Classification: **Restricted** **BM Code: EP.17.03.07**

Issue Purpose **Approved for Use** **April, 2006**

Sakhalin Energy Investment Company LTD.

STATUS OF BENTHOS AND FOOD SUPPLIES IN FEEDING AREAS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2005

Document Number: 0000-S-90-04-T-8079-04-E
Revision 01

Document History

Filename 0000-S-90-04-T-8079-04-E

Date	Issue	Custodian	Process Owner	Authoriser	Consulted	Distributed
21-04-06	01	Lisanne Aerts	Andrew J.Pearce	Andrew J.Pearce		
		AJP	AJP	AJP		

Revision Details

Rev	Location of Change	Brief Description of Change
01		Approved for Use.

STATUS OF BENTHOS AND FOOD SUPPLIES IN FEEDING AREAS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2005

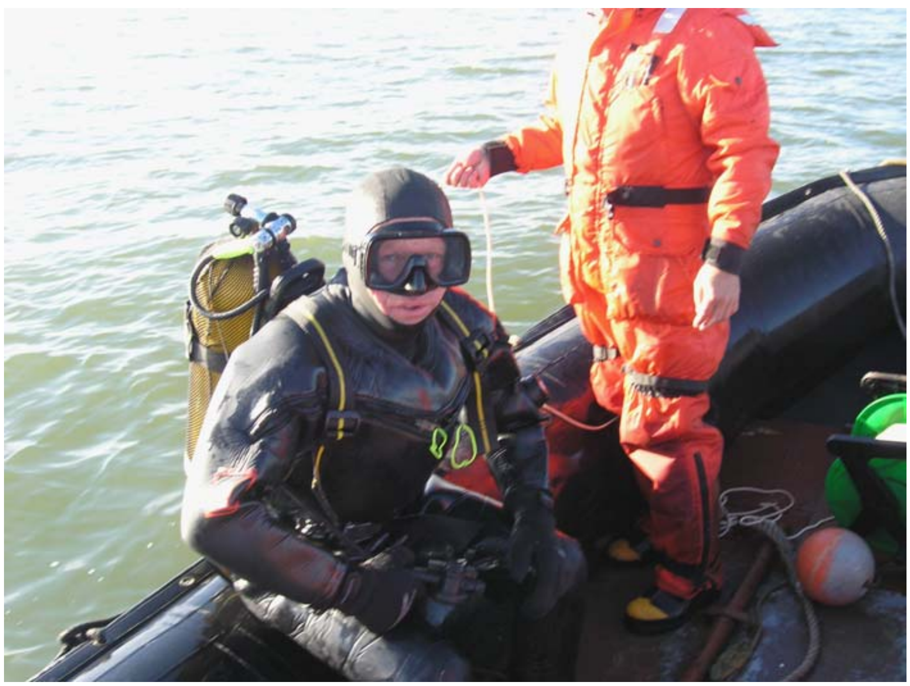
(BASED ON RESULTS OF BOTTOM GRAB STUDIES ON STANDARD TRAVERSES

V. I. FADEEV

MARINE BIOLOGY INSTITUTE OF THE FAR EAST BRANCH OF THE RUSSIAN ACADEMY OF SCIENCES (IBM DVO RAN)

VLADIVOSTOK

[e-mail: vfadeev@mail.primorye.ru]



Diving work from a Zodiac motor launch in August 2005

VLADIVOSTOK
2006

F A R   E A S T   B R A N C H   O F   T H E
R U S S I A N   A C A D E M Y   O F   S C I E N C E S

MARINE BIOLOGY INSTITUTE

APPROVED BY:
Director, Marine Biology Institute of the Far East
Branch of the Russian Academy of Sciences,
Corresponding Member of RAS

___________ A. V. Adrianov

REPORT
ON SCIENTIFIC RESEARCH

STATUS OF BENTHOS AND FOOD SUPPLIES
IN FEEDING AREAS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2005

(BASED ON RESULTS OF BOTTOM GRAB STUDIES ON STANDARD TRAVERSES)

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

VLADIVOSTOK
2006

FAR EAST BRANCH OF THE
RUSSIAN ACADEMY OF SCIENCES

MARINE BIOLOGY INSTITUTE

APPROVED BY:
Director, Marine Biology Institute of the Far East
Branch of the Russian Academy of Sciences,
Corresponding Member of RAS
A. V. Adrianov

REPORT
ON SCIENTIFIC RESEARCH

STATUS OF BENTHOS AND FOOD SUPPLIES
IN FEEDING AREAS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2005

(BASED ON RESULTS OF BOTTOM GRAB STUDIES ON STANDARD TRAVERSES)

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

VLADIVOSTOK
2006

TABLE OF CONTENTS

LIST OF FIGURES II
LIST OF TABLES III
LIST OF PHOTOGRAPHS III
LIST OF APPENDICES III
INTRODUCTION 1
MATERIALS AND METHODS 4
1. Materials and Methods for Field Studies 4
1.1. Material 4
1.2. Field Study Methods 9
2. Laboratory Analysis of Materials 9
2.1. Analysis of Particle Size Distribution of Bottom Sediments 9
2.2. Analysis of the Concentrations of Heavy Metals, Petroleum Hydrocarbons and Organochlorine Pesticides in Bottom Sediments 11
2.3. Analysis of Benthos Samples 13
RESULTS AND DISCUSSION 16
3. Characteristics of Water Column and Bottom Sediments 16
3.1. Distribution of Water Temperature and Salinity during the Study Period 16
3.2. Particle Size Distribution of Bottom Sediments in the Areas 20
3.3. Classification of Stations According to Similarity of Particle Size Distribution 27
3.4. Particle Size Distribution of Bottom Sediments at Gray Whale Feeding Sites 30
3.5. Concentrations of Petroleum Hydrocarbons, Heavy Metals and Organochlorine Pesticides (OCP) 31
4. Benthos Composition and Quantitative Distribution in the Areas 35
4.1. Piltun area 35
4.2. Offshore Area 55
Note: Abbreviated names of complexes used in Figure 23 are given in parentheses. 59
4.3. Benthos at Gray Whale Feeding Sites 66
CONCLUSIONS 71
ACKNOWLEDGMENTS 76
REFERENCES 77
APPENDICES

LIST OF FIGURES

Figure 1. Bottom grab station locations on two traverses in 2005...8
Figure 2. Water temperature distribution (T° C) of the surface water layer in the Piltun (A) and Offshore (B) areas in September 2005...18
Figure 3. Distribution of depths (m) in the Piltun area. 21
Figure 4. Distribution of bottom sediment fractions (% of dry sediment weight) in the Piltun area: gravel-pebble fraction (A; > 1 mm). 21
Figure 5. Distribution of bottom sediment fractions (% of dry sediment weight) in the Piltun area: coarse sand (B; 0.5 – 1 mm); medium sand (C; 0.25 – 0.5 mm). 22
Figure 6. Distribution of bottom sediment fractions (% of dry sediment weight) in the Piltun area: fine sand (D; 0.1 – 0.25 mm); aleurite (E; < 0.1 mm). 23
Figure 7. Distribution of depths (m) in the Offshore area. 24
Figure 8. Distribution of bottom sediment fractions (% of dry sediment weight) in the Offshore area: gravel-pebble fraction (A; > 1 mm). 24
Figure 9. Distribution of bottom sediment fractions (% of dry sediment weight) in the Offshore area: coarse sand (B; 0.5 – 1 mm); medium sand (C; 0.25 – 0.5 mm). 25
Figure 10. Distribution of bottom sediment fractions (% of dry sediment weight) in the Offshore area: fine sand (D; 0.1 – 0.25 mm); aleurite (E; < 0.1 mm). 26
Figure 11. Classification of 2005 stations according to the 10-fraction sediment composition in the areas. 29
Figure 12. Distribution of petroleum hydrocarbon concentrations (μg/g) in bottom sediments in the Piltun and Offshore areas in 2005...32
Figure 13. Locations of benthic grid sampling stations in the Piltun area in 2005. 1 – bottom grab sampling stations on standard grid; 2 – bottom grab sampling stations marked as Z on 20-meter isobath; 3 – diving transects. 38
Figure 14. Variation in total benthos biomass (g/m^2) with depth of 5 benthos groups in the Piltun area in 2005. 39
Figure 15. Variation in the proportion of the total biomass (in %) of 5 benthos groups with depth in the Piltun area in 2005. 39
Figure 16. Isopod biomass distribution (g/m^2) in the Piltun area according to materials from 2004 (A) and 2005 (B)...42
Figure 17. Amphipod biomass distribution (g/m^2) in the Piltun area based on materials from 2004 (A) and 2005 (B)...45
Figure 18. Sand lance biomass distribution (g/m^2) (A) and total macrobenthos biomass in 2005 (B) in the Piltun area...50
Figure 19. Distribution of complexes in the Piltun area based on 2002-2005 data. 52
Figure 20. Dendrogram of the similarity of stations in the Piltun area based on collections from 2002-2005. 52
Figure 21. Diagram of benthic sampling stations in the Offshore area in 2005. 56
Figure 22. Dendrogram of the similarity of stations in the Offshore area in 2002-2005 according to macrobenthos structure. 58
Figure 23. Distribution of benthic complex in the Offshore area in 2004-2005. The numbers of the complexes are given in Table 14. 62
Figure 24. Proportion of ampeliscid amphipods in the total benthos biomass in the Offshore area based on 2005 data. 62
Figure 25. Ampeliscid amphipod biomass distribution (g/m^2) in the Offshore area in...........64
Figure 26. Chart of the locations of gray whale feeding sites studied in 2002-2005 and the distribution of feeding sites by depths in the Piltun area in 2002-2005..........................69

LIST OF TABLES

Table 1. Description of Materials Collected in 2005. 6
Table 2. Distribution of stations in the Piltun area by depths in collections from 2005 and 2001-2004. 7
Table 3. Classification of bottom sediments used in the report (Bezrukov and Lisitsin, 1960; Shepard, 1976). 10
Table 4. Water surface layer temperatures (°C) in 2005 and 2004. 16
Table 5. Characteristics of sediment groups in Piltun and Offshore areas. 28
Table 6. Characteristics of sediment groups at whale feeding sites. 30
Table 7. Organochlorine pesticide concentrations (ng/g) in bottom sediments at 4 stations in the Piltun area. 33
Table 8. Heavy metal concentrations in the area of the Piltun – Astokh field based on published data* and in the study area. 34
Table 9. Concentrations of DDT and its metabolites (∑DDT), α- and γ-isomers of hexachlorocyclohexane (∑HCH) and petroleum hydrocarbons in bottom sediments of different areas of the Gulf of Peter the Great (Sea of Japan) and the study area. 34
Table 10. Macrobenthos biomass distribution (g/m^2) in the Piltun area for 4 depth categories in 2004 and 2005 and for the entire area in 2003, 2004 and 2005. 37
Table 11. Composition of benthos complexes of the Piltun area. 51
Table 12. Frequency of occurrence of benthos taxonomic groups in the Offshore area. 55
Table 13. Macrobenthos biomass distribution (B, g/m^2) in the Offshore area based on materials from 2004-2005 field work. 57
Table 14. Quantitative characteristics (g/m^2) of macrobenthos complexes in the Offshore area based on materials from 2002-2005 59
Table 15. Benthos Colony Density (A, spec./m^2) and Biomass (B, g/m^2) at Gray Whale Feeding Sites in the Offshore area in 2005. 70

LIST OF PHOTOGRAPHS

Photo 1. Large isopods *Saduria entomon* (Is) and young crabs *Hyas coarctatus* (De2) in a bottom grab sample from the sand dollar zone. 41
Photo 2. Sand lance *Ammodytes hexapterus* in a sample from a gray whale feeding site in 2005 49
Photo 3. Bottom grab sample (0.2 m^2) from *Amphipoda* complex. 53
Photo 4. Bottom grab sample (0.2 m^2) from sand dollar complex. 53
Photo 5. Bottom grab sample (0.2 m^2) from the cumacean and ampeliscid complex. 65
Photo 6. Bottom grab sample (0.2 m^2) with bivalve mollusks and ampeliscids. 65

LIST OF APPENDICES

APPENDIX 1. ADDITIONAL FIGURES 84
APPENDIX 2. Sampling log for July-October 2005 for the expedition of the Institute of Marine Biology of the Far East Branch of the Russian Academy of Sciences aboard the research vessel *Academic Lavrentiev and Academic Oparin* 94
APPENDIX 3. Granulometric Composition of Bottom Sediments. 105
APPENDIX 4. Concentrations of Petroleum Hydrocarbons (mcg/g dry sediment) and 10 Toxic Metals (mcg/g dry sediment) in Bottom Sediments of the Piltun and Offshore areas based on 2005 Field Study Results. 115

APPENDIX 5. Taxonomic List of Benthic and Nektobenthic Species Observed in the Piltun and Offshore areas in 2001-2005. 117
APPENDIX 6. Quantitative Characteristics of Benthos at Stations in the Piltun area (colony density - A, spec./m^2; biomass - B, g/m^2). 124
APPENDIX 7. Quantitative Characteristics of Benthos at Stations in the Offshore area (colony density - A, spec./m^2; biomass - B, g/m^2). 127
APPENDIX 8. Quantitative Characteristics of Benthos at Gray Whale Feeding Points in the Piltun area (colony density - A, spec./m^2; biomass - B, g/m^2). 130

INTRODUCTION

General overview[1]. We know that two independent gray whale (*Eschrichtius robustus*) populations (LeDuc et al., 2002) reside in the Pacific Ocean: the eastern or California-Chukotka population, which reached a size of about 18,000 animals in 2001 (Rugh et al., 1999; Le Boeuf et al., 2000; Rugh, 2003), and the western Pacific or Korean-Okhotsk population, numbering over 100 animals (Yakovlev and Tyurneva 2006).

After commercial whaling was halted during the 1940's, the eastern gray whale population has fully recovered, although its estimated size decreased from 26,000 in 1998 (Rugh et al., 1999) to 18,000 in 2001 (Rugh, 2003). Despite the fact that an increase in the death rate, a low birth rate and deterioration of the physical condition of some of the animals were observed in the eastern population in 1999 and 2000 (Moore et al., 2001), the status of the population was reasonably stable due to its large size (LeBoeuf et al., 2000).

In contrast to the eastern population, the Korean-Okhotsk gray whale population has never been large and according to the estimates of experts did not exceed 2,000 – 2,500 thousand individuals at its peak (Berzin, 1974; Yablokov and Bogoslovskaya 1984). Many years of whaling brought the population to the brink of extinction, and it was only in the early 1970's that gray whales began to be sighted off northeastern Sakhalin (Berzin, 1974; Brownell and Chun, 1977; Blokhin et al., 1985). A 40-year ban on whaling (beginning in the 1960's) failed to produce a substantial recovery of the whale population. According to optimistic estimates, the whale population numbers between 100 and 250 animals, although most researchers estimate the population as not more than 100 whales (Blokhin, 1996; Blokhin and Burdin, 2001; Vladimirov, 2000; Sobolevsky, 1999, 2000; Sobolevsky, 2000, 2001; Weller et al., 1999, 2000, 2001, 2002, 2004). In 2005 however, 113 individual whales were photographed in a photo ID program (Yakovlev and Tyurneva, 2006), indicating that the population contains more than 100 individuals. It has been hypothesized that there are fewer than 50 remaining individuals capable of reproduction (Weller et al., 2001). The low reproduction rate, genetic uniqueness (LeDuc et al., 2002) and small overall size of the Korean-Okhotsk gray whale population (Weller et al., 2000; Vladimirov, 2000) have

[1] Since the history of benthos studies and data on the benthos distribution in the Eastern Sakhalin area and on the feeding of the California-Chukotka gray whale population have been analyzed and summarized in detail in the report: Kusakin, O. G., E. I. Sobolevsky and S. A. Blokhin. Survey of Benthos Studies on the Northeastern Sakhalin Shelf. Interim Report of the Marine Biology Institute of the Far East Branch of the Russian Academy of Sciences (IBM DVO RAN) and the Pacific Research Institute of Fisheries and Oceanography (TINRO). Vladivostok, 2001, 89 pp., we have not undertaken a survey of the literature on these issues in this section. We shall merely cite published data in a discussion of the results and elsewhere as necessary, especially since the report (Kusakin et al., 2001) is available on the website www.sakhalinenergy.com.

prompted inclusion of the species in category I of the IUCN Endangered Species List (USFWS, 1997; Hilton-Taylor, 2000; Weller and Brownell, 2000) and the Russian Federation Red Book (2000).

The startup of offshore commercial oil and gas development on the eastern Sakhalin Shelf in the mid-1990's necessitated comprehensive study of the Western Pacific gray whale population to assess the possible anthropogenic impact on the population and to develop approaches to minimize the effects of negative factors (Berzin and Vladimirov, 1996; Vladimirov, 2000). In particular, in development of the joint declaration of the Gore-Chernomyrdin Commission "On Measures to Ensure the Preservation of Biodiversity in the Sakhalin Island Area" dated 7 February 1997, in connection with the development of oil and gas fields on the island shelf, the Russian and American sides in 1998 prepared a joint "Korean-Okhotsk Gray Whale Population Monitoring and Research Program," which was approved by the State Committee on Environmental Protection (Goskomekologiya) of Russia and the U. S. Fish and Wildlife Service (Weller et al., 2001). The program proposed multidisciplinary studies of the Okhotsk-Korean population during the whales' feeding season off eastern Sakhalin: abundance and distribution surveys, acoustic studies, and a study of benthos as the key component in the diet of gray whales.

In 2001, 10 diving transects were sampled in the northeastern Sakhalin coastal zone in an area from Niyskiy Bay in the south to Tront Bay in the north. Four transects were sampled in the traditional Piltun gray whale feeding area – the area of Piltun Bay. It was demonstrated that at depths of 5 to 15 m, this area is characterized by a great abundance of forage benthos, primarily amphipods and isopods (Fadeev, 2002).

Until recently, the Piltun area was considered the only gray whale feeding area off the east coast of Sakhalin Island during the summer and fall period, although small groups of animals were also sighted at a considerable distance from shore and at significant depths (Sobolevsky, 1999; Miyashita et al., 2001). On 10 September 2001, however, observers M. Maminov and Y. Yakovlev, while working aboard a seismic research support vessel, observed seven gray whales feeding out to sea from Chayvo Bay. The aerial and vessel-based surveys of the area that followed resulted in the discovery of a second gray whale feeding area (the Offshore area) (Maminov and Yakovlev, 2002). The area is located on a line from the middle part of Chayvo Bay to the southern part of Niyskiy Bay 20-45 km from the latter in a depth zone of 30-65 m. In 2001, whales were present there from September to November (Blokhin et al., 2002), and the counts varied from 48 to 83 animals.

A work scope was developed in 2002 for a multidisciplinary study of gray whales, both in the well-known shallow-water feeding area (the Piltun area off Piltun Bay) and the new deep-water area (the Offshore area). The field phase of the work was conducted in 2002-2005 (Fadeev, 2003, 2004, 2005) within the scope of three expeditions aboard the seagoing tug *Nevelskoy* and the research vessel *Akademik Oparin*. The array of studies included gray whale prey/benthos surveys.

The first data obtained in 2002 on the benthos composition and distribution in the Offshore area indicated that gray whales feed there in areas of ampeliscid amphipod dominance (Fadeev, 2003). *Ampelisca* amphipods are the most common and best known prey in gray whale feeding grounds (Zimushko and Lenskaya, 1970; Blokhin and Pavlyuchkov, 1980, 1996, 1999; Bogoslovskaya, 1996; Zenkovich, 1937; Kusakin et al., 2001; Bogoslovskaya et al., 1981, 1982; Jones and Swartz, 2002; Nerini, 1984; Oliver et al., 1983, 1984). Whales feed in the Piltun area in shallow coastal areas dominated by amphipods that differ from ampeliscid amphipods in both ecology and type of diet (Sobolevsky et al., 2000; Fadeev, 2003, 2004, 2005).

The objective of this survey was to study quantitative distribution and status of benthos in the Piltun and Offshore gray whale feeding area and at feeding sites of individual whales based on field data from 2005 to understand the nature of gray whale distribution and movement in response to prey distribution.

The work was done under the "Korean-Okhotsk Gray Whale Population Monitoring and Research Program" funded by the Sakhalin II (operator: Sakhalin Energy Investment Company Limited (SEIC)) and Sakhalin-1 (operator: Exxon Neftegas Limited (ENL)) projects.

Study Objectives. This report was prepared based on the results of benthos studies conducted, in July-October 2005 on two oceanographic cruises in the coastal waters of northeastern Sakhalin, by expeditions of the Marine Biology Institute (IBM) of the Far East Branch (DVO) of the Russian Academy of Sciences (RAN) aboard the research vessels *Akademik Lavrentyev* and *Akademik Oparin*.

The tasks of the study were:

- to conduct benthos studies in the Piltun and Offshore whale feeding areas by collecting bottom grab samples;
- to study benthos in the near-shore zone (up to a depth of 12 m) of the Piltun traverse using diving equipment and underwater video photography;
- to investigate the benthos composition where gray whales are observed feeding (whale feeding sites);

- to obtain information on the species composition and abundance (colony density and biomass) of individual taxonomic groups and common species of benthos from analysis of macrobenthos collections;
- to assess the composition and abundance of macrobenthos in the whale feeding areas and outside the feeding zones;
- to perform a morphometric analysis of the common species of amphipods to assess the size compositions;
- to obtain data on the particle size distribution of sediments in the feeding areas and whale feeding sites and the concentrations of petroleum hydrocarbons and heavy metals in the bottom sediments; and
- to perform a comparative analysis of the benthos distribution in the Piltun and Offshore areas based on materials from 2005 and 2002-2004.

MATERIALS AND METHODS

1. Materials and Methods for Field Studies

1.1. Material

Timing for performance of the studies. Field work to study benthos and the food supply of gray whales was performed by a field team from the Institute of Marine Biology of the Far East Branch, Russian Academy of Sciences, aboard the research vessels *Akademik Lavrentyev* and *Akademik Oparin* from 17 July to 7 October 2005.

Special features of the field work in 2005. The field work from 2004-2005 differed in certain aspects from the work in 2002-2003. The distinguishing features of the work (increased number of stations at whale feeding sites at depths greater than 15-20 m in the Piltun area and larger numbers of epibenthos and plankton collections at the whale feeding sites) were prompted primarily by the nature of the whale distribution that developed in 2004-2005:

1. In contrast to 2002-2003, gray whales were absent from the Offshore area in July and August 2004-2005. In September 2004 and 2005, a relatively small number of feeding whales were observed, compared with 2002-2003 (48 to 83 animals) were recorded there.

2. The proportion of whales feeding at depths greater than 15 m increased somewhat in the northern part of the Piltun area in 2004-2005. The proportion of such whales was less than 10% in 2002-2003. This difference prompted more detailed study of benthos in the Piltun area at the whale feeding sites at depths greater than 15-20 m and collection of plankton and epibenthos samples at these locations.

In addition, certain features of the studies in 2004 and 2005 were conditioned by the technical characteristics of the field research vessel *Akademik Oparin* (draft 4.5 m). A vessel with a draft of 1.5 m was used in 2002-2003. The deeper draft of the vessel used in 2004-2005 limited the opportunities to collect samples at depths less than 10-12 m. Hence, in 2005, three diving transects were sampled in the Piltun area at depths of 3-12 m from a Zodiac boat in support. A light bottom grab sampler was used for benthos sampling from the Zodiac in 2004 and was not very effective (Fadeev, 2005).

Characteristics of field collections. Two gray whale feeding areas were studied in 2005: 1 – the Piltun area (the near-shore zone in the section from Odoptu Bay to the southern part of Piltun Bay); 2 – the Offshore area (30-45 km from the coastline in the section from the middle part of Chayvo Bay to the southern part of Niyskiy Bay).

A consistent approach was used in planning the locations of benthos stations in the two areas in 2005 and 2002-2004. During planning of the studies in 2002, the waters of the Piltun area were divided into 60 sectors of equal area making up five blocks corresponding to the aerial survey sectors (Yazvenko et al., 2001) (Appendix 1. Fig. P1.1). Within each sector, the locations of the stations were determined according to a random number table in 2002 (60 stations) and 2003 (60 stations). In 2005, with the clients' consent, the decision was made to repeat the station layout from 2004, which was prompted by features of the distribution of some of the whales in 2004-2005 in the northern part of the Piltun area. The stations of 2002 and 2003 were some distance apart, even within the same sector. The distances between the same stations in the same sectors in 2002 and 2003 varied from 0.06 to 5.3 km (2.34±0.18 km, on the average). The station grid from 2003 was repeated in 2004-2005. The accuracy of the vessel's positioning at 2003 stations in 2004-2005 was determined by the navigation conditions and amounted to 110±10 m. In light of the size of the vessel (length 75 m), the accuracy of repeated positioning at 2003 sites in 2004-2005 can be regarded as satisfactory.

During the initial planning of the work in 2002, the waters of the Offshore area were divided into 36 sectors (4 blocks), each with an area of about 115 sq. km (Appendix 1. Fig. P1.2). During the expeditions in 2002 and 2003, there were 36 stations in the Offshore area. The area of individual sectors in the Offshore area is larger than in the Piltun area, and the distances between the same stations of the same sector in 2003 and 2002 accordingly are substantially greater there – from 0.33 to 10.75 km (5.08±0.48 km, on average). In accordance with the statement of work from 2004, the station grid in the Offshore area was expanded eastward (compared to 2002 and 2003) to define the size of the section with the greatest abundance of forage benthos – ampeliscid amphipods. A station grid covering the sample collections of 2002-2004 was repeated in the Offshore area in 2005.

Combined diagrams of the layout of stations in 2002-2004 in the Piltun and Offshore areas are presented in Appendix 1 (Figs. P1.1 and P1.2).

The locations of benthos stations in 2005 are shown in Fig. 1. Bottom grab benthos samples were collected at 203 stations (Table 1). In addition to sampling at standard benthos stations (120 stations), collection of benthos (83 stations, 249 samples) and epibenthos and plankton (106 samples) was performed at gray whale feeding sites. The following samples were taken to study the characteristics of bottom sediments: 185 samples to determine the particle size distribution of the sea bottom, and 60 samples to assess the concentrations of heavy metals and petroleum hydrocarbons.

A complete record of the samples, including coordinates and water temperature and salinity characteristics is given in Appendix 2 (Table P2.1).

Table 1. Description of Materials Collected in 2005.

Area	Van Veen bottom grab sampler	Diving collections	Epibenthic net	Bongo plankton net
	Stations (samples)	Stations (samples)	samples	samples
Piltun area	72/229	15/60	0	0
Offshore area	48/144	0	0	0
Whale feeding sites	83/249	15/68	42	64
Total	**203/622**	**30/128**	**42**	**64**

As in 2002-2004, bottom grab sample collections in 2005 were taken from aboard the vessel, which imposed restrictions on the minimum depth for benthos collection. Specifically, this limited the opportunity to study the most abundant sections of the Piltun area at depths of 5-15 m. The shallowest depths for bottom grab sample collections from the vessels were 11 m in 2002, 8 m in 2003 and 11 m in 2004 (Table 2).

Table 2. Distribution of stations in the Piltun area by depths in collections from 2005 and 2001-2004.

Depth Range	Number of Stations				
	2005	2004	2003	2002	2001
1 - 5 m	**6**	6	0	0	5
6 -10 m	**7**	7	10	0	5
11-15 m	**15**	6	19	16	5
16-20 m	**12**	13	7	13	5
21-25 m	**27**	14	12	18	5
26-30 m	**15**	13	10	11	5
31-35 m	**5**	5	5	2	0
Total	**87**	64	63	60	30

As indicated by diving data from 2001 (Fadeev, 2002) and 2003 (Fadeev, 2004), the sections of the Piltun area with the most abundant food organisms are at depths up to 15-20 m. Therefore, in 2004 bottom grab sample collection was performed on three transects in a depth range of 3-12 m from a Zodiac. The south transect was located in direct proximity to the diving transects of 2001 and 2003. Dives were made on three transects in the depth range of 3-12 m in 2005 in accordance with the statement of work for more detailed study of benthos in the shallow whale feeding zone in the Piltun area (Table 2).

Benthos collections were taken at 7 stations in the Piltun area (with the highest prey biomass) at the start (July) and end of the expedition (late September) to study the size composition and assess the growth rates of common amphipod species. To assess the macrodistribution of forage macrobenthos and its relationship to hydrological conditions, a transect of 14 stations running from the southernmost (Piltun Lighthouse) to the northernmost part (Odoptu) of the Piltun area in a depth range of 20-25 m was studied. Three bottom grab samples were taken at each station, and an oceanographic profile was made from the water surface to the bottom using a VTS-hydrological probe (England). From 6 to 10 bottom grab samples were taken in sequence as the vessel drifted at 3 stations in the Piltun area to study the micro- and mesodistribution of forage macrobenthos. The position of each bottom grab sampler at the moment of contact with the seabed was recorded by GPSMAP, allowing computation of the distance between samples and accordingly to assess the aggregation and size of prey patches.

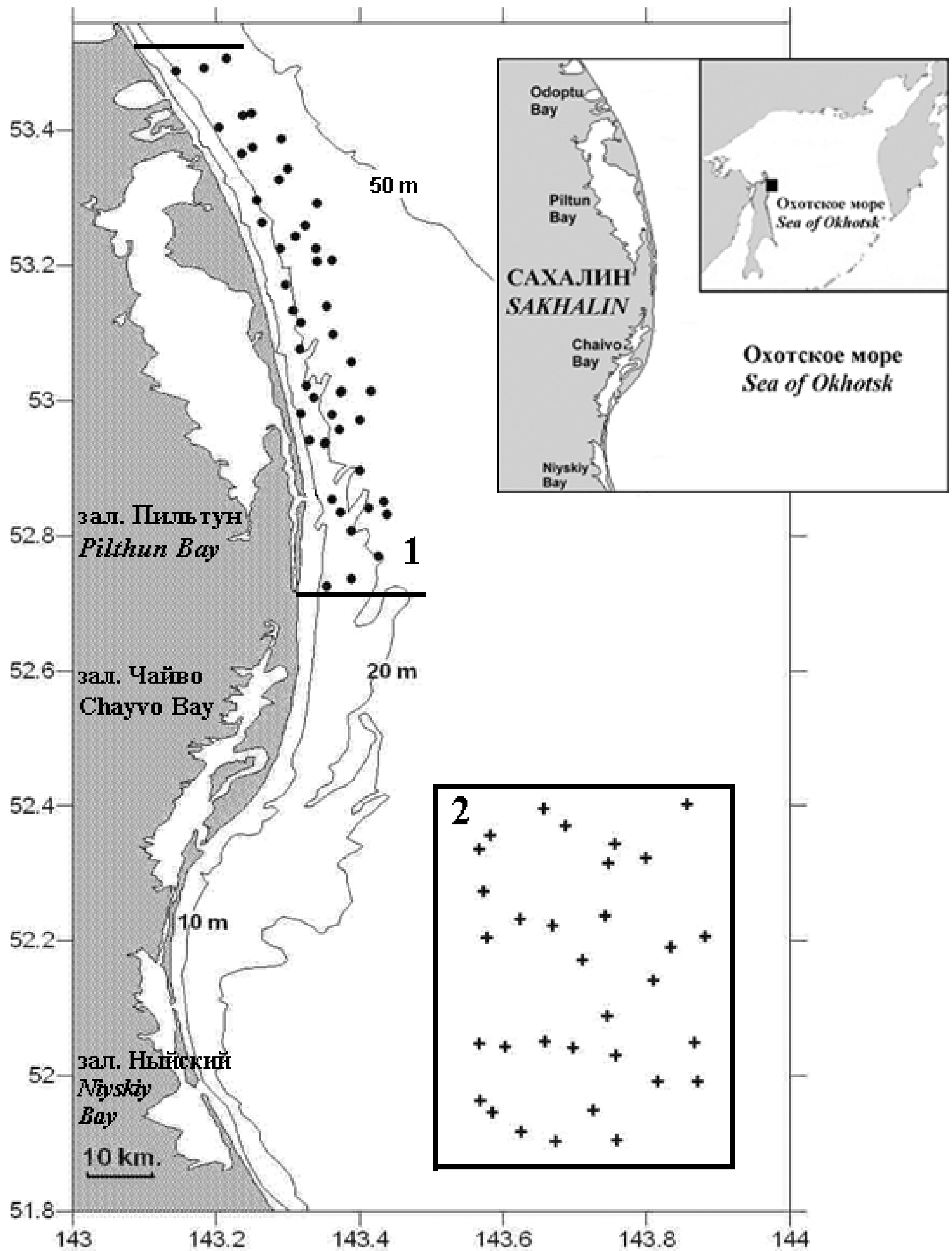


Figure 1. Bottom grab station locations on two traverses in 2005.

1 – stations in the **Piltun area**;

2 – stations in the **Offshore area**.

1.2. Field Study Methods

All benthos sampling from the vessel on the expedition was performed with a Van Veen bottom grab sampler (grab area 0.2 m^2, weight 57 kg). Three replicate samples were taken at each station. Before the start of grab sampling, an underwater video recording was made of the water column and the bottom surface at each station to obtain information on the presence of plankton accumulations in the water column or of epibenthos in the bottom water layers. An *epibenthic net* with an area of 0.25 m^2 was used to assess the quantity and composition of epibenthos, and a double *Bongo net* was used for plankton. Underwater video was taken of the water column and the bottom surface at each station, the location was recorded by GPS, and the depth, water surface and bottom temperature and salinity were recorded. The water temperature and salinity were measured at depths up to 20 m with a MultiLine P4 hydrologic probe (Germany) and at deeper levels with the VTS probe (England).

Aboard the vessel, the *macrobenthos* samples were washed on a washing table through a system of three sieves – 5 mm (to remove coarse bottom fractions and large animals – flat sea urchins and mollusks), 1 mm, and 0.5 mm (the bottom sieve) – and fixed with 4% formalin. Then all the benthos and epibenthos samples were transferred to 75% alcohol. The washed benthos samples were photographed with an Olympus digital camera. To analyze the *particle size distribution* and the concentrations of *petroleum hydrocarbons* and *heavy metals*, a sample was taken from the surface sediment layer using a Teflon pipe sampler. The samples were placed in plastic packets and special dishes and left in a cooler until they could be sent to the laboratory for analysis.

