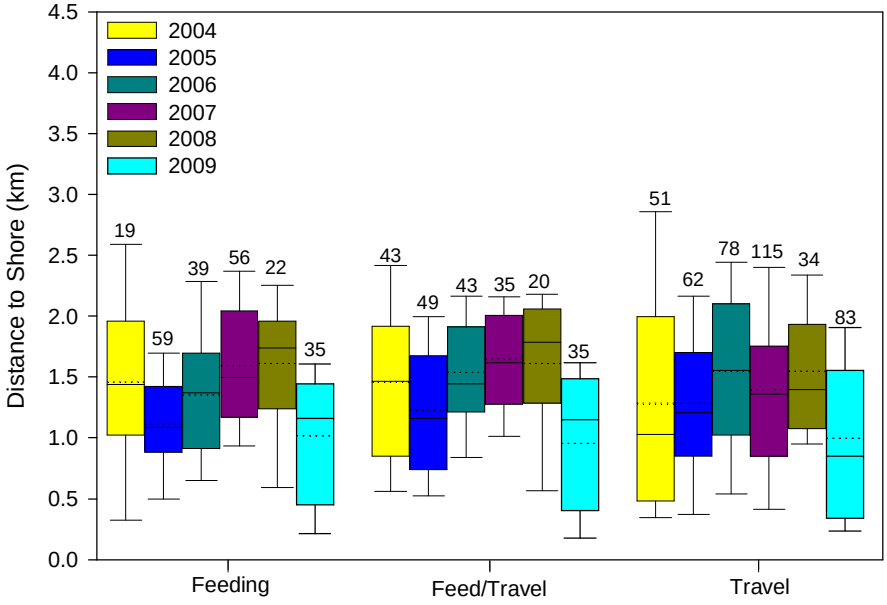


Figure 26. Distance to shore of western gray whales during three behavioral states. Display as in Figure 12.

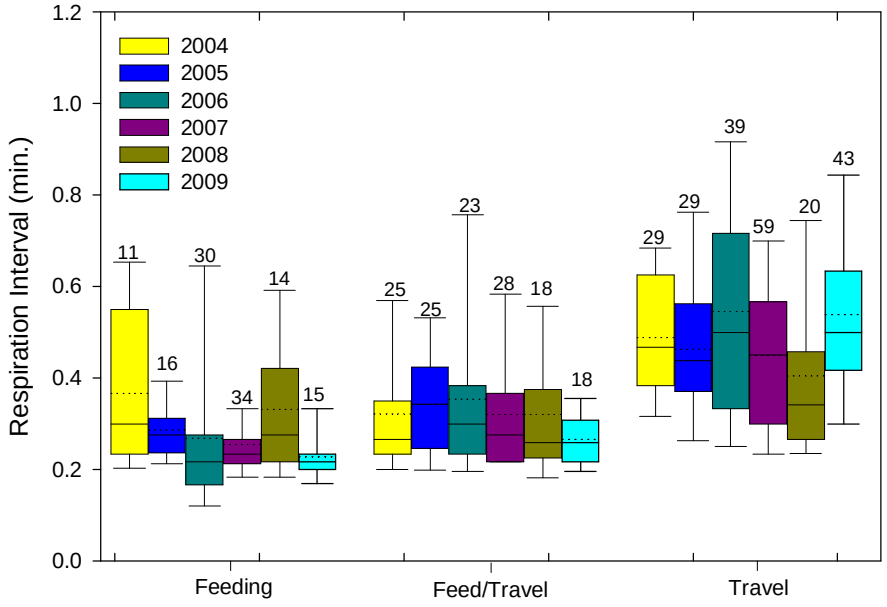


Figure 27. Respiration interval of western gray whales during three behavioral states. Display as in Figure 12.

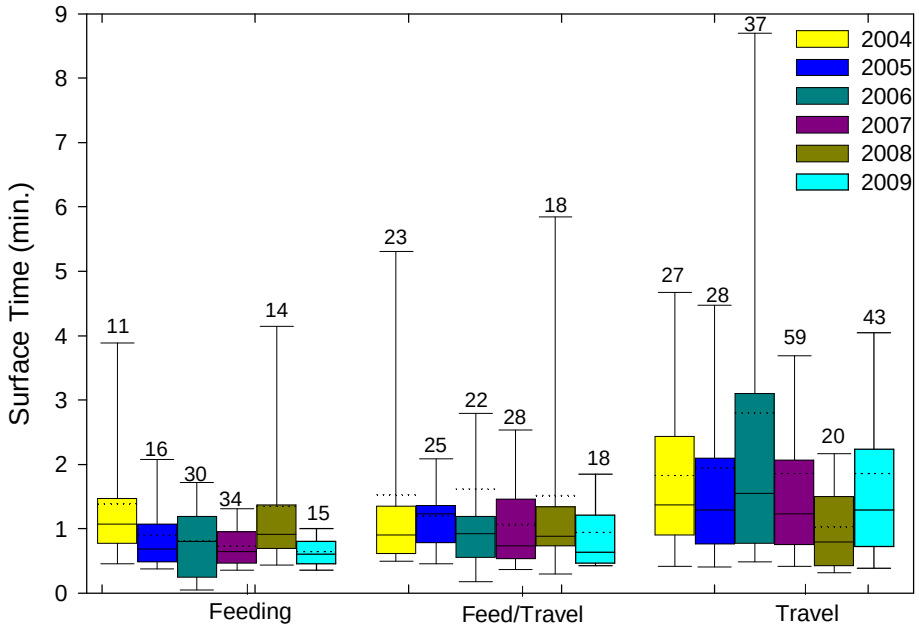


Figure 28. Surface time of western gray whales during three behavioral states. Display as in Figure 12.

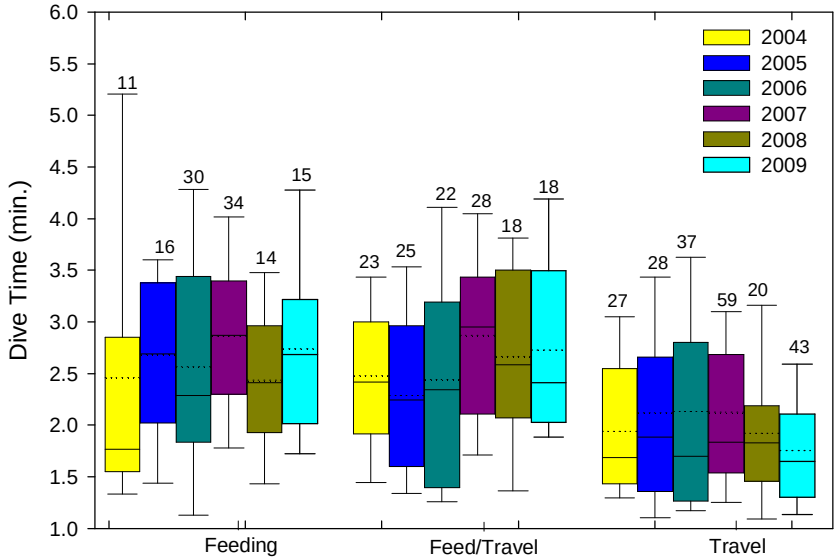


Figure 29. Dive time of western gray whales during three behavioral states. Display as in Figure 12.

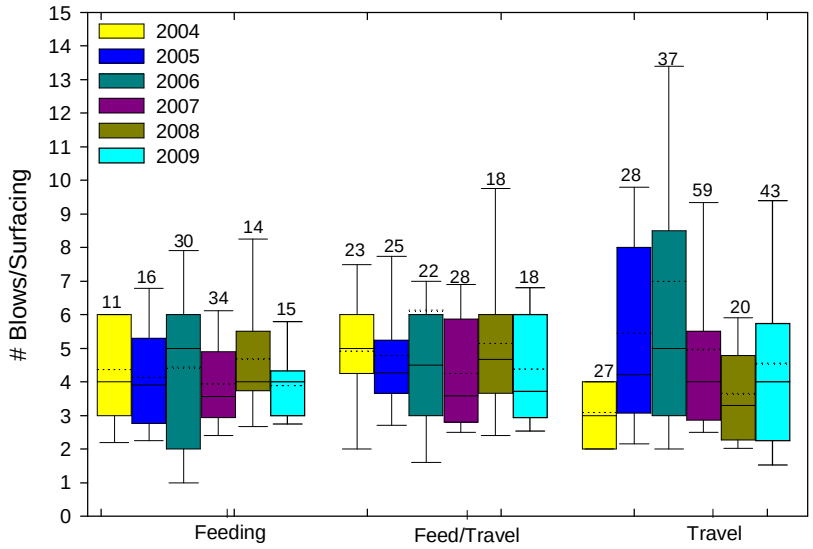


Figure 30. Number of blows per surfacing of western gray whales during three behavioral states. Display as in Figure 12.

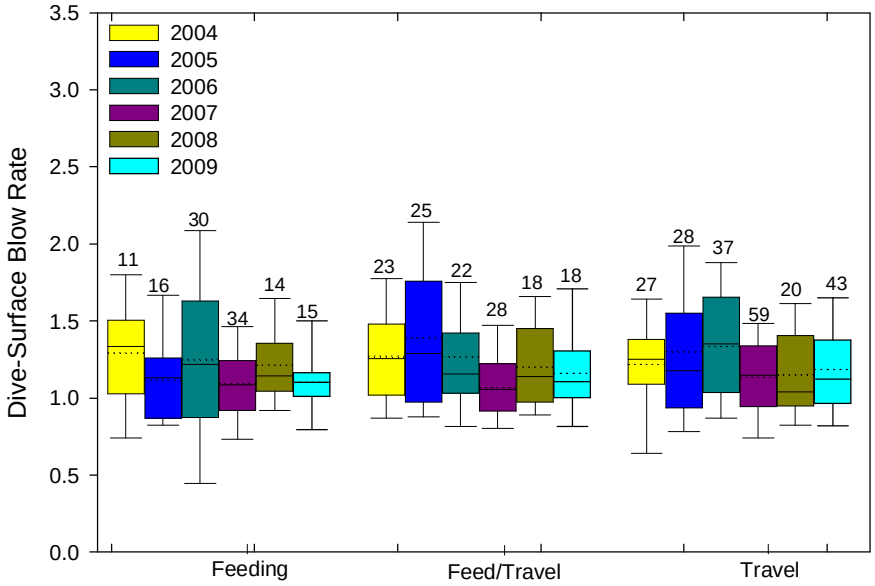


Figure 31. Dive-surface blow rate of western gray whales during three behavioral states. Display as in Figure 12.