2. Laboratory Analysis of Materials

2.1. Analysis of Particle Size Distribution of Bottom Sediments

<u>The particle size distribution of bottom sediments</u> was analyzed at the *Shelf Problems Laboratory of the Far East State University* (DVGU) by two standard Russian methods: screen and areometric. The analysis determined the percentage concentrations in the sea bottom of fractions of the following sizes: larger than 10 mm; 10-5; 5-2; 2-1; 1-0.5; 0.5-0.25; 0.25-0.1; 0.1-0.05; 0.05-0.01; 0.01-0.005; and smaller than 0.005 mm. The moisture content (W) and specific gravity of the bottom soil samples were determined preliminarily by the standard Russian method. The bottom sample was then dried and sifted through a set of

sieves with mesh sizes of 10, 5, 2 and 1 mm. The soil fractions remaining on the sieve and the fraction that passed through the sieve with a 1 mm mesh were weighed. The sediment that passed through the sieve with a mesh size of 1 mm was transferred to a porcelain cup that had been weighed in advance and then was weighed. The soil sample was poured into a flask with a capacity of 1000 cm^3, which was then filled with distilled water (approx. 300 ml). The soil with water added was allowed to stand for one day. After standing for a day, 1 cm^3 of a 25% ammonia solution was added to the sample, and the flask with the sample was boiled for one hour and then cooled to room temperature. The suspension obtained was poured into a 1-liter glass cylinder through a sieve with a mesh size of 0.1 mm. The soil particles left in the sieve with a mesh size of 0.1 mm were dried, sifted through a set of sieves with mesh sizes of 0.5, 0.25 and 0.1 mm, and then weighed separately. The suspension was agitated for one minute, until the sediment was stirred up completely from the bottom of the cylinder. An areometer was introduced, and its readings were determined one minute after the agitation stopped for the fraction smaller than 0.05 mm, after 30 minutes for the fraction smaller than 0.01 mm, and after three hours for the fraction smaller than 0.005 mm. The Classification of sediments according to particle size composition (Table 3) has been used to designate soil types.

Table 3. Classification of bottom sediments used in the report (Bezrukov and Lisitsin, 1960; Shepard, 1976).

Sediment Group	Types of Sediments	Abbreviation in Text	Predominant Particle Size, mm	Md, mm
Coarsely fragmented (psephites)	Pebbles	Peb	>10	
Coarsely fragmented (psephites)	Gravel: Coarse Medium Fine	 Grc Grm Grf	 10-5 5-2 2-1	
Sandy (psammites)	Sands: Coarse Medium Fine	 Sc Sm Sf	 1-0.5 0.5-0.25 0.25-0.1	 1-0.5 0.5-0.25 0.25-0.1
Silt (aleurites)	Coarse aleurites Fine aleurite silt	Ac Af	0.1-0.05 0.05-0.01	0.1-0.05 0.05-0.01
Clay (pelites)	Coarse pelite	Pec	<0.01	0.01-0.005

Note: Md, mm, is the median diameter of the soil particles. Numbers in the column are the range of values for the type of sediment in question.

2.2. Analysis of the Concentrations of Heavy Metals, Petroleum Hydrocarbons and Organochlorine Pesticides in Bottom Sediments

Heavy metals. The concentrations of iron, zinc, chromium, copper and lead were measured on a Nippon Jarrell-Ash AA-855 atomic absorption spectrophotometer. A single-slot burner was used as the atomizer, with an acetylene-air gas mixture. A deuterium lamp was used for background correction. The test sensitivity (μg/ml) was 2 for iron; 0.02 for zinc; 0.005 for copper; and 0.02 for chromium. Aluminum and barium concentrations were measured with an acetylene-nitrous oxide gas mixture. The test sensitivity was 2 μg/ml for aluminum and 1 μg/ml for barium. Cadmium, lead and arsenic concentrations were determined on a Hitachi 170-70 atomic absorption spectrophotometer with a graphite-tube atomizer. Zeeman effect background correction was used. The test sensitivity (μg/ml) was: 0.0002 for cadmium; 0.005 for lead; and 0.02 for arsenic. Mercury concentrations were determined by the flameless atomic absorption method using a Hiranuma Hg-1 microanalyzer. The test sensitivity was 0,0001 μg/ml.

The samples were prepared for atomic absorption analysis by accepted Russian methods, namely the procedures developed by the Azov Fishery Research Institute (RD-15-229-91 – Cd; RD-15-241-91 – Cu; RD-15-227-91 – As; RD-15-231-91 – Pb; RD-15-228-91 – Cr; RD-15-232-91 – Hg), as follows: bottom sediment samples were dried at 105°C. A 1 g specimen weighed with an accuracy of 0.01 g, was transferred to a glass beaker, and 10 ml of concentrated HNO_3 was added. The beaker was kept at room temperature for 24 hours, after which 5 ml of double distilled H_2O was added, and the beaker was heated at 120 °C for three hours (during which the beaker was covered with watch glass). Then 3 ml of concentrated $HClO_4$ was added to the cooled solution, and the mixture was heated at 180 °C until HCl vapor appeared. The residue was filtered and brought up to a volume of 25 ml with double distilled H_2O in a measuring flask. Acid-soluble forms of the heavy metals (with the exception of mercury) were determined in the mineralization product.

Samples were prepared as follows for mercury assay: 1 g of a carefully homogenized specimen with natural moisture content was treated with 50% sulfuric acid and 6% potassium permanganate, with subsequent reduction of mercury with stannous chloride, according to the procedure "Determination of Total Mercury in Bottom Sediments by the Flameless Atomic Absorption Method," RD-15-226-91, developed by the Azov Fishery Research Institute.

The laboratory glassware used in the decomposition process was washed with diluted nitric acid and rinsed three times with double distilled water.

The concentrations of zinc, copper, chromium, iron, barium, cadmium, lead, arsenic and aluminum (C, μg/g) were computed by the formula:

$$C = X*V/P, \text{ where}$$

X – concentration of the target element in the final sample solution, μg/ml;

P – sample weight, g (dry);

V – final sample solution volume, ml.

The mercury concentration in the sample (C, μg/g dry mass) was computed by the formula:

$$C = X/P, \text{ where}$$

X – mercury concentration in the sample in question (μg/l).

P – sample weight, g (dry).

Upon arrival of the bottom sediment samples, they were checked for possible contamination due to unsealing of the packaging, as well as for the acceptability of the transfer conditions, and were checked for adequate sample size, after which the sample labels were checked against the accompanying documents. The sample characteristics were logged. The samples were prepared for analysis according to the procedures described above. The standard solutions used were solutions prepared from reference specimens of metals listed in the State Registry of Measures which had passed GSORM official tests.

Every spectrophotometer used had passed initial calibration according to the manufacturer's instructions. Before the analyses of bottom sediment samples, three-point calibration of the instruments was performed, and the linearity of response factors for each of the metals to be measured was checked. The relative standard deviations for the initial calibration and the subsequent calibrations were within limits of 3 to 5%. Three control samples were prepared for each procedure for sample preparation for atomic absorption assays of metals.

Chlorinated pesticides. The sediments were dried at 70 °C and analyzed for concentrations of chlorinated hydrocarbons (*p,p'*-DDT , *p,p'*-DDD and *p,p'*-DDE, and α- and γ-isomers of HCH). Chlorinated hydrocarbons were analyzed by gas-liquid chromatography according to the standard procedures of the Russian Meteorological Service (Guide 1979; Methodological Guidelines 1996) on an LSM-8 gas chromatograph with a glass column (1 m × 3 mm, stationary phase SE–30, column temperature 220 °C, detector temperature 250 °C).

The method is based on extracting chlorinated hydrocarbons with a mixture of organic solvents (acetone-hexane), isolating the extracts with sulfuric acid and an aqueous solution of sodium sulfite in the presence of tetrabutyl ammonium (TBA) sulfate, and subsequent determination of the chlorinated hydrocarbons in the concentrated extract by gas-liquid chromatography. The substances are identified according to the retention time relative to DDE. The quantities of the substances are calculated according to the respective peak heights. When polychlorinated biphenyls (PCBs) are present in a sample, they are separated from the organochlorine pesticides (OCP) by alkaline dehydrochlorination (in alcohol solution).

The minimum detectable quantity (MDQ) was 0.3-0.5 ng/g of dry bottom sediment for DDT, DDD and DDE, and 0.1 ng/g of dry sediment for α-HCH and γ-HCH.

Petroleum hydrocarbons. The sediments were dried at 70 °C and analyzed for the total (gross) concentration of petroleum hydrocarbons. Petroleum hydrocarbons were extracted with n-hexane, and their concentration was determined by IR spectrophotometry according to the standard procedures of the Russian Meteorological Service (Guide 1979; Methodological Guidelines 1996).

The method is based on extracting petroleum hydrocarbons from bottom sediment samples with a basic ethanol solution, with transfer of the component under analysis to hexane, removal of extraneous compounds by sorption onto aluminum oxide, replacement of the solvent with carbon tetrachloride, and subsequent measurement of the concentration of petroleum hydrocarbons by IR spectrophotometry. The minimum detectable quantity of petroleum hydrocarbons is 5 μg/g of dry bottom sediment.

2.3. Analysis of Benthos Samples

Laboratory processing of *macrobenthos* consisted of determining the benthos species composition and quantitative characteristics in the sample (biomass and count for each species and for individual taxonomic groups, and total biomass and count of macrobenthos in the sample). A total sorting of the animals was performed. Large organisms were counted visually, and small ones were counted with the MBS-10 binocular microscope. The gross weight of large benthic organisms was determined with a VLKT-100 electronic scale accurate to 10 mg, and the gross weight of small organisms was determined on a torsion scale accurate to 1 mg. Before weighing, the organisms were dried on filter paper for one minute. Afterward, specific biomass per square meter was calculated based on the capture area of the sampler and rounded to 0.01 g. The average biomass error was determined with the same degree of accuracy. The colony density of organisms per square meter was also calculated and rounded to the nearest whole number.

For colonial animals (*Hydroidea, Bryozoa, Spongia*), the number of individual colonies was counted; when it was not possible to determine the number of colonies without ambiguity (presence of fragments of colonies, aggregation of colonies, etc.), the number was indicated by a question mark "?" in the table. Taxonomic identification of the species in the sample collections was performed by various qualified expert taxonomists[2] with many years' experience with the animal group in question. In cases where the species was represented by juvenile individuals (young without clear taxonomic features), i.e., it was not possible to identify the species, the designation *sp. juv.* was used for the taxon name. It was impossible to identify the species in some cases due to severe damage; in that case, the designation *sp.* was used for the taxon name.

The index "frequency of occurrence of the species" (P, %) – the ratio of the number of quantitative samples in which the species was encountered to the total number of quantitative samples in the area, expressed as a percentage – was used to assess the rate of occurrence (incidence) of species in the sandy bottom sediment. This index is important primarily as a characteristic of food organisms, since it characterizes their availability to the consuming species.

Traditional single-factor methods as well as the methods of multidimensional statistical analysis, including classification and ordination methods (Afifi and Eyzen, 1982) using the statistical software package Statistica 6.0 (Borovikov, 2001) and Primer v5 (Clarke and Gorley, 2001), were used to describe the communities. A tetragonal data matrix in the form of a list of benthic species for each station, with quantitative characteristics of the species, served as the primary basis for the analysis. The Bray-Curtis similarity coefficient for each pair of samples was calculated based on the data matrix. Dendrograms were constructed by the mean-link method (Clarke and Green, 1988; UNEP; 1995). Quantitative characteristics of benthos (abundance and biomass) normally have an empirical distribution that differs from the norm. Therefore, in comparison of samplings using parametric criteria,

[2] The following associates of the IBM DVO RAN, the DVGU and the Zoological Institute of the Russian Academy of Sciences (ZIN RAN) took part in the taxonomic processing of the main groups: Candidate of Biological Sciences L. L. Budnikova (Amphipoda), Candidate of Biological Sciences M. V. Malyutina (Isopoda), Candidate of Biological Sciences G. M. Kamenev (bivalve mollusks), Candidate of Biological Sciences V. V. Gulbin (gastropods), Candidate of Biological Sciences E. V. Bagaveyeva (marine worms), Candidate of Biological Sciences S. F. Chaplygina (hydroids), Candidate of Biological Sciences V. N. Romanov (Ascidia), Candidate of Biological Sciences A. V. Chernyshev (nemertines) and doctor of biological sciences V. S. Levin (Apoda).

the source data were transformed based on the nature of the empirical distribution (Elliott, 1977).

The entropic index of sorting of sediments was used to assess the classification of bottom sediment soils. The *entropic index of sorting* of sediments (H_s) was calculated based on the Shannon-Wiener Species Diversity Index (H) by the formula: $H_s = -\sum p_i \times (\ln p_i)$, where p_i is the proportion of the i fraction in the sediment; and n is the number of fractions in the analysis. This measure is independent of the type of distribution function of sediment particles by sizes and is determined solely by the divisibility of the particle size distribution analysis and the fraction size scale selected. The *normalized sorting index* (H_s/H_{max}, where $H_{max} = \ln n$) takes on a value from 0 (ideally graded sediments) to 1 (absolutely nongraded).

For plotting charts of the distribution of the characteristics of bottom sediments and the water column, concentrations of contaminants and indices of quantitative abundance of macrobenthos, standard procedures of the SURFER 7 cartographic system (Surface Mapping System) were used. The cartographic system was used only for illustrating the general nature of the distribution of parameters in the water area studied. Therefore, the “simple planar surface” version of the polynomial regression method was used in calculating isolines. This method produces good results when large-scale trends in the spatial distribution of data need to be identified. The ideology of the method has been described in detail (Draper and Smith, 1981). On the whole, the procedure for taking, processing and analyzing samples was consistent with generally accepted methods (Bilyard and Becker, 1987).

RESULTS AND DISCUSSION

3. Characteristics of Water Column and Bottom Sediments

3.1. Distribution of Water Temperature and Salinity during the Study Period

The water surface layer temperature and salinity were measured in the waters studied during the period from 17 July to 5 October 2005. The water temperature and salinity measurement results from individual stations are presented in Appendix 2, the spatial distribution of water temperature fields in the Piltun and Offshore areas is shown in Fig. 2, and the water salinity distribution is shown in Fig. P1.3.

Surface layer water temperature. During the study period, the temperature of the water surface layer in the Piltun area varied to a significant degree: from 0.5 to 13.2 °C in August and 9 to 14.1 °C in September (Table 4). It was observed during analysis of the materials from 2003 that there was a statistically significant difference in the water temperature in August 2003 and 2001 (Fadeev, 2004). The water temperature was lower in September 2003 than during the analogous period in 2002. The water temperature in the area was 8.78±0.8°C in August 2001 and 4.01±0.82 °C in August 2003. The water temperature in August 2004 was significantly higher than in August 2003 (7.48±0.6 °C compared to 4.01±0.82 °C, respectively). The water temperature in the Piltun area in August 2005 had values similar to August 2004. The water temperature in September 2005 (11.77±0,12°C) was significantly higher than during the corresponding period in 2003 and 2004 (9.87±0.32°C and 8.58±0.1°C, respectively).

Table 4. Water surface layer temperatures (°C) in 2005 and 2004.

Parameter	Piltun area					Offshore area		
	Jul 2005	**Aug 2005**	**Sep 2005**	Aug 2004	Sep 2004	**Aug 2005**	**Sep 2005**	Aug 2004
Average	7.75	8.08	11.77	7.48	8.58	12.4	12.2	10.15
Standard deviation	0.33	0.52	0.12	0.6	0.1	0.34	0.11	0.23
Minimum	2.1	0.5	9	5.1	7.7	11	11	6.7
Maximum	13.2	13.0	14.1	9.2	10.7	14	13	12.4
Observations	57	34	64	43	66	10	37	32

A spot of colder water was observed in the northern part of the Piltun area in 2001-2005, which could have been caused by a persistent upwelling of deep waters in the area (Krasavtsev et al., 2000; Rutenko, 2006). The temperature of the surface water layer in the Offshore area in August 2005 (12.4±0.34°C) was significantly higher than in 2003 and 2004 (7.95±0.27°C and 10.15±0.23°C, respectively). The distributions of temperature and salinity were more regular than in the Piltun area (Figures 2 and P1.3). Zones of reduced salinity are observed in the Piltun area in the estuarine sections of the Piltun and Odoptu lagoons (lowest salinity 15.2 ‰. The salinity of the surface water layer did not drop below 26 ‰ in the Offshore area.

A detailed analysis was performed on seasonal dynamics of water temperature and salinity in August-September 2004 and 2005 in the study area by associates of the Pacific Oceanographic Institute (POI) of the DVO RAN (Borisov et al., 2005; Rutenko, 2006). It was established that temperature and salinity characteristics of the water along Piltun in August and September differ substantially (Fig. 2A). The average characteristics for <u>August</u>:

1. The temperature in the relatively mixed near-shore zone is 5.5 – 8 °C, and the salinity is 28 – 30 ‰. The waters of the shelf water mass are within the 20-meter isobath.
2. A section with depths of 20 – 30 m occupies the shelf front, with a sharper temperature differential of 1 – 8.4 °C and a salinity differential of 28 – 31.5 ‰.
3. Beyond the 30-meter isobath is the impact zone of the water masses of the Sea of Okhotsk, with a temperature of 0.5 – 8.6 °C and salinity of 28.7 – 32.6 ‰.

The average characteristics for <u>September</u>:

1. The temperature of the shelf waters is 7.7 – 9.4 °C, and the salinity is 29.55 – 29.95 ‰ as far as the 20-meter isobath, with values of 6.3 – 9.2 °C and 30 – 31.2 ‰ as far as the 30-meter isobath. Hence, there was an increase in the area occupied by shelf water masses in September. The reason was intensification of wind activity, which resulted in significant mixing and the formation of a thick upper quasi homogeneous layer (UQL). In addition, due to the intensification of Ekman transfer of waters of the UQL away from shore, upwelling intensified, leading to the penetration of the littoral shelf by water from the Sea of Okhotsk at levels near the bottom.
2. Accordingly, the shelf front moved toward the 40-meter isobath, and the area occupied by the marine water structure decreased. The range of average temperatures of this structure is 3 – 9.2 °C, and average salinity range is 30.2 – 32.3 ‰.

According to oceanographic data, the water temperature in the near-shore zone of the Piltun area can vary by 8-10 °C within 2-3 days due to wind surge, and salinity can vary by 5 ‰ (Kruglov et al., 2006).

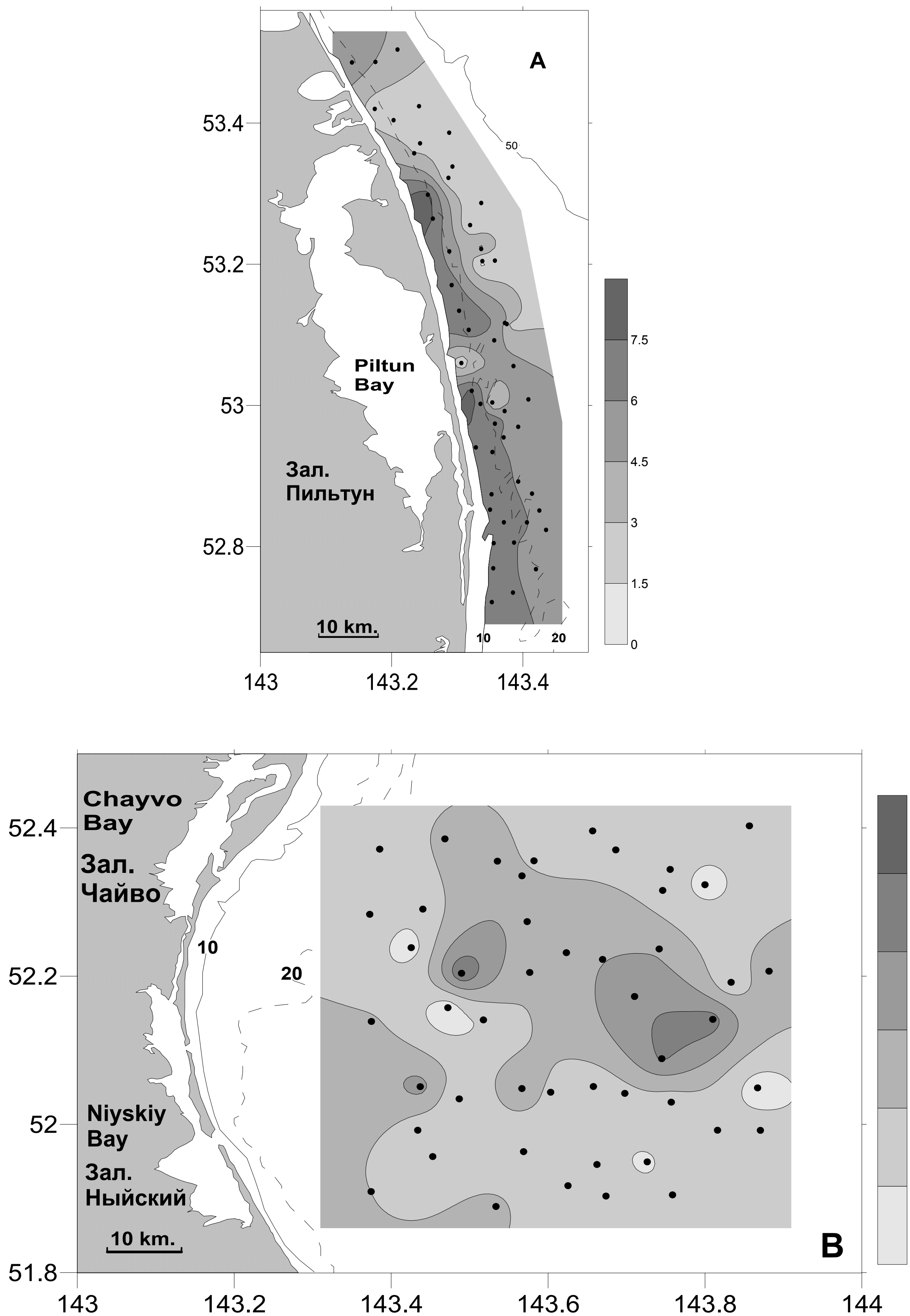


Figure 2. Water temperature distribution (T° C) of the surface water layer in the Piltun (A) and Offshore (B) areas in September 2005.

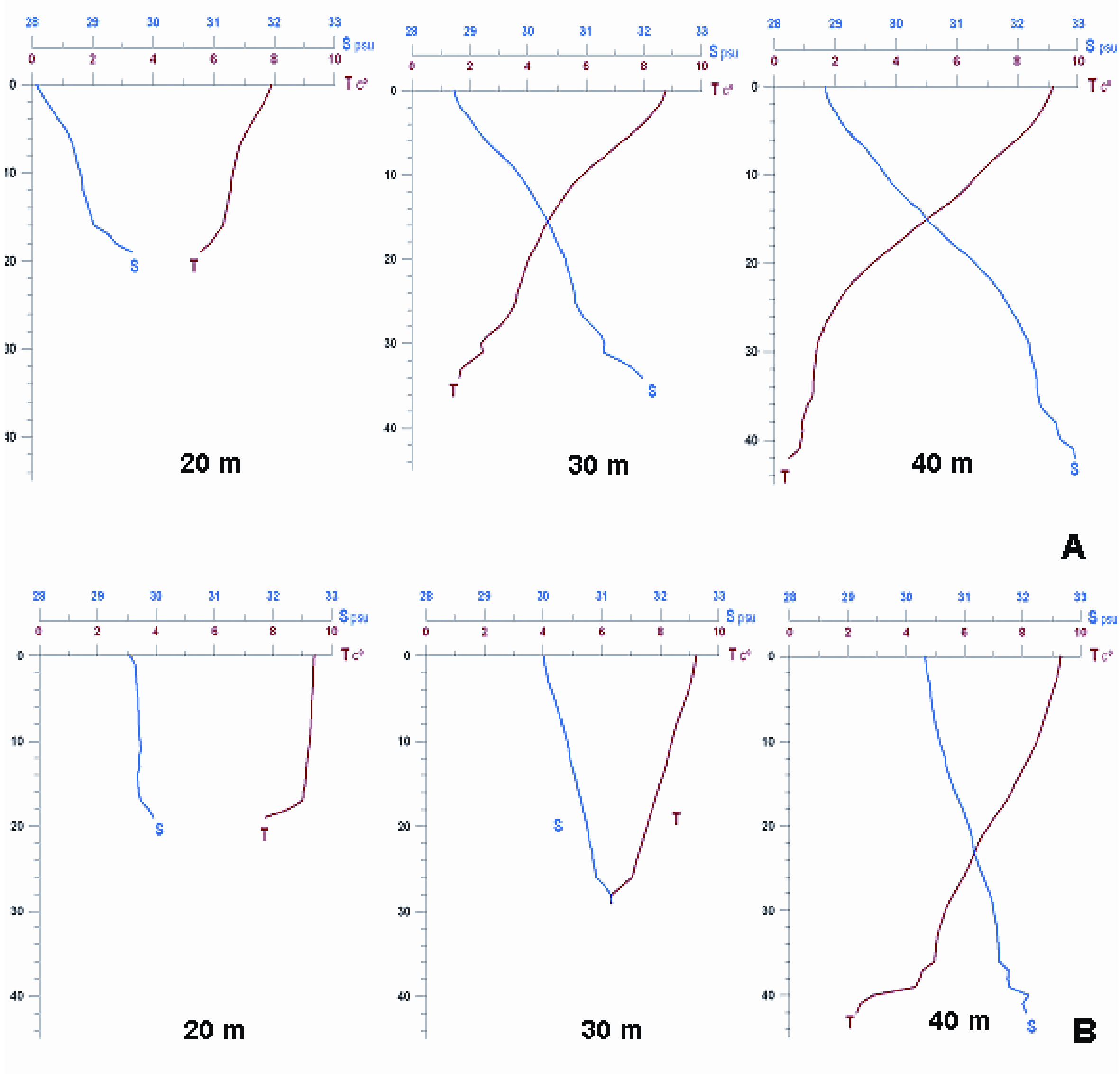


Figure 2A. Vertical temperature and salinity profiles averaged for August (A) and September (B) as far as 20-, 30- and 40-meter isobaths (per Borisov et al., 2005).

3.2. Particle Size Distribution of Bottom Sediments in the Areas

The particle size distribution of bottom sediments was studied based on laboratory analyses of 185 soil samples taken at benthos stations and whale feeding sites. The grain size distribution of the sea bottom is given in Appendix 2 (Table P2.2). The distribution of the main bottom sediment fractions (coarse silt and sand: fine, medium and coarse, and gravel) is shown in Figures 4-6 for the Piltun area and Figures 8-10 for the Offshore area. Figures 3 and 7 show the distribution of depths in the Piltun and Offshore areas according to the data from stations in these areas.

A sharp prevalence of sandy (psammite) fractions at most of the stations is characteristic of the bottom sediments throughout the area. Of 185 stations in all areas, sands (fine – 63%; medium – 24%) are prevalent at 76% of the stations, and gravel-pebble bottoms mixed with sands of various grain sizes account for 22%. The proportion of the fine sand fraction is in excess of 60% at most of the stations.

Piltun area. In the process of describing the distribution of soils according to field data from 2001-2003, it was observed that fine sandy bottoms are prevalent at depths up to 10-15 m throughout the area. As the depth increases, they are replaced by medium and coarse sands and gravel-pebble bottom areas mixed with sands of various grain sizes (Fadeev 2002-2005).

According to data of the 2005 expedition, fine sands were prevalent at 45% of the stations in this area, and medium sands were prevalent at 19% of the stations. Gravel-pebble bottoms, often mixed with sands of various grain sizes, are encountered in patches at depths greater than 15-20 m (Figure 4). The highest proportion (more than 30%) of the silt-clay fraction in the sea bottom is observed in a local area at depths greater than 20 m in the channel areas of the Piltun Lagoon. The active hydrodynamics of the area probably promotes the transfer of fine soil fractions to greater depths. The effect of lagoons on the accumulation of silt-clay fractions can be seen in two areas: off Odoptu Bay and Piltun Bay (Figure 6). A similar trend was observed in the data from 2001-2004.

Offshore area. The depths in the Offshore area increase smoothly from 20 to 60 m (Figure 7). The proportion of the fine sand fraction in the sea bottom increases with depth (Figure 10D). On the whole, fine sands were prevalent at 75% of the stations in the Offshore area. Gravel bottoms and coarse-grained sand have a patchy distribution (Figures 8 and 9).

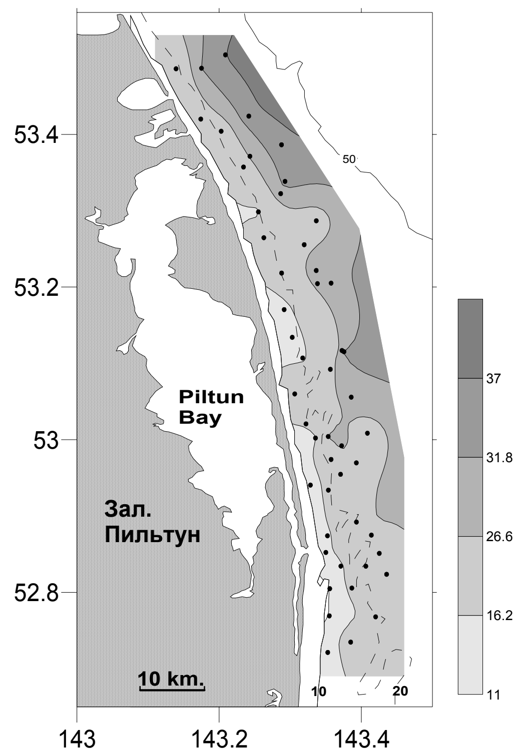


Figure 3. Distribution of depths (m) in the Piltun area.

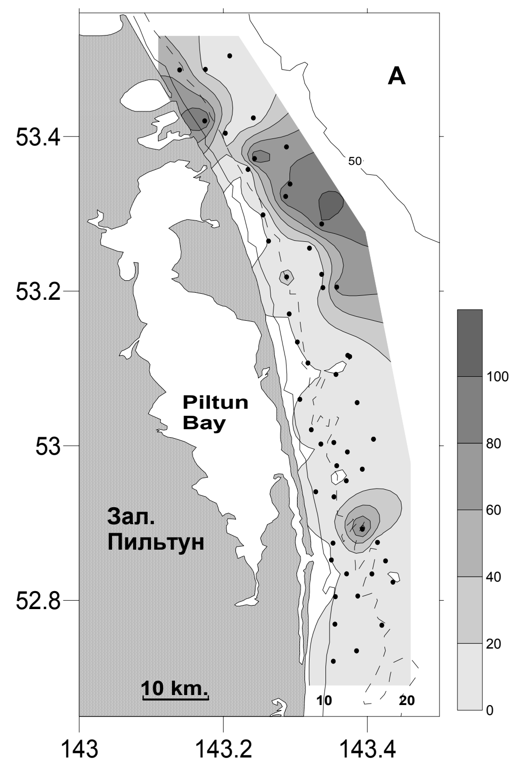
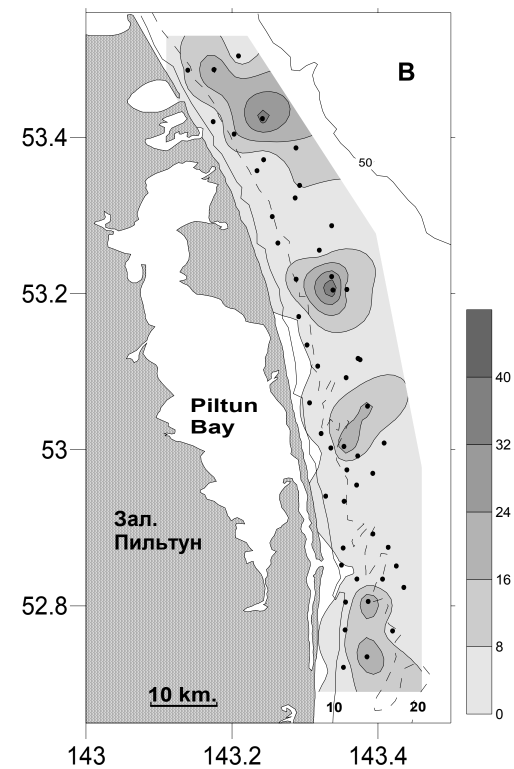


Figure 4. Distribution of bottom sediment fractions (% of dry sediment weight) in the Piltun area: gravel-pebble fraction (A; > 1 mm).



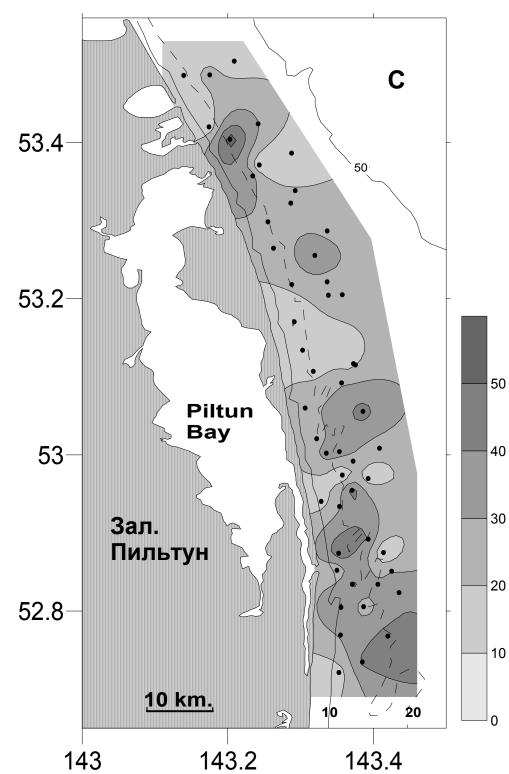


Figure 5. Distribution of bottom sediment fractions (% of dry sediment weight) in the Piltun area: coarse sand (B; 0.5 – 1 mm); medium sand (C; 0.25 – 0.5 mm).

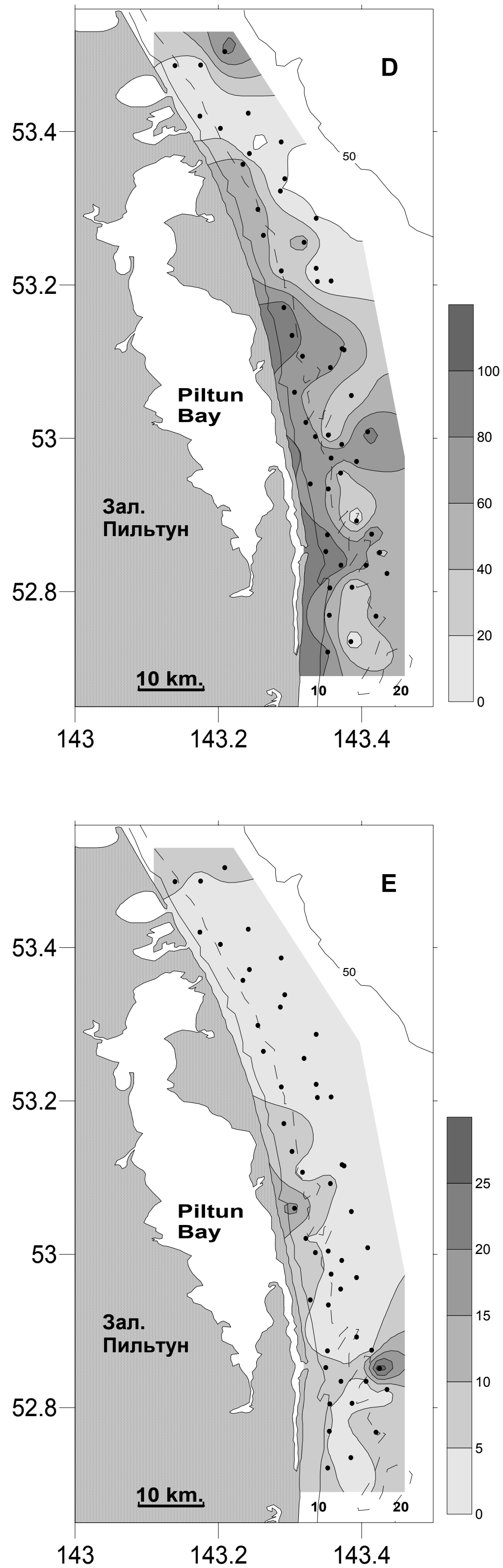


Figure 6. Distribution of bottom sediment fractions (% of dry sediment weight) in the Piltun area: fine sand (D; 0.1 – 0.25 mm); aleurite (E; < 0.1 mm).

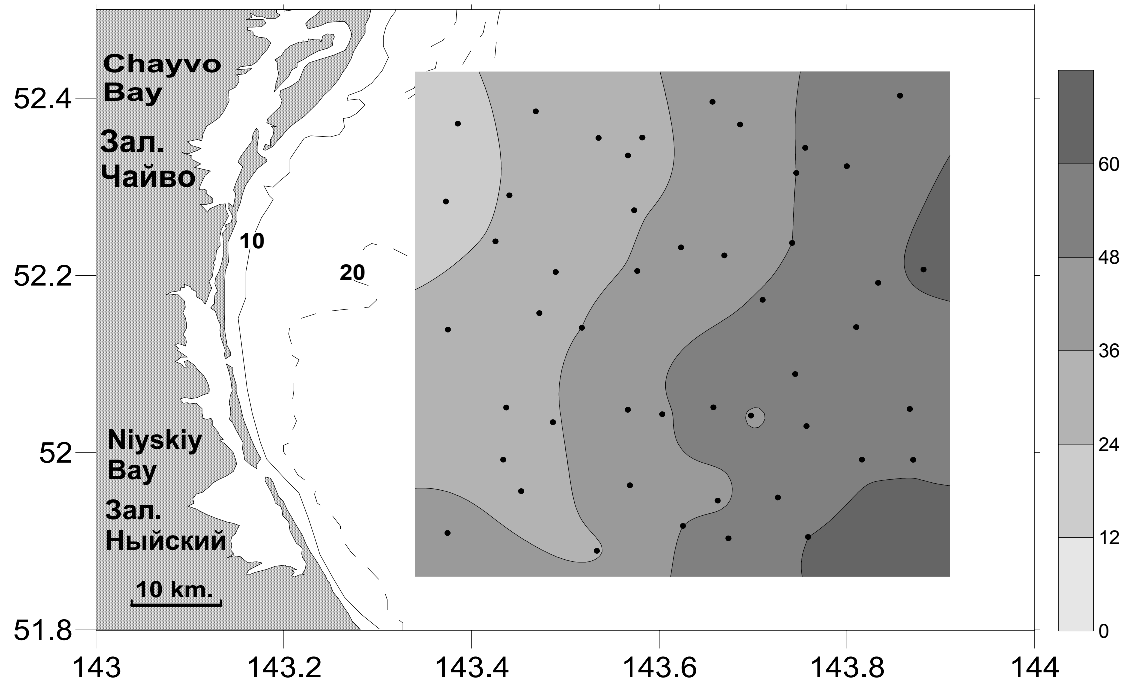


Figure 7. Distribution of depths (m) in the Offshore area.

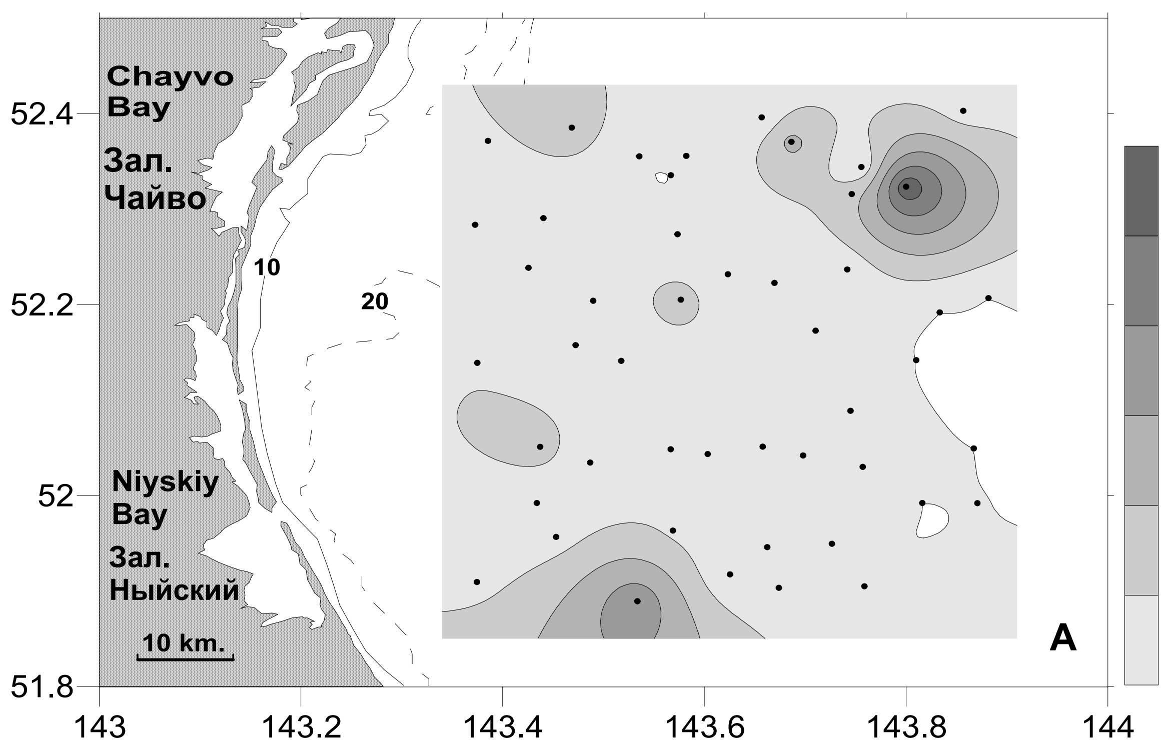


Figure 8. Distribution of bottom sediment fractions (% of dry sediment weight) in the Offshore area: gravel-pebble fraction (A; > 1 mm).

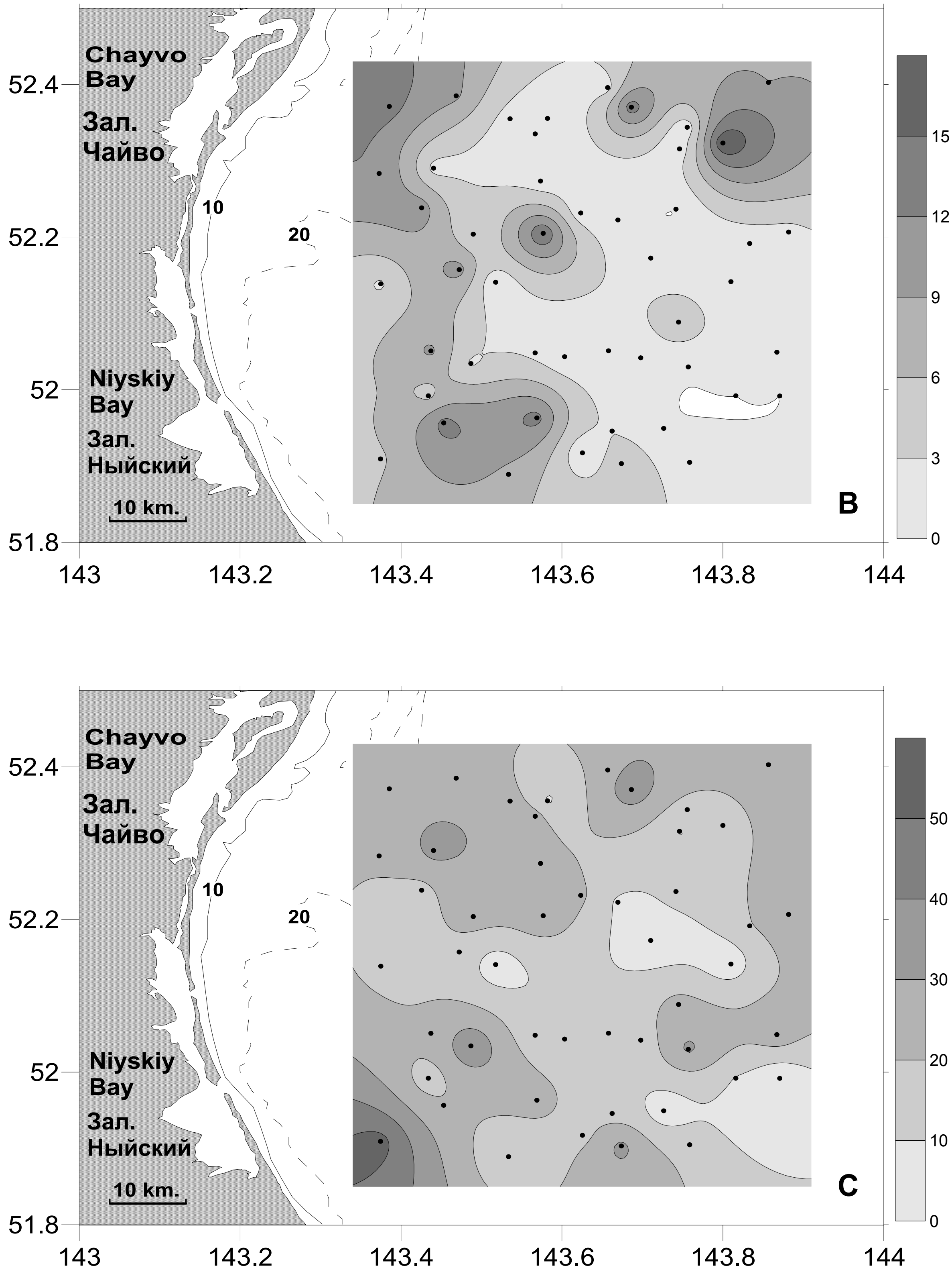


Figure 9. Distribution of bottom sediment fractions (% of dry sediment weight) in the Offshore area: coarse sand (B; 0.5 – 1 mm); medium sand (C; 0.25 – 0.5 mm).

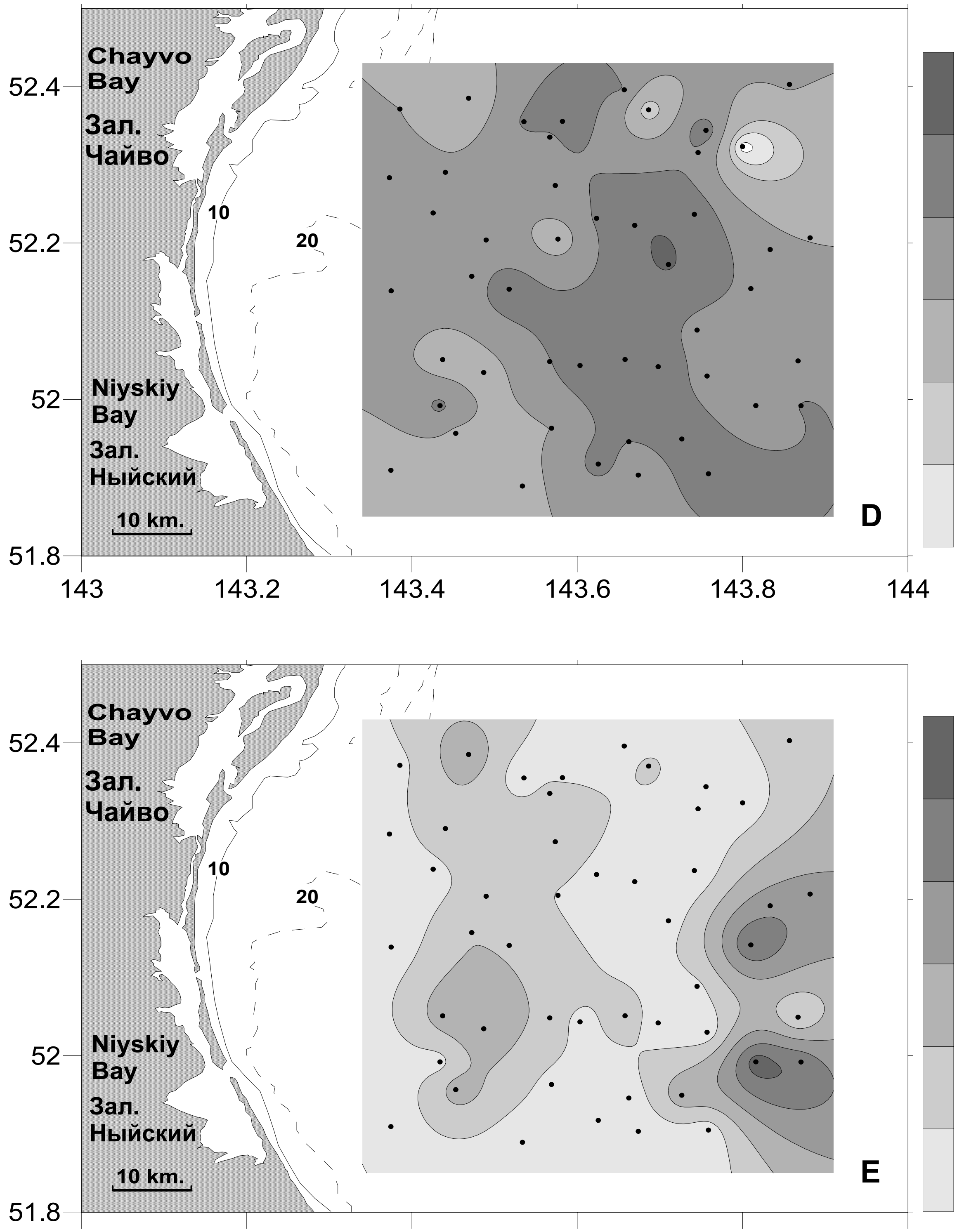


Figure 10. Distribution of bottom sediment fractions (% of dry sediment weight) in the Offshore area: fine sand (D; 0.1 – 0.25 mm); aleurite (E; < 0.1 mm).

3.3. 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 (classified) by cluster analysis procedures (Ward's clustering method, Euclidean distance). Dendrograms are shown in Fig. 11.

It follows from the dendrograms that three to four groups of stations can be distinguished in all areas based on similarity of particle size distribution – A, B, C and D. Table 5 gives averaged characteristics for each of the sediment groups for the Piltun and Offshore areas based on data from 2005 and 2001-2004. In 2005 sediment group D was not present in the samples.

Group A in all areas is made up of stations with a sharp prevalence of the 0.1-0.25 mm fraction (fine sand) in the sediment. According to 2001-2005 data, the proportion of this fraction varies from 72 to 89% of dry sediment weight in sediments of the Piltun area. The normalized entropic index of sorting is 0.43 (ideally graded sediment has an index of 0). The average depth of occurrence of sediments of this group in the Piltun area is 19 m.

Group B includes stations where medium-grained sand is prevalent in the bottom, mixed with up to 20% coarse sand. The value of the entropic index of sorting varies from 0.6 to 0.68. The average depth of the sediments of this group in the Piltun area is 20.4 m.

Group C is made up of stations without clear dominance of any of the fractions. The bottom is a gravel fraction mixed with sand fractions. Fractions of 0.5-1.0 mm (coarse sand) and 1.0-2.0 mm (small gravel) have the highest values. The entropic index of sorting varies from 0.6 to 0.68 (absolutely nongraded sediment has a value of 1). The average depth of the stations of this sediment group in the Piltun area is 26 m.

Based on 2003-2004 data, a fourth group, ***group D***, in addition to ***groups A-C***, has been distinguished in the Offshore area (Table 5). The group includes stations where fine sand is prevalent, mixed with a significant amount of the aleurite fraction (24-28%).

Hence ***group A*** corresponds to well-sorted fine-grained sands, ***group B*** to medium-sorted sands of varying grain size (a mixture of fine and medium sands), and ***group C*** corresponds to poorly sorted gravel bottoms mixed with sands of varying grain size, pebbles and exposed detritus. The composition of the sediment groups in the Piltun area described according to 2005 data matches the results of bottom sediment analysis based on the materials of the 2001-2004 studies well (Table 5). Based on 2005 data, three sediment groups have also been distinguished in the Offshore area (Figure 11.3, Table 5).

Table 5. Characteristics of sediment groups in Piltun and Offshore areas.

Sediment groups	Sediment fractions						H_s	H_s/H_{max}	Code
	Peb	Gr	Sc	Sm	Sf	A+Pe			
Piltun area according to data of 2005									
A	0	4.1	5.07	12.25	**74.48**	4.1	0.72	0.42	Sm
B	0	9.75	29.04	**54.2**	4.72	2.29	1.21	0.67	Smc
C	6.1	36.15	22.02	20.48	11.68	3.57	1.29	0.69	Gr+Scm
Piltun area according to data of 2003 (Fadeev, 2005)									
A	0	0.52	1.56	19.6	**72.89**	5.45	0.75	0.43	Sf
B	0.00	10.69	20.65	**56.76**	7.82	4.08	1.21	0.67	Smc
C	8.56	49.16	24.08	10.16	5.00	3.04	1.29	0.69	Gr+Scm
Piltun area according to data of 2003 (Fadeev, 2004)									
A	0.83	1.98	2.12	10.93	**75.48**	8.66	0.81	0.42	Sf
B	0	4.81	13.61	**63.85**	17.12	0.6	1.5	0.64	Sm+Sf
C	5.01	44.3	20.28	16.8	11.88	1.74	2.16	0.84	Gr+Scmf
Piltun area according to data of 2002 (Fadeev, 2003)									
A	0.39	1.21	0.77	11.41	**84.52**	1.7	0.82	0.32	Sf
B	0.26	8.11	9.64	**47.81**	32.64	1.54	1.77	0.68	Sm+Sf
C	1.05	37.28	14.81	17.49	25.96	3.41	2.12	0.82	Gr+Sfmc
Piltun area according to data of 2001 (Fadeev, 2002)									
A	0	1	0.8	5.9	**89.5**	2.8	0.65	0.28	Sf
B	0.2	3.4	5.6	40.8	**48.4**	1.6	1.55	0.6	Sf+Sm
C	9.7	46.8	18.8	12	8.9	3.9	2.15	0.83	Gr+Scm
Offshore area according to data of 2005									
A	0	0.75	1.01	10.38	**82.67**	5.19	0.61	0.27	Sf
B	0	2.87	2.6	19.31	**66**	9.22	1.1	0.66	Sf+Sm
C	5.32	30.93	11.73	18.32	29.38	4.32	1.71	0.76	Gr+Sf
Offshore area according to data of 2004 (Fadeev, 2005)									
A	0.00	0.65	1.32	3.68	**88.14**	6.21	0.5	0.33	Sf
B	0.00	0.29	1.06	21.41	**71.22**	6.02	0.8	0.45	Sf+Sm
C	7.40	28.06	5.08	19.76	25.14	14.56	1.65	0.87	Gr+Sf
D	0.00	0.35	0.55	3.30	**67.60**	28.20	0.78	0.44	Sf+A
Offshore area according to data of 2003 (Fadeev, 2004)									
A	0	0.31	0.31	3.32	**90**	6.06	0.6	0.26	Sf
B	0	0.05	0.75	33.65	**64.7**	0.85	1.05	0.45	Sf+Sm
C	3	**50.6**	20.35	20.05	5.55	0.45	1.85	0.71	Gr+Scm
D	0.18	0.38	0.44	1.81	**72.75**	24.43	1.02	0.39	Sf+A
Offshore area according to data of 2002 (Fadeev, 2003)									
A	0.71	2.74	2.4	15.65	**75.4**	3.1	1.2	0.47	Sf
B	0.31	3.49	5.41	**52.03**	37.55	1.21	1.52	0.59	Sm+Sf
C	0.44	18.49	21.83	36.69	20.66	1.89	2.07	0.86	Gr+Scmf

Notes to Tables 5 and 6: for abbreviations of sediment fractions, see Table 3. H_s is the entropic index of sorting of bottom sediments, and H_s/H_{max} is the normalized entropic index of sorting. **Boldface** indicates the dominant bottom fractions; values for fractions that make up the bottom base, in the absence of dominant bottom fractions, are **shaded**.

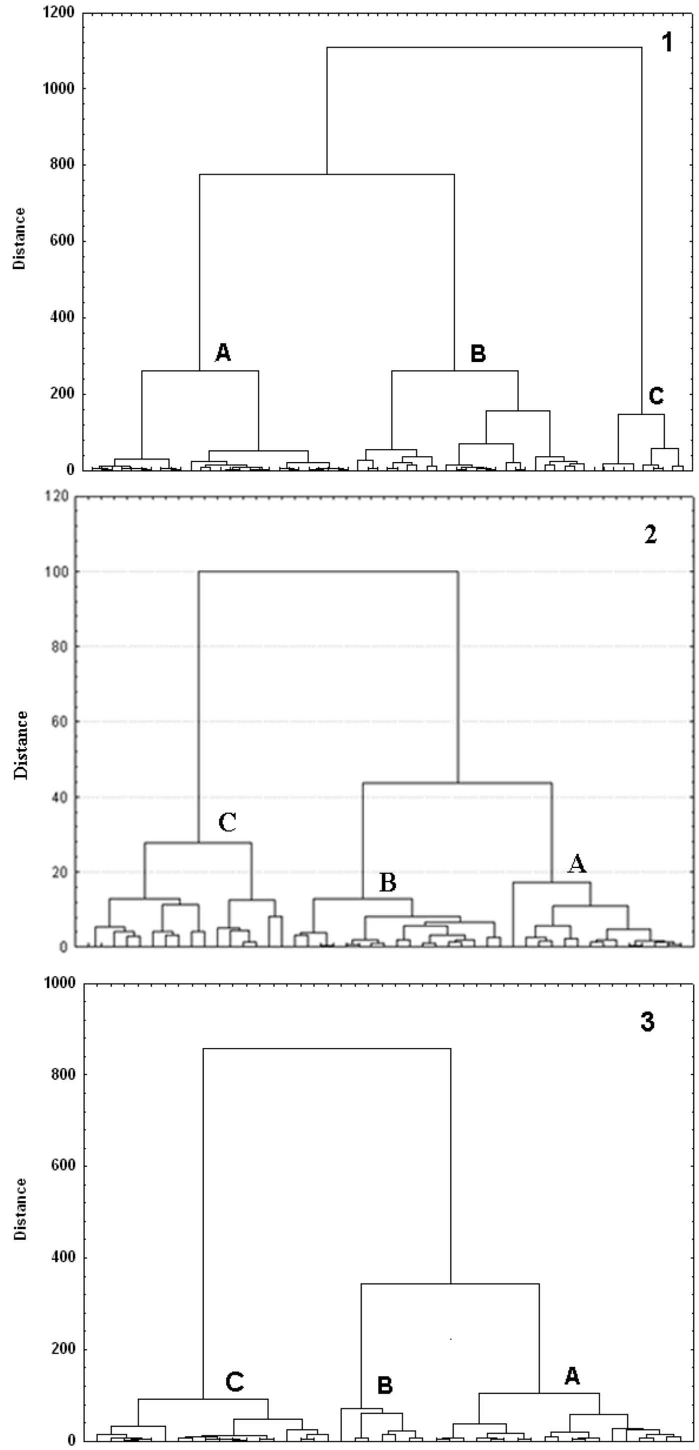


Figure 11. Classification of 2005 stations according to the 10-fraction sediment composition in the areas.

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

3.4. Particle Size Distribution of Bottom Sediments at Gray Whale Feeding Sites

The sediment composition classification at gray whale feeding sites in the Piltun and Offshore areas was considered based on data from 2001-2004 (Fadeev, 2002-2005). Bottom sediments were sampled at nine gray whale feeding sites in the Piltun feeding area in 2001. The average depth of the feeding sites was 9±0.9 m. Analysis indicated that the bottoms at the feeding sites were fine-grained sands in all cases (proportion of the fraction of 0.1-0.25 mm, from 73.95 to 94.34%); i.e., the bottoms are classified as *group A*.

In 2002, bottom sediments were sampled at 46 whale feeding sites in the Piltun area (21 stations; average depth 12±0.7 m) and the Offshore area (25 stations; average depth 41±0.9 m). Sandy bottoms were prevalent at all the feeding sites in the Piltun area. Fine-grained sands were prevalent at 53% of the stations, medium sands at 38%, and a mixture of fine and medium sands was observed at 9% of the stations. Sandy bottoms were also prevalent at the whale feeding sites in the Offshore area. Medium sands and a mixture of fine and medium sands were prevalent at 36% of the stations, and 12% of the stations had fine and coarse sands (Fadeev, 2003).

In 2003, bottom sediment samples were taken at 51 whale feeding sites in the Piltun (12 stations; average depth 18.6±1.6 m) and Offshore areas (39 stations; average depth 50.8±0.9 m). Well-sorted fine sands (*sediment group A*) were prevalent at all gray whale feeding sites in both areas. About 15% of the whale feeding sites had medium-sorted mixed sandy bottoms (medium and fine sands).

Most of the whale feeding sites in 2005 and 2004 were in the Piltun area. Only 8 whale feeding sites were investigated in the Offshore area in 2005 (in 2004 - only two feeding whales were observed). Most of the whales in 2005, as in previous years, fed in the Piltun area, in a zone of fine- and medium-grained bottoms.

Table 6. Characteristics of sediment groups at whale feeding sites.

Sedi-ment groups	Sediment fractions						H_s	H_s/H_{max}	Code
	Peb	Gr	Sc	Sm	Sf	A+Pe			
Whale feeding sites (2005 stations)									
A	0	0	0.27	3.36	**92.37**	4	0,54	0,27	Sf
B	0	3.64	1.27	**65.22**	22.2	7.67	1,2	0,56	Sm
C	0	38.22	22.26	19.28	14.42	5.82	1,35	0,64	Gr+Scmf
Whale feeding sites (2004 stations, per Fadeev, 2005)									
A	0	0.85	2.17	13.77	75.49	7.72	0.81	0.45	Sf
B	0	2.25	10.51	**57.43**	28.54	1.27	1.05	0.57	Sm
C	1.14	15.33	15.51	38.18	27.52	2.32	1.44	0.7	Smfc+Gr

3.5. Concentrations of Petroleum Hydrocarbons, Heavy Metals and Organochlorine Pesticides (OCP)

Assessment of the concentrations of high-priority pollutants – petroleum hydrocarbons, heavy metals and organochlorine pesticides – in the sea bottom of the gray whale feeding area is important from the point of view of potential impact of pollution on both gray whale food resources (the accumulation of toxic substances in prey tissues) and the habitat conditions in the feeding area. The first studies of the distribution of pollutants in the Piltun area were performed based on data from diving work in 2001. During field work in 2001, 30 bottom sediment samples were collected on 10 transects (at depths of 5–10–20 m), i.e., in the zone of most intense feeding of the whales, to assess the concentrations of petroleum hydrocarbons and 10 heavy metals (copper, aluminum, arsenic, barium, cadmium, chromium, iron, mercury, lead and zinc). At 10 stations in the gray whale habitat in the Piltun Bay – Odoptu Bay area, 10 bottom sediment samples were taken to determine the organochlorine pesticides (OCP) concentration. It was established that during the study period in 2001, the main pollutants had low concentrations and were distributed relatively evenly in the study waters; i.e., no significant effect of pollutants on benthos was observed (Fadeev, 2002).

In 2004 and 2005, a total of 60 bottom sediment samples were collected for analysis of the concentrations of petroleum hydrocarbons and 10 heavy metals in the Piltun (43 samples) and Offshore areas (17 samples). 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, 4 samples were taken at depths of 10-15 m to study the concentration of OCP in the bottom sediments. Samples were taken in the same depth range as in 2001.

<u>Petroleum hydrocarbons</u>. Appendix 4 and Table 9 give data on the concentration of petroleum hydrocarbons in the bottom sediments of the Piltun and Offshore areas. The petroleum hydrocarbon concentration at stations of the Piltun area varied from 0.8 to 4.0 μg/g of dry sediment weight and averaged 2.0±0.05 μg/g of dry sediment weight, which is less than the natural background values of the petroleum hydrocarbon concentration at greater depths. The spatial distribution of petroleum hydrocarbons is shown in Figure 12. The lower petroleum hydrocarbon concentrations in the Piltun area are associated with the Near-Shore zone.

<u>Organochlorine pesticides</u>. Chlorinated hydrocarbons get into the waters off northeastern Sakhalin with the Amur River flow and are entrained from the waters of coastal lagoons. The presence of pesticides in the bottom deposits is a distinguishing feature of the

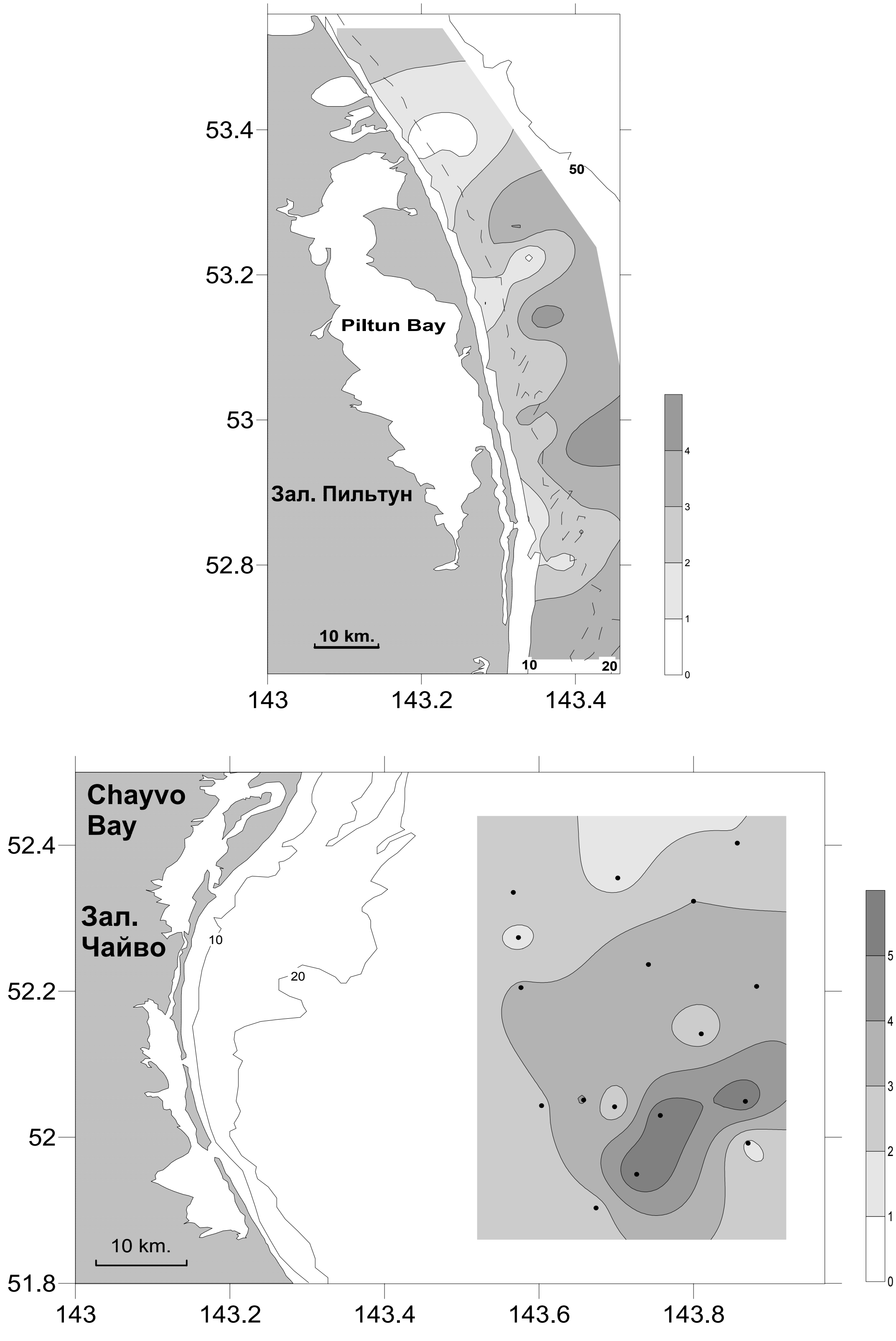


Figure 12. Distribution of petroleum hydrocarbon concentrations (µg/g) in bottom sediments in the Piltun and Offshore areas in 2005.

Table 7. Organochlorine pesticide concentrations (ng/g) in bottom sediments at 4 stations in the Piltun area.

Station	Depth	DDT	DDE	DDD	∑DDT	α-HCH	γ-HCH	∑HCH
2-2N	15	1	0.3	0.4	1.7	0.1	0.2	0.3
2-3M	16	0.6	0.2	0.2	1	0	0.2	0.2
2-4M	15	1.3	0.2	0.2	1.7	0.3	0.1	0.4
4-1S	16	1.1	0.2	0.3	1.6	0.1	0.1	0.2

northeast shelf of the Sea of Okhotsk. The data of Table 7 show that the DDT concentration and the total concentration of DDT and its metabolites in the bottom sediments vary only slightly and do not exceed the background levels for the northeastern Sakhalin area.

Heavy metals. We know that the heavy metal concentrations in bottom deposits of the seas and oceans depend on a large number of factors. Differences in concentration levels can be conditioned by the mineralogical composition and particle size distribution of the sea bottom. Sandy bottoms, for example, due to their lower sorption capacity, typically have lower concentrations of heavy metals than aleurite-pelite deposits. Hydrodynamic conditions, physical and chemical processes and biogenic sedimentation processes affect the accumulation and distribution of microelements. All these factors play a role in the constant variation of the concentrations of many chemical elements in the surface layer of bottom deposits.

Results of the analysis of 60 sediment samples for concentrations of 10 heavy metals (copper, aluminum, arsenic, barium, cadmium, chromium, iron, mercury, lead and zinc) are given in Appendix 4. The sediment specimens collected at depths of 3-10-20 m (30 samples) are distinguished by low concentrations of toxic heavy metals, which is consistent with the natural geochemical background of the area. Similar values of heavy metal concentrations were determined in the bottom deposits of different areas of the northeast shelf of the Sea of Okhotsk. In addition, the distribution of practically all heavy metals is characterized by minimum concentrations at depths up to 15-20 m, i.e., in the zone of the most intense feeding of gray whales.