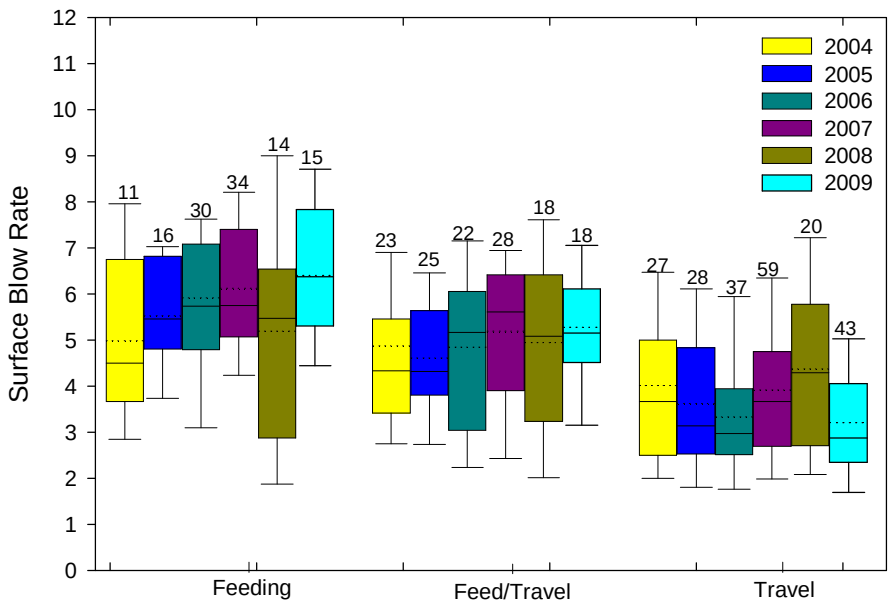


Figure 32. Surface blow rate of western gray whales during three behavioral states. Display as in Figure 12.

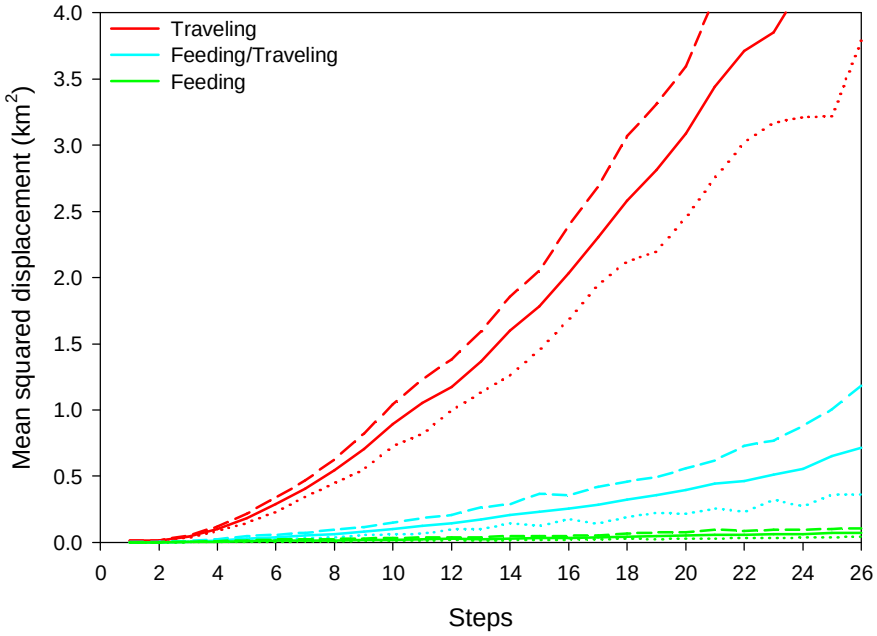


Figure 33. Mean squared displacement of western gray whales during three behavioral states. The upper and lower 95% confidence intervals are represented by dashed and dotted lines,dotted lines, respectively.

Distribution of Behavioral Activity – Figure 34 illustrates areas of observed feeding, feeding/traveling, and traveling activities in the study area. Feeding behavior varied within the study area ranging from little to no concentrated feeding in the northern part of the feeding area to concentrated feeding in "patchy" distributions in other areas. Gray whales were observed to be primarily feeding in the regions south of Odoptu Station. Some of the areas of feeding activity were observed to be continually utilized throughout the feeding season, while other feeding areas were utilized for a shorter period of time (Figure 35). For example, the feeding "patch" observed north of Station 07 occurred earlier in the feeding season, while feeding offshore of South Station continued for most of the feeding season. It should be noted that the distributional behavioral activity presented here is not likely to be representative continuously for the entire coastal observation range and therefore there may be gaps of information, especially for areas between stations as sampling and identifying behavior is more difficult with increasing distances from the observation platform. In other words, there may have been some feeding in other areas along the coastline, for example between 2nd and 1st station, but whales in this region were not sampled as frequently as those animals that were closer to the station.

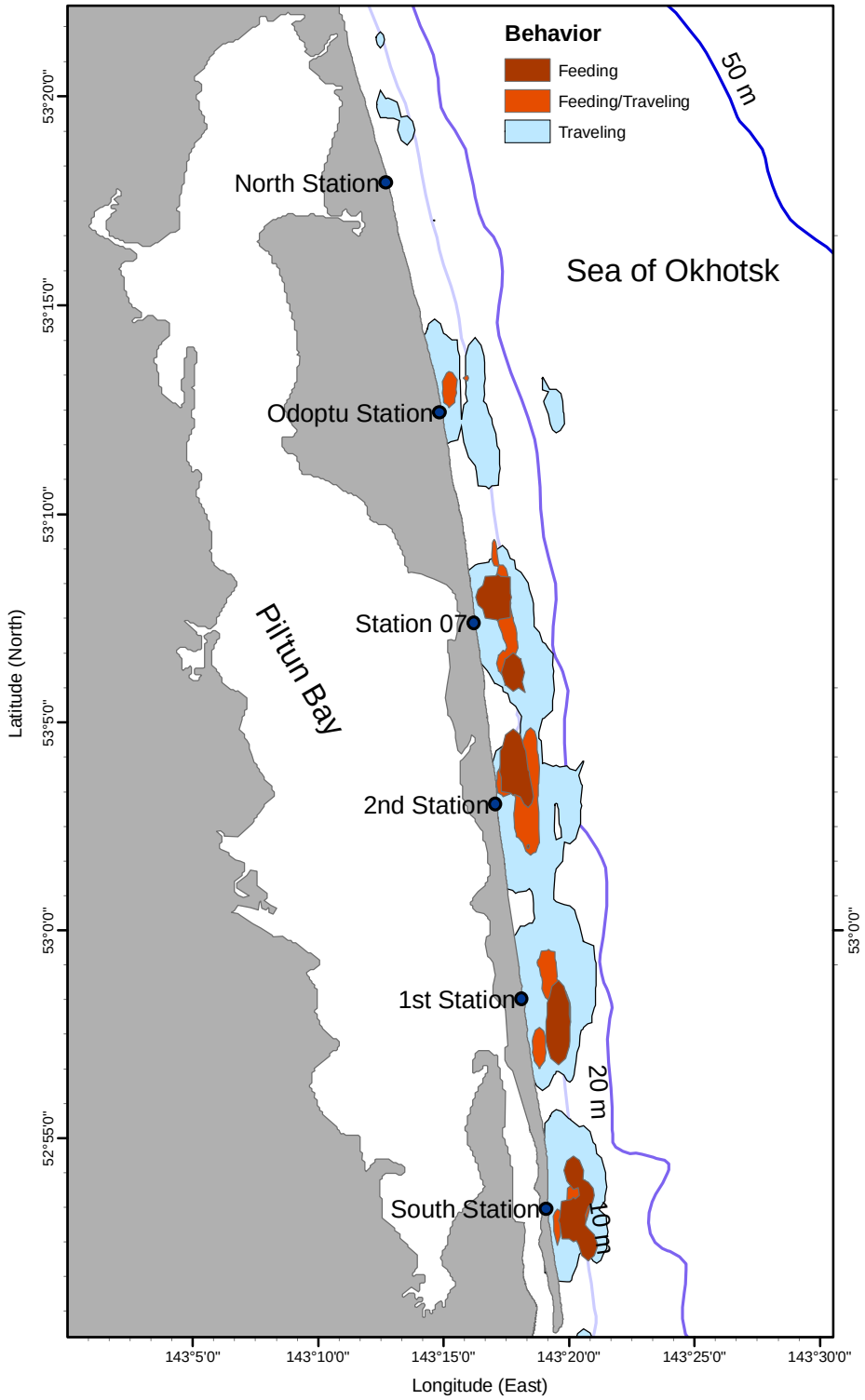


Figure 34. Feeding, Feeding/Traveling and Traveling tracklines of western gray whales in the Piltun feeding area from July - September 2009. Contours represent the 90% kernel density probability.