Published data (Status of the Environment in the Piltun-Astokh Field Area 1996, 1997) on the heavy metal concentrations in the area of the Piltun – Astokh field (Table 8) fully confirm our conclusion concerning the low concentrations of heavy metals in the study area.

Table 8. Heavy metal concentrations in the area of the Piltun – Astokh field based on published data* and in the study area.

Elements	Concentration, µg/g				
	Published	**PAC****	**2001**	**2004**	**2005**
As	2.5 –	-	1.25 – 4.8	0.47 – 2.07	0 – 2.20
Ba	268 –	-	46.7 – 89.6	0.96 – 22.55	0.9 – 20.42
Cd (µg/g)	<0.01 – 0.13	4.2 – 9.6	0.001 – 0.006	0.001 – 0.3	0 – 0.27
Cr (µg/g)	0.6 – 121	160 – 370	1.32 – 8.91	1.61 – 37.35	1.6 – 33.20
Cu (µg/g)	0.6 – 6.7	108 – 270	0.23 – 1.46	0.26 – 6.6	0.79 – 6.60
Hg (µg/g)	0.001 – 0.047	–	0.013 – 0.125	0 – 0.025	0.0002 – 0.023
Pb (µg/g)	5.1 – 19.5	112 – 218	0.17 – 0.39	0.001 – 6.4	0 – 1,90
Zn (µg/g)	3.1 – 29.1	271 – 410	2.0 – 7.18	0.88 – 37.6	1.98 – 15.10

Note: * - published data: Status . . ., 1996, 1997.
PAC** – probable active concentration of toxic metals (Belan, 2001)

Table 9. Concentrations of DDT and its metabolites (∑DDT), α- and γ-isomers of hexachlorocyclohexane (∑HCH) and petroleum hydrocarbons 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*	**∑HCH,** ng/g dry weight**	**∑DDT,** ng/g dry weight**
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***	0–0.03 (0.007)	<0.1– 0.6 (0.29)	1.3–4.8 (2.31)
Piltun area, 2003***	0.004–0.016 (0.008)	–	–
Piltun area, 2004***	0–0.005 (0.002)	<0.1– 0.4 (0.23)	1.0–3.9 (1.91)
Offshore area, 2004***	0.002–0.005 (0.003)	–	–
Piltun area, 2005***	0-0.004 (0.002)	<0.1- 0.4 (0.32)	1.0-1.6 (1.5)
Offshore area, 2005***	0.001-0.006 (0.003)	-	-

Note:
* According to: Belan, 2001 (data from 1986–1994; concentration range given);
** According to: Tkalin, 2001 (data from 1994; concentration range given and in parentheses - average values);
*** - our data.

Comparing the petroleum hydrocarbon and OCP concentrations in the study area to published data from the waters of Far East seas (Table 9) suggests that for all the pollutants considered, their maximum concentrations in the study area are in line with the minimum concentrations in the Gulf of Peter the Great (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 no significant effect of pollutants on benthos was observed during the study period. These results 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.

4. Benthos Composition and Quantitative Distribution in the Areas

In light of the fact that the Piltun and Offshore areas differ considerably with regard to both environmental conditions and the nature of the seafloor population, the benthos distribution is considered separately in each of the areas: Piltun and Offshore.

Benthos studies were performed in the Piltun area in 2001-2005 and in the Offshore area in 2002-2005. Diving surveys in 2001 indicated that the highest forage benthos biomass levels are observed in a zone immediately adjacent to the coast in the Piltun area, at depths less than 15 m. Bottom grab collecting was performed from the vessel on expeditions in 2002 through 2005. No material could be obtained in the areas with the highest forage benthos biomass levels, in a depth range of 5-10 m using grab samples obtained by the vessel. In 2004 grab samples were taken at depths between 3-12m using a Zodiac as a platform were possible and in 2005 the same depth range was sampled with SCUBA.

4.1. Piltun area

There were 60 stations within the area during the 2002 expedition at depths of 11 to 35 m (181 bottom grab samples, average depth 20.4±0.8 m). In 2003, there were 63 bottom grab sampling stations in the area at depths of 8 to 33 m (189 bottom grab samples, average collection depth 18.7±0.9 m). There were 10 stations that year in the range of 8-10 m.

There were a total of 64 bottom grab sampling stations in the Piltun area in 2004: 51 stations with sampling from the vessel in the range from 11 to 35 m, and 13 stations from a motor launch at depths from 3 to 10 m.

There were 72 bottom gray sampling stations (229 samples) with sampling from the vessel and 15 diving stations (60 samples) from the motor launch at depths of 3-12 m in the

Piltun area in 2005. The locations of the vessel stations in 2005 coincided in most cases with the stations from 2004. A diagram of the locations of the stations is shown in Figure 13, and a combined map of the stations from 2002-2003 and 2004-2005 is shown in Figure P1.1 (Appendix 1).

The benthos distribution is considered below based on materials from field work in 2005 and 2001–2004 (Fadeev, 2002-2005).

4.1.1. Quantitative Abundance and Distribution of Benthos Based on Data from 2005 and 2001-2004

Total benthos biomass. Based on materials from 2001-2002, similar trends were noted in the distribution of total benthos biomass in the Piltun area: an increase in total biomass with depth is observed throughout the area. The increase in total biomass with depth is defined by the course of biomass variation of a flat sea urchin, the sand dollar *Echinarachnius parma*; their proportion in the total biomass of the area is from 61 to 70% and increases to 85-95 % at depths of 25-30 m. The proportion of other groups in the total biomass is significantly lower: crustaceans – from 9 to 17%; bivalve mollusks – from 8 to 13%; isopods – 4-5%. The proportion of key forage benthos (amphipods, isopods) in the total biomass decreases with depth: from 40-59% at 5-15 m to 1-4% at 20-30 m (Fadeev, 2002, 2003).

According to materials from 2003-2004, the average benthos biomass in the Piltun area at depths of 8–30 m (minimum collection depth, 8 m) was more than 500 g/m^2 at a colony density of more than 6000 spec./m^2. The sand dollar *E. parma* accounts for the largest proportion (70%) in the benthos biomass. The proportion of sea urchins in the total benthos biomass increased as the depth increased, from 20% at 15 m to 95% at 25-30 m. The biomass of the main whale food component – amphipods – decreased from 146 g/m^2 (74% of the total benthos biomass) at a depth of 8-11 m to 9 g/m^2 (1.2%) in the range of 26-30 m. The sharpest changes in the quantitative abundance of benthos were observed in a range of 15 – 20 m (Fadeev, 2004, 2005).

Based on bottom grab collections in 2005, the average benthos biomass in the area was 392.4±63.3 g/m^2 and did not differ significantly from the data from 2004 (501.2±93.8 g/m^2). As in previous years, flat sea urchins account for the main proportion of biomass, at 67%, and the proportion of sea urchins at depths greater than 20 m reaches 83%. The quantitative abundance of the main forage benthos component – amphipods – decreased from

65 g/m^2 (52% of total benthos biomass) at depths of 11-15 m to 18 g/m^2 (3%) in the depth range of 26-30 m. Since the station locations were the same in most cases in 2005 and 2004 in the depth range of 11-30 m, one can conclude that no substantial changes were observed in total benthos biomass (Table 10).

Biomass of basic taxonomic groups and common species of benthos. Crustaceans (amphipods, isopods, decapod crustaceans and cumaceans), bivalve mollusks and marine worms are of the greatest interest for assessing food supplies for the diet of the gray whale in the water area studied.

Crustaceans (*Crustacea*). The main crustacean groups had high frequencies of occurrence in 2005 collections: amphipods – 92%; isopods – 60%; and cumaceans – 56%. Despite the high frequency of occurrence of crustaceans in the Piltun area, their proportion in benthos biomass varies considerably within the water area and with the depth.

Based on materials from 2001-2004, the overall proportion of crustaceans in macrobenthos biomass in the Piltun Bay area was from 40 to 55% at depths of 5–10 m and only 3-10% at 26-30 m. Three types of crustacean biomass changes were observed with increasing depth. Amphipods and isopods had maximum biomass at 5-15 m; it decreased sharply at depths greater than 20 m. The change in cumacean biomass was in the opposite direction. It was at a minimum at depths less than 20 m and increased with depth. Decapod biomass was low at all depths and varied only slightly.

Table 10. Macrobenthos biomass distribution (g/m^2) in the Piltun area for 4 depth categories in 2004 and 2005 and for the entire area in 2003, 2004 and 2005.

Groups	Depth								Entire Area		
	11-15 m		16-20 m		21-25 m		26-30 m				
	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2003
Amphipoda	**64.7**	**111.2**	23.0	61.1	20.1	22.3	18.0	39.6	38.8±7.2	47.4±7.7	54.6±8.7
Isopoda	8.7	10.7	15.6	18.5	26.1	19.3	13.3	23.3	15.3±2.2	18.5±3.6	23.5±3.7
Bivalvia	31.0	39.3	120.6	22.4	84.7	16	10.7	19.2	59.0±13.9	23.1±4.1	48.2±11.9
Cumacea	1.7	1.1	2.2	0.1	2.1	0.1	2.7	2.5	1.7±0.6	1.1±0.4	2.1±0.9
Echinoidea	8.3	44.5	51.4	161.3	**498.3**	**489.1**	**482.2**	**640.9**	257.6±58.6	377.1±94.8	390±64.7
Polychaeta	1.8	3.3	7.7	2.3	16.5	12.2	18.7	9.2	10.6±2.5	7.5±1.9	18.4±5.3
Pisces	6.8	22	8.1	2.9	21.4	25.2	31.5	29.1	16.3±4.4	14.8±4.8	4.6±1.6
Rest	3.5	0.6	4.3	0.1	2.6	2.1	1.1	6.1	3.2±1.2	2.6±0.8	16.2±3.2
Total	**126.7**	**234.8**	**222.8**	**270.5**	**651.8**	**594.7**	**568.2**	**778.3**	**392.4±63.3**	**501.2±93.8**	**556±69.4**

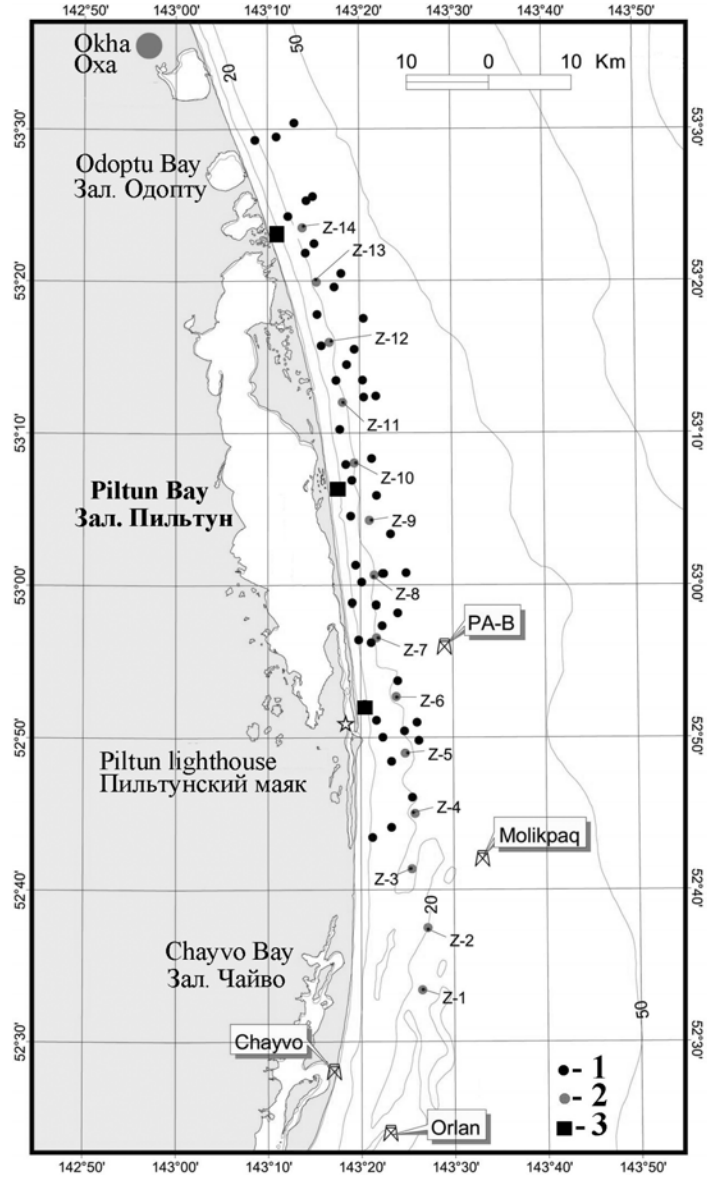


Figure 13. Locations of benthic grid sampling stations in the Piltun area in 2005. 1 – bottom grab sampling stations on standard grid; 2 – bottom grab sampling stations marked as Z on 20-meter isobath; 3 – diving transects.

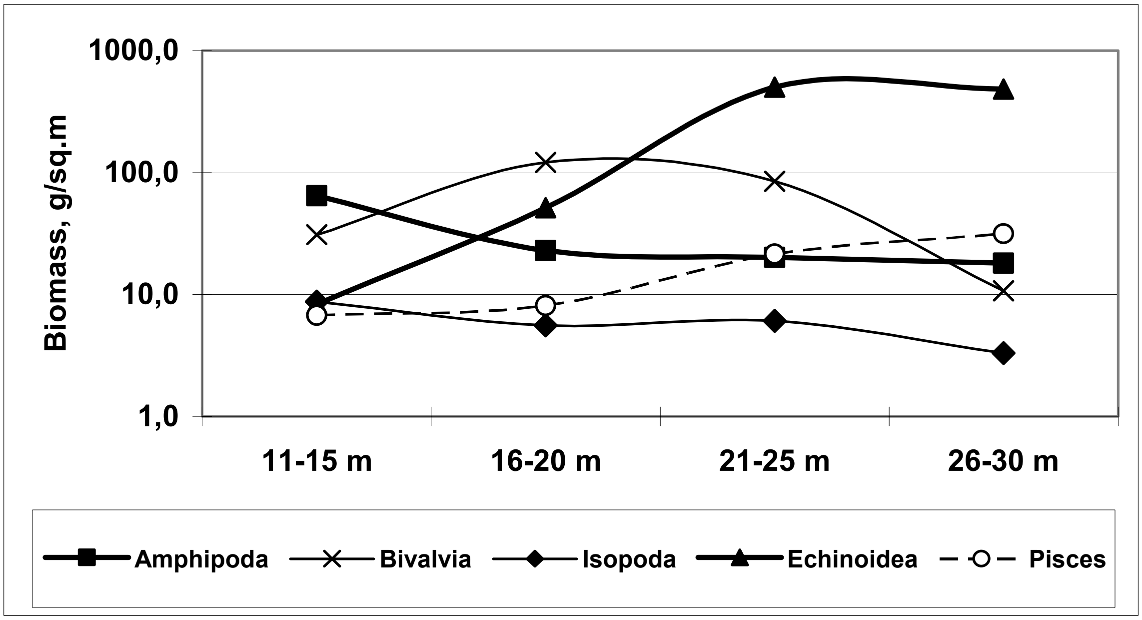


Figure 14. Variation in total benthos biomass (g/m^2) with depth of 5 benthos groups in the Piltun area in 2005.

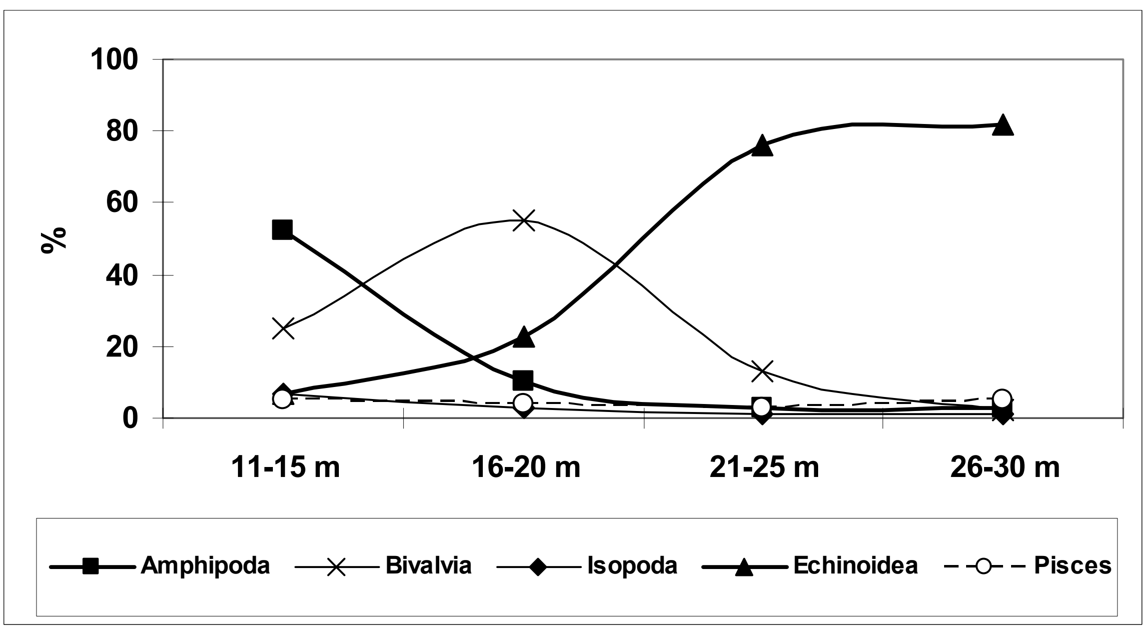


Figure 15. Variation in the proportion of the total biomass (in %) of 5 benthos groups with depth in the Piltun area in 2005.

Based on materials from 2005, the proportion of amphipods in the total biomass reached 54% at depths of 11-15 m and decreased to 8% in the range of 26-30 m.(Figure 14). The trend of benthos biomass proportion decreasing with depth is absent for the other crustaceans (isopoda and cumacea) (Table 10). The spatial distribution of crustaceans in the Piltun area according to materials from 2005 is shown in Figure P1.6 (Appendix 1). As in 2003-2004, some patchy areas of high crustacean biomass are observed in the coastal zone. The largest crustacean accumulations in the area are observed in the coastal zone of Piltun Bay, in the southern and northern parts. These shallow-water accumulations are made up of amphipods and isopods. Spots of high biomass at depths greater than 20 m are made up of cumaceans. The occurrence of specific species groups in the Piltun feeding area is described in more detail in the following paragraphs.

<u>Isopods (*Isopoda*)</u>. According to materials from diving studies in 2001, the relative proportion of isopods in the total macrobenthos biomass was 14.1% at depths of 5–10 m and only 2.4% at 11–30 m. The average isopod biomass in this range (5-10 m) was 25.0 g/m^2. It was demonstrated that the small isopod *Synidotea cinerea* (average body weight 0.02 g) has the greatest significance in the benthos biomass of the Piltun area. Maximum biomass values for this species were observed at depths less than 15 m. This isopod had the highest rate of occurrence of all macrobenthos species – 86% - in the study areas at depths of 5-30 m. From all isopod species only individuals of *S. cinerea* were encountered in deeper waters. According to results of analysis of samples from diving studies, the greatest colony density of *S. cinerea* (up to 5000 spec./m^2) is associated with tube mats of the polychaeta *Onuphis shirikishinaiensis*.

The second species – the large isopod *Saduria entomon* (body weight up to 5 g, average weight 2.1 g) – is encountered significantly less frequently in the Piltun area (P = 25%). In the zone of mass sand dollar development, this species can form local accumulations, which made it possible to consider this isopod, along with other crustaceans, as potential prey for gray whales (Photo 1). The biomass of this species increases with depth (Fadeev, 2002). The isopod *S. entomon* had a 16% frequency of occurrence in 2002 collections. The biomass of this species at depths of 11 to 30 m varied from 1.5 to 56 g/m^2.

The isopod distribution in the Piltun area in 2003 had a distinctly patchy nature. The patchy nature of the isopod biomass distribution in the shallow zone was conditioned by local accumulations of the small isopod *Synidotea cinerea*. The density of this species in the accumulations reached 3600 spec./m^2 with biomass of 55 g/m^2. At depths greater than 15 m,

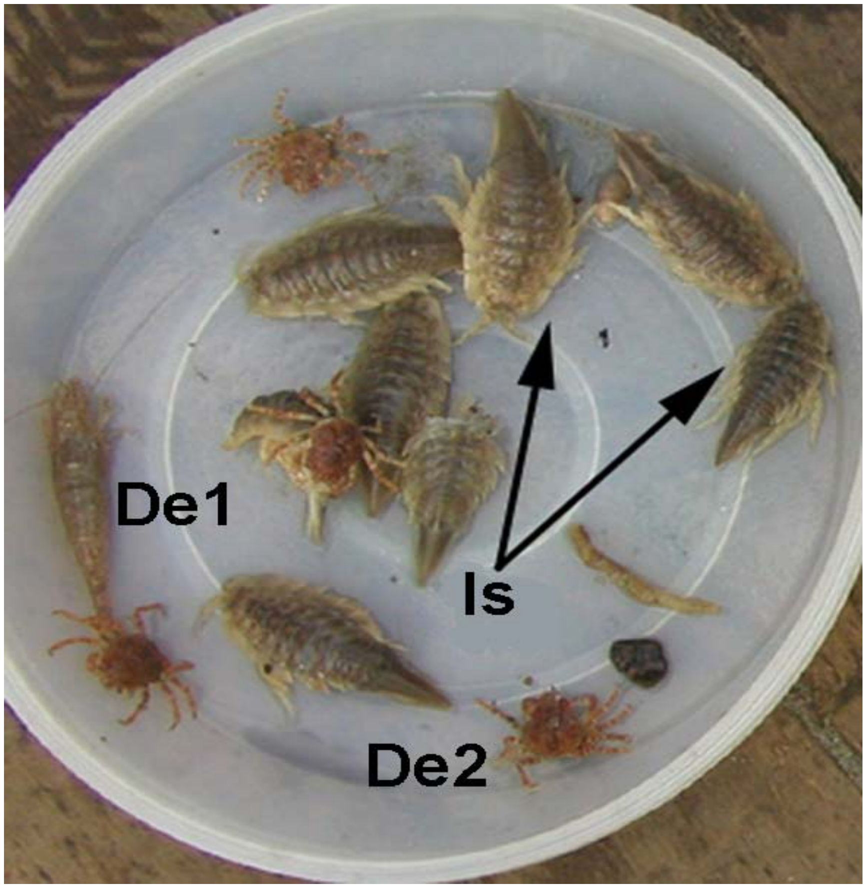


Photo 1. Large isopods *Saduria entomon* (Is) and young crabs *Hyas coarctatus* (De2) in a bottom grab sample from the sand dollar zone.

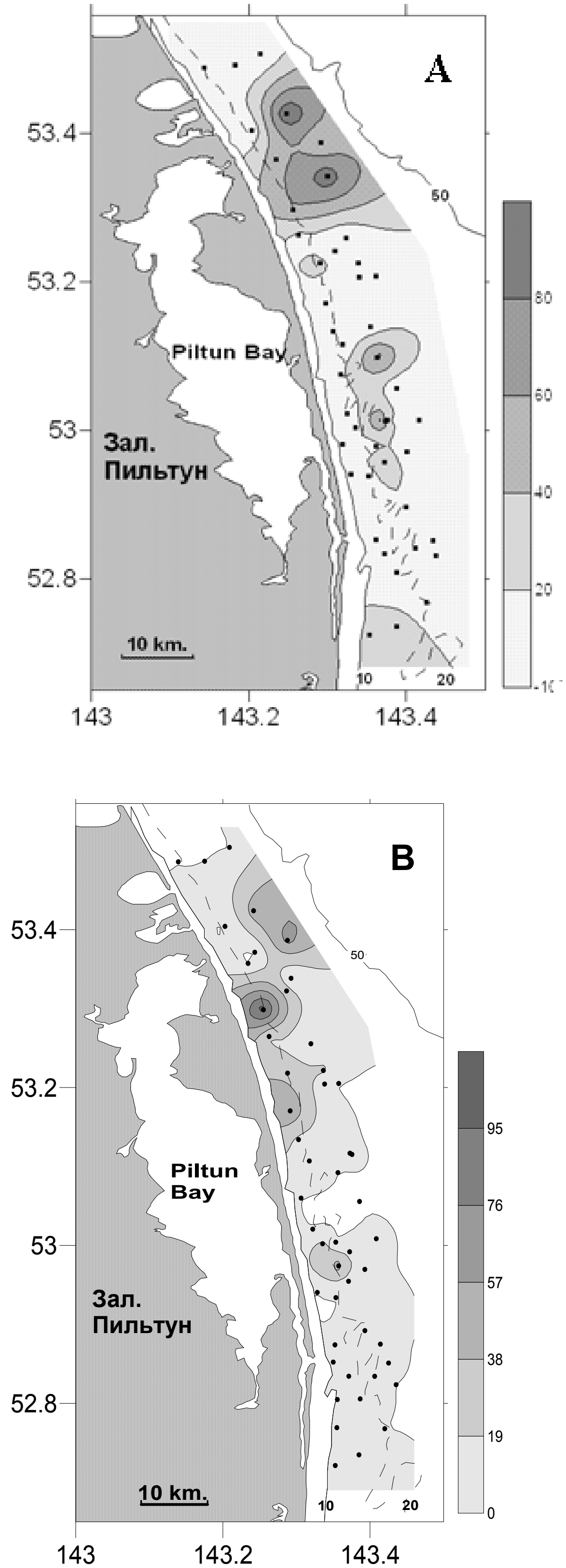


Figure 16. Isopod biomass distribution (g/m^2) in the Piltun area according to materials from 2004 (A) and 2005 (B).

areas of elevated isopod biomass were characterized by accumulations of the large isopod *Saduria entomon*.

The biomass of this species in local accumulations reached 128 g/m^2 at a colony density of 75 spec./m^2. However, analysis of the spatial distribution of biomass of this species indicated that such accumulations are rare and occupy a small area in the sand dollar zone (Fadeev, 2004). For example, accumulations of *Saduria entomon* with a biomass greater than 30 g/m^2 were observed at 6 stations in 2003. The isopods were present at each station in only one bottom grab sample out of three taken at the station. Flat sea urchins without isopods, with biomass up to 1200 g/m^2, were prevalent in the other two samples at these stations. The proportion of samples with isopod dominance in the biomass was only 6% at depths greater than 15-20 m in 2003 and was less than 3% when bottom grab sample collections from 2002 were included. Despite the low frequency of occurrence of local accumulations of large isopods at depths greater than 15-20 m, they can be used in feeding of individual whales, but they cannot serve as a regular food resource. A similar nature of the isopod distribution was observed in the Piltun area in 2004 (Fadeev, 2005).

The proportion of isopods in benthos biomass at depths of 11-30 m in 2005 collections was 4.5% at an average biomass of 15.3±2.2 g/m^2, which is not substantially different from the data of 2004: 4% and 18.5±3.6. No clear trend in the change in isopod biomass is observed with increasing depth (Table 10, Figure 14). As in 2004, the highest biomass levels (more than 90 g/m^2) were observed at depths greater than 20 m within local accumulations of the large isopod *Saduria entomon*.

The spatial distribution of isopods in the Piltun area was similar in nature in 2005 and 2004 (Figures 16A and 16B). The isopod biomass distribution is distinctly patchy. Some differences are observed in the zone immediately adjacent to the shore, at depths less than 15 m. The number of areas of elevated isopod biomass there in 2005 was lower than in 2004. At depths greater than 15-20 m, local isopod accumulations in 2004 and 2005 can be charted most clearly in the northern part of the Piltun area (Figures 16 A and 16B).

<u>Characteristics of the dominant isopod species</u>. The large isopod *Saduria entomon* is a saltwater Pan-Arctic circumpolar species represented by relic populations in the boreal zone. It resides throughout a broad depth range: 0-44 m in the Arctic (Crimmon and Bray, 1962), and 1-270 m in the Baltic Sea (Jarvekulg, 1979). According to published data, the maximum habitat temperature in the Arctic and the seas of the Far East is 10 °C (Crimmon and Bray, 1962). The species reaches sexual maturity at the age of 3-4 years (Jarvekulg, 1979). It inhabits the lagoons of eastern Sakhalin and is encountered throughout the Piltun lagoon,

where it is the only predator among the epibenthic invertebrates (Kafanov et al., 2003). This isopod is an active cannibal predator (Leonardsson, 1991; Sparrevik and Leonardsson, 1998), and its accumulations are temporary in nature.

Amphipods (*Amphipoda*). According to diving data from 2001, 10 species of amphipods had a frequency of occurrence higher than 25% at depths of 5–30 m in the Piltun feeding area, and three species had a frequency of occurrence higher than 50% (*Eohaustorius eous eous* – 81%; *Grandifoxus longirostris* – 75%; and *Pontoporeia affinis* – 71%). The average amphipod biomass for the entire area at depths of 11–30 m was 114.1±15.7 g/m^2. It was noted that the most substantial changes in biomass and frequency of occurrence of common amphipod species occur in the range of 15-20 m in the Piltun area (Fadeev, 2002). In 2002-2003 collections at depths of 8–30 m, 37 amphipod species were recorded (Appendix 4). Of these, six species have a frequency of occurrence (P) higher than 50%: *Eohaustorius eous eous* (P = 100%), *Pontoporeia affinis* (98%), *Grandifoxus longirostris* (86%), *Eogammarus schmidti* (81%), *Anisogammarus pugettensis* (78%), and *Westwoodilla sp.* (65%). Of the species with a frequency of occurrence higher than 25%, nine species had the highest biomass levels: *Grandifoxus longirostris, Eohaustorius eous eous, Pontoporeia affinis, Eogammarus schmidti, Atylus collingi, Pontharpinia robusta, Anonyx nugax,* and *Westwoodilla sp.* The average amphipod biomass levels for the entire area were similar in 2002 and 2003. It was demonstrated based on data from 2001-2003 that the most substantial change in amphipod biomass occurred at depths of 15-20 m (Fadeev, 2003, 2004). In materials from 2004, the average amphipod biomass in the Piltun area was 47.4±7.7 g/m^2, which is comparable to the data from 2002 – 42.7 g/m^2 – and 2003 – 54.6 g/m^2 (Fadeev, 2005).

In 2005, the average amphipod biomass was 38.8±7.2 g/m^2 for the entire depth range studied in the Piltun area, which does not differ significantly from the data from 2004 – 47.4±7.7 g/m^2. As in 2004, the average amphipod biomass amounts to about 9% of the total benthos biomass. More than 95% of amphipod biomass is accounted for by two species: *Pontoporeia affinis* (more than 60% of the total amphipod biomass) and *Eogammarus schmidti* (more than 30%). Amphipods have their highest quantitative abundance levels at depths less than 15 m. The sharpest decrease in the abundance of amphipods occurs in the range of 15-20 m (Table 10; Figures 14 and 15). The proportion of amphipods is more than 50% of the total benthos biomass at depths of 11-15 m and less than 5% at depths greater than 20 m.

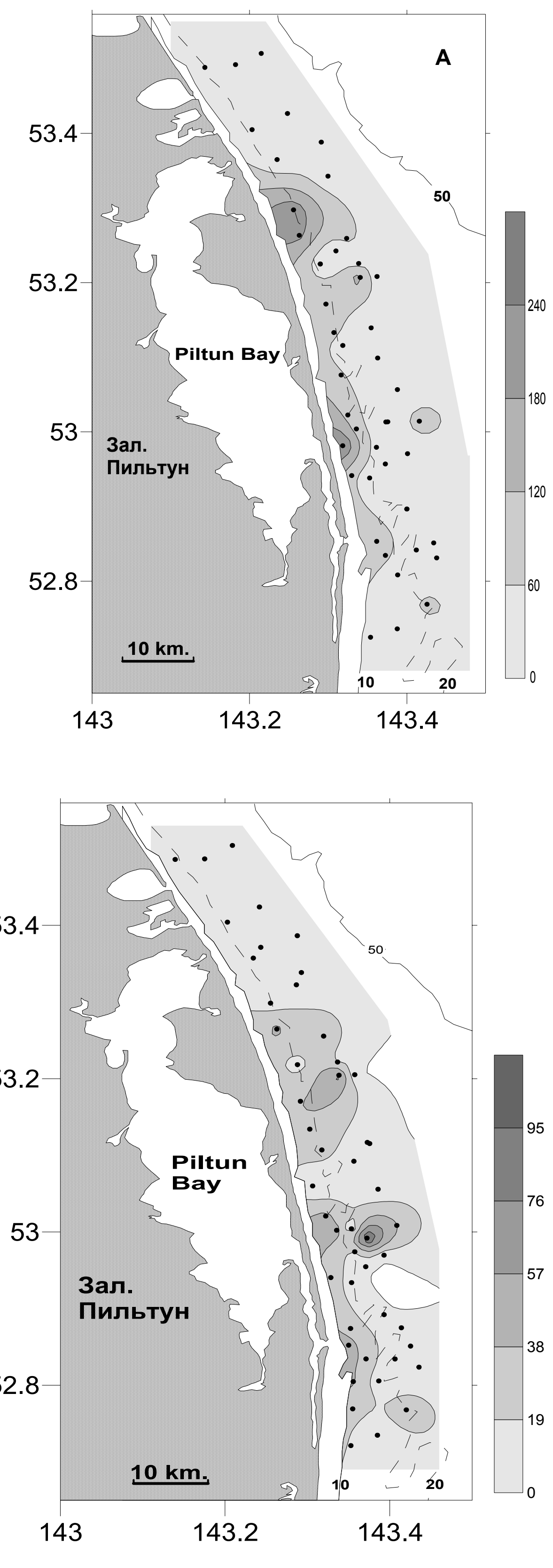


Figure 17. Amphipod biomass distribution (g/m^2) in the Piltun area based on materials from 2004 (A) and 2005 (B).

The nature of the spatial distribution of amphipod biomass in the Piltun area shows similar trends in 2005 and 2004: the zone of high biomass is associated with the parts of the water area nearest the shore, and the amphipod distribution is patchy (Figure 17). The amphipod biomass distribution was more regular in 2004 (Figure 17A) than in 2005 (Figure 17B), and local spots of elevated biomass can be seen in the northern and middle parts of the area. According to materials from 2002 and 2003, spots of elevated biomass were located primarily in the southern and middle parts of the Piltun area. In 2004 and 2005, local areas of elevated amphipod biomass are seen in the middle and northern parts of the area and are more pronounced than in 2003. The section in the northern part of the Piltun area is larger in area and has higher amphipod quantitative abundance levels.

Characteristics of the dominant amphipod species. The amphipod *Pontoporeia affinis* **(**= *Monoporeia affinis***)** is a saltwater Pan-Arctic circumpolar species represented by relic populations in the boreal zone. It inhabits the northern arctic seas and lakes of Northern Europe and North America. In the Baltic Sea, it lives at depths of 0.5-300 m with salinity of 1.5-18‰ and temperatures up to 12.8 °C (Jarvekulg, 1979). In the Piltun area, the species is encountered both in freshened Piltun lagoon areas and in offshore areas with normal salinity. With respect to feeding type, it is a burrowing deposit feeder. In digging up the top layer of the bottom and stirring up the bottom sediment during feeding, *P. affinis* has a significant impact on bivalve mollusk juveniles (Segestrale, 1973), meiobenthic animals (Olafsson and Elmgren, 1991) and even zooplankton (Albertsson and Leonardsson, 2001). It breeds in winter, and juveniles emerge from the hatching pouch in spring; individuals die after the first breeding (Jarvekulg, 1979). 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). In the Baltic Sea, *P. affinis* is among the highly productive benthic species (Andersin et al., 1984).

Cumaceans (*Cumacea*). Based on materials from 2001, the average biomass of cumaceans at depths of 5–30 m was 17.1±3.5 g/m^2. The biomass of cumaceans increased with depth. A similar relationship could be traced in the materials from 2002-2004. The biomass of cumaceans was 5.35 g/m^2 in the range of 11–15 m and increased to 48.9 g/m^2 at a depth of 30 m. The average biomass was 10.9±2.8 g/m^2. The maximum colony density of cumaceans of 24,800 to 37,600 spec./m^2 with a biomass of 84 to 113 g/m^2 was observed at depths of 30-32 m (Fadeev, 2002-2005).

Cumaceans had a high frequency of occurrence – 56% – in the 2005 collections. As previously at depths up to 30 m, four cumacean species were observed: *Lamprops affinis, Lamprops quadriplicata, Diastylopsis dawsoni* and *Diastylis bidentata.* The first three species were encountered in small numbers at depths less than 15 m. Only *Diastylis bidentata* is encountered at all depths; it accounts for more than 98% of the total cumacean biomass. The average cumacean biomass for the entire area in 2005 was 1.7 g/m^2, which is not substantially different from the data from 2004: 1.1 g/m^2. Cumacean biomass levels from 2005 and 2004 are significantly lower than the biomass levels of 2001 and 2002 (17.1 and 10.9 g/m^2). The differences in biomass in different years are explained by the fact that the station layout in 2003-2005 differed from the 2002 layout; i.e., cumacean accumulations inspected in 2002 were not covered in the studies in 2005 and 2004.

Bivalve mollusks (*Bivalvia*). Based on data from diving studies in 2001, only three bivalve mollusk species had a frequency of occurrence higher than 25% and were dominant in regard to biomass in the Piltun Bay area in 2001: *Siliqua alta, Macoma lama* and *Megangulus luteus*. For the water area as a whole, the biomass of *Bivalvia* increased somewhat from 5 m to 10–15 m, with a subsequent decrease at depths greater than 20 m. The average biomass value for bivalve mollusks for the entire water area at depths of 11–30 m was 103.2±25.15 g/m^2. The average biomass of bivalve mollusks in the range of 11–30 m in 2002 was 40.36±8.81 g/m^2. Four species make up the basis of bivalve mollusk biomass: *Megangulus luteus* (frequency of occurrence P = 56%), *Macoma lama* (P = 45%), *Siliqua alta* (P = 31%) and *Mactromeris polynyma* (P = 1%). The spatial distribution of bivalve mollusks in the Piltun area was similar in 2001 and 2002. Areas of elevated biomass had a spotty distribution and were associated with the southern, middle and northern parts of the area (Fadeev, 2002, 2003).

In the materials from 2005 and 2004, 30 species of bivalve mollusks were recorded (Appendix 5). Of these, five species had a frequency of occurrence higher than 25%: *Megangulus luteus* (frequency of occurrence P = 60-71%), *Macoma lama* (P = 25-35%), *Siliqua alta* (P = 30-32%), *Mysella kurilensis* (P = 28-30%) and *Mactromeris polynyma* (P = 25-27%). The average bivalve mollusk biomass in the Piltun area in 2005 is 59.0±13.9 g/m^2 (Table 7). The bivalve mollusk biomass varies only slightly throughout the depth range studied (Figures 14 and 15). The spatial distribution of bivalve mollusks from 2002-2005 had a distinctly aggregated nature. This conclusion is also supported by the nature of the spatial distribution of the bivalve mollusk complex in the Piltun area (Figure 21).

Sand lance *Ammodytes hexapterus*. The materials from 2004-2005 are distinguished from 2002-2003 by a significantly higher proportion of the fish *Ammodytes hexapterus* in the total benthos biomass of the Piltun area. The frequency of occurrence of the sand lance in bottom grab sample collections in 2002-2003 was 5-8% at an average biomass of 4.6-6.2 g/m^2. The frequency of occurrence of the sand lance in 2004 was 14.8% at 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 biomass in the samples. The densest accumulations in 2004 were observed in the northern and middle parts of the Piltun area.

The sand lance was encountered in low numbers throughout the Piltun area in 2005, as in 2004, but the densest accumulations were found in the northern and middle parts of the area, at depths greater than 15-20 m. While the average biomass was 16.3±4.4 g/m^2 for the whole area, its biomass reached 150 – 236 g/m^2 within local accumulations. The frequency of occurrence of the sand lance in the northern part Piltun area in 2005 was 25%.

Sand lance accumulations were observed for the first time in the Piltun area during diving work in 2001 (Fadeev, 2002). The sand lance was observed in a zone of fine-grained and medium sandy bottoms, mainly in the southern and middle sections of the Piltun area, at depths greater than 10 m. A distinguishing feature of the ecology of the sand lance is the fact that individuals of the species bury themselves in the surface layer of sand during the day, which makes it possible to count the species in accumulations with reasonable accuracy. Adult sand lances were prevalent in the 2005 collections at depths greater than 20 m at gray whale feeding sites in the northern part of the Piltun area (Photo 2). The sand lance density in the densest accumulations reached 140-160 spec./m^2. Sand lance accumulations in the Piltun area were not associated with any macrobenthos community; the nature of the sea bottom is the determining factor. Based on the high sand lance biomass levels in accumulations and their high fuel value, according to the results of 2001 studies, the sand lance was considered potential prey for whales in the Piltun area (Fadeev, 2002), especially since this species has already been noted as prey for gray whales from stomach contents (Zimushko and Lenskaya, 1970).

The question of the possible role of the sand lance in the feeding of gray whales in the Piltun area needs more detailed study. It is significant than an increase has been observed in the frequency of occurrence and biomass of the sand lance in the northern part of the area from 2003 to 2005. This process has occurred concurrently with a decrease in the number of whales in the offshore Area and the appearance of a grouping of whales feeding at depths greater than 20 m in the northern part of the Piltun area.

Photo 2. Sand lance *Ammodytes hexapterus* in a sample from a gray whale feeding site in 2005.

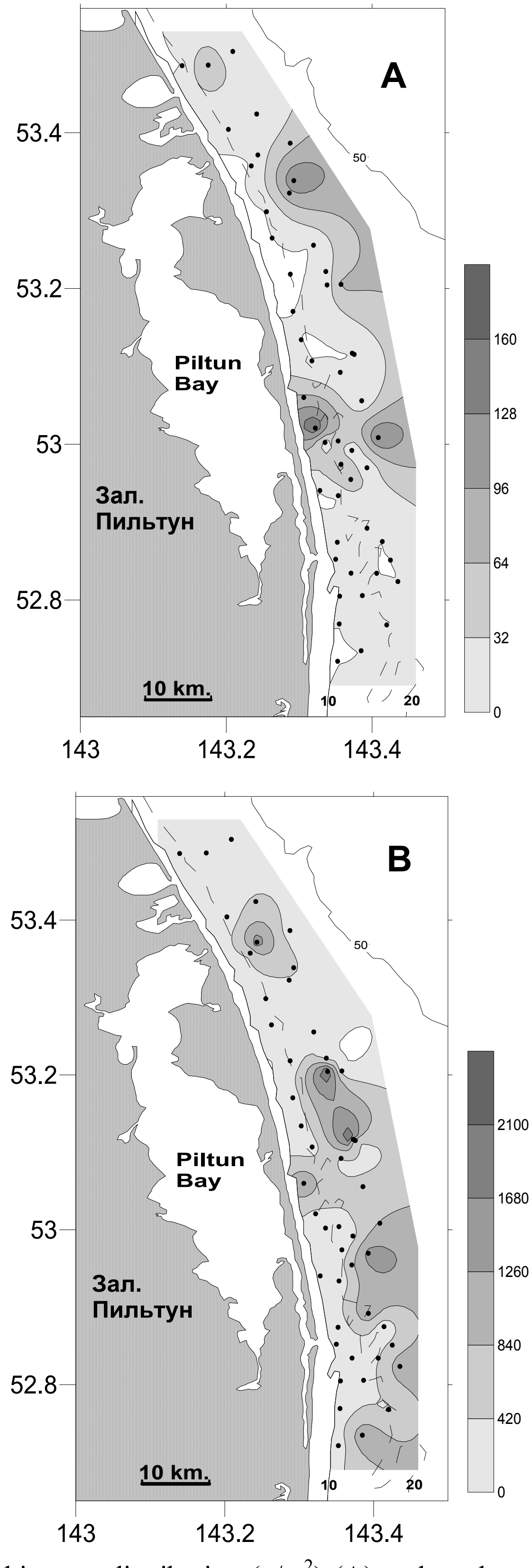


Figure 18. Sand lance biomass distribution (g/m^2) (A) and total macrobenthos biomass in 2005 (B) in the Piltun area.

4.1.2. Composition and Distribution of Benthos Complexes According to 2005 and 2002-2004 Data

Cluster analysis was used to identify irregularities in the benthos distribution – the 207 stations (2002-2005) were grouped according to similarity of the quantitative ratios of benthos taxonomic groups (Table 11). The classification results are presented in dendrograms (Figure 22). The groups of stations with the greatest similarity in benthos composition are not, strictly speaking, biocoenotic units. The benthos composition can be divided into a number of smaller complexes that differ in both the composition and the quantitative abundance of the taxonomic groups (Table 11). In the Piltun area a total of three benthos complexes could be identified from all the stations sampled. Figure 19 shows how these three complexes were distributed among the sampling stations in the Piltun Feeding Area.

Table 11. Composition of benthos complexes of the Piltun area.

Taxonomic Group	*Amphipoda* complex		*Bivalvia* complex		Sand dollar *E. parma* 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	4772	**87.79**	1368	29.37	689	23.41
Bivalvia	80	21.95	361	**99.98**	62	62.48
Cumacea	161	1.48	210	1.84	603	1.53
Decapoda	0	0	2	0.88	2	2.26
Echinoidea	1	1.34	11	39.3	181	**849.45**
Gastropoda	2	1.98	5	2.74	2	12.92
Isopoda	281	15.94	129	10.64	9	14.01
Pisces	2	9.46	3	12.06	4	27.01
Polychaeta	56	3.65	63	16.88	72	18.77
Total	5355	143.59	2152	213.69	1626	1011.84

Amphipoda complex includes 56 stations at depths of 5 to 23 m (average depth 15 m) in the fine- and medium- sand zone. The complex is distributed in a belt along the coast in the Piltun area (Fig. 21). The average biomass of the complex (143.6 g/m^2) is made up primarily of amphipods – 61%; isopods – 14%; and bivalve mollusks – 14% (Photo 3). The complex includes 29 amphipod species with a total biomass of 87.8±12.5 g/m^2 at a colony density of 4772±1170 spec./m^2. Four species have the greatest quantitative abundance: *Pontoporeia affinis, Eogammarus schmidti, Eohaustorius eous eous* and *Anisogammarus pugettensis*. They account for 95% of the average biomass and colony density of amphipods in the complex.

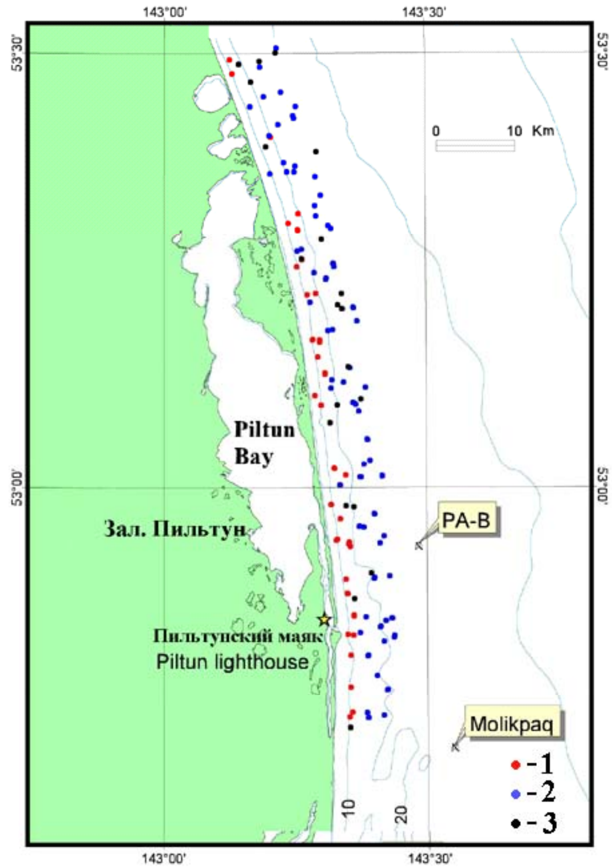


Figure 19. Distribution of complexes in the Piltun area based on 2002-2005 data.
Complex designations: 1 – amphipods; 2 – sand dollars; 3 – bivalve mollusks.

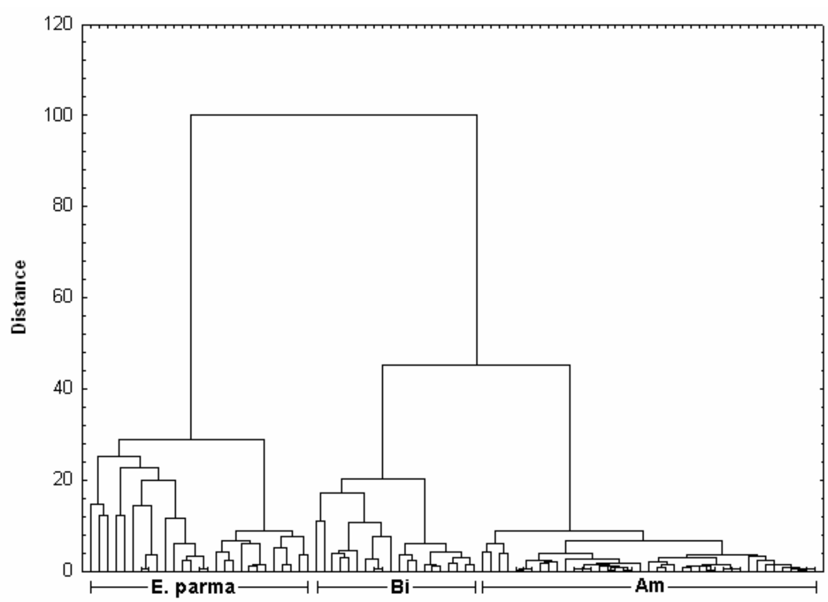


Figure 20. Dendrogram of the similarity of stations in the Piltun area based on collections from 2002-2005.
In dendrogram: Am – amphipod complex; Bi – bivalve mollusks complex; E. parma – sand dollars complex.

Photo 3. Bottom grab sample (0.2 m^2) from *Amphipoda* complex.

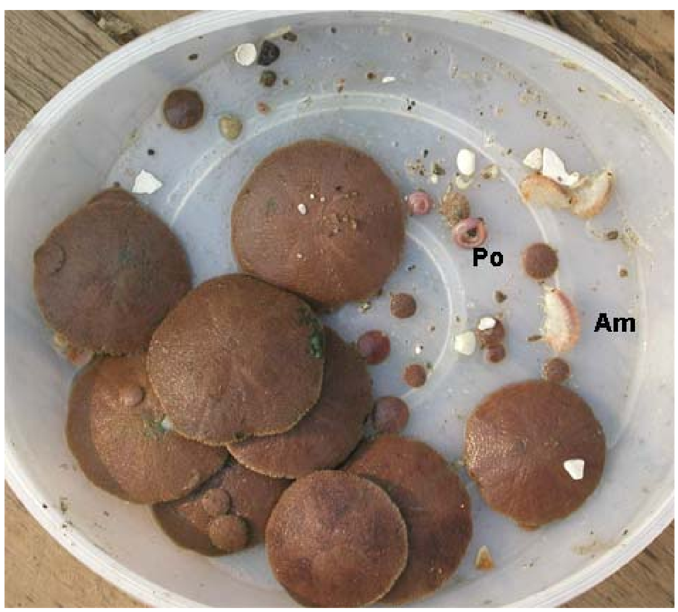


Photo 4. Bottom grab sample (0.2 m^2) from sand dollar complex.
Am – amphipods *Anonyx nugax*;
Po – polychaetes *Ophelia limacina.*

This group of species, in turn, is dominated by *Pontoporeia affinis,* which makes up 85% of biomass and 80% of colony density of the complex. Second in significance in the complex is the isopod group, represented by two species: *Synidotea cinerea* and *Saduria entomon*. The dominant species, *S. cinerea*, has a frequency of occurrence in the complex of 95%, and it accounts for 94% of the total isopod biomass. The complex includes 10 species of mollusks, of which five species have a frequency of occurrence greater than 50%: *Megangulus luteus, Siliqua alta, Tridonta borealis, Liocyma fluctuosum, Macoma lama.* These species account for more than 92% of the biomass of bivalve mollusks (23 g/m^2).

Based on diving data from 2001, the bottom areas having dominance of similar compositions of amphipods and isopods are located in the near-shore zone of the Piltun area at depths of 5-17 m (Fadeev, 2002). The amphipods *Pontoporeia affinis* had the greatest abundance in the coastal amphipod complex in 2001-2004.

<u>*Bivalvia* complex</u> includes 37 stations at depths of 9 to 29 m (21 m, average) on fine sands and mixed gravel and sand bottoms. In contrast to the amphipod complex, it has a distinctly spotty distribution in the area (Figure 19). The composition of the complex includes 18 bivalve mollusk species with a biomass of 100±37.2 g/m^2 at an average complex biomass of 213.7 g/m^2. Eight species have the highest frequency of occurrence: *Megangulus luteus, Astarte arctica, Macoma lama, Tridonta borealis, Siliqua alta, Mysella kurilensis, Liocyma fluctuosum* and *Mactromeris polynyma*. They account for more than 98% of the total biomass of the complex. The bivalve mollusk complex is not homogeneous: *Megangulus luteus* is dominant in the shallow areas, and *Astarte arctica* is dominant in deeper waters (deeper than 20-25 m). Within the complex, the total amphipod and isopod (primarily *Saduria entomon*) biomass is more than 50% of the biomass of bivalve mollusks. Analysis of the data from whale feeding sites in 2002-2004 indicates that whale feeding occurs in areas occupied by the *Bivalvia* complex.

<u>Sand dollar *Echinarachnius parma* complex</u> (Photo 4) has been described in detail based on materials from 2001-2003 (Fadeev, 2002, 2003, 2004) and is not covered in this report.

In resuming the analysis of the distribution of macrobenthos complexes based on materials from 2002-2004 and 2005, we note that most of the sea bottom in the Piltun area is occupied by two complexes: a shallow-water coastal <u>amphipod complex</u> with a high proportion of forage components, and a deeper-water <u>sand dollar complex</u> with an extremely low proportion of prey in its biomass. The provisional boundary between complexes is at depths of about 20 m (Fig. 19).

4.2. Offshore Area

4.2.1. Quantitative Abundance and Distribution of Benthos Based on Data from 2005 and 2004

There were 48 stations (144 bottom grab samples) at depths from 19 to 62 m (average depth 42.5±1.7 m, n=48; in 2004, 49.3±2.3 m, n=32) in the Offshore area in 2005. Diagrams of station locations in the Offshore area are shown in Figures 19 and P1.2. In contrast to the diagrams of station locations in 2002-2004, there was a full grid of stations (48 stations) throughout the Offshore area during the 2005 expedition (P1.2).

The bottom is sandy in most of the Offshore area with well-sorted fine sand at 40 stations, and sands of varying grain size mixed with gravel and pebbles at 8 stations. The proportion of the aleurite-pelite fraction is more than 25-30% of the dry sediment weight at a number of stations.

There were 18 benthos taxonomic groups recorded in the collections; they differ substantially in their frequency of occurrence at the stations (Table 12).

Table 12. 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	100	*Nemertinea*	48	*Echinoidea*	22	*Bryozoa*	9
Bivalvia	100	*Decapoda*	47	*Isopoda*	16	*Caprellida*	8
Cumacea	100	*Hydroidea*	43	*Pisces*	12	*Ophiuroidea*	8
Polychaeta	95	*Sipunculida*	38			*Ascidiacea*	6
Actinia	84						
Gastropoda	70						
Holoturoidea	62						

As in 2003-2004, groups with a frequency of occurrence greater than 50% form the basis of the benthos biomass throughout the waters of the Offshore area: amphipods, cumaceans, bivalve mollusks, marine worms and sea anemones. There are also groups with a lower frequency of occurrence throughout the area which nevertheless form local sections with very high biomass – sand dollars *E. parma* (P = 22%). For the Offshore area as a whole, these taxonomic groups account for more than 95% of the average total benthos biomass – 527±56 g/m^2 (n=48). Figures for the quantitative abundance of benthos for the Offshore area in 2005 are given in Table 14.

Analysis of the total average benthos biomass and the biomass of individual groups for the 2005 and 2003-2004 collections indicates that statistically significant differences in the average values are observed in a number of cases. The average total benthos biomass was significantly higher in 2004 than in 2003 (899.1±85.8 g/m^2 and 630.1±64.3 g/m^2, respectively; t-test, t = 3.46, df = 62, p <0.05). Statistically significant differences in the overall distribution of total biomass are due to the fact that the study area was expanded eastward in 2004 in response to the observed distribution of whales in 2003 (Fig. P1.2). This was done to outline the area of elevated amphipod biomass. Accordingly, quite a few stations with high biomass not covered in 2003 were sampled (Fadeev, 2005).

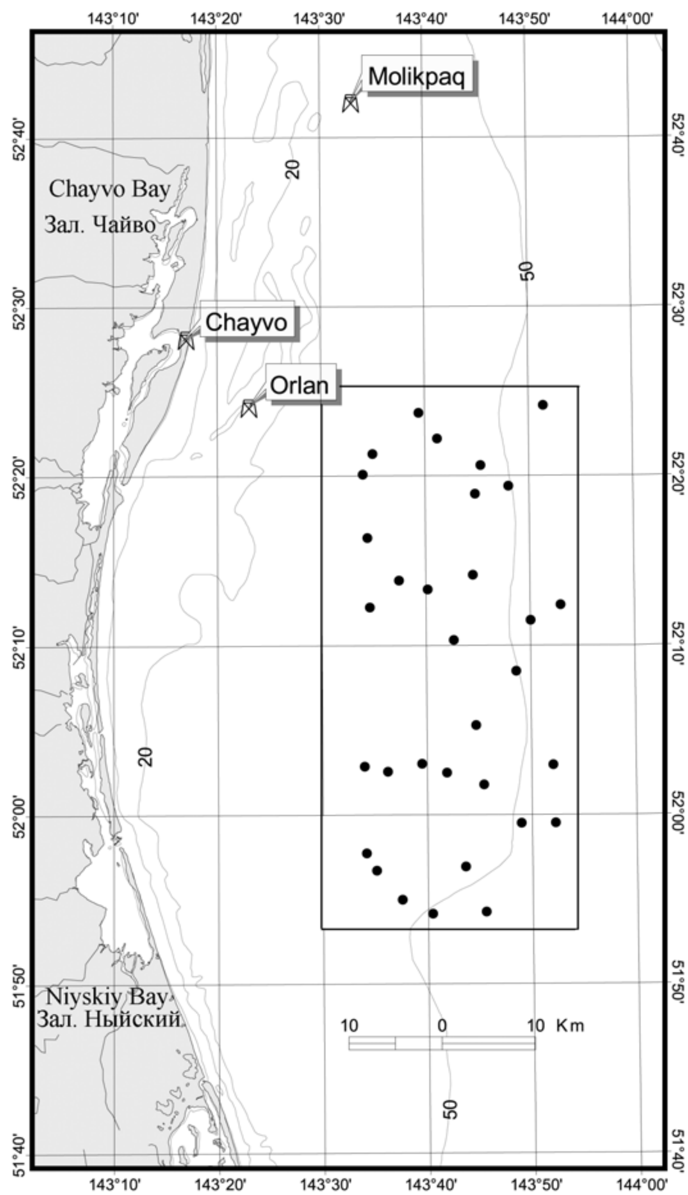


Figure 21. Diagram of benthic sampling stations in the Offshore area in 2005.

Analysis of the total average benthos biomass of the Offshore area based on 2005 and 2004 collections indicates a statistically significant different in the average biomass level. The average total benthos biomass was significantly higher in 2004 than in 2005 (899.1±85.8 g/m^2 and 526.6±52.3 g/m^2, respectively; t-test, $t = 3.56$, $df = 73$, $p=0,0006<0,001$). However, the statistical significance of biomass differences for 2004 and 2005 at such a high level is explained by particular features of the sampling system in 2005. There were stations in the near-shore zone of the Offshore area in 2005 which were not covered in 2004 (Fig. P1.2). The near-shore (western) part of the Offshore area is characterized by low benthos biomass levels (Fadeev, 2003; 2004).

The biomass of the main groups (amphipods, bivalve mollusks, sea anemones and cumaceans) in 2005 was comparable to the 2004 data. The biomass of amphipods – the most important component in the diet of whales in the Offshore area – was 200.2±35.7 g/m^2 and 328.5±41.2 g/m^2, respectively, in 2005 and 2004. Year-to-year variations in the average amphipod biomass are statistically significant at a low level ($p = 0.003<0.05$) and are explained by features of the sampling systems in 2005.

Statistical analysis showed that in the parts of the Offshore area where benthic samples were taken in 2003, 2004 and 2005 (20 stations, Fig. P 1.2), the differences between the years in the total biomass of benthos and the total biomass of the main prey item - Ampelisca eschrichti - were statistically insignificant.

Table 13. Macrobenthos biomass distribution (B, g/m^2) in the Offshore area based on materials from 2004-2005 field work.

Parameter	Depth										Entire Area (**Bsumm**)	
	Amphipoda		*Actinia*		*Bivalvia*		*Echinoidea*		*Polychaeta*			
	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004
Average B	200.2	328.5	76.5	184.6	91.7	114.1	85.5	164.2	23.8	42.7	526.6	899.1
Standard deviation	35.7	41.2	13.7	42.1	15.7	19.5	36.2	74.2	3.9	22.8	52.3	85.8
Proportion, % of **Bsumm**	35.7	36.5	13.7	20.5	15.7	12.7	36.2	18.3	3.9	4.7	100	100%
Minimum	0.3	0.4	0	0	0	5.4	0	0	0	0.1	100.8	196
Maximum	1334	1094	396.9	1169	427	370.4	1238	1548	104	739.8	1806	2204
P, %	100	100	84	91	100	100	22	25	95	100		
Number of stations	48	32	48	32	48	32	48	32	48	32		

Notes: **Bsumm** is the average total benthos biomass, g/m^2 ; P, % is the frequency of occurrence, %.

The spatial distribution of benthos biomass was similar in 2005 and 2004. Amphipod biomass increases in moving from shore toward deeper water (Figures 26, 27). A similar trend was observed in 2002-2003. The 2004 expedition succeeded for the first time in outlining the zone of the highest amphipod biomass levels (Figure 27B). In moving eastward from the maximum biomass zone, there is a sharp decrease in the quantitative abundance of amphipods. There is a parallel gradual increase in the proportion of aleurite-pelite fractions in the seabed.

The other groups (sea anemones, bivalve mollusks and cumaceans) that make up most of the biomass have a distinctly spotty distribution.

As in 2002-2004, accumulations of bivalve mollusks, sea anemones, cumaceans and sand dollars have the most aggregated distribution. Higher biomass areas of these groups are on the edge of the amphipod mass development zone (Figures P1.9 and P1.12). The nature of the distribution of total benthic colony density is determined by specific features of the distribution of cumaceans and amphipods. The macrobenthos high-density zone coincides with cumacean colonies in the eastern part of the area and with areas of amphipod mass development in the western part.

4.2.2. Composition and Distribution of Benthos Complexes in the Offshore area Based on Materials from 2005 and 2004

Based on materials from 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 occupies the largest part of the water area and is of great importance as an active feeding ground for gray whales (Fadeev, 2004, 2005).

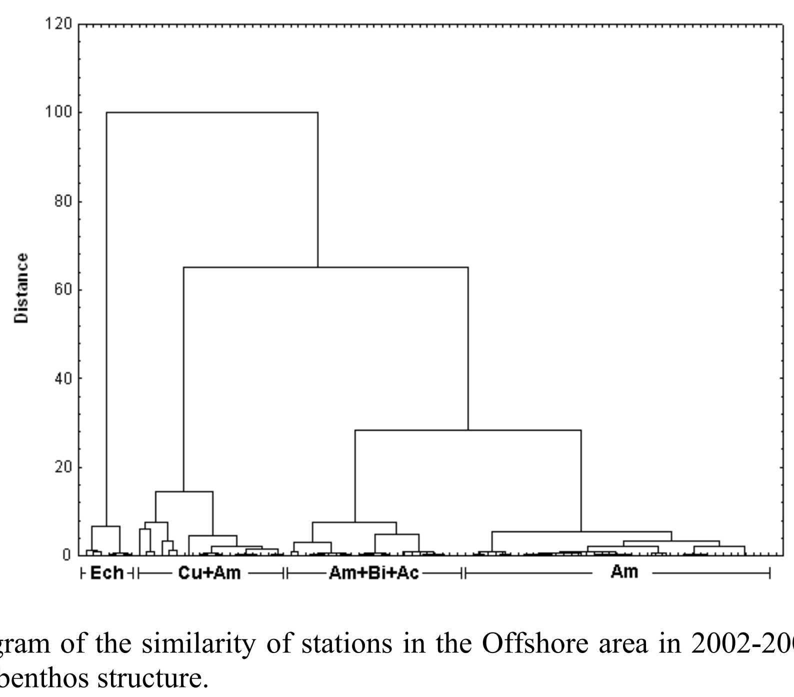


Figure 22. Dendrogram of the similarity of stations in the Offshore area in 2002-2005 according to macrobenthos structure.

Table 14. Quantitative characteristics (g/m^2) of macrobenthos complexes in the Offshore area based on materials from 2002-2005

Parameter	Taxonomic Group					Average total biomass (**Bsumm**)
	Amphipoda	*Actinia*	*Bivalvia*	*Echinoidea*	*Cumacea*	
1. Complex *Ampelisca eschrichti* (Am)						
Average biomass	**513.94**	100.13	49.06	0.7	18.6	644.37
Standard deviation	97	42.53	17.42	0.7	7.43	145.48
Proportion in **Bsumm**, %	79	12	7	0	2	100%
2. Complex *Diastylis bidentata* + *Amphipoda* (Cu+Am)						
Average biomass	**134.53**	39.11	26.05	17.86	**122.63**	338.5
Standard deviation	18.08	16.23	11.48	6.45	29.16	44.36
Proportion in **Bsumm**, %	39	11	7	5	36	100%
3. Complex *Ampelisca eschrichti* + *Bivalvia* + *Actinia* (Am+Bi+Ac)						
Average biomass	**320.58**	**184.88**	**108.88**	1.69	35.6	622.59
Standard deviation	20.5	21.2	28.4	1.69	12.39	47.82
Proportion in **Bsumm**, %	51	30	17	0	5	100%
4. Complex *Echinarachnius parma* (E. parma)						
Average biomass	22.43	97.16	105.32	676.62	42.45	946.07
Standard deviation	9.24	37.39	56.75	117.97	17.63	164.87
Proportion in **Bsumm**, %	2	10	11	73	4	100%

Note: Abbreviated names of complexes used in Figure 23 are given in parentheses.

All the stations of 2005 and 2002-2004 were grouped according to similarity of the quantitative relationships among benthos taxonomic groups. A similar approach was used in classifying the stations of the Piltun area (Section 4.1.3). The classification results are illustrated with a dendrogram (Figure 24). Based on materials from 2002-2005, four benthos complexes are distinguished in the Offshore area (Table 15):

I. Complex with dominance of sand dollars *Echinarachnius parma*. The average depth was 31.5±1.8 m (18 stations at depths of 18-47 m). Sand dollars are dominant at all stations, with an average biomass of 670 g/m^2 (more than 85% of the total biomass).

This complex was described in detail in the Piltun area at depths greater than 20 m based on data from 2001-2004 (Fadeev, 2003, 2004). According to materials from 2002-2005, it occupies local sections in the Offshore area in the northern part of the water area (Figure 25).

Based on published data (Averintsev et al., 1979), there is a gigantic subarctic-latitude association of the sand dollar *Echinarachnius parma* in the area of northeastern Sakhalin Island at depths of 15-120 m which occupies an area of about 13,000 km^2, i.e., about 40% of the shelf area, off eastern Sakhalin. The *E. parma* community is associated with shallow sandy bottoms and silted sands, where bottom currents with sufficiently high speeds are present (Koblikov, 1983a,b). As the current speed decreases southward along the eastern Sakhalin shelf and bottom silting increases, the sand dollars were replaced by other species. Mobile seston-feeders (flat sea urchin, etc.) 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). According to observations conducted in 1995-1996, the content of suspended matter in the water column varied from 0.93 to 11.8 mg/l, with suspended matter of biological origin prevalent (CSA, 1996, 1997). 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 36 km to the north. They connect the cause of such changes with an indirect anthropogenic effect – over harvesting of the Kamchatka crab and flounder (which feed on the sand dollars, which has resulted in disruption of the balance in the "predator-prey" system.

II. Complex with dominance of cumaceans *Diastylis bidentata* and amphipods *Ampelisca eschrichti*. The average depth is 28.6±1.8 m (21 stations at depths of 24-31 m). The average total biomass of the complex is 338±44 g/m^2, and the dominant species account for more than 80% of the biomass (cumaceans – 58.7%; and amphipods – 23%). The complex occurs in patches at depths of 24 to 31 m in the western part of the area, on fine-grained and mixed sands. Amphipod *A. eschrichti* is a subdominant species with biomass of 134 g/m^2.