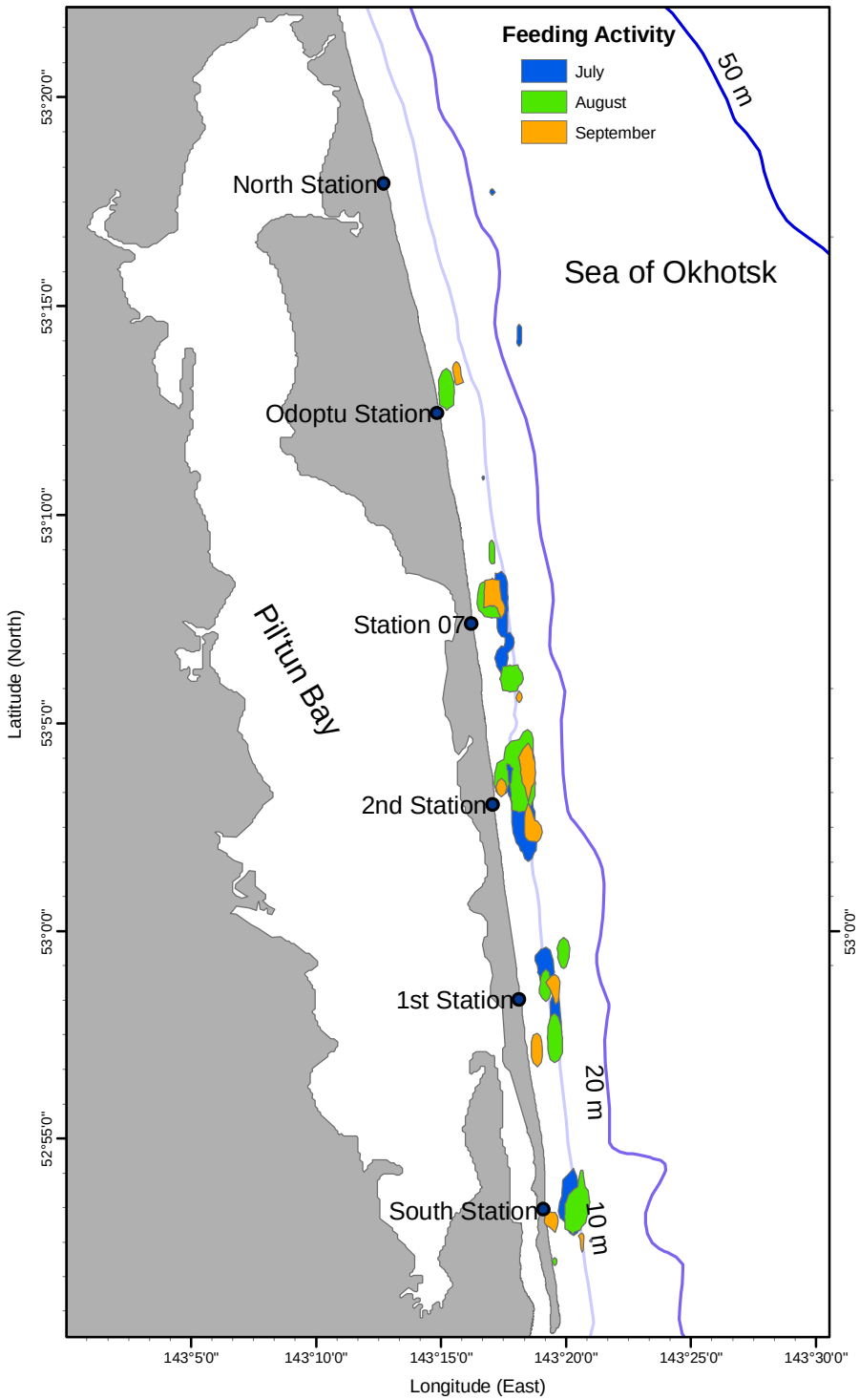


Figure 35. Feeding activity (feeding + feeding/traveling behavioral states) observed for western gray whales in the nearshore Piltun feeding area during July, August, and September 2009. Contours represent the 90% kernel density probability.

4.6 Abundance, Movement, and Respiration Near Pile Driving Activity

For a preliminary assessment of potential associations of western gray whale behavioral patterns in relation to pile driving activity, we examined the whales observed closest to the activity (Station 07) compared to those whales observed elsewhere. These analyses considered the behavioral state of the animal as a covariate since behavioral states have been identified to explain a significant amount of variation in the majority of the response variables (Gailey *et al.* 2007 b, c).

With the exception of distance from shore, there were no differences in movement patterns for whales observed closest to the pile driving activity compared to other areas. Whales were observed to be significantly closer to shore (i.e. closer to the pile driving activity) at Station 07 than those whales observed elsewhere. This result could be related to the nearshore feeding "patch" where concentrated feeding activity occurred earlier in the feeding season (Table 13). With the exception of 2002-2003, the mean distance from shore of whales observed at Station 07 has tended to be closer to shore compared to the other stations in the study area. Therefore, this result may be a natural utilization of the feeding habitat in this area.

Table 13. Western gray whale movement parameters in relation to whales observed closest to pile driving activity compared to other areas.

	Variable	Feeding	Feeding/Traveling	Traveling	P
Station 07	Speed (km/h)	0.9 ± 0.45 (8)	1.3 ± 0.75 (7)	3.7 ± 2.01 (18)	0.4801
	Reorientation rate (°/min)	38.6 ± 14.22 (8)	21.6 ± 13.56 (7)	10.3 ± 6.68 (18)	0.3363
	Linearity Index	0.6 ± 0.23 (8)	0.9 ± 0.13 (7)	1.0 ± 0.06 (18)	0.5878
	Mean vector length	0.6 ± 0.22 (8)	0.8 ± 0.19 (7)	0.9 ± 0.08 (18)	0.7091
	Ranging index (m/min)	11.6 ± 7.25 (8)	20.0 ± 12.94 (7)	59.2 ± 33.48 (18)	0.7294
	Distance from shore	0.5 ± 0.41 (8)	0.4 ± 0.41 (7)	0.5 ± 0.44 (18)	<0.0001
	Acceleration $(km/h)^2$	0.0 ± 0.11 (8)	-0.1 ± 0.21 (7)	0.0 ± 0.35 (18)	0.3463
Other Stations	Speed (km/h)	0.8 ± 0.48 (27)	1.5 ± 0.89 (29)	4.0 ± 1.72 (65)	
	Reorientation rate (/min)	32.0 ± 13.60 (27)	21.5 ± 12.52 (29)	8.9 ± 7.12 (65)	
	Linearity Index	0.6 ± 0.23 (27)	0.8 ± 0.17 (29)	1.0 ± 0.05 (65)	
	Mean vector length	0.5 ± 0.24 (27)	0.8 ± 0.21 (29)	0.9 ± 0.10 (65)	
	Ranging index (m/min)	9.6 ± 6.99 (27)	23.1 ± 15.05 (29)	63.5 ± 28.53 (65)	
	Distance from shore	1.2 ± 0.49 (27)	1.2 ± 0.47 (29)	1.1 ± 0.73 (65)	
	Acceleration $(km/h)^2$	0.0 ± 0.13 (27)	-0.1 ± 0.13 (29)	0.1 ± 0.28 (65)	

None of the surface-respiration-dive parameters were significantly different at the location closest to the pile driving area compared to other regions (Table 14). Dive time was slightly longer at the station closest to pile-driving activity. However, water depth was not considered as part the analysis which has been an important explanatory variable in past analyses (see Gailey *et al.* 2007 b, c).

Table 14. Western gray whale respiration parameters in relation to whales observed closest to the pile driving location compared to other areas.

	Variable	Feeding	Feeding/Traveling	Traveling	P
Station 07	Respiration Interval (min)	0.22 ± 0.017 (5)	0.27 ± 0.028 (4)	0.49 ± 0.137 (10)	0.3863
	Blows/Surfacing	4.15 ± 0.958 (5)	3.08 ± 0.833 (4)	4.29 ± 2.749 (10)	0.5093
	Surface Time (min)	0.67 ± 0.210 (5)	0.57 ± 0.226 (4)	1.68 ± 1.375 (10)	0.3901
	Dive Time (min)	2.85 ± 0.519 (5)	3.25 ± 1.146 (4)	1.89 ± 0.522 (10)	0.0624
	Surface Blow Rate	6.81 ± 1.468 (5)	5.73 ± 1.672 (4)	3.43 ± 1.299 (10)	0.1470
	Dive-surface Blow Rate	1.22 ± 0.267 (5)	0.89 ± 0.197 (4)	1.10 ± 0.331 (10)	0.1094
Other Stations	Respiration Interval (min)	0.23 ± 0.068 (10)	0.27 ± 0.068 (14)	0.55 ± 0.207 (33)	
	Blows/Surfacing	3.76 ± 1.137 (10)	4.75 ± 2.281 (14)	4.64 ± 3.005 (30)	
	Surface Time (min)	0.63 ± 0.244 (10)	1.05 ± 0.827 (14)	1.92 ± 1.903 (30)	
	Dive Time (min)	2.68 ± 0.986 (10)	2.58 ± 0.751 (14)	1.71 ± 0.508 (30)	
	Surface Blow Rate	6.20 ± 1.401 (10)	5.15 ± 1.191 (14)	3.14 ± 1.213 (30)	
	Dive-surface Blow Rate	1.04 ± 0.189 (10)	1.24 ± 0.276 (14)	1.22 ± 0.292 (30)	

Proportionally, the behavioral states observed at the station closest to the pile driving activity were very similar to those observed elsewhere. For example, 55% of the whales tracked were observed to be traveling near the pile driving activity and 54% of the whales monitored elsewhere were observed to be traveling. There was a slightly higher percentage (24%) of feeding behavior near the pile driving location compared to other regions (22%).

The mean and maximum relative abundance of western gray whales for each day of effort are plotted in Figure 36 and Figure 37, respectively. In relation to the region closest to the pile driving activity (Station 07), the number of whales varied throughout the feeding season. At the onset of the observation period, approximately 4-7 whales were observed in the study area, which was comparable to abundance levels seen in previous years. From early to mid-August, there was a noticeable

decrease in the number of whales at Station 07. By late August the number of whales at this station returned to similar (or even higher numbers) than observed observed earlier in the season (Figures 36–38).