The distribution of cumaceans was considered in describing the Piltun area (section 4.1.1), also based on data from 2001 (Fadeev, 2002). Based on materials from 2002, the relationship between the colony density of cumaceans *D. bidentata* and amphipods *A. eschrichti* in the Offshore area was examined. The amphipod colony density decreased, while the cumacean colony density increased, as the depth increased (Fadeev, 2003). Ampeliscid amphipods and cumaceans are seston-feeders and filter-feeders; i.e., both species obtain nutrition by filtering the seabed water. In areas of greatest abundance, their density reaches very high values: cumaceans, up to 87,000 spec./m^2; and amphipods, more than 31,000 spec./m^2. It could be expected that competition for food supplies would result in a spatial separation between accumulations with the highest biomass levels of amphipod *A. eschrichti* and cumacean *D. bidentata*.

Analysis of benthos at gray whale feeding sites in the Offshore area based on materials from 2002 indicated that the whales fed in areas where this complex was dominant in a number of cases (Fadeev, 2003). However, the question of the possibility of gray whales' using cumaceans for their diet remains unclear. It is known that there is a threshold amphipod body size (6-8 mm, according to: Rice and Wolman, 1973; Nerini, 1984) below which they cannot be used for feeding. If this principle is valid for other crustaceans as well, it is worth noting that the cumaceans in collections from the Offshore area are significantly smaller. The relationship between the sizes of cumaceans and amphipods can be judged based on the bottom grab sample fragment in Photo 5.

On the other hand, quite a high ampeliscid biomass level was observed in this complex (based on data from 2002-2005, more than 130 g/m^2). Gray whales may feed in the areas of this complex within the ampeliscid pockets.

III. Complex with dominance of amphipod *Ampelisca eschrichti*. The average depth is 52.6±1.9 m (64 stations in the range of 30-65 m). The complex occupies the eastern part of the Offshore area. The average biomass is 644±145 g/m^2, and the biomass of the dominant group – amphipods – is more than 510 g/m^2 (79% of total biomass). The complex includes 35 species, of which 14 species are found only in the Offshore area. One species – *A. eschrichti* – is distinctly dominant in regard to frequency of occurrence, colony density and biomass. Its biomass makes up 95-100% of the total amphipod biomass at certain individual stations. The maximum ampeliscid biomass had similar values in 2004 and 2005: 1237 and 1334 g/m^2, respectively, at 100% frequency of occurrence in the collections.

Materials from 2005 and 2004 from the Offshore area (Table 15) make possible to conclude that quantitative abundance levels for *A. eschrichti* are high. The ampeliscid colony density and biomass in the area are comparable to, and in some cases exceed, the values in benthos of other highly productive areas of the North Pacific (Kuznetsov, 1964; Koblikov, 1983a, 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). In contrast to the dominant species in the amphipod complex of the Piltun area, the ampeliscids live in tubes attached to the bottom in areas with significant bottom currents (Mills, 1967; Wildish and Kristmans, 1997).

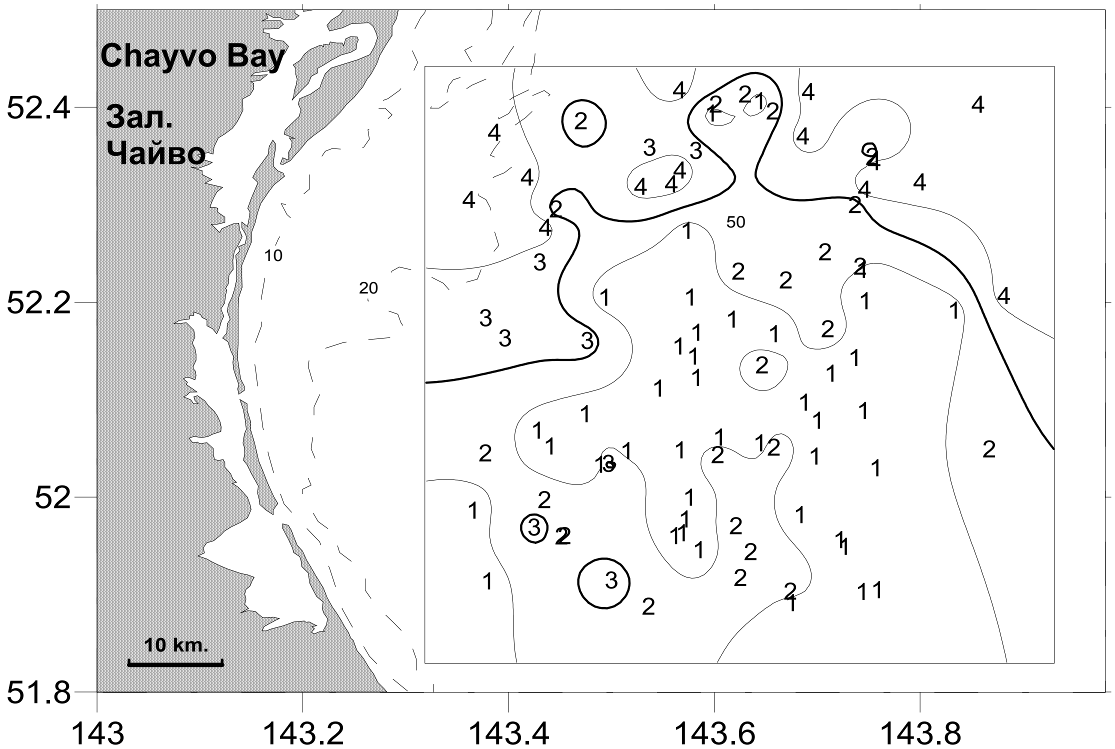


Figure 23. Distribution of benthic complex in the Offshore area in 2004-2005. The numbers of the complexes are given in Table 14.

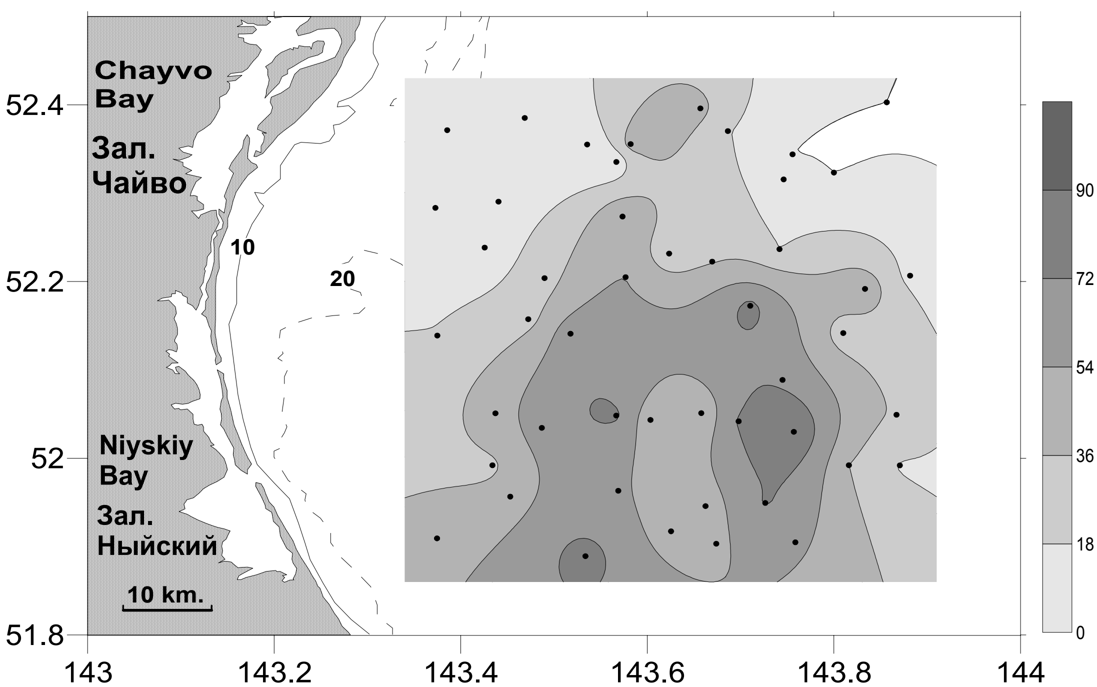


Figure 24. Proportion of ampeliscid amphipods in the total benthos biomass in the Offshore area based on 2005 data.

The ampeliscid size composition was analyzed based on materials from 2004 and 2001-2003. The average body length was 11.38±0.43 mm in 2001 (n = 210) and 13.78±0.31 mm in 2002 (n = 2015). More than 90% of the individuals have a body size larger than 6 mm, which supports the suitability of the ampeliscid colonies in the Offshore area for gray whale feeding. The average body length in 2003 was 14.1±0.26 mm (n = 592). The distribution of ampeliscid body sizes was similar in 2003 and 2004. The average ampeliscid body length in 2004 was 13.91±0.41 mm (n = 610), and the proportion of individuals with body sizes larger than 6 mm is 83%.

IV. Complex with dominance of amphipod *A. eschrichti*, bivalve mollusks and sea anemones. Photo 6 shows a fragment of a bottom grab sample taken within the complex. The average depth was 37.1±2.2 m (49 stations in a range of 23-47 m). The complex occurs in patches on the edge of the ampeliscid complex. The average biomass of the complex is 622±48 g/m^2. Ampeliscids, bivalve mollusks and sea anemones account for about 95% of the biomass of the complex. The complex includes 18 recorded species of bivalve mollusks. Two species have the highest frequency of occurrence: *Serripes groenlandicus* (P = 50%) and *Liocyma fluctuosum* (30%). The **complexes III** and **IV** have the highest average caloric content of forage benthos at 946 and 515 kcal/m^2 (Fadeev, 2005).

The dominant species in regard to biomass in the benthos complex – amphipods *Ampelisca eschrichti* and bivalve mollusks *S. groenlandicus* and *L. fluctuosum* – are classified according to feeding type as seston-feeders and filter-feeders of the seabed water and are associated with hydrodynamically active sections of the shelf. A high seston concentration in the seabed water and the presence of steady bottom currents that facilitate seston transfer are necessary conditions for their existence. Sea anemones, which are predators according to feeding type, are also involved with the transfer of food particles by bottom currents. Active seabed hydrodynamics promotes the transfer of larvae from existing sestonophage colonies to new areas and leads to a patchy (spotty) distribution.

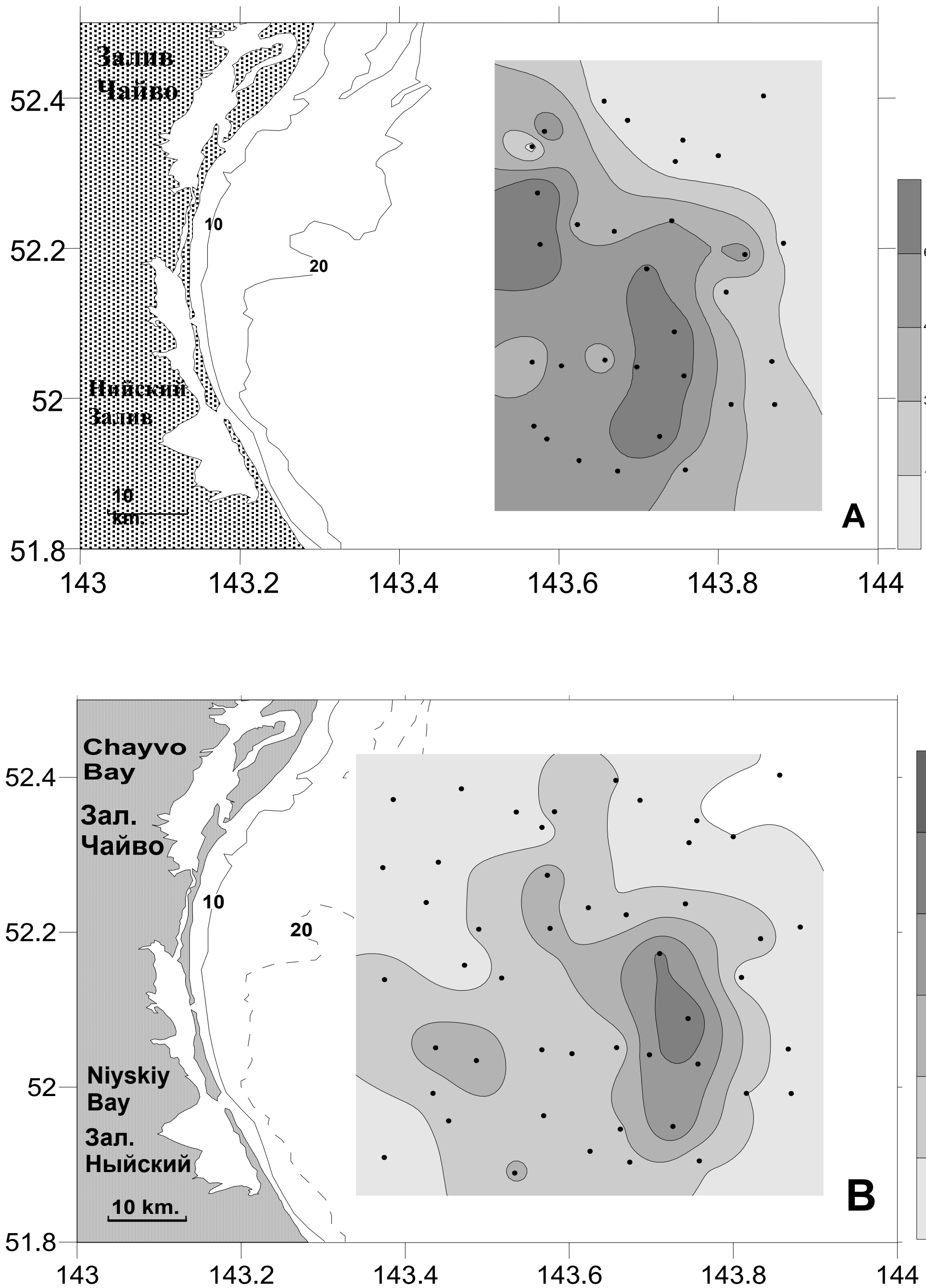


Figure 25. Ampeliscid amphipod biomass distribution (g/m^2) in the Offshore area in 2004(A) and 2005 (B).

Photo 5. Bottom grab sample (0.2 m^2) from the cumaceans and ampeliscids complex.

Photo 6. Bottom grab sample (0.2 m^2) with bivalve mollusks and ampeliscids.

4.3. Benthos at Gray Whale Feeding Sites

Bottom grab samples were collected at gray whale feeding sites in the Piltun and Offshore areas for the first time in 2002. There were 46 sampling stations: 21 stations in the Piltun area, and 25 stations in the Offshore area. The average biomass at whale feeding sites in the Piltun area was 234.4 g/m^2. Amphipods and isopods accounted for more than 50% of the total biomass. Whale feeding sites in the Offshore area were located at depths of 33 to 45 m. The average biomass was 1228 g/m^2, with ampeliscid amphipods accounting for up to 560 g/m^2 (Fadeev, 2003). There were 51 stations at whale feeding sites in 2003: 12 stations in the Piltun area, and 39 stations in the Offshore area. Based on 2003 data, the average depth of the feeding sites in the Piltun area was 18.6±1.6 m. The average benthos biomass at feeding sites was 164.2 g/m^2, with amphipods and isopods accounting for 79% of the biomass. Most of the whales foraged at depths less than 20 m in 2002 and 2003 (Fadeev, 2004).

4.3.1. Whale Feeding Sites in the Piltun area in 2004 and 2005

In 2004, 50 whale feeding sites were studied in the Piltun area at depths of 14-35 m (Figure 28). The average depth of the whale feeding sites inspected in 2004 was 23.5±0.9 m, which differs substantially from the data for 2003 – 18.6±1.6 m – and 2002 – 19.5±1.5 m.

The whale feeding sites inspected in 2004 were selected by two methods: some of the sites were identified during observation of whales from the vessel, and the rest were identified during photo-identification work from aboard the Zodiac. It was primarily sites at depths greater than 20 m that were investigated in this process, due to redistribution of some of the whales to these depths during the 2004 study period. All the sites were identified during work from the motorboat in 2002-2003, and sampling covered all depth ranges and reflected the distribution of feeding whales in the survey waters.

Therefore, the sampling of feeding sites for 2004 was artificially "shifted" to greater depths and does not reflect the actual distribution of feeding whales throughout the water area. As in previous years, most of the whales in the Piltun area foraged at depths less than 20 m. The "shift" of the whale feeding site sampling to depths greater than 20 m in 2004 can easily be traced in histograms of the distribution of stations by depths (Figure 28). Bear in mind in analyzing the materials from the 2004 feeding sites that the errors in determination of the coordinates of whale feeding sites by a vessel-based observer were inevitable. A vessel-based observer cannot visually record "prey patches," and whales diving in search of a prey patch can be classified as "feeding whales" in this case. The distance to a diving (feeding) whale is determined visually, after which the coordinates of the feeding site are defined according to a navigation chart. The visually determined distance to the whale is from 1 km (minimum distance for the vessel's approach to the whale) to 3-6 km; naturally, there can be substantial errors in the feeding site coordinates obtained as a result. Keep in mind, in addition, that errors are inevitable in positioning the vessel at the feeding site to perform bottom grab sampling based on the coordinates. Both "prey patches" at a whale feeding site and the coordinates of the site can be recorded more clearly in identifying whale feeding sites from the Zodiac during Photo-ID work. In this process, sampling can be performed either from the vessel or directly from the Zodiac, depending upon the depth.

Photo-ID data were used in 2005 to determine the coordinates of whale feeding sites. In this process, whale feeding sites in the northern part of the Piltun area both in the near-shore zone and at depths greater than 20 m were inspected. A histogram of the distribution by depths of the feeding sites studied in 2005 (Figure 28) indicates the presence of two groupings of feeding whales in the northern part of the Piltun area: a near-shore, shallow-water grouping (feeding depths up to 15-20 m), and a deep-water grouping (feeding depths of 20-30 m). The average depth for all feeding sites in 2005 was 18.5±1.1 m.

Materials from 39 (111 samples) of 59 stations were used for analysis of benthos at gray whale feeding sites in 2004. The sea bottom at 13 stations in the depth range of 25-35 m, based on underwater videography data and bottom grab samples, is made up of dense gravel/pebble fields. Benthos in such soils has the form of sessile epibenthic fauna – sponges, hydroids, etc. According to video data and samples of the epibenthic system, there are no accumulations of planktonic or epibenthic fauna in the bottom layers or the water column.

Practically all the stations at whale feeding sites in 2004-2005 at depths up to 15-20 m are classified as associated with the coastal amphipod complex in regard to the benthos structure (see section 4.1.3). The average benthos biomass there is 139.5±30.5 g/m^2, with the following accounting for most of the biomass: amphipods (78.6±8.5 g/m^2), isopods (15.2±4.3 g/m^2) and bivalve mollusks (33.5±11.5 g/m^2). More than 95% of the amphipod biomass is made up of *Eogammarus schmidti.*

Data from 23 bottom sampling stations (69 samples) and underwater video of the bottom water layer and the surface of bottom sediments at these stations were used to analyze the benthos composition at feeding sites at depths greater than 20 m. Two complexes are widespread in the Piltun area at depths greater than 20 m: 1 – bivalve mollusks, and 2 – flat sea urchins (Fadeev, 2003, 2004). It follows from Figure 21 that most of the bottom area is occupied by the complex of flat sea urchins, the sand dollar *Echinarachnius parma,* which is characterized by low levels of quantitative abundance of prey benthos (Table 12). Benthos prey groups are unevenly distributed within the flat sea urchin community. For example, local areas with high biomass of large isopods *Saduria entomon* (more than 30 g/m^2) were found within the sea urchin community based 2003 data. Such accumulations were observed at six stations, but at each of the stations, isopods were present in only one bottom grab sample of the three taken at the station. Flat sea urchins without isopods, with biomass up to 1200 g/m^2, were dominant in the other two samples at these stations. The proportion of samples with isopod dominance in the biomass is only 6% in the zone deeper than 15-20 m in 2003 and less than 3% including the bottom grab collections from 2002. It was concluded that despite the low frequency of occurrence of local accumulations of large isopods at depths greater than 15-20 m, they can be used for feeding by individual whales; however, they are not a regular food resource (Fadeev, 2004, 2005).

The average biomass of individual benthos groups at a station, calculated based on three bottom grab samples, yields an approximate assessment of the variability of quantitative abundance figures for benthos. At the same time, due to microscale aggregation of benthos, each individual sample can characterize a specific section of the bottom within the community. Therefore, we analyzed benthos in 69 separate bottom grab samples from whale feeding sites at depths greater than 20 m. In 52 of the 69 samples (75%), flat sea urchins were dominant in regard to biomass (dominance index of 50 to 99%). Of the other 17 samples (24.6%), bivalve mollusks were prevalent in nine (13%); i.e., the composition of biota there was similar to the bivalve mollusk complex. Of the other eight samples, the fish Pacific sand lance *Ammodytes hexapterus* has the greatest biomass (from 72 to 392 g/m^2) in four (5.8%), the amphipod *Eogammarus schmidti* is dominant in two samples (122-153 g/m^2), and the isopod *Saduria entomon* is dominant in two (87.8 and 69.7 g/m^2).

Hence 11% of the samples within the dominance zone of flat sea urchins had high prey benthos levels, which reflects microaggregation in the macrobenthos distribution. The isopod *Saduria entomon* and the amphipod *Eogammarus schmidti* also have high abundance levels at whale feeding sites in the shallow-water zone of the Piltun area (Fadeev 2003, 2004, 2005). A significant increase was observed in the frequency of occurrence (14% in 2004 and more than 20% в 2005) and biomass (up to 160-230 g/m^2) in accumulations of the Pacific sand lance *Ammodytes hexapterus* in 2004 and 2005 (compared to 2001-2003), primarily in the northern part of the Piltun area.

As already mentioned, an increase in the frequency of occurrence and biomass of the sand lance in the northern part of the area was observed from 2003 to 2005. This process occurred concurrently with a decrease in the number of whales in the Offshore area and the appearance of a grouping of whales feeding at depths greater than 20 m in the northern part of the Piltun area.

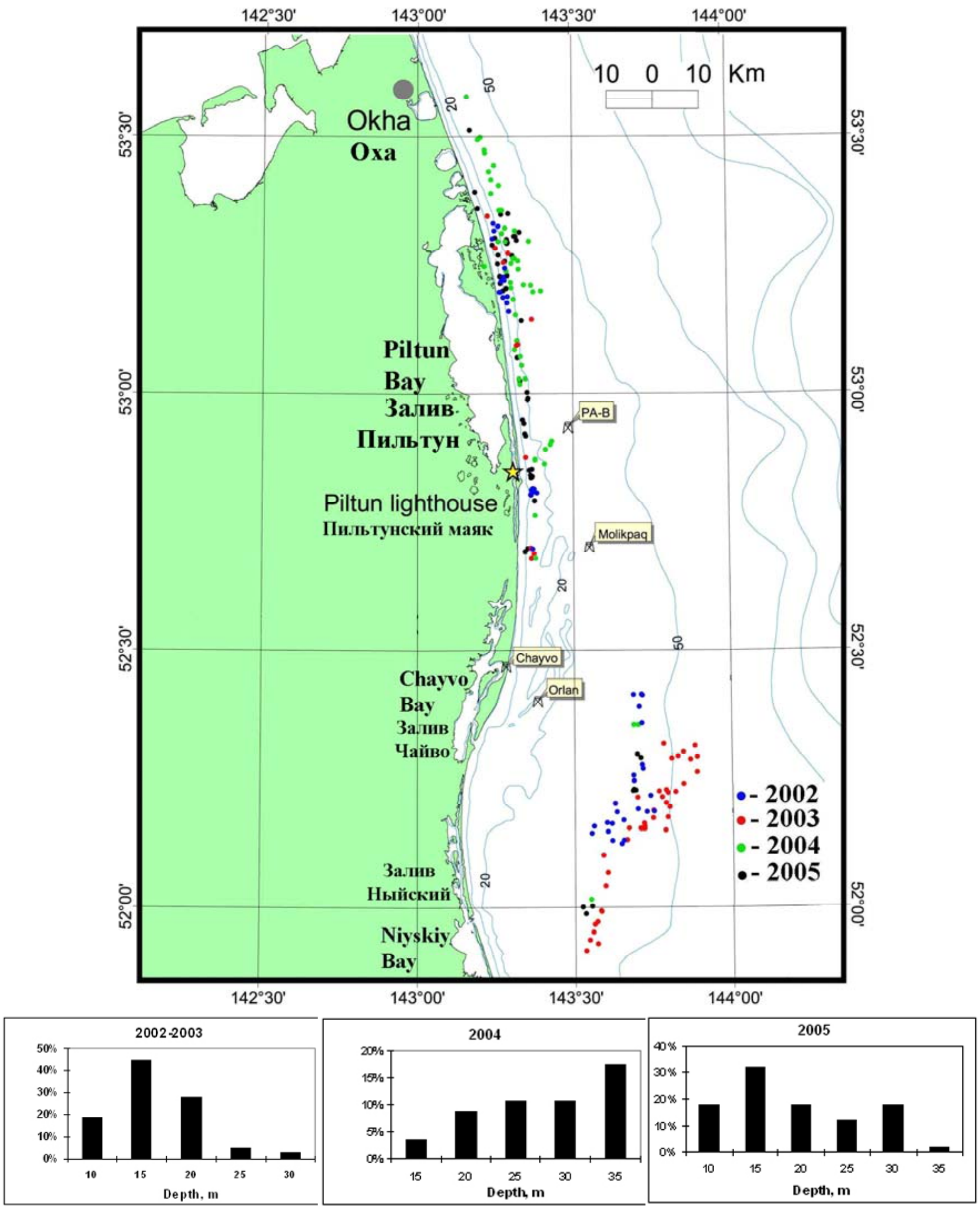


Figure 26. Chart of the locations of gray whale feeding sites studied in 2002-2005 and the distribution of feeding sites by depths in the Piltun area in 2002-2005.

4.3.2. Whale Feeding Sites in the Offshore Area in 2004 and 2005

Based on 2003 data, gray whales foraged in the Offshore area at depths of 41-63 m (50.8±0.9 m, on the average) in the ampeliscid amphipod dominance zone. Benthos at whale feeding locations had high biomass values (up to 1351 g/m^2) and averaged 605 g/m^2. Six benthos groups had a frequency of occurrence higher than 75%: amphipods, sea anemones, bivalve mollusks, polychaeta, decapods, crustaceans and cumaceans. These groups accounted for 98% of the average biomass at whale feeding sites. The proportion of ampeliscids in total amphipod biomass varied from 95 to 100% (Fadeev, 2004).

There was a sharp decrease in the number of whales feeding in the Offshore area in 2004-2005, as compared with 2002-2003. There were two stations at whale feeding sites in the Offshore area in 2004 and 8 in 2005. During 2002-2003, when the number of feeding whales in the Offshore area was at a higher level, 64 whale feeding sites were studied. The locations of the whale feeding sites in 2004-2005 are shown in Figure 23. As indicated above, the quantitative abundance levels of amphipod *Ampelisca eschrichti* in the Offshore area in 2005 did not differ substantially from the figures for 2003-2004. Taking into account the data on the low concentrations of key pollutants in the sediments of the Offshore area (section 3.4), one can conclude that the very small number of gray whales feeding in the Offshore area in 2004-2005 is not related to the benthos status. All the benthos groups found at the 10 whale feeding sites in 2004-2005 are common in the benthos of the Offshore area and are included in the complex *Ampelisca eschrichti* and the complex *A. eschrichti + Bivalvia + Actinia* (Table 14). Feeding of gray whales within these complexes was observed in 2002 and 2003. It follows from 2005 data (Table 15) that the average ampeliscid biomass at the whale feeding sites is more than 360 g/m^2. As indicated previously, whales feed in the Offshore area primarily where ampeliscid biomass is more than 200-300 g/m^2 (Fadeev, 2003, 2004). Maximum ampeliscid biomass of 1351 g/m^2 at a colony density of more than 27,000 spec./m^2 was found at one of the whale feeding sites.

Table 15. Benthos Colony Density (A, spec./m^2) and Biomass (B, g/m^2) at Gray Whale Feeding Sites in the Offshore area in 2005.

Parameter	***Amphipoda***		***Actinia***		***Bivalvia***		***Polychaeta***		***Cumacea***		***Average***	
	A	B	A	B	A	B	A	B	A	B	A	B
Average	7938	366.3	161	214.8	37	57.2	60	21.6	9778	77.2	18075	766.4
Standard deviation	3315	168.5	56	56.5	15	41	10	4.9	2888	19	3060	151.4
Minimum	1727	89.5	18	26.2	8	1.3	17	4.8	1000	9.9	6899	344.6
Maximum	27125	1351.2	420	410	125	296.5	93	39.9	21210	131.9	30014	1561.5

The sharp decrease in the number of whales feeding in the Offshore area in 2004, while high prey benthos abundance levels were preserved, may indicate that the prey abundance and/or composition in the Piltun area was more attractive to the whales than the prey situation in the Offshore area.

CONCLUSIONS

1. Bottom grab collections of benthos taken in July-October 2005 in the coastal waters of northeastern Sakhalin in the section between Odoptu Bay and Niyskiy Bay served as material for the study. Benthos studies were performed in two gray whale feeding areas: Piltun Feeding Area and Offshore Feeding Area (an areas with depths of 30 – 60 m at a distance from the shoreline along the Chayvo Bay area). Bottom grab collections of benthos were performed at 120 stations (373 samples). In addition, the benthos collections included 82 stations from gray whale feeding sites in the Piltun (74 stations) and Offshore (8 stations) areas. Three diving transects were run from a motorboat at depths of 3-12 m in the shallows of the Piltun area (30 stations, 128 samples). Due to feeding of some of the whales at depths greater than 15-20 m in 2004-2005 in the northern part of the Piltun area, it became necessary to assess alternative food sources – large plankton and sea-bed epibenthos. For this purpose, epibenthos collection was performed from the water layer near the bottom with an epibenthic net (42 samples) and a Bongo plankton net (64 samples). The water column and the surface of the seabed were photographed at all the stations with an underwater television system.

2. During the study period, the temperature of the water surface layer in the Piltun area varied considerably: from 0.5 to 13.2 °C in August and from 9 to 14.1 °C in September. The water temperature in the Piltun area in August 2005 was similar to August 2004. The water temperature in September 2005 (11.77±0.12°C) was significantly higher than during the corresponding period in 2003 and 2004 (9.87±0.32°C and 8.58±0.1°C, respectively). The temperature of the surface water layer in the Offshore area in August 2005 (12.4±0.34°C) was significantly higher than in 2003 and 2004 (7.95±0.27°C and 10.15±0.23°C, respectively). The distribution of temperature and salinity was more regular there than in the Piltun area. Zones of reduced salinity were observed in the Piltun area in the estuarine sections of the Piltun and Odoptu lagoons (lowest salinity 15.2%). The salinity of the surface water layer in the Offshore area did not drop below 26%.

3. Analysis of the particle size distribution of 185 bottom sediment samples indicated that prevalence of sandy (psammite) bottom fractions is characteristic of both areas. Fine sands were prevalent at 45% of the stations in the Piltun area, and medium sands were prevalent at 19% of the

stations. Patches of gravel-pebble bottoms, often mixed with sands of varying grain size, are encountered at depths greater than 20-25 m. The highest proportion (more than 30%) of aleurite-pelite sediments in the seabed is observed in a local area at depths greater than 20 m in the area of the channels of Piltun Lagoon. The effect of lagoons on the accumulation of aleurite-pelite can be seen in two areas: off Odoptu Bay and Piltun Bay. A similar tendency was found in materials from 2001-2004. Fine sands were prevalent at 75% of the stations in the Offshore area. Gravel bottoms and coarse-grained sand are found in patches in the northern part of the area.

4. The bottom sediments at gray whale feeding sites were investigated at 82 stations. Most of the whales in 2005, as in 2002-2004, fed in the Piltun area, in a zone of fine- and medium-grained bottoms. The sediments at whale feeding sites can be classified according to three groups with respect to particle size distribution: fine- and medium-grained sands, and sands with varying grain size mixed with small gravel.

5. Analysis of the concentrations of key pollutants – petroleum hydrocarbons, heavy metals and organochlorine pesticides – in the sediments and their distribution in the waters in question makes it possible to conclude that there is no substantial pollutant impact on benthos of the Piltun and Offshore feeding areas at present. This situation may be the result of the active hydrodynamic conditions in these waters and the movement of water along the shore by the Eastern Sakhalin Current, which prevent the accumulation of pollutants in sandy sediments.

6. In the **Piltun area** in 2005, there were 87 bottom sampling stations: 72 stations from the vessel in the depth range of 11 to 35 m, and 15 diving stations from a motor launch at depths of 3 to 12 m. The locations of the vessel-based stations for 2005 were the same in most cases as in 2004.

The average benthos biomass for bottom grab collections in 2005 was 392.4±63.3 g/m^2, which did not differ substantially from 2004 data (501.2±93.8 g/m^2).

As in previous years, flat sea urchins, the sand dollar *Echinarachnius parma*, accounted for most of the biomass at 67%, and the proportion of the sea urchin reaches 83% at depths greater than 20 m. The quantitative abundance of the main forage benthos component – amphipods – decreased from 65 g/m^2 (52% of total benthos biomass) at depths of 11-15 m to 18 g/m^2 (3%) at depths of 26-30 m. Since the locations of the stations in the depth range of 11-30 m was the same in most cases in 2005 and 2004, one can conclude that there were no substantial changes in total benthos biomass. The sharpest changes in the quantitative abundance of benthos occur in the range of 15-20 m. At most of the stations in the Piltun area, it is at these depths that a sharp decrease in the biomass of amphipods, isopods and bivalve mollusks and an increase in flat sea urchin biomass occur. Materials from 2005 confirm the basic trends in the distribution of total benthos biomass in the Piltun area observed in analysis of the collections from 2001-2004.

The proportion of crustaceans in the overall biomass was 54% at depths of 11-15 m and decreased to 9% in the range of 26-30 m. Amphipods have the clearest declining trend in the proportion in benthos biomass with increasing depth. Several areas of higher biomass of crustaceans (amphipods and isopods) with a patchy distribution were observed in the shallow zone of the Piltun area. The largest crustacean accumulations in the area are in the southern and northern parts of the Piltun area.

The average amphipod biomass for the entire depth range studied in the Piltun area was 38.8±7.2 g/m^2, which is comparable to the data from 2004 – 47.4±7.7 g/m^2. More than 85% of amphipod biomass is accounted for by two species: *Pontoporeia affinis* (60% of total amphipod biomass) and *Eogammarus schmidti* (more than 30%). The highest quantitative abundance levels for amphipods occur at depths less than 15-20 m. The proportion of amphipods is more than 50% of the total benthos biomass at depths of 11-15 m and less than 5% at depths greater than 20 m.

The nature of the spatial distribution of amphipod biomass in the Piltun area has similar trends in 2005 and 2004 – a zone of elevated biomass is associated with the near-shore sections of the water area, and the amphipod distribution is patchy. The amphipod biomass distribution in 2004 was more aggregated than in 2005. Local patches of elevated biomass were observed in the northern and middle parts of the Piltun area in 2004 and 2005. Based on materials from 2002 and 2003, patches of elevated amphipod biomass were found primarily in the southern and middle parts of the Piltun area. Local areas of elevated amphipod biomass are found in the charts for 2004 and 2005 in the middle and northern parts of the area and are more distinct than in 2003. The section in the northern part of the Piltun area in 2005 has a larger area and higher quantitative abundance levels for amphipods then in 2004.

The difference between materials from 2004-2005 and 2002-2003 is the significantly larger proportion sand lance *Ammodytes hexapterus* of the total benthos biomass of the Piltun area. In 2002-2003 the frequency of occurrence of the sand lance in bottom grab collections was 5-8%, with an average biomass of 4.6-6.2 g/m^2. The frequency of occurrence of the sand lance in 2004 was 14.8%, with an average biomass of 14.8±4.8 g/m^2. The sand lance biomass varied from 68 to 366 g/m^2 within local accumulations, which was 25 to 48% of the biomass in the samples. Accumulations with the greatest density in 2005 were found in the northern and middle parts of the Piltun area at depths of 20-30 m. At a frequency of occurrence of 25%, its biomass reached 150 – 236 g/m^2 within local accumulations.

Based on the materials of bottom grab collections from 2002-2005, three macrobenthos complexes have been distinguished in the Piltun area. In regard to biomass, two groups of benthic organisms occupy most of the bottom area for biomass: a shallow-water coastal amphipod complex with a high proportion of prey, and a deeper-water flat sea urchin complex with an extremely low proportion of prey. The provisional boundary between the complexes is located at depths of about 20 m. The average biomass of the amphipod complex (143.6 g/m^2) is accounted for primarily by amphipods – 61%, isopods – 14%, and bivalve mollusks – 14%. The complex includes 29 amphipod species with a total biomass of 87.8 ±12.5 g/m^2 at a colony density of 4772±1170 spec./m^2. Four species have the greatest quantitative abundance: *Pontoporeia affinis, Eogammarus schmidti, Eohaustorius eous eous* and *Anisogammarus pugettensis,* which account for 95% of the average biomass and colony density of amphipods in the complex. High quantitative abundance figures for the amphipod complex in the Piltun area are conditioned by its highly eurybiontic nature, short life cycle and high growth rates of the dominant amphipod species – *Pontoporeia affinis*.

7. In the **Offshore area** in 2005, there were 48 stations (144 bottom grab samples) at depths from 19 to 62 m (average depth 42.5±1.7 m, n=48; in 2004, 49.3±2.3 m, n=32). The average total benthos biomass was significantly higher in 2004 than in 2005 (899.1±85.8 g/m^2 and 526.6±52.3 g/m^2, respectively; t-test, $t = 3.56$, $df = 73$, $p<0.0006<0.001$). However, the statistical significance of biomass differences between 2004 and 2005 at such a high level is explained by particular features of the sampling system in 2005. There were stations in the near-shore zone of the Offshore area in 2005 that were not covered in 2004. The near-shore zone of the Offshore area is characterized by low benthos biomass levels.

Statistical analysis showed that in the parts of the Offshore area where benthic samples were taken in 2003, 2004 and 2005 (20 stations, Fig. P 1.2), the differences between the years in the total biomass of benthos and the total biomass of the main prey item - Ampelisca eschrichti - were statistically insignificant.

Based on materials from 2002-2005, four benthos complexes were distinguished in the Offshore area. Complexes with the amphipod *Ampelisca eschrichti* as the dominant species have the greatest importance for assessing the food potential of the area. Two complexes – ampeliscid amphipods, and ampeliscids+sea anemones+bivalve mollusks – occupy most of the bottom in the Offshore area. Of the area of the Offshore area (2160 km^2), the occupy 35 and 33% (747 and 706 km^2). These complexes have the highest average caloric content of forage benthos at 946 and 515 kcal/m^2. The average depth for all the feeding sites in 2005 was 41.8±0.83 m.

8. In the Piltun area, 74 whale feeding sites at depths of 5-35 m were investigated in 2005. The average depth of the whale feeding sites sampled in 2005 was 18.5±1.1 m, which differs from the data for 2004 – 23.5±0.9m. As in previous years, most of the whales in the Piltun area in 2005 foraged at depths less than 20 m within the coastal amphipod complex. Analysis of bottom grab samples from whale feeding sites at depths greater than 20 m in the zone of the flat sea urchin complex indicated that 11% of the samples had high abundance of prey organisms. The Pacific sand lance *Ammodytes hexapterus* (up to 240 g/m^2), the amphipod *Eogammarus schmidti* (122-153 g/m^2) and the isopod *Saduria entomon* (87.8 and 69.7 g/m^2) have the highest biomass in these samples.

There was a sharp decrease in the number of whales feeding in the Offshore area in 2004, and although the numbers were higher in 2005 compared with 2004, they were still lower than in 2002 and 2003. There were two stations at whale feeding sites whales in the Offshore area in 2004 and 8 in 2005. In 2002-2003, when the number of feeding whales in the Offshore area was at a high level, 64 whale feeding sites were studied. Since the figures for quantitative abundance of benthos in the Offshore area in 2004-2005 did not differ in a statistically significant way from the 2003 season, one can conclude that the drop in the number of gray whales is not related to the benthos status. The sharp decrease in the number of whales feeding in the Offshore area in 2004, while high prey benthos abundance levels were preserved, may indicate that the prey abundance and/or composition in the Piltun area was more attractive to the whales than the prey situation in the Offshore area.

In addition, an increase in the frequency of occurrence and biomass of the sand lance in the northern part of the Piltun feeding area was observed in 2003-2005. This process took place concurrently with a decrease in the number of feeding whales in the Offshore area and the appearance of a grouping of whales feeding at depths greater than 20 m in the northern part of the Piltun area. This hypothesis that all these processes are interrelated needs further confirmation.

ACKNOWLEDGMENTS

Many specialists took part in the early stages of the studies and rendered invaluable assistance in completing the project. We shall mention in particular our colleagues in the field work in 2002-2005: Yu. Yakovlev, N. Prokhorov, V. Zharikov, N. Ivanov, V. Denisov, M. Maminov and K. Feldman, whose professionalism supported the completion of the entire scope of planned field studies.

L. N. Khorolskaya, T. A. Krivosheyeva, V. V. Mordukhovich, I. L. Davydkova, N. Demchenko and M. Repina rendered great technical assistance in the laboratory analysis of the collections and the performance of morphometry on the amphipods.

We wish to express special thanks to taxonomists of the IBM DVO RAN, the PIBOC (Pacific Institute of Bioorganic Chemistry), FEB RAN, ZIN (Zoological Institute, St. Petersburg) RAN, TINRO-Center, and DVGU (Far East State University, Vladivostok): Professor V. A. Kudryashov, Candidate of Biological Sciences L. L. Budnikova, Candidate of Biological Sciences M. V. Malyutina, Candidate of Biological Sciences G. M. Kamenev, Candidate of Biological Sciences V. V. Gulbin, Candidate of Biological Sciences S. F. Chaplygina, Candidate of Biological Sciences A. V. Chernyshov and Candidate of Biological Sciences V. N. Romanov for their meticulous work in determining the benthos species composition.

Sonya K. Meier (LGL Limited, environmental research associates, Canada) and the author developed the Scope of Work for this study. We wish to thank Lisanne Aerts (SEIC), Dr. H. R. Melton (ExxonMobil), and Sonya K. Meier and Dr. S. R. Johnson (LGL Limited) for critical comments at the stage of preparation of the final report. Dr. S. B. Yazvenko provided help and support in preparing for the expedition and during the field work and commented on the Russian version of the report. D. Baker (LGL Limited) helped prepare the final version of the report.

REFERENCES

Afifi, A., and S. Eyzen. 1982. Statistical Analysis: Approach to Computer Use. Moscow: Mir. 488 pp.

Albertsson J., Leonardsson K. 2001. Deposit-feeding amphipods (Monoporeia affinis) reduce the recruitment of copepod nauplii from benthic resting eggs in the northern Baltic Sea // Marine Biology, 138: 793 – 801.

Andersin, A.B., Lassig, J., and Sandier, H. 1984. On the biology and production of Pontoporeia affinis Lindstr. in the Gulf of Bothnia // Limnologica, 15: 395- 401.

Averintsev, V. G., V. I. Sirenko, A. M. Sheremetevskiy, V. N. Koblikov, V. A. Pavlyuchkov and A. I. Piskunov. 1979. Some Patterns in the Distribution of Life on the Eastern Sakhalin Shelf and in the Northwest Part of the Sea of Okhotsk // Summaries of papers of the XIV Pacific Ocean Scientific Congress, Khabarovsk. pp. 16-17.

Belan, T. A. 2001. Feature of the Abundance and Species Composition of Benthos in the Presence of Pollution (Gulf of Peter the Great, Sea of Japan). Author abstract for dissertation for degree of candidate of biological sciences. Vladivostok: TINRO-Center. 22 pp.

Berzin, A. A. Practical Problems in the Study of Whales (Using the Example of Pacific Whales). 1974. Zoologiya pozvonochnykh [Vertebrate Zoology], v. 6, pp. 159-189.

Berzin, A. A., and V. L. Vladimirov. Anthropogenic Impact on Whales of the Sea of Okhotsk. 1996. Izv. TINRO. v. 121, pp. 4-8.

Bezrukov, P. L., and A. P. Lisitsin. 1960. Classification of Sediments of Modern Bodies of Water // Proc. USSR Academy of Sciences Oceanology Institute. v. 32, pp. 3-15.

Bilyard G. R., and Becker S. 1987. Recommend protocols for sampling and analyzing subtidal benthic macroinvertebrate assemblages in Puget Sound. US EPA. Washington, 1987. 30 p.

Blokhin, S.A. 1996. Distribution, numbers and behavior of gray whales (*Eschrichtius robustus*) of the American and Western populations in the areas of their distribution off the coasts of the Far East, Izv. TINRO. vol. 121, pp. 36-53 (in Russian).

Blokhin S.A., Maminov M.K., and Kosygin G.M. 1985. On the Korean-Okhotsk population of gray whales. Rep. Int. Whal. Commun.- No 35.- p. 375-376.

Blokhin, S. A., and V. A. Pavlyuchkov. 1981. Feeding of Gray Whales of the California-Chukotka Population in Waters of the Chukotka Peninsula in 1980. Research on Marine Mammals of the North Pacific in 1980-1981. Moscow: 1981, pp. 88-89.

Blokhin, S. A., and V. A. Pavlyuchkov. 1996. Feeding of Gray Whales during the Summer-Fall Season in the Coastal Waters of the Chukotka Peninsula. Izv. TINRO, 1996, v. 121, pp. 26-35.

Blokhin, S. A., and V. A. Pavlyuchkov. 1999. Feeding of Gray Whales of the California-Chukotka Population in Mechigmen Bay. Izv. TINRO, 1999, v. 126, pp. 442-446.

Blokhin, S. A., and A. M. Burdin. 2001. The Distribution, Abundance, and Several Behavioral Traits of the Gray Whale Eschrichtius robustus of the Asian Population off the Northeast Sakhalin Coast. Biologiya morya. V. 27, No. 1, pp. 15-20.

Blokhin, S. A., S. B. Yazvenko, V. L. Vladimirov and S. I. Lagerev. 2002. The Abundance, Distribution and Behavior of Gray Whales (Eschrichtius robustus) in the Coastal Waters of Northeast Sakhalin in the Summer and Fall of 2001 (According to Aerial Observations). Marine Mammals of the Holarctic. Proceedings of the 2nd International Conference, Baikal, Russia. Pp. 36-38.

Bogoslovskaya, L.S. The Gray Whale//Priroda, 1996, No. 12, pp. 46-60.

Bogoslovskaya L. S., Votrogov L. M., Semenova T.N. 1981. Feeding habits of gray whales off Chukotka peninsula // Rep. Int. Whal. Commn. 1981. № 31. Pp. 507-510.

Bogoslovskaya L. S., Votrogov L. M., Seraenova T. N. 1982. Distribution and feeding of gray whales off Chukotka in the summer and autumn of 1980 // Rep. Int. Whal. Commn. 1982. № 32. Pp. 385-389.

Borisov S.V., Gritsenko A.V., Dmitrieva A.V., Karnauhov A.A., Kruglov M.V. and Rutenko A.N. 2005. Acoustic Studies on the North East Sakhalin Shelf, Volume 1: Equipment, Methodology and Data; 30 July to 7 October, 2004; Sakhalin, Russian Federation // Pacific Oceanological Institute (FEB RAS) report for Exxon Neftegas Ltd. and Sakhalin Energy Investment Co.

Brownell, R. L. (Jr.), and C. Chun. 1977. Probable existence of the Korean stock of gray whales (Eschrichtius robustus) // J. Mammalogy 58: 237-239.

Clarke K.R., and R.N. Gorley. 2001. PRIMER v5: User Manual/Tutorial. PRIMER-E: Plymouth. 91 P.

Clarke, K R., and R. N. Green. 1988. Statistical design and analysis for a 'biological effects' study // Mar. Ecol. Prog. Ser. V. 46. No. 1-3. P. 213-226.

Crimmon H. and J. Bray. 1962. Observation on the isopod. Mesidotea entomon in the Western Canadian Arctic Ocean. J. Fish. Res. Board Canada. V. 19, N 3. Pp. 489-496

CSA. Status of the Environment in the Piltun-Astokh Field Area. 1996. CSA Report on 1995 Study Results. Continental Shelf of Sakhalin Island, Russian Federation. 121 pp.

CSA. Status of the Environment in the Piltun-Astokh Field Area. 1997. CSA Report on 1996 Study Results. 76 pp.

Draper, N. and H. Smith. 1981. Applied Regression Analysis. Wiley-Interscience. 709 pp.

Dunham, J. S. and D. A. Duffus. 2001. Foraging patterns of gray whales in central Clayoquot Sound, British Columbia. Marine Ecology Progress Series 223:299-310.

Dunham, J. S and D. A. Duffus. 2002. Diet of gray whales (Eschrichtius robustus) in Clayoquot Sound, British Columbia, Canada. Marine Mammal Science 18(2):419-437.

Elliott, J. M. 1977. Statistical analysis of samples of benthic invertebrates // Freshwater Biol. Ass., Sci. Publ., v. 25. pp. 3-15.

Hilton –Taylor, C. 2000. IUCN Red List of Threatened Species, 2000. IUCN/SSC, Gland, Switzerland.

Jones M.L. and Swartz S.L. 2002. Gray Whale Eschrichtius robustus. In: Encyclopedia of Marine Mammals. Perrin W., Würsig B. and Thewissen J.G.M. (eds.). Academic Press, New York, NY. Pp. 524 – 536.

Fadeev, V. I. 2002. Benthos Studies in the Feeding Grounds of the Okhotsk-Korean Gray Whale Population. Final Report. Institute of Marine Biology of DVO RAN. Vladivostok. 171 pp.

Fadeev, V. I. 2003. Benthos and Prey Studies in Feeding Grounds of the Okhotsk-Korean Gray Whale Population. Final report on Materials from Field Work in 2002 Aboard the Research Vessel Nevelskoy. Institute of Marine Biology of DVO RAN. Vladivostok. 116 pp.

Fadeev, V. I. 2004. Benthos and Prey Studies in Feeding Grounds of the Okhotsk-Korean Gray Whale Population. Final report on Materials from Field Work in 2003 Aboard the Research Vessel Nevelskoy. Institute of Marine Biology of DVO RAN. Vladivostok. 189 pp.

Fadeev, V. I. 2005. Benthos and food supply studies in feeding areas of the Okhotsk-Korean gray whale population. Final Report by the Institute of Marine Biology, Far Eastern Branch of the Russian Academy of Science, Vladivostok, Russia, for Sakhalin Energy and Exxon Neftegas. 150 pp.

Handbook on Methods for Analysis of Pollutants in Sea Bottom Sediments. 1979. No. 43. Moscow Gidrometeoizdat. 39 pp.

Jarvekulg, Arvi. 1979. Benthic Fauna of the Eastern Baltic Sea. Distributional Composition and Ecology. Tallin: Valgus. 382 pp.

Kafanov, A. I., V. S. Labay and N. V. Pecheneva. 2003. Biota and Macrobenthos Communities of northeastern Sakhalin Lagoons. Yuzhno-Sakhalinsk: Sakhalin Fishery and Oceanography Research Institute. 173 pp.

Karnauhov A.A., Kruglov M.V., and Rutenko A.N. 2005. Acoustic Studies on the North-East Sakhalin Shelf, Volume 2: Analysis, Conclusions and Recommendations; 30 July to 7 October, 2004; Sakhalin, Russian Federation // Pacific Oceanological Institute (FEB RAS) report for Exxon Neftegas Ltd. and Sakhalin Energy Investment Co.

Borovikov, V. 2001. STATISTICA: The Art of Computer Data Analysis. For professionals. St. Petersburg: Piter, 2001. 656 pp.

Koblikov, V. N. 1983a. Quantitative Characteristics of the Benthic Population in Waters of the Sea of Okhotsk off Sakhalin. Quantitative and Qualitative Distribution of Benthos: Food Supply for Benthos-Eating Fish. Moscow: VNIRO, 1983, pp. 4-21.

Koblikov, V. N. 1983b. Macrobenthos Composition and Quantitative Distribution on the Okhotsk Sea Shelf of Sakhalin. Izv. TINRO, 1983, v. 106, pp. 90-97.

Koblikov, V. N. 1986. Benthic Communities of the Continental Shelf and the Upper Part of the Sakhalin Coastal Slope of the Sea of Okhotsk. TINRO. Manuscript deposit. at TsNIITEIRKh. 54 pp.

Kussakin, O.G., E.I. Sobolevsky, S.A. Blokhin. 2001. A review of benthos investigations on the shelf of the northeast Sakhalin. Draft Report by the Institute of Marine Biology, Far East Branch of the Russian Academy of Sciences, and the Pacific Research Institute of Fisheries and Oceanography (TINRO), State Comm. for Fish. and Oceanog., Vladivostok. 89 pp.

Kuznetsov, A. P. 1964. Distribution of benthic fauna in the western Bering Sea by trophic zones and general issues of trophic zonation // Trans. Inst. Okeanol. AN SSSR, v. 69, pp. 98-177.

Krasavtsev, V. B., K. L. Puzankov and G. V. Shevchenko. 2000. Upwelling Formation on the Northeast Shelf of Sakhalin Island under the Influence of Wind. Theme issue of Far-

Eastern Research and Development Hydrometeorological Institute (DVNIGMI) N 3. Vladivostok: Dalnauka, 2000, pp. 106-120.

Krasnaya Kniga Rossiyskoy Federatsii (Zhivotnye) [Red Book of the Russian Federation (Animals)]. 2000. As and Astrel-Balashikha, Aginskoye, 862 pp. (http://nature.ok.ru/redbook.htm).

Kussakin O.G., E.I. Sobolevsky, and S.A. Blokhin. 2001. A Review of Benthos Investigations on the Shelf of the Northeast Sakhalin. Report by the Institute of Marine Biology, Far East Branch of Russian Academy of Sciences, Vladivostok, Russia, to Sakhalin Energy Investment Company, Yuzhno-Sakhalinsk, Russia. 91 pp. (in Russian). [available on the Sakhalin Energy Investment Company website].

Le Boeuf, B.J., M. Perez-Cortes, R. Urban, B.R. Mate, F. Ollervides. 2000. High gray whale mortality and low recruitment in 1999 potential causes and implications // J. of Cetacean Res. and Management. V. 2. Pp. 85 - 99.

LeDuc, R. G., Weller D. W., Hyde J., Burdin A. M., Rosel P. E., Brownell R. L., Würsig B. and Dizon A. E. 2002. Genetic differences between western and eastern gray whales (Eschrichtius robustus) // J. Cetacean Res. Manage. Vol. 4(1). Pp. 1 - 5.

Leonardsson, K. 1991. Effects of cannibalism and alternative prey on population dynamics of Saduria entomon (Isopoda) // Ecology. V. 72: 1273 - 1285.

Makarov, V. V. 1937. Materials on Quantitative Survey of Benthic Fauna of the Northern Part of the Bering and Chukotka Seas. Issled. Dalnevostochnykh morey SSSR, Issue 25, pp. 260-289.

Maminov M.K. and Y.M. Yakovlev. 2002. New data on the abundance and distribution of the gray whale on the northeastern Sakhalin shelf. Conference "Marine Mammals of Holarctic." Baikal, Russia, September 11-13, 2002, pp.170-171.

Methodological Guidelines. Determination of Contaminants in Samples of Marine Bottom Sediments and Suspensions. 1996. RD 52.10.556-95. Federal Service of Russia for Hydrometeorology and Environmental Monitoring. Moscow. 50 pp.

Mills E. L. 1967. The biology of ampeliscid amphipod crustacean sibling species pair // J. Fish. Res. Board Can. 1967. V. 24. Pp. 305-355.

Miyashita, T., S. Nishiwaki, V. A. Vladimirov and N. V. Doroshenko. 2001. Paper SC/53/RMP5 presented to the IWC Scientific Committee, July 2001 (unpublished). 12 pp.

Moore, S. E, W. L. Perryman, F. Gulland, H. Perez-Cortez, P. R. Wade, L. Rojas-Bracho and T. Rowles. 2001. Are gray whales hitting "K" hard? // Mar. Mammal Science 17(4):954-958.

Nerini, M. 1984. A review of gray whale feeding ecology. *In* The Gray Whale, (*Eschrichtius robustus)*. M.L. Jones, S.L. Swartz and S. Leatherwood (eds). Academic Press, Inc., Orlando, Flordia, pp.451-463.

Nerini, M. K., and J. S. Oliver. 1983. Gray whales and the structure of the Bering Sea benthos // Oecologia (Berlin). V. 59. Pp. 224 – 225.

Neyman, A. A. 1988. Quantitative Distribution and Trophic Structure of World Ocean Shelf Benthos. VNIRO, 1988, 100 pp.

Olafsson E., Elmgren R. 1991. Effects of biological disturbance by benthic amphipods (Monoporeia affinis) on meiobenthic community structure: a laboratory approach // Mar. Ecol. Prog. Ser. V. 74: 99 – 107.

Oliver, J. S., P. N. Slattery, M. A. Silberstein and E. F. O'Connor. 1983. A comparison of gray whale feeding in the Bering Sea and Baja California // Fisheries Bull V. 81. P.:501-512.

Oliver, J. S., P. N. Slattery, M. A. Silberstein and E. F. O'Connor. 1984. Gray whale feeding on dense ampeliscid amphipod communities near Bamfield, British Columbia // Canadian Journal of Zoology V. 62. P:41-49.

Rice, D. W., A. A. Wolman. 1973. The life history and ecology of the gray whale (Eschrichtius robustus) // Spec. Publ. Amer. Soc. Mammal. V. 3. Pp. 1-143.

Rugh, D. J., M. M. Muto, S. E. Moore and D. P. DeMaster. 1999. Status review of the eastern North Pacific stock of gray whales. U.S. Dep. of Comm. NOAA Tech. Memo. NMFS-AFC-103. 96 pp.

Rugh, D. J. 2003. Gray whale census 2001/2002. U.S. Department of Commerce. National Marine Mammal Laboratory. http://nmml.afsc.noaa.gov/CetaceanAssessment/ Gray Whale/ GrayCensus01-02.htm.

Rutenko, A. N. 2006. Acoustic studies on the northeast shelf of Sakhalin Island. Vol 1: Objectives and Data, Chapter 3.5 – Bathymetric and Hydrological Studies / Report of the Pacific Oceanographic Institute of Far East Branch of the Russian Academy of Sciences, Vladivostok, for Exxon Neftegas Limited and Sakhalin Energy Investment Company, Ltd.

Segestrale, S. G. 1967. Observations of summer breeding in populations of the glacial relict Pontoporeia affinis (Lindstrom) (Crustacea, Amphipoda) living at greater depths in the Baltic Sea // J. Exp. Mar. Biol. Ecol. 1: 55-64.]

Segestrale, S. G. 1973. Results of bottom fauna sampling in certain localities in the Tvarminne area (Inner Baltic) with special reference to the so-called Macoma-Pontoporeia theory // Comm. Biologica. 67: 1-12.

Shepard, F. P. 1976. Marine Geology. Leningrad: Nedra. 488 pp.

Sobolevsky E. I. 1999. Observations of the Behavior of Gray Whales (Eschrichtius robustus) on the Northeast Sakhalin Shelf. Ekologiya, No. 2, pp. 121-126.

Sobolevsky, E.I. 2000. Marine mammal studies offshore northeast Sakhalin, 1999. Final Report by the Institute of Marine Biology, Far East Branch of Russian Academy of Sciences, Vladivostok, for Sakhalin Energy Investment Company, Yuzhno-Sakhalinsk. 149 pp.

Sobolevsky, E. I. 2001. Marine mammal studies offshore northeast Sakhalin, 2000. Final Report by the Institute of Marine Biology, Far East Branch of Russian Academy of Sciences, Vladivostok, for Sakhalin Energy Investment Company, Yuzhno-Sakhalinsk. 199 pp.

Sobolevsky, E. I., Yu. M. Yakovlev, O.G. Kusakin. 2000. Some Data on the Macrobenthos Composition in Gray Whale (Eschrichtius gibbosus Erxl., 1877) Forage Areas on the northeastern Sakhalin Shelf. Ekologiya. No. 2, pp. 144-146.

Sobolevsky E. I. 2000. The Current Abundance and Distribution Pattern of Gray Whales on the Northeast Sakhalin Shelf. Marine Mammals of the Holarctic. Arkhangelsk, 2000, pp. 350-353.

Sparrevik E., Leonardsson K. 1998. Recruitment in the predacious isopod Saduria entomon (L.): alternative prey reduces cannibalism // J. Exp. Mar. Biol. V. 221: 117-130.

Status of the Environment in the Piltun-Astokh Field Area. 1996. CSA Report on 1995 Study Results. Continental Shelf of Sakhalin Island, Russian Federation. 121 pp.

Status of the Environment in the Piltun-Astokh Field Area. 1997. CSA Report on 1996 Study Results. 76 pp.

Stoker, S. W. 1981. Benthic invertebrate macrofauna of the eastern Bering-Chuckchi continental shelf. In: The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. 1. D. W. Hood and J. A. Calder (eds.). Off. Marine Pollution Assessment, NOAA. Distributed by University of Washington Press, Seattle.

Tkalin, A. V. 2001. Pollution of the Marine Environment in the Area near the Mouth of the Tuman River. Environmental Status and Biota of the Northeast Part of the Gulf of Peter the Great and the Mouth of the Tuman River. Vladivostok: Dalnauka, v. 2, pp. 20–26.

UNEP. 1995. Statistical analysis and interpretation of marine community data. Reference Methods for Marine Pollution Studies. UNEP. No 64. 54 pp.

USFWS (U.S. Fish and Wildlife Service). 1997. Endangered and threatened wildlife and plants. U.S. Dep. of Interior, U.S. Government Printing Office, Washington, D.C. 52 pp.

Vladimirov, V. A. 2000. Problems in protecting a population of polar and gray whales of the Sea of Okhotsk which is on the verge of extinction. Marine Mammals of the Holarctic. Arkhangelsk.

Weller D.W., R.L. Brownell, Jr. 2000. Eschrichtius robustus (Asian or Northwest Pacific Stock), in: C. Hilton-Taylor (comp.) 2000 IUCN Red List of Threatened Species. IUCN/SSC, Gland, Switzerland and Cambridge, United Kingdom.

Weller D.W., B. Wursig, A.M. Burdin, A. L. Bradford. 2001. Gray whales off Sakhalin Island, Russia: June-September 2000. A joint U.S.-Russian scientific investigation. Interim Report by Texas A&M University, College Station, TX, and Kamchatka Institute of Ecology and Nature Management, Russian Academy of Sciences, Petropavlovsk-Kamchatskii, Russia, for Sakhalin Energy Investment Company Limited, Yuzhno-Sakhalinsk, Russia. 24 pp.

Weller D. W., B. Wursig, A.L. Dradford, A.M. Burdin, S.A. Blokhin, H. Minakuchi. 1999. .Gray whales (Eschrichtius robustus) off Sakhalin Island, Russia: seasonal and annual patterns of occurrence // Marine mammal science. V. 15, N 4. Pp. 1208-1227.

Weller, D.W., A.M. Burdin, A.L. Bradford, G.A. Tsidulko, Y.V. Ivashchenko. 2002. Gray whales off Sakhalin Island, Russia: June-September 2001. A joint U.S.- Russia Scientific Investigation.

Wildish D., D. Kristmans. 1997. Benthic suspension feeders and flow. Cambridge Univ. Press. 409 pp.

Yablokov, A.V., and L.S. Bogoslovskaya. 1984. A review of Russian research on the biology and commercial whaling of the Gray Whale. In: The Gray Whale Eschrichtius robustus. M.L. Jones, S.L. Swartz, and S. Leatherwood (eds.), Academic Press, Orlando etc., pp. 465-485.

Yazvenko S., T. MacDonald, S.K. Meier, S. Blokhin, S.R. Johnson, V. Vladimirov, S. Lagerev, M. Maminov, E. Razlivalov, and M. Newcomer. 2002. Aerial marine mammal monitoring during the 2001 3-d seismic survey of Odoptu block, northeast Sakhalin Island, Okhotsk Sea, Russia. Final Report by LGL Limited, Sidney, for Exxon Neftegas Limited, Yuzhno-Sakhalinsk, Russia. 163 pp.

Zimushko, V. V., and S. A. Lenskaya. 1970. On Feeding of Gray Whales (Eschrichtins gibbosus Erxl.) in Summer Feeding Grounds. Ekologiya, 1970, v. 3, pp. 26-35.

Zenkovich, V. A. 1937. Feeding of Far East Whales. Proceedings of the USSR Academy of Sciences. v. 16, No. 4, pp. 231-234.

APPENDICES 1 – 8

TO REPORT

CURRENT STATUS OF THE BENTHOS AND FOOD SUPPLY IN FEEDING GROUNDS OF THE OKHOTSK-KOREAN GRAY WHALE POPULATION IN 2005

APPENDIX 1. ADDITIONAL FIGURES

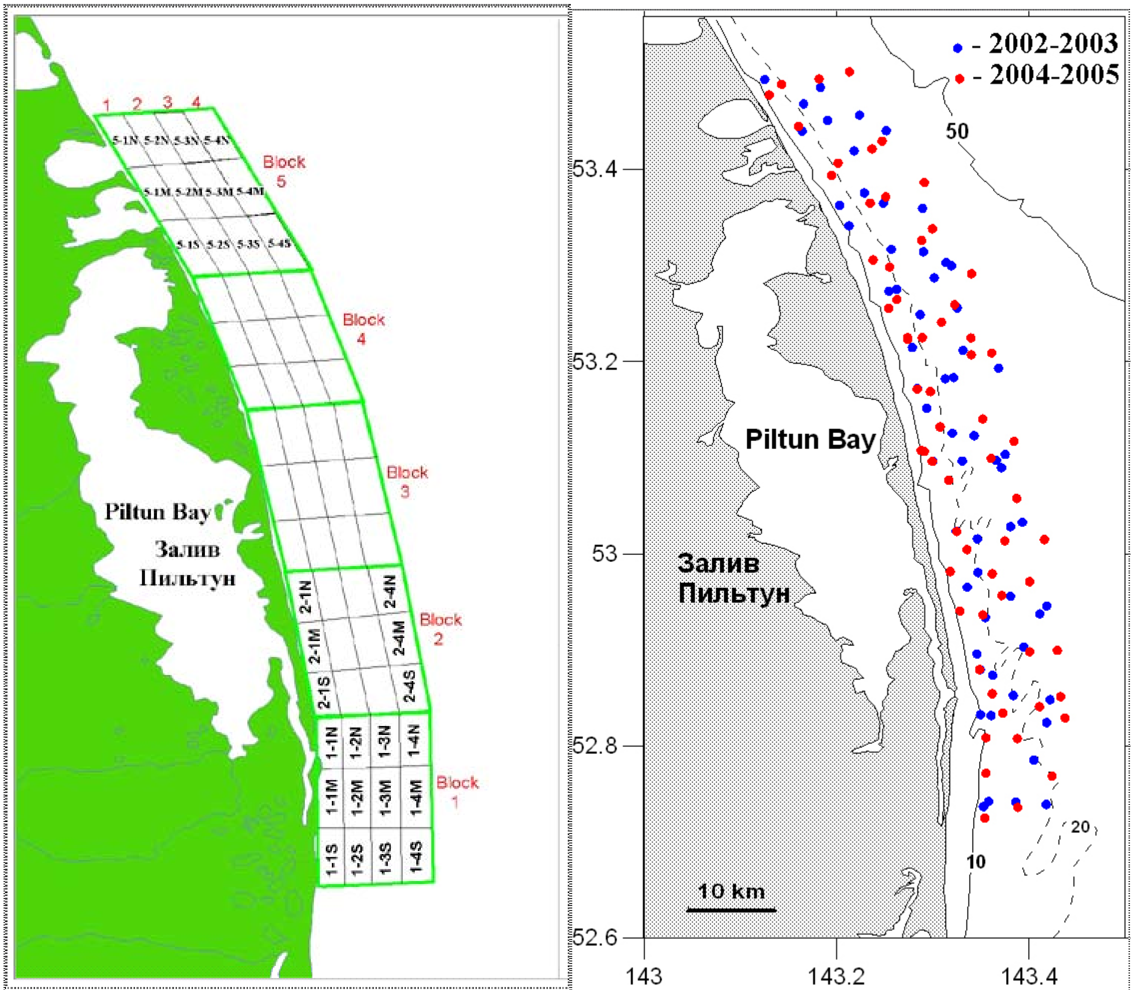


Figure P1.1. Chart of blocks in the Piltun Area and stations in 2002-2005.