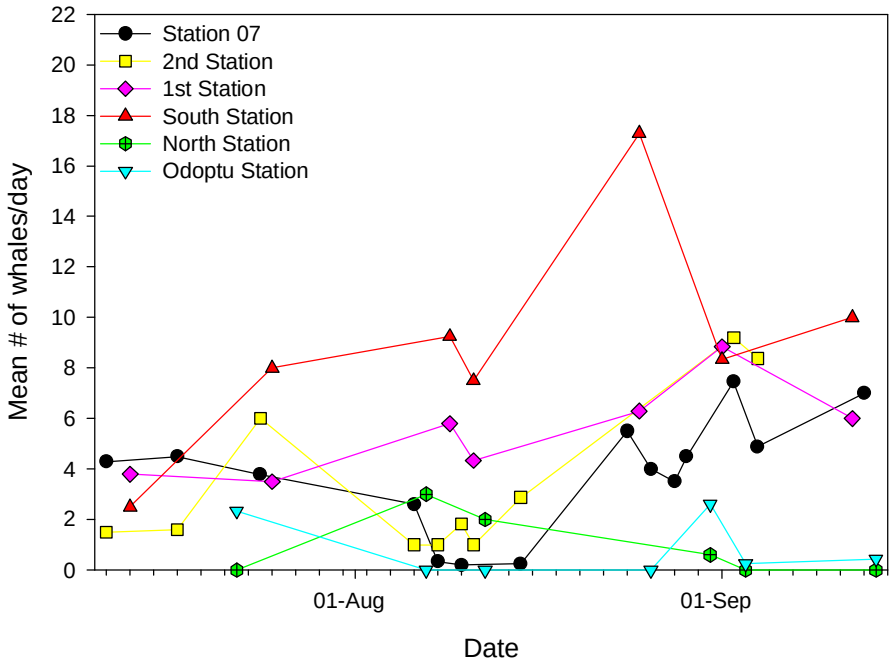


Figure 36. Mean number of whales per scan day at six shore-based station during the summer of 2009.

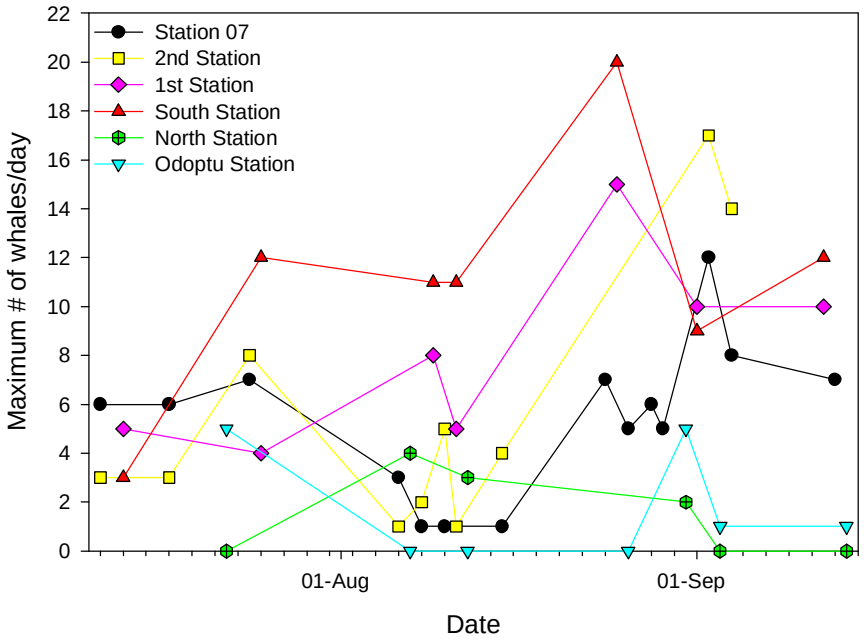


Figure 37. Maximum number of whales per scan day at six shore-based stations during the summer of 2009.

Social Activity – Western gray whales have been observed to engage in social bouts each feeding season. Socializing behavior has been more frequently observed during the latter part of their feeding season (late-August through September). This may be indicative of successful feeding as animals engage in more energetic activities. During each of these occasions, the animals' behavior and movements were similar. There were periods of surface-activity with flukes, pectorals, heads, and other parts of an animal's body above the surface of the water, and periods of apparent "chasing", when one animal rapidly moved away from the group, and the rest of the social group then "chased" this animal. Once the other individuals "caught up" with the individual that moved away, the surface activity continued and similar active events were repeated. In 2005, 2006, and 2008 relatively few occasions of social activity were observed compared to the previous field seasons. In 2007, a total of six occasions of social activity were recorded. During the 2009 field season, two occasions of social activity were observed at 1st Station. On 1 September, a group of three to four individuals was tracked for almost one hour at 3.9 – 4.4 km

from shore. Whales were displaying sexual-social activity with observations of a penis at the surface. On 12 September, four gray whales were tracked for one hour socializing and traveling (towards the end of the observation) at 1.8 – 2.6 km from shore.

4.7 Killer Whales

Six groups of killer whales were observed in the study area during the 2009 field season. The first killer whale sighting occurred on 11 July at 2nd Station. This group of 6-7 individuals (including a calf) was observed during a scan, but was also tracked for 30 minutes, was travelling north approximately 1 – 1.2 km from shore. No gray whales were observed in the area during that time. An hour later, three killer whales (possibly the same group) were sighted at Station 07 at approximately 0.8 km from shore with the minimal distance to gray whales of 1.4 km. On 10 August at 2nd Station, a group of 3-5 killer whales (including a calf) was observed during two consecutive scan sessions. The group was approximately 1.5 km from shore. The minimal distance between this killer whale group and gray whales sighted during the same scan was 2.5 km. In the same day, a group of three killer whales was observed during two consecutive scan sessions at Station 07, approximately 0.8 and 2 km from shore, respectively. The group was also tracked for 30 minutes while traveling northeast and socializing at approximately 0.5 -1.4 km from shore. No gray whales were observed in the area during that time. A single adult male killer whale was sighted during a scan at Odoptu Station (4.5 km from the shore) on 18 August. No gray whales were observed at that station for the entire day. Another sighting of killer whales was recorded on 15 August at 2nd Station (one individual) and Station 07 (two individuals) during scans. For both sightings, the killer whales were within 500 m from shore. Most likely the same killer whales (group size of 5-6 individuals, including a large male and calf) were tracked for 10 and 20 minutes from both stations that day with some socializing behavior observed. The minimal distance between killer whales and gray whales sighted within the same scans was 2 km at Station 07 and 6.4 km at 2nd Station. The last killer whale sighting occurred on 28 August at Odoptu Station, with no gray whales seen in the area during that time.

Three killer whales were traveling south at approximately 3.5 km distance from shore. For each of the above observations, no obvious changes were observed in gray whale behavior due to the presence of killer whales.

4.8 Discussion

The majority of the population of western gray whales has been noted to annually return to the nearshore and offshore feeding grounds off the northeastern portion of Sakhalin Island, Russia. The rationale for such site fidelity to a small geographic area could be for historic reasons, exceptional high concentrations of prey (Chapter 3), and/or stability or consistency in prey abundance compared to other potential feeding areas. Similar site fidelity to preferential feeding areas (albeit larger geographic areas) has been reported for gray whales of the eastern population (for example, Pike 1962, Hatler and Darling 1974, Würsig *et al.* 1986, Dunham and Duffus 2002, Jones and Swartz 2002).

Gray whales are an important ecological species. Their method of bottom feeding disrupts benthic communities and suspends sediments. Benthic communities can be dominated by dense mats of amphipod species, which is a predominate prey item for gray whales. Other scavenger species, such as lysianassid amphipods, have been observed to be in higher abundance in recent feeding “pits” of gray whales than surrounding (non-feeding pit) areas (Oliver and Slattery 1985). Increased organic material is usually left in a feeding pit weeks to months after the feeding, which stimulates recolonization. In addition, surface feeding and diving sea birds have been associated with feeding gray whale activity (Grebmeier and Harrison 1992). As a result of their feeding, gray whales affect the ecology in a dynamic way upon which many other species may depend on for their annual foraging activity.

Although western gray whales have continually returned to their feeding grounds off northern Sakhalin Island each year, there has been a considerable amount of intra and inter-year variability. Early observations of western gray whale abundance indicated extensive use of the feeding area near the mouth of the lagoon as well as higher abundance of whales in the offshore feeding area (Weller *et al.* 1999,

Johnson *et al.* 2007). In 2002-2004, however, more gray whales were observed in the northern part of the study area compared to those regions at the mouth of the lagoon. This northerly-occurring trend continued for three years. Since 2005, there has been a decline in whale abundance in the northern region and a corresponding increase in abundance at the mouth of the lagoon. In 2009, this pattern of few whales in the northern portion and higher abundance in the southern portion of the study area continued. The central part of the study area has had less drastic fluctuations in abundance compared to the northern and southern regions of the nearshore feeding habitat (Table 15).

In 2008, there was a notable decline in the number of individual gray whales returning to the feeding grounds off of the northeastern coast of Sakhalin Island (Gailey *et al.* 2009, Vladimorov *et al.* 2009, Yakovlev and Tyurneva 2009). Since 2004, an increasing amount of research effort has been conducted to identify gray whales off the southeastern coast of the Kamchatka peninsula. In 2008, there was a corresponding increase (25 individuals) in the number of gray whales sighted off of Kamchatka that have also been sighted off of the Sakhalin coast in previous years (Yakovlev and Tyurneva 2009). The Kamchatka region is approximately 1000 km to the east of Sakhalin Island and may represent an alternative summer feeding ground for western gray whales. The population may have historically used the Kamchatka and other unknown feeding habitats in the past or some individuals may preferentially forage there on some temporal basis every year.

It remains unclear why a decreased percentage of the western gray whale population did not inhabit the feeding grounds off northeastern Sakhalin Island in 2008 compared to the number of individuals that were identified in 1997-2007. Amphipod biomass, one of the prey items of gray whales in the nearshore coastal waters off of Sakhalin has significantly changed in recent years with higher concentrations in 2002-2004 and notable decreases in 2005 and, especially, 2006. Amphipod biomass increased in 2007-2009 compared to 2006, but generally lower than concentrations observed in 2002-2004 (Chapter 3). These changes in benthic food resources could be one explanation for the decreased number of whales

observed in 2008. Prey abundance may have been particularly high off of other areas, such as Kamchatka, and therefore certain individuals remained there for that feeding season, or whales could have been searching other regions for an alternative feeding source. Unfortunately, little is known about prey availability in other regions compared to Sakhalin for 2008 as well as previous years. Another plausible explanation for the lower number of whales off of Sakhalin could be in relation to potential avoidance to the area as a result of continual anthropogenic activity. From 2005-2007, there has been a number of human-related activities in relation to oil and gas development (CGBS Installation (late July-Sept. 2005), Pipeline construction (mid-June - Sept. 2006), top-side installation (late-June - mid-July 2007) and seismic operations (Aug.-Sept 2007)). The continual and cumulative impacts of such activity is one plausible explanation for the lower number of whales observed off of Sakhalin in 2008. Such relationships have been noted in the past for the eastern gray whale population where gray whales abandoned preferential breeding lagoons as a result of increasing levels of anthropogenic activity (Gard 1974, Bryant *et al.* 1984). However, in 2009, the overall number of western gray whales returning to the Sakhalin feeding grounds increased compared to that of 2008, but were similar in numbers to previous years (Chapters 1, 2, and this chapter). Therefore, there does not appear to be a continual decreasing use of the feeding grounds off Sakhalin. In 2008, pile driving activity was suggested to be a contributing factor to the decreased number of whales observed on the feeding grounds. Pile driving activity in 2008 occurred until early July and recommenced 10 Sept 2008. Therefore, the activity was not present throughout the feeding season. In 2009, pile driving activity was occurring for the majority of the western gray whale feeding season. However, the number of whales utilizing the feeding grounds were similar to previous observations (2002-2007) and higher than the numbers observed in 2008. This would suggest that pile driving activity is not likely to be the primary factor for the decreased number of whales feeding off of Sakhalin in 2008.

Within a feeding season, gray whale abundance and distribution has been observed to have considerable amount of intra-seasonal variability. For example, in 2006, observations were conducted south of our usual (and present) study area to monitor

pipeline dredging activity that was close to shore. Western gray whale abundance in this region was suspected to be low based on previous surveys (Vladimirov *et al.* 2005, 2006). However, later in the feeding season, in August and September, the abundance of whales to the south increased significantly compared to earlier in the season (Gailey *et al.* 2007a, Vladimirov *et al.* 2007). In 2007, the distribution of gray whales was more uniform in the Piltun feeding area in August. In September, however, there appeared to be an apparent abandonment of the northern region, with higher concentrations of whales in the southern portion of the study area monitored here. In 2009, there were noticeable decreases in whale abundance during the month of August in the middle part of the study area compared to the number of animals observed in July. In September, the abundance again increased to even higher levels then observed earlier in the season.

In 2004-2005, the northern regions had substantially higher number of whales than other regions. From 2004-2006, every observation day sighted whales in this region with a minimum of 2 whales per scan and a maximum of 17 whales per scan. In 2007, 36% of the observation days found zero whales in this northern region. Interestingly, the majority (80%) of the zero whale observation days in 2007 were observed during the latter part of the season (September) where whales were no longer utilizing the area. In 2008 and 2009, there was apparent low abundance in these regions that were previously utilized extensively in the past. In 2009, the most northern location, North Station, the majority of the sightings (83%) were observed in July and August, while only 5 gray whales were sighted in September. Most of the whales in these regions were observed to be traveling. The traveling whales in the northern part of the study area were predominately (82% of the observed tracks) traveling south. Other regions of the study area, such as the central part and that of the lagoon mouth, have been consistently utilized by western gray whales. These areas may represent more stable/consistent prey sources between feeding seasons. It has been suggested that changes in prey types and concentrations may be the reasons for annual shifts in gray whale abundance and distribution (Fadeev 2009). However, few analyses have considered intra-seasonal variability in whale abundance in relation to prey availability. As gray whales feed during the season,

they decrease the biomass of their prey. For example, in 2009, initial behavioral observations found concentrated feeding north of Station 07 in July. As the feeding season progressed, this feeding area or "patch" appeared to be utilized less. The concentrated feeding earlier in the season likely decreased the biomass and dependent on when benthic samples are taken, the biomass values may not reflect the concentrations at the time the animals were feeding.

Table 15. Summary of number of whales and pods per scan for 2001-2009. Stations proceed from highest latitude (North Station) to lowest latitude (South Station). Sightings between 0-20 and 160-180 where removed from 2004 - 2009 data sets to properly compare relative abundance of gray whales to the methods of 2001-2003 (see methods). Sightings from 2006-2007 were summarized from mid-July to September since this period was more typical of past field seasons.

Number Whales									
Station	2001	2002	2003	2004	2005	2006	2007	2008	2009
North Station	-	-	-	5.7 ± 3.49 (23)	9.1 ± 4.70 (10)	7.2 ± 2.99 (19)	2.3 ± 2.00 (38)	1.3 ± 1.25 (7)	0.8 ± 1.44 (22)
Odoptu Station	-	8.4 ± 4.59 (16)	5.6 ± 4.31 (29)	12.2 ± 5.77 (24)	5.6 ± 4.52 (11)	4.2 ± 2.63 (20)	2.1 ± 1.92 (46)	1.3 ± 1.22 (9)	0.9 ± 1.75 (19)
Muritai	2.3 ± 1.49 (34)	-	-	-	-	-	-	-	-
Station 07	1.8 ± 1.35 (41)	3.3 ± 2.74 (29)	2.3 ± 3.32 (55)	5.9 ± 4.13 (31)	3.6 ± 1.96 (21)	1.9 ± 1.67 (32)	1.5 ± 1.52 (33)	1.7 ± 0.75 (18)	3.0 ± 2.06 (63)
Midway	2.7 ± 1.87 (40)	-	-	-	-	-	-	-	-
2nd Station	2.3 ± 1.88 (34)	2.0 ± 1.83 (37)	1.8 ± 1.75 (37)	3.7 ± 2.95 (28)	3.94 ± 2.18 (18)	2.8 ± 2.02 (46)	2.7 ± 2.24 (36)	3.1 ± 1.53 (36)	3.9 ± 3.81 (38)
Mt. Kiwi	4.0 ± 2.7 (42)	-	-	-	-	-	-	-	-
1st Station	-	1.9 ± 1.98 (35)	1.2 ± 1.84 (46)	3.1 ± 3.00 (45)	2.8 ± 1.83 (16)	2.6 ± 2.09 (58)	3.7 ± 2.75 (45)	2.0 ± 1.09 (27)	4.0 ± 3.53 (35)
South Station	-	-	-	2.3 ± 2.35 (37)	5.5 ± 3.77 (16)	4.8 ± 3.00 (44)	6.8 ± 3.93 (38)	5.4 ± 2.42 (33)	7.1 ± 3.9 (35)

Number Pods									
Station	2001	2002	2003	2004	2005	2006	2007	2008	2009
North Station	-	-	-	3.8 ± 2.10 (23)	6.1 ± 3.44 (10)	4.7 ± 2.23 (19)	1.4 ± 1.18 (38)	0.9 ± 0.69 (7)	0.5 ± 0.96 (22)
Odoptu Station	-	5.7 ± 2.85 (16)	4.4 ± 3.01 (29)	8.4 ± 3.83 (24)	3.9 ± 2.55 (11)	2.9 ± 1.94 (20)	1.5 ± 1.38 (46)	0.9 ± 0.78 (9)	0.5 ± 0.9 (19)
Muritai	1.6 ± 1.05 (34)	-	-	-	-	-	-	-	-
Station 07	1.3 ± 0.94 (41)	2.2 ± 1.75 (29)	1.7 ± 2.22 (55)	4.1 ± 2.35 (31)	2.4 ± 1.47 (21)	1.6 ± 1.36 (32)	1.1 ± 1.06 (33)	1.4 ± 0.70 (18)	2.1 ± 1.41 (63)
Midway	2.0 ± 1.25 (40)	-	-	-	-	-	-	-	-
2nd Station	1.7 ± 1.29 (34)	1.5 ± 1.37 (37)	1.3 ± 1.22 (37)	2.4 ± 1.47 (28)	2.9 ± 1.67 (18)	2.3 ± 1.66 (46)	1.8 ± 1.64 (36)	2.2 ± 1.03 (36)	2.5 ± 2.7 (38)
Mt. Kiwi	2.6 ± 1.43 (42)	-	-	-	-	-	-	-	-
1st Station	-	1.5 ± 1.40 (35)	1.0 ± 1.50 (46)	2.2 ± 1.89 (45)	2.5 ± 1.75 (16)	2.0 ± 1.57 (58)	2.5 ± 1.78 (45)	1.6 ± 0.84 (27)	2.7 ± 2.3 (35)
South Station	-	-	-	1.7 ± 1.61 (37)	2.6 ± 2.68 (16)	3.9 ± 2.21 (44)	5.0 ± 3.37 (38)	4.1 ± 2.03 (33)	4.9 ± 2.64 (35)

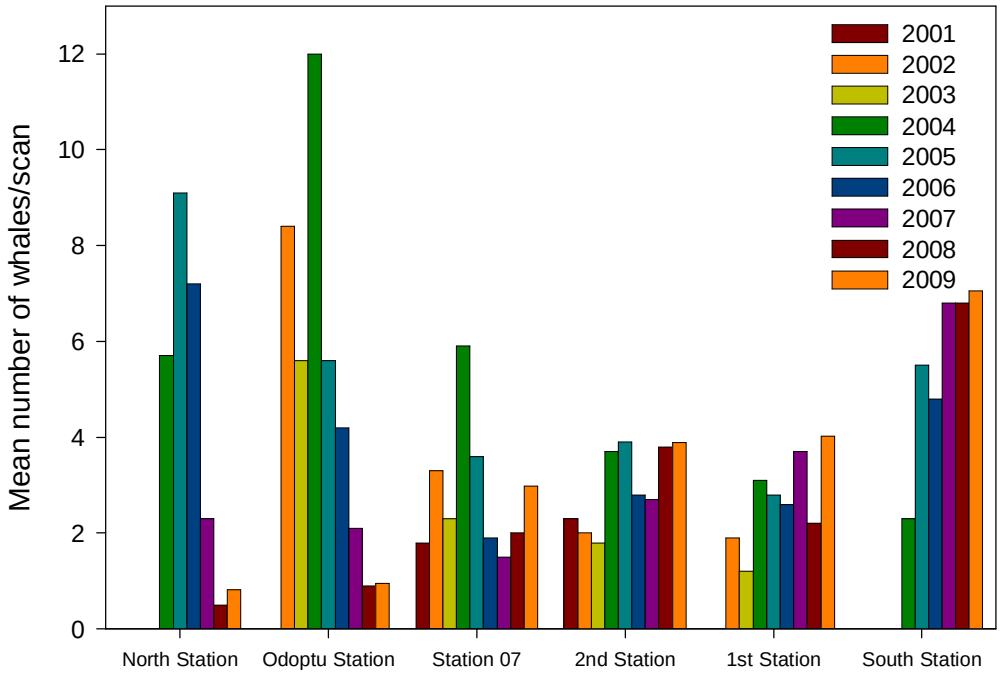


Figure 38. Annual relative abundance of western gray whales at six shore based stations from 2001-2009. Sightings between 0-20 and 160-180 degrees were removed from 2004 - 2009 data sets to properly compare relative abundance of gray whales to the methods of 2001-2003 (see methods). Sightings from 2006-2007 were summarized from mid-July to September since this period was more typical of past field seasons.

In 2009, gray whales were on average 1.7 km from shore. This east-west distribution pattern is comparable to an average distance of 1.5 to 1.8 km from shore in 2005-2008. In 2003 and 2004, the average distances from shore were slightly higher (2.3 and 2.1 km, respectively); distributional patterns illustrated a consistent feeding area in waters greater than 5 km from shore and greater than 20 m depths during those feeding seasons. This slightly further offshore feeding area had a high abundance of sand lance (Fadeev 2004, 2005). Although sand lance has not been previously shown to be the primary prey source for gray whales, gray whales are known to be highly adaptable and exploit seasonal abundance of different prey items and it is likely the whales were exploiting these high concentrations of sand lance or some

other epibenthic food sources during those years. However, in 2007 and 2008, the more distant from shore feeding area was not extensively utilized, which corresponded with lower abundance of sand lance (Fadeev 2008, 2009). In general, western gray whales are typically within water depths less than 20 m (~4-5 km from shore). Regions greater than 20 m water depth are dominated by sand dollars (Echinoidea) that have little nutritional value to gray whales. The primary prey items (amphipods, bivalves, isopods) have been shown to be in great abundance in water depths < 20 m for the Piltun feeding area (Chapter 3).

Although there has been considerable amount of annual and intra-seasonal variability in abundance and distribution, no significant patterns have been found to date in relation to daily abundance. For a given year, sample sizes may be too small to detect these patterns (if they existed) and/or other factors may contribute to daily changes in abundance and distribution patterns. Multi-year analyses of abundance and distribution information while taking into account tide, weather conditions, temporal factors, and prey availability data would likely yield further insights and understanding of how western gray whales are utilizing their feeding habitat. The increased sample size from a multi-year analysis would allow for finer exploration of the temporal component to examine potential changes in relative abundance patterns on a daily basis.

Behavioral observations of western gray whales have been conducted in the near-shore Piltun feeding area for the past nine summer-fall periods. The first year of observation resulted in initial descriptions of western gray whale behavior, as well as an assessment of potential influences of a seismic survey that occurred in close proximity to the near-shore feeding habitat (Würsig *et al.* 2002, Gailey *et al.* 2007b). With the exception of a seismic survey late in 2004, the 2002-2004 field seasons were relatively free of anthropogenic activity, and these years provided needed baseline information to better understand natural patterns of gray whale movements and behaviors.

In 2009, the general observations of movement and respiration patterns of western gray whales were similar to those observed in previous years with the exception of 2002 (Table 16). In 2002 (a non-construction year), gray whales were observed to be traveling more throughout the study area. We hypothesized that increased traveling activity could be representative of a different foraging strategy, such as feeding more on prey in the water column as opposed to benthic foraging. Gray whales could be feeding more on “clouds” of water column prey, which tend to be distributed in a somewhat “rare and random” poisson fashion. Similar greater travel between locations was evident for eastern gray whales feeding on mysids, rather than feeding on bottom-dwelling ampeliscid amphipods, off Vancouver Island, Canada (Guerrero 1989). The overall movement patterns in 2009 were slightly, but non-significantly, higher with speeds of 2.7 km/h and range index of 41.4 m/min, compared to the 1.9 - 2.6 km/h speeds and 31.1 - 40.8 m/min range indices observed in 2001-2008. Again, this may be representative of increased traveling behavior compared to that of feeding and feeding/traveling representative tracklines in the dataset. In the past four years, there have been small increases in speed and range as well as decreased values for reorientation rates (Table 16). Behavioral activity in 2009 indicated that gray whales were feeding in a patchy distribution (Figures 34 and 35), being concentrated primarily in the central and southern portion of the study area (Station 07 to South Station) and little to no feeding was observed in the northern region. The patchy distribution of prey could be one explanation for increased traveling behavior.

In 2002, blow interval and dive time tended to be higher and lower, respectively, than observed in other years, indicative of the greater amount of travel in that year (Gailey *et al.* 2005, Table 16). The general blow interval and dive time in 2009 were more similar to those of 2003-2008, which are comparable to those of bottom-feeding eastern gray whales in the northern Bering Sea (Würsig *et al.* 1986) and off Vancouver Island, Canada (Guerrero 1989). Dive times were generally lower than those reported for eastern gray whales, which is likely due to the shallow depth of the nearshore Piltun feeding region. Previous studies on eastern gray whales have

found a general increase in dive time for whales observed in deeper water depths (Würsig *et al.* 1986). In addition, Gailey *et al.* (2007c) found that water depth was significantly associated with dive time, indicating that whales had longer durations of dives in deeper waters.

The general activity of western gray whales on their feeding grounds was predominantly classified into three behavioral states: 1) feeding, 2) feeding/traveling, and 3) traveling. Other behaviors were observed, such as resting, milling, and socializing behaviors, however the sample size was relatively small for detailed evaluations. Movement and respiration patterns were significantly different when whales engaged in these different modes of activity. Gray whales tended to move faster, more directional, and covered a larger range while traveling compared to feeding/traveling and feeding. Movement patterns were also different between the two different modes of feeding behavior (feeding/traveling and feeding). Differences in movement patterns during feeding and feeding/traveling behavior could be representative of the different foraging strategies, such as feeding in one area with high concentration of food, while feeding/traveling in areas of lower prey density or on different prey types (water column compared to benthic feeding). Feeding/traveling behavior could be also related to a “search” mode where whales are investigating or plowing the bottom in lower prey density areas in search for higher concentrations. Observations of whales feeding in one localized area for several hours suggest that the prey concentrations at that location was particularly high compared to surrounding areas.

When whales were engaged in feeding or feeding/traveling activities, there were no differences in how the whales cycled through their surface-respiration-dive cycles. While whales were feeding, their respiration patterns were optimized to spend less time at the surface in order to return to the prey resources. While traveling, the whales dive time decreased, surface time increased, and the duration between blows at the surface were longer compared to that of the feeding states. Taken together, whales were spending more time at the surface while traveling, which

may be related to the increased speeds (i.e. increased energetic activity) of movement during traveling.

“Displacement” analyses in the past four years have indicated significantly different patterns for traveling whales than those found in previous years (2002-2005). However, there were non-significant differences in displacement for animals that were feeding or feeding/traveling. Displacement values combine movement patterns of directionality, reorientation, and speed. As noted previously, the past four years indicated slightly higher speeds, directionality, and range indices, which the combination of these movement indicators resulted in higher displacement values. It is unknown why whales were observed to be traveling faster. As previously suggested, this could be related to a more patchy distribution of prey where animals were traveling more directionally between known patches. Alternatively, there could be more whales in the datasets that were disturbed by some anthropogenic activity, for example close vessel approaches or responses to “noisy” activity. Western gray whales have been noted to behaviorally respond to both sound levels and close vessel approaches in previous years (Gailey *et al.* 2007 b, c). However, higher speed values were also noted in 2002 when no activity was occurring near the Piltun feeding habitat.

There is some circularity between the definitions of behavioral states as a natural predictor for variables of movement, such as speed, directionality, and range indices. For example, we would expect a lower linearity (i.e. less linear movement) and range indices for whales observed to be feeding (“remains in one localized area with non-directional movement and consistent periods of dives”) compared to those animals that are classified as traveling (“swimming in one general direction and often remaining at the surface without consistent dives”). Behavioral states of the animal are important to provide context to help understand and monitor, despite some circularity in its definition, because these activities are “normal” for western gray whales and we were interested in explaining/identifying “normal” and aberrant behavior associated with natural and anthropogenic events. In other words, we could

estimate that traveling whales normally do so at a speed of *X* km/h, then in effect check for association between higher (or lower) speeds for traveling whales in the presence of higher (or lower) anthropogenic sound levels. In addition, it is known that marine mammals respond differently in relation to their current behavioral state. Resting whales, for example, are more likely to be disturbed by sounds than animals engaged in foraging and social activity (NRC 2003, Richardson and Würsig 1995).

Other behavioral states, such as resting, milling, socializing, playing, etc., were less frequently observed. This leads to low statistical power for analyzing these states, which obviously limits quantitative interpretation. In addition, behavioral states such as socializing often consist of more than one individual, which increases the difficulty of reliably tracking or conducting a focal follow unless one distinctive individual can be recognized within the group. In 2001-2008, observed socializing behavior occurred during a similar time period as in previous years (end of August through September). The increase in social bouts in the latter part of the summer has similarly been described for eastern gray whales off St. Lawrence Island (Würsig *et al.* 1986). It is unknown why gray whales engage in these activities more in the latter part of the feeding season, but one hypothesis is that increased social activity may be associated with successfully feeding where animals can engage in more energetic activities. The descriptions of social behavior observed in the western gray whales are similar to those described for the eastern population on their feeding grounds and are akin to descriptions of courting and mating behavior (Sauer 1963, Fay 1963, Jones and Swartz 2002). In fact, the majority of the social behavior observations during 2001-2009 included observations of apparent sexual activity, as indicated by general social behavior and – at times -- an exposed penis. Although sexual-related activity continues to be observed on the feeding grounds, it likely serves some unknown social purpose that is ultimately non-reproductive (Jones and Swartz 2002).

Table 16. Summary statistics for movement and respiration data collected during 2001 - 2009. Dashes (-) separate numbers that indicate ranges; plus/minus (±) separate means and standard deviations, and numbers in parentheses are sample sizes.

Variable	2001	2002	2003	2004	2005	2006	2007	2008	2009
Leg Speed (km/h)	1.9 ± 1.49 (510)	3.2 ± 2.06 (74)	2.3 ± 1.04 (47)	2.2 ± 1.30 (116)	2.2 ± 1.84 (124)	2.6 ± 2.12 (140)	2.4 ± 1.76 (176)	2.6 ± 2.02 (59)	2.7 ± 2.03 (120)
Linearity	0.8 ± 0.23 (482)	0.8 ± 0.24 (74)	0.8 ± 0.29 (47)	0.8 ± 0.23 (116)	0.8 ± 0.91 (124)	0.8 ± 0.24 (140)	0.8 ± 0.23 (176)	0.8 ± 0.24 (59)	0.8 ± 0.22 (120)
Acceleration (km/h^2)	0.0 ± 0.71 (506)	0.1 ± 0.50 (74)	0.0 ± 0.23 (47)	0.0 ± 0.22 (116)	0.0 ± -0.03 (124)	0.0 ± 0.27 (140)	0.0 ± 0.23 (176)	0.0 ± 0.17 (59)	0.0 ± 0.21 (120)
Reorientation Rate (°/min.)	17.4 ± 13.72 (506)	21.0 ± 19.32 (74)	26.0 ± 18.76 (47)	19.1 ± 15.17 (116)	21.4 ± 15.85 (124)	19.5 ± 15.92 (140)	17.3 ± 14.52 (176)	19.8 ± 18.48 (59)	16.8 ± 14.98 (120)
Distance to Shore (km)	1.1 ± 0.66 (510)	-	2.3 ± 1.23 (283)	2.1 ± 1.45 (984)	1.5 ± 1.19 (502)	1.5 ± 0.66 (140)	1.4 ± 0.72 (176)	1.6 ± 0.60 (59)	1.0 ± 0.65 (120)
Mean Vector Length	0.8 ± 0.26 (482)	0.8 ± 0.27 (74)	0.7 ± 0.29 (47)	0.8 ± 0.22 (116)	0.7 ± 0.85 (124)	0.8 ± 0.25 (140)	0.8 ± 0.24 (176)	0.8 ± 0.26 (59)	0.8 ± 0.24 (120)
Ranging Index	-	-	31.1 ± 18.06 (47)	32.9 ± 22.31 (116)	32.8 ± 24.71 (124)	39.6 ± 35.91 (140)	36.2 ± 29.87 (176)	40.8 ± 34.47 (59)	41.4 ± 34.27 (120)
Blow Interval (blows/min.)	0.4 ± 0.14 (271)	0.5 ± 0.19 (46)	0.4 ± 0.13 (34)	0.4 ± 0.17 (64)	0.4 ± 0.15 (66)	0.4 ± 0.21 (81)	0.4 ± 0.18 (105)	0.3 ± 0.13 (40)	0.41 ± 0.207 (63)
Blows per Surfacing	5.2 ± 3.93 (234)	4.9 ± 4.45 (42)	4.2 ± 1.38 (34)	4.2 ± 1.63 (64)	5.1 ± 2.86 (66)	6.2 ± 6.73 (81)	4.9 ± 3.22 (105)	4.5 ± 2.15 (40)	4.6 ± 3.15 (61)
Surface Time (min.)	1.6 ± 1.84 (241)	1.7 ± 1.50 (42)	1.7 ± 1.78 (34)	1.8 ± 1.73 (64)	1.6 ± 1.73 (66)	2.0 ± 3.13 (81)	1.6 ± 1.97 (105)	1.2 ± 1.16 (40)	1.5 ± 1.85 (61)
Dive Time (min.)	2.5 ± 0.92 (239)	1.8 ± 0.80 (44)	2.2 ± 0.77 (34)	2.4 ± 0.80 (64)	2.2 ± 0.84 (66)	2.4 ± 1.13 (81)	2.5 ± 0.94 (105)	2.7 ± 0.94 (40)	2.2 ± 0.87 (61)
Dive-Surface Blow Rate	1.2 ± 0.34 (236)	1.3 ± 0.32 (42)	1.3 ± 0.42 (34)	1.2 ± 0.32 (64)	1.3 ± 0.42 (66)	1.3 ± 0.48 (81)	1.1 ± 0.33 (105)	1.2 ± 0.24 (40)	1.2 ± 0.28 (61)

Killer whales are one of the few known predators of gray whales. Predation on gray whales has been documented for the eastern population (Baldridge 1972, Goley and Straley 1994, George and Suydam 1998) and it is likely to occur to some degree on the smaller population of western gray whales. Indirect evidence of killer whale interactions with western gray whales is apparent by the tooth rake marks on the bodies of some individuals. Interactions of killer whales and western gray whales may at times result in successful predation, especially on calves or recently weaned calves. Transient killer whales have been sighted infrequently (~2-9 times per field season) in the Piltun feeding grounds. Western gray whales have generally not been observed to respond to the presence of killer whales. In 2009, six groups of killer whales were observed, which is less than the nine groups observed in 2007, but higher than the one sighting of killer whales in 2008. As observed in previous years, western gray whales indicated no response in the presence of killer whales. For the past nine years, there has only been one observation of harassment by killer whales. This observation occurred in 2006, when a group of 4-6 killer whales was observed to be harassing two adult gray whales, the killer whales were seen at the surface near and round the gray whales and the gray whales responded by increasing their speed of movement and moving inshore (Gailey *et al.* 2007a).

With some understanding of the amount of natural variability that can exist, our long-term study has continued to examine indicators of behavioral response that potentially could be affecting foraging by gray whales. In the past four years, a considerable amount of anthropogenic activity has occurred compared to 2002-2004. In 2005, construction activities related to placement of a concrete gravity based structure occurred with behavioral associations related to near-shore vessel activity and sound levels related to construction (Gailey *et al.* 2007c). In 2006 and 2007, construction activity related to pipeline placement and top-sides installation at the PA-B site occurred in the vicinity of the Piltun feeding area. In 2008, there was less direct industry activity, although seismic and onshore pile driving operations occurred. The seismic exploration occurred in the northern part of the study area during early to mid September while onshore pile driving occurred near our Station 07 until July 4 and recommenced on September 10. In 2009, both onshore pile driving and seismic activity continued. On-shore pile driving was at

the same location (near Station 07) and continued for most of the gray whale feeding season. Seismic operations were observed in the northern part of the study area later (late-August through September) in the feeding season.

This report preliminarily assessed those abundance, respiration, and movement patterns at the location closest to the pile driving activity for a general examination of responses to the activity. Distance from shore was the only variable found to be significantly different for Station 07 (station closest to the pile driving activity) compared to those stations that were further from the activity. All other movement and respiration response indicators were not significantly different. Due to sound propagation, it is possible that sound levels produced from the onshore pile driving could be higher further from shore compared to areas closer to the pile driving sound source (Rutenko 2010). Therefore, the result of whales being closer to shore could be due to avoidance of higher sound level exposure. Alternatively, the closer distance to shore may be related to prey availability as whales were seen to be feeding in an area closer to shore. For example, there was a closer to shore feeding area near Station 07 (see Figure 35) that was directly offshore of the pile driving activity. In fact, the majority of the closest distance from shore observations at Station 07 were of whales engaged in feeding activity. Sound propagation may not always follow this inshore-offshore pattern and may, at times, be louder closer to shore. Analyses are currently being conducted to examine the sound propagation from the pile driving activity as well as examine potential relationships between western gray whale behavior, distribution, and abundance and the pile driving activity. These analyses will be presented in a later report.

The mean and maximum daily abundance values did highlight a period from 6-18 August when whale abundance near the pile driving activity was particularly low compared to those observations before and after that period. During this same time, there was a decrease in abundance at the station 10 km south (2nd Station), while other stations further south had a corresponding increase in whale abundance. Currently it is unknown if this shift in abundance was natural (i.e. prey availability, predator response) or associated with pile driving and/or other activities, such as vessels, that were occurring. As previously noted, there can be considerable amount of intra-seasonal variability in how whales are utilizing their habitat. In fact, the 2009

abundance estimates for Station 07 were similar and even on the high end of the number of whales seen in previous years (Figure 38). It is important, however, to conduct proper analyses that examine any potential response of western gray whales to the activity that occurs in order to understand and minimize disruptions in foraging. Whale displacement out of a preferential feeding habitat is a particular concern, especially when the population is particularly stressed by other contributing factors or when displacement out of an area results in decreased feeding for individuals. This could occur if an activity is long in duration within a feeding season or frequent across multiple feeding seasons. During a seismic survey in 2001, whale distribution was noted to change with fewer whales in the vicinity of the seismic survey area (Weller *et al.* 2002, Yazvenko *et al.* 2007). However, for 2009, whale abundance did return to higher levels while pile driving continued throughout the feeding season. If the low counts observed in August were related to industrial activity, the observed shift may have been due to some anomalous (potentially "loud") activity during this period that resulted in the displacement of whales or the whales may have been initially disrupted and later habituated to the activity. Initial inspections of sound levels, however, have not found any anomalous loud sounds generated near Station 07 for the period of observed decrease in whale abundance (Rutenko *et al.* 2010), but more analyses are being conducted to fully examine these data and their potential relationships between abundance, distribution, and behavioral responses.

The general analyses presented here in relation to anthropogenic activity did not consider the sound levels associated with the activity or even if the activity was occurring at the time. Onshore pile driving occurred intermittently and was not continuously operating and only occurred for a small portion of any given day (Rutenko *et al.* 2010). However, the data represented here only evaluated a subsample and do not consider entire tracks or respiration observations due to analytical concerns of over-representation/pseudoreplication. More complex multivariate analyses are needed to account for pseudoreplication and autocorrelation issues. As well, natural factors that have been shown to influence movement and respiration were not taken into account (see Gailey *et al.* 2007b,c). To further understand changes in western gray whale abundance, distribution, movement, and behavior, additional analyses will be needed which incorporate both

natural factors and potential anthropogenic impact variables. Such a framework allows use of the entire dataset collected and enhances our understanding of western gray whale patterns on a daily, monthly, season, and annual basis. We believe the results presented here indicate considerable variability. There are natural factors that are likely to explain a portion of the variability observed. Anthropogenic activity is also one plausible explanatory factor. Additional analyses that consider multiple explanatory variables (both natural and anthropogenic affects) will be conducted to examine these relationships further. These analyses are complex and take time to pool all the necessary information together to properly examine factors that could influence gray whale behavior and abundance.

In summary, this report provides initial results of western gray whale behavior that was observed in 2009 and compares these results to similar analyses of past years. The results may have been confounded by anthropogenic activity (i.e. pile driving, seismic activity, etc) and it is presently unknown how these activities may have affected the distribution, abundance, and behavior of western gray whales. Over the past nine years, there has been a considerable amount of annual and intra-seasonal variation in how western gray whales are utilizing their feeding habitat. One of the major influences of abundance and distribution of gray whales on their feeding grounds is the amount and types of prey available. However, more sophisticated analyses are needed to link information related to prey availability and gray whale presence, distribution, behavior, and movement. In 2009, there were apparent distribution shifts in whale abundance and these shifts may have been natural or related to construction activity. Movement and respiration patterns were found to be similar with slightly higher (albeit non-significant) movement parameters in the past four years. Past analyses have indicated significant effects on movement related to vessel activity and sound levels (Gailey *et al.* 2007 b, c). To further examine if potential impacts occurred in 2009, additional analyses are being conducted to take into account when activity was occurring and at what sound levels whales were exposed to, while attempting to consider natural factors that have been shown to influence their behavior, abundance, and distribution.

4.9 Acknowledgements

We acknowledge the logistic help of Doug Bell, Koen Broker, Yuri Bychkov, Vladimir Efremov, Mike Jenkerson, Ervin Kalinin, Rodger Melton, Judy Muir, Lisanne Aerts, Ildar Aupov, Sergei Tyurin, Olga Tyurneva, Sandra Werner, Yuri Yakovlev, Valentina Yetskalo, and Igor Zhmaev. Judy Muir and Yuri Bychkov provided density estimates based on gray whale sightings during the scan surveys, and Lucia Ferreira created the density maps. Research assistants Andrei Ermoshin, Aleksandr Kalachev, Ivan Krupin, and Alexei Filipiechev were excellent helpers in the field. Alexai Bratov and Sergei Gubarev provided transportation services. We thank them all.

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APPENDIX 1. Daily summary of theodolite, focal behavior, and scan data collected during the summer of 2009.

Station	Date	Start Day	End Day	Effort(hrs)	# Tracks	# Focals	# Scans
2nd Station	11-Jul-09	11:30:06	19:25:58	7.93	1	0	8
Station 07		11:05:05	19:37:27	8.54	5	4	7
South Station	12-Jul-09	9:51:40	10:14:52	0.39	0	0	0
1st Station		9:20:06	10:24:26	1.07	1	1	0
South Station	13-Jul-09	13:00:15	17:37:44	4.63	4	2	2
1st Station		12:51:44	18:07:09	5.26	3	1	5
2nd Station	17-Jul-09	8:02:22	16:38:55	8.61	2	1	5
Station 07		7:29:48	14:32:19	7.04	1	0	4
Odoptu Station	22-Jul-09	9:40:43	17:25:22	7.74	2	0	3
North Station		9:46:58	17:27:34	7.68	1	0	1
2nd Station	23-Jul-09	7:29:14	9:33:01	2.06	1	1	0
Station 07		7:16:26	10:36:56	3.34	0	0	0
2nd Station	24-Jul-09	8:03:17	19:34:11	11.52	7	4	3
Station 07		6:55:34	16:43:38	9.80	4	0	9
South Station	25-Jul-09	8:39:33	17:43:53	9.07	6	1	5
1st Station		7:48:55	14:16:14	6.46	1	1	2
2nd Station	31-Jul-09	8:23:50	10:06:33	1.71	0	0	0
Station 07		8:24:17	9:28:09	1.06	1	0	0
2nd Station	6-Aug-09	10:48:59	18:57:32	8.14	4	2	1
Station 07		10:38:23	19:20:16	8.70	3	2	5
Odoptu Station	7-Aug-09	7:18:37	14:18:08	6.99	0	0	4
North Station		7:33:51	14:12:04	6.64	0	0	5
2nd Station	8-Aug-09	12:39:29	19:11:03	6.53	1	1	7
Station 07		12:05:12	19:57:11	7.87	1	1	6
South Station	9-Aug-09	8:45:52	17:35:52	8.83	9	3	4
1st Station		8:32:43	18:10:48	9.64	7	3	5
2nd Station	10-Aug-09	7:30:57	17:08:48	9.63	1	1	6
Station 07		7:12:56	16:53:14	9.67	1	1	10
South Station		9:27:52	18:37:12	9.16	6	3	6
1st Station	11-Aug-09	8:48:55	15:36:14	6.79	3	0	3
2nd Station		7:54:38	8:14:02	0.32	0	0	1
Odoptu Station	12-Aug-09	8:08:03	10:34:28	2.44	0	0	1
North Station		7:51:28	10:35:57	2.74	1	1	2
2nd Station	15-Aug-09	9:25:27	17:50:01	8.41	3	1	8
Station 07		9:04:11	18:00:08	8.93	0	1	8
Station 07	24-Aug-09	16:28:26	17:57:34	1.49	0	0	2
South Station	25-Aug-09	8:46:04	18:04:38	9.31	8	1	7
1st Station		8:03:51	18:40:36	10.61	6	3	7
Station 07	26-Aug-09	7:13:05	12:31:23	5.31	4	0	2
Odoptu Station		7:31:26	12:30:06	4.98	1	1	1
Station 07	28-Aug-09	12:47:08	18:21:17	5.57	2	1	6
Odoptu Station		13:12:46	18:27:51	5.25	3	0	0
2nd Station	29-Aug-09	14:07:48	16:00:57	1.89	1	0	0
Station 07		13:08:38	14:52:03	1.72	1	0	2
Odoptu Station	31-Aug-09	7:56:45	14:06:06	6.16	2	0	5
North Station		8:02:29	13:45:23	5.72	1	0	5
South Station	1-Sep-09	8:52:51	18:44:41	9.86	6	0	3
1st Station		8:19:02	19:07:28	10.81	6	2	6
2nd Station	2-Sep-09	8:07:08	18:47:16	10.67	7	3	5
Station 07		7:57:31	19:01:19	11.06	5	1	11
Odoptu Station	3-Sep-09	8:04:03	13:26:09	5.37	1	1	4
North Station		7:45:55	13:26:54	5.68	1	0	4
2nd Station	4-Sep-09	8:00:42	18:05:44	10.08	9	2	8
Station 07		7:36:45	18:52:05	11.26	8	4	9
South Station	5-Sep-09	11:09:07	12:24:37	1.26	0	0	0
1st Station		8:48:57	11:38:08	2.82	0	0	0
South Station	12-Sep-09	10:37:12	17:21:27	6.74	4	1	7
1st Station		8:51:30	18:37:23	9.77	7	4	6
2nd Station	13-Sep-09	8:24:56	13:58:32	5.56	4	1	1
Station 07		8:00:26	13:41:48	5.69	2	1	1
Odoptu Station	14-Sep-09	9:12:44	18:10:53	8.97	2	1	7
North Station		9:17:45	17:45:50	8.47	1	0	9
1st Station	15-Sep-09	8:29:49	10:32:25	2.04	2	0	0
South Station	18-Sep-09	9:27:38	10:26:18	0.98	1	0	1
1st Station		8:39:01	10:43:11	2.07	2	0	1
TOTAL				412.47	177	63	256