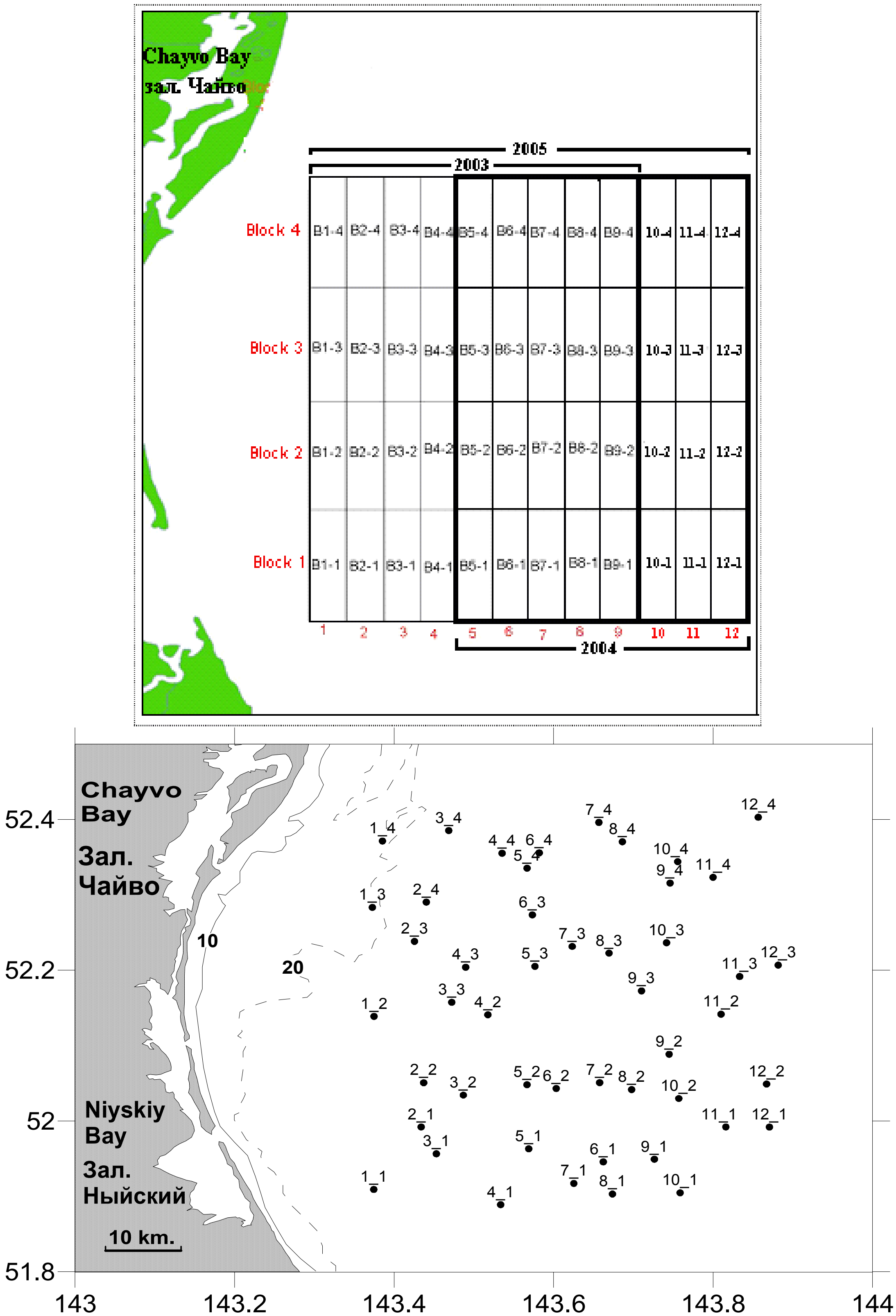


Figure P1.2. Chart of blocks in the Offshore area and stations in 2005.

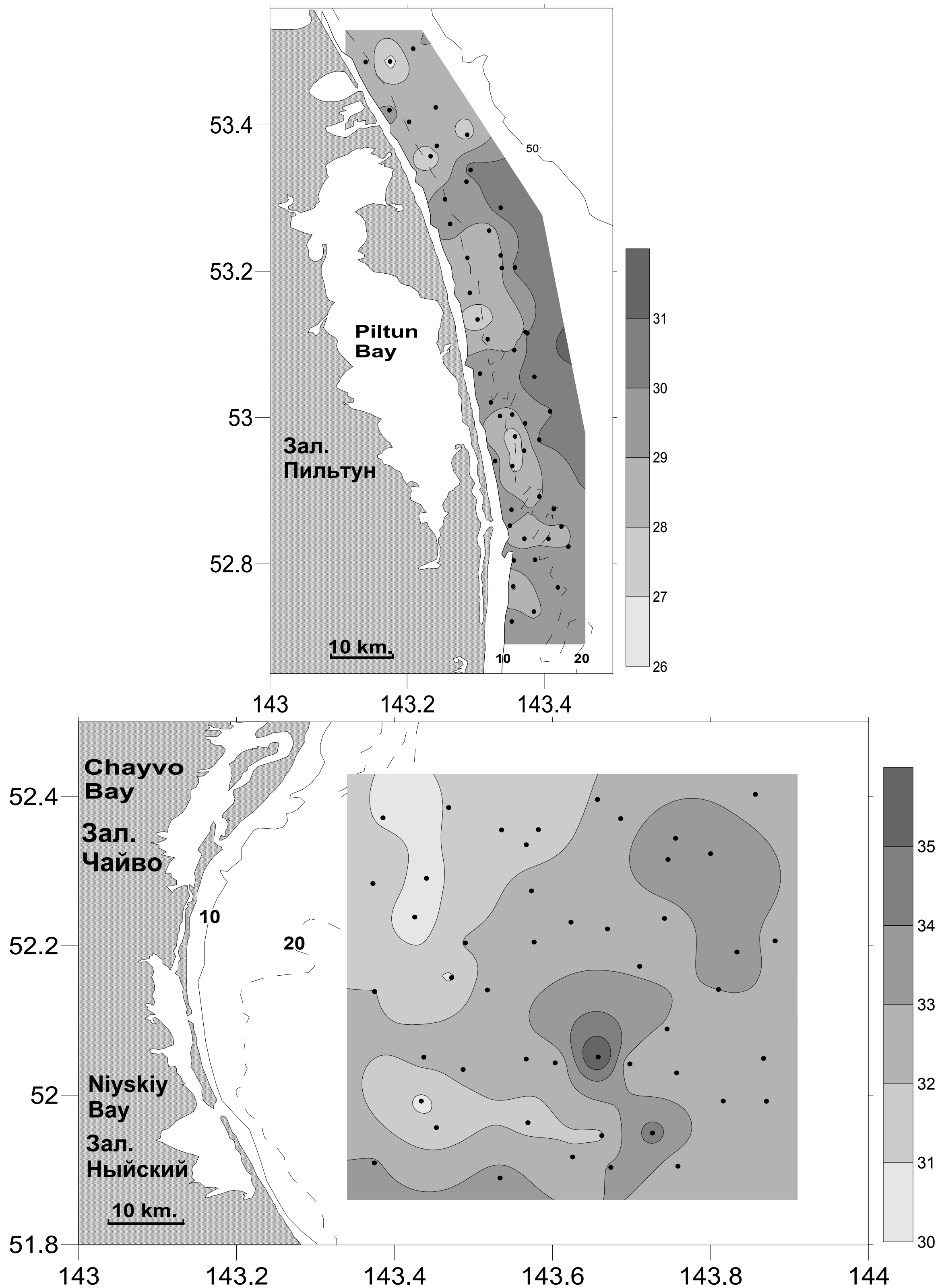


Figure P1.3. Distribution of salinity (S, %) of the surface water layer in the Piltun and Offshore areas during the study period.

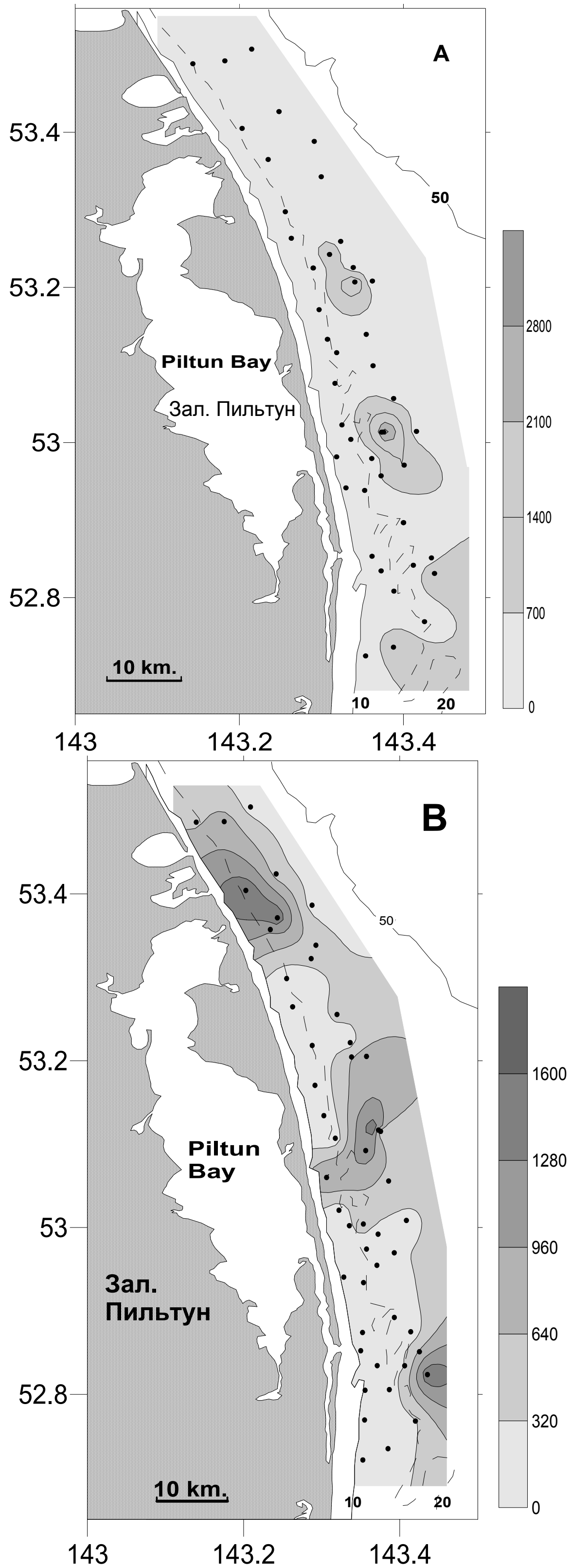


Figure P1.4. Distribution of total biomass (g/m^2) of macrobenthos in the Piltun area in 2004 (A) and 2005 (B).

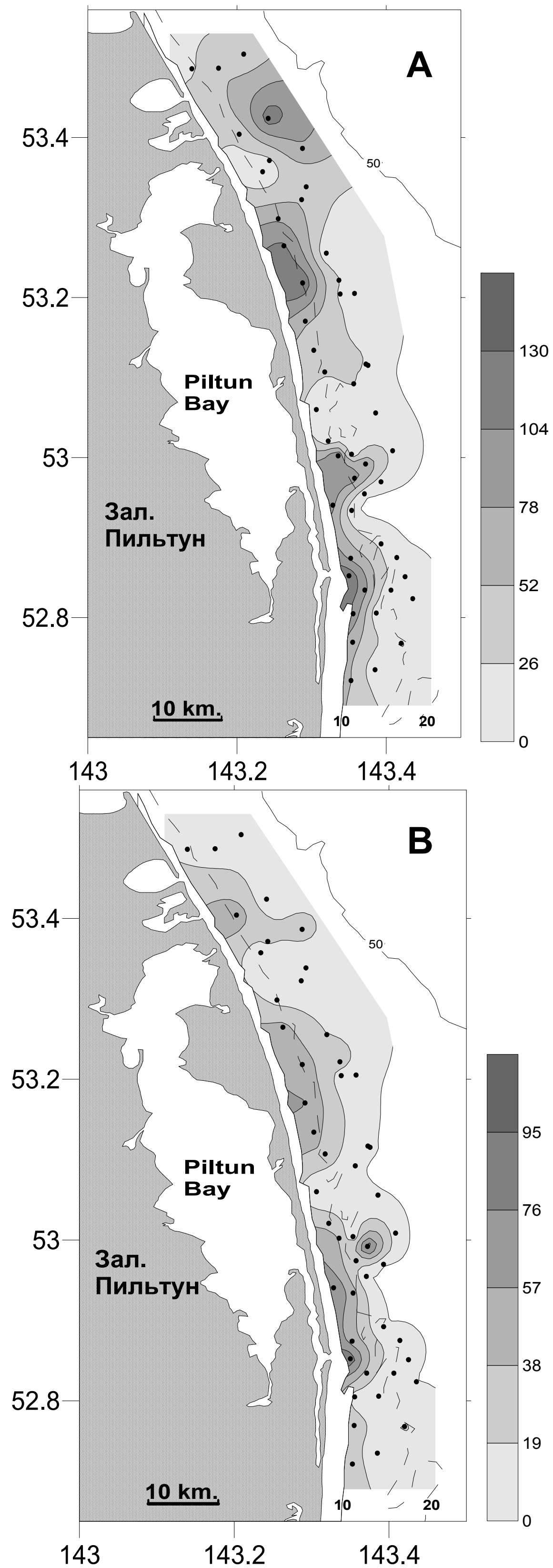


Figure P1.5. Distribution of total biomass (g/m^2) of amphipods and isopods (A) and proportion (%) of amphipods (B) in benthos biomass in the Piltun area in 2005.

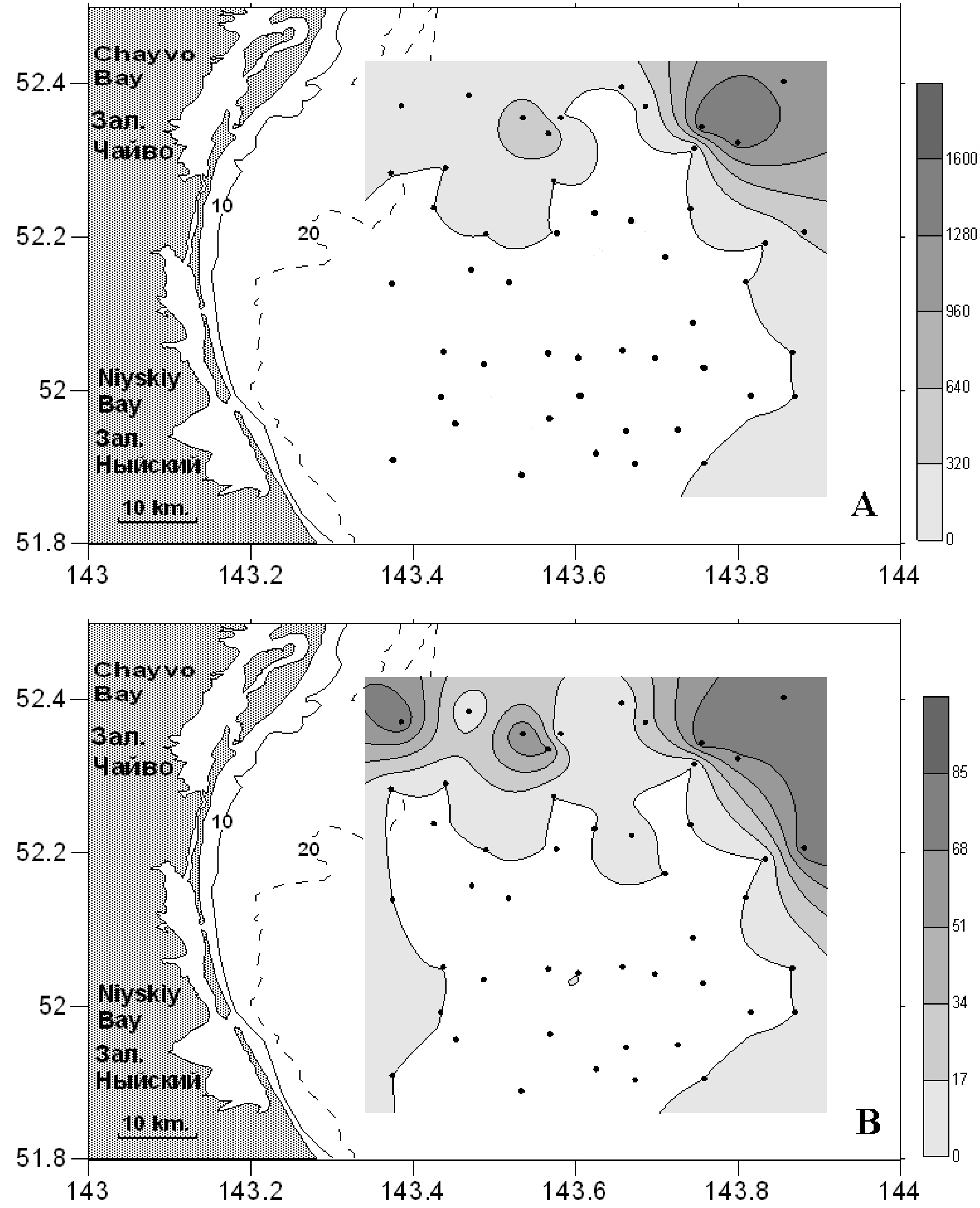


Figure P1.6. Distribution of biomass (A; g/m^2) and proportion (B; %) of flat sea urchins in the total benthos biomass in the Offshore area in 2005.

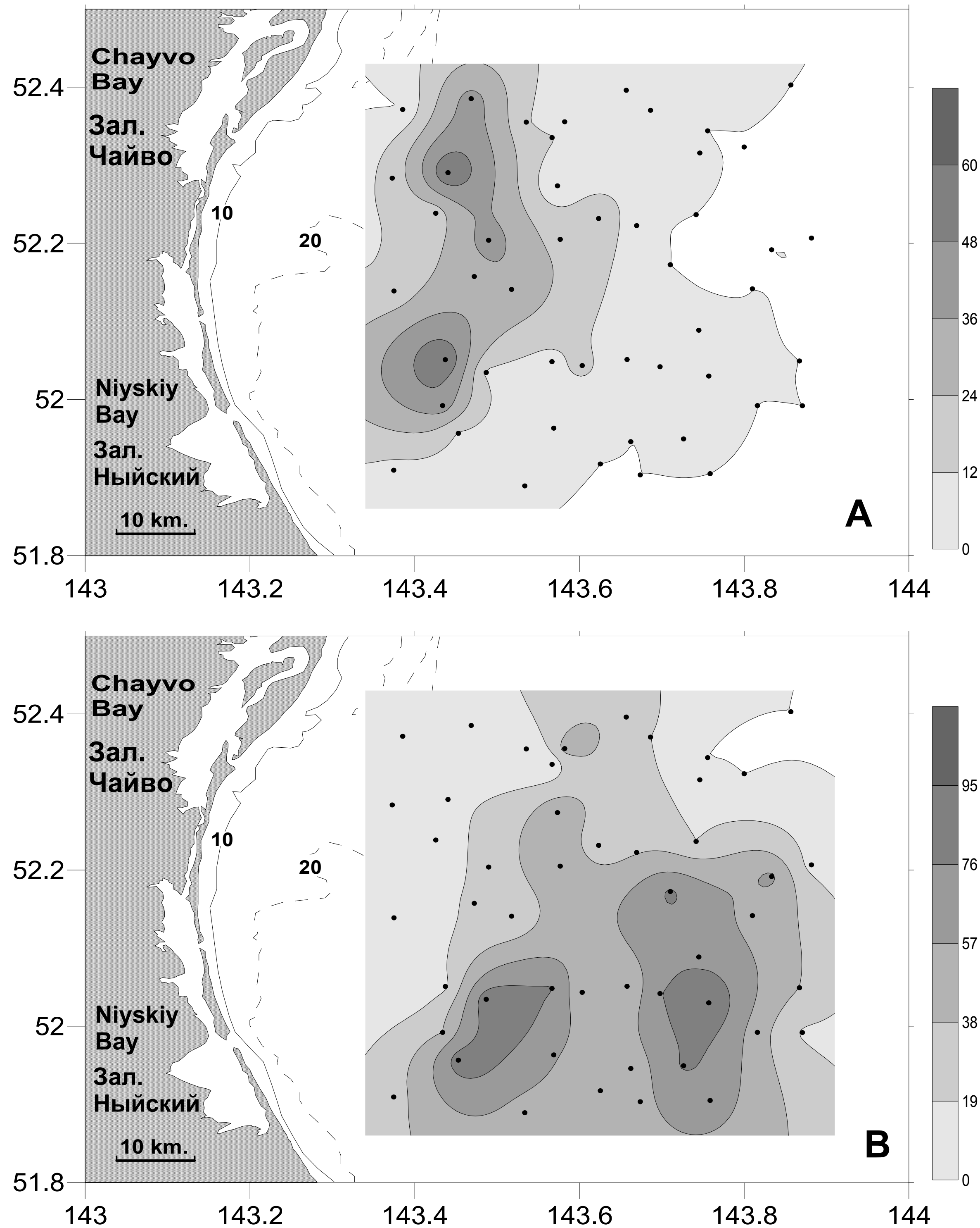


Figure P1.7. Proportion (%) of cumaceans (A) and amphipods (B) in the average benthos biomass (g/m^2) in the Offshore area in 2005.

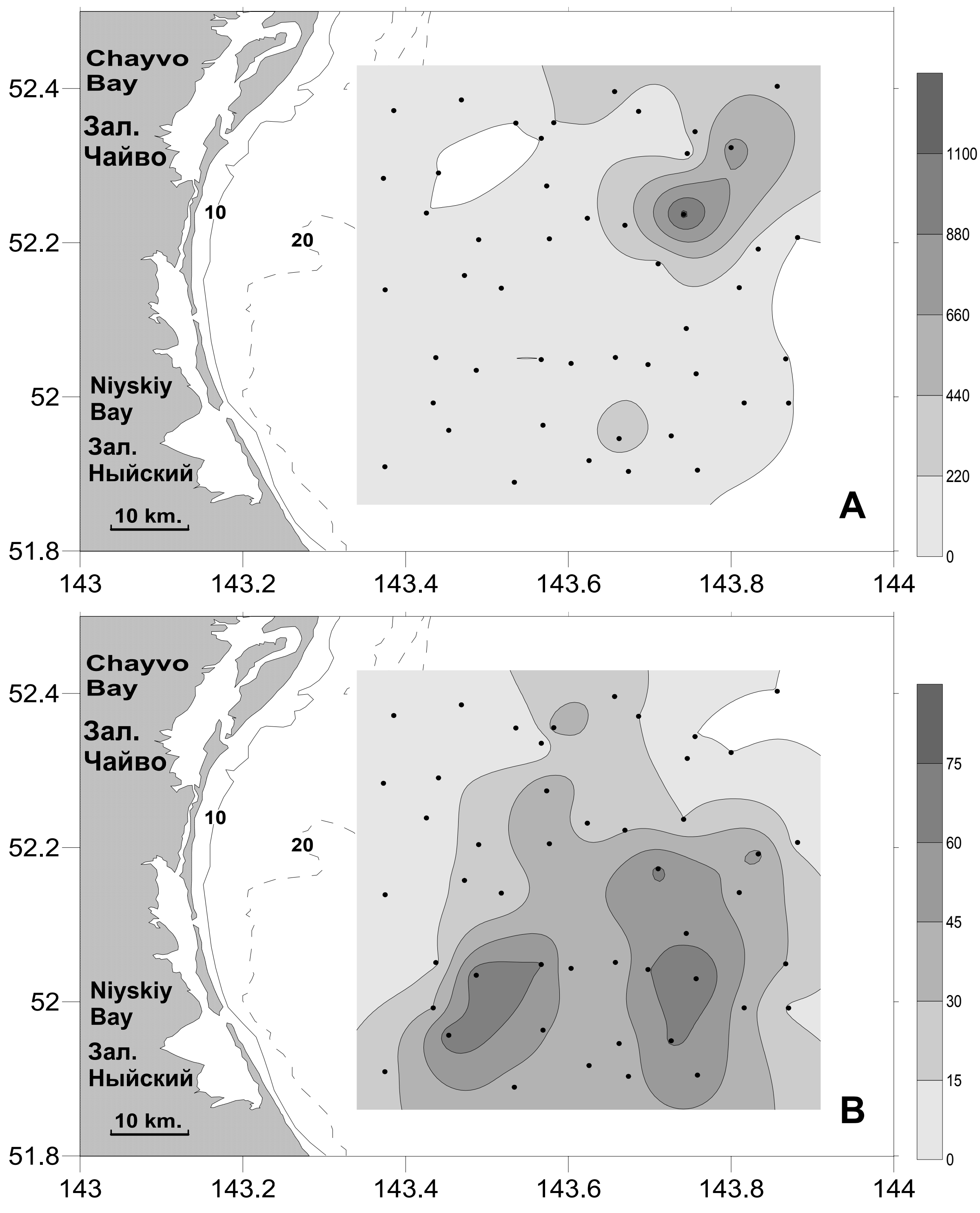


Figure P1.8. Biomass (A; g/m^2) and proportion (B; %) of sea anemones in the total benthos biomass in the Offshore area in 2005.

APPENDICES 2 – 8

APPENDIX 2. Sampling log for July-October 2005 for the expedition of the Institute of Marine Biology of the Far East Branch of the Russian Academy of Sciences aboard the research vessel *Academic Lavrentiev and Academic Oparin.*

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
1	1	1-1M	Piltun Area	52,80484	143,35556	26.09.2005	11:20	11	18	9	29,8	3	-	-	+
2	2	1-1MR	Piltun Area	52,80506	143,38618	18.07.2005	11:50	11	12	11	27,1	6	-	-	+
3	3	1-1N	Piltun Area	52,87411	143,35229	18.07.2005	10:28	15	18	9	28,8	3	-	-	+
4	4	1-1NR	Piltun Area	52,87291	143,34133	19.07.2005	17:00	15	16	9	28,5	6	-	-	+
5	5	1-1S	Piltun Area	52,72129	143,35270	15.07.2005	17:00	13	20	9	28,6	3	-	-	+
6	6	1-2M	Piltun Area	52,99199	143,37221	16.07.2005	20:35	27	18	5	28,6	3	-	-	+
7	7	1-2N	Piltun Area	53,02071	143,32214	19.07.2005	20:34	17	20	11	30,1	3	-	-	+
8	8	1-2S	Piltun Area	52,94050	143,32833	19.07.2005	15:15	11	20	9	28,8	3	-	-	+
9	9	2-1M	Piltun Area	52,83437	143,37110	18.07.2005	10:00	15	18	9	28,7	3	-	-	+
10	10	2-1N	Piltun Area	52,85226	143,35000	26.09.2005	8:30	15	18	9	28,6	3	-	-	+
11	11	2-1NR	Piltun Area	52,85194	143,35694	19.07.2005	10:35	15	12	12	27,2	6	-	-	+
12	12	2-1S	Piltun Area	52,76922	143,35492	17.07.2005	15:15	11	20	9	28,8	3	-	-	+
13	13	2-2M	Piltun Area	52,97416	143,35742	26.09.2005	9:48	15	18	13	30,7	3	-	-	+
14	14	2-2MR	Piltun Area	52,83394	143,37037	16.07.2005	10:56	15	12	11	27,1	6	-	-	+
15	15	2-2N	Piltun Area	53,00221	143,33544	18.07.2005	22:00	15	18	10	30,1	3	-	-	+
16	16	2-2S	Piltun Area	52,93393	143,35355	21.07.2005	14:54	19	18	11	28,3	3	-	-	+
17	17	2-3M	Piltun Area	53,13412	143,30280	21.07.2005	15:15	14	18	9	27,2	3	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
18	18	2-3N	Piltun Area	53,17047	143,29145	21.07.2005	16:00	14	18	9	27,2	3	-	-	+
19	19	2-3S	Piltun Area	53,10700	143,31747	17.07.2005	11:25	15	18	9	27,2	3	-	-	+
20	20	2-4M	Piltun Area	53,26467	143,26283	26.09.2005	9:48	24	18	13	28,7	3	-	-	+
21	21	2-4N	Piltun Area	53,29850	143,25517	21.07.2005	10:56	15	12	11	27,2	3	-	-	+
22	22	2-4S	Piltun Area	53,21827	143,28788	31.07.2005	16:49	20	18	9	27,2	3	-	-	+
23	23	2-5M	Piltun Area	53,40417	143,20290	30.07.2005	11:30	22	17	4	29,3	3	-	-	+
24	24	2-5N	Piltun Area	53,48598	143,13945	31.07.2005	19:25	19	17	7	30,6	3	-	-	+
25	25	2-5S	Piltun Area	53,35729	143,23428	19.07.2005	17:20	23	17	4	29,3	3	-	-	+
26	26	3-1M	Piltun Area	52,80566	143,38659	18.07.2005	10:47	18	18	9	29,4	3	-	-	+
27	27	3-1N	Piltun Area	52,83427	143,40625	19.07.2005	18:45	26	18	9	28,3	3	-	-	+
28	28	3-1S	Piltun Area	52,73480	143,38493	18.07.2005	16:00	20	20	9	24,6	3	-	-	+
29	29	3-2M	Piltun Area	52,95469	143,37072	26.09.2005	15:54	24	18	9	28,1	3	-	-	+
30	30	3-2MR	Piltun Area	52,95435	143,37034	01.08.2005	9:10	24	12	10	27,0	6	-	-	+
31	31	3-2N	Piltun Area	53,00684	143,37116	16.07.2005	13:20	25	16	2	29,5	3	-	-	+
32	32	3-2NR	Piltun Area	53,05933	143,37198	18.07.2005	21:37	25	20	10	30,0	6	-	-	+
33	33	3-2S	Piltun Area	52,89213	143,39300	01.08.2005	13:27	25	18	9	28,0	3	-	-	+
34	34	3-3M	Piltun Area	53,00418	143,35341	01.08.2005	9:15	27	16	3	27,8	3	-	-	+
35	35	3-3N	Piltun Area	53,20445	143,33823	21.07.2005	10:20	28	9	1	27,3	3	-	-	+
36	36	3-3S	Piltun Area	53,09223	143,35636	01.08.2005	14:50	25	18	9	27,0	3	-	-	+
37	37	3-4M	Piltun Area	53,25549	143,31963	31.07.2005	13:20	25	16	2	28,8	3	-	-	+
38	38	3-4N	Piltun Area	53,32242	143,28655	31.07.2005	14:30	30	17	3	29,3	3	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
39	39	3-4S	Piltun Area	53,06000	143,30628	31.07.2005	16:20	25	17	2	29,5	3	-	-	+
40	40	3-5M	Piltun Area	53,42010	143,17423	30.07.2005	13:00	23	17	4	29,5	3	-	-	+
41	41	3-5N	Piltun Area	53,48669	143,17523	31.07.2005	18:00	32	17	7	30,6	3	-	-	+
42	42	3-5S	Piltun Area	53,37136	143,24332	19.09.2005	12:30	27	17	4	29,0	3	-	-	+
43	43	4-1M	Piltun Area	52,82365	143,43540	18.07.2005	8:50	25	18	9	28,7	3	-	-	+
44	44	4-1N	Piltun Area	52,85108	143,42516	18.07.2005	9:40	22	18	9	28,1	3	-	-	+
45	45	4-1NR	Piltun Area	52,84289	143,43539	19.07.2005	17:53	25	18	9	29,9	6	-	-	+
46	46	4-1S	Piltun Area	52,76793	143,41999	17.07.2005	14:05	16	20	9	28,9	3	-	-	+
47	47	4-2M	Piltun Area	52,96970	143,39291	16.07.2005	10:15	25	20	8	28,8	6	-	-	+
48	48	4-2N	Piltun Area	53,00852	143,40845	18.07.2005	21:09	24	18	11	30,5	3	-	-	+
49	49	4-2S	Piltun Area	52,87500	143,41400	31.07.2005	13:55	26	18	9	29,9	3	-	-	+
50	50	4-3M	Piltun Area	53,11530	143,37550	31.07.2005	18:50	33	17	4	29,5	3	-	-	+
51	51	4-3N	Piltun Area	53,20516	143,35740	21.07.2005	18:00	30	17	4	29,5	3	-	-	+
52	52	4-3S	Piltun Area	53,05576	143,38571	31.07.2005	10:42	28	18	9	27,0	3	-	-	+
53	53	4-4M	Piltun Area	53,28683	143,33657	31.07.2005	16:00	23	17	4	29,8	3	-	-	+
54	54	4-4N	Piltun Area	53,33846	143,29265	21.07.2005	18:50	33	17	4	29,3	3	-	-	+
55	55	4-4S	Piltun Area	53,22168	143,33653	31.07.2005	17:40	30	18	9	27,0	3	-	-	+
56	56	4-5M	Piltun Area	53,42396	143,24173	30.07.2005	9:30	35	17	4	29,5	3	-	-	+
57	57	4-5N	Piltun Area	53,50424	143,20892	31.07.2005	18:45	37	17	7	28,9	3	-	-	+
58	58	4-5S	Piltun Area	53,38645	143,28769	27.09.2005	10:50	35	17	4	29,7	3	-	-	+
59	59	Z-01	Piltun_Zond	52,55130	143,43503	11.08.2005	8:30	19	20	12	28,8	3	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
60	60	Z-02	Piltun_Zond	52,61818	143,44069	11.08.2005	9:25	22	20	9	28,5	3	-	-	+
61	61	Z-03	Piltun_Zond	52,68343	143,41682	11.08.2005	10:13	25	20	9	30,0	3	-	-	+
62	62	Z-04	Piltun_Zond	52,74261	143,42343	11.08.2005	11:02	25	20	9	30,2	3	-	-	+
63	63	Z-05	Piltun_Zond	52,81712	143,40781	11.08.2005	11:10	22	21	5	29,9	3	-	-	+
64	64	Z-06	Piltun_Zond	52,87421	143,39152	11.08.2005	12:50	23	21	11	30,2	3	-	-	+
65	65	Z-07	Piltun_Zond	52,93969	143,35709	11.08.2005	13:29	22	22	9	30,6	3	-	-	+
66	66	Z-08	Piltun_Zond	53,00703	143,35511	11.08.2005	14:05	22	22	9	30,3	3	-	-	+
67	67	Z-09	Piltun_Zond	53,06973	143,35000	11.08.2005	14:40	28	22	9	30,7	3	-	-	+
68	68	Z-10	Piltun_Zond	53,13423	143,32053	11.08.2005	15:18	22	22	12	30,6	3	-	-	+
69	69	Z-11	Piltun_Zond	53,20063	143,30092	11.08.2005	16:13	20	22	9	30,6	3	-	-	+
70	70	Z-12	Piltun_Zond	53,26690	143,27355	11.08.2005	17:01	21	22	13	28,9	3	-	-	+
71	71	Z-13	Piltun_Zond	53,32644	143,25284	11.08.2005	17:44	23	20	12	28,5	3	-	-	+
72	72	Z-14	Piltun_Zond	53,39046	143,22769	11.08.2005	18:27	30	15	10	28,0	3	-	-	+
73	73	Pil-01	Piltun_Dive	53,37955	143,17338	12.09.2005	9:30	3	12	10	29,0	4	-	-	+
74	74	Pil-02	Piltun_Dive	53,37985	143,17515	11.09.2005	10:15	5	16	11	27,6	4	-	-	+
75	75	Pil-03	Piltun_Dive	53,38137	143,18347	11.09.2005	11:00	7	15	11	30,6	4	-	-	+
76	76	Pil-04	Piltun_Dive	53,38050	143,19192	11.09.2005	11:30	10	15	8	27,1	4	-	-	+
77	77	Pil-05	Piltun_Dive	53,37963	143,20037	12.09.2005	12:00	12	17	9	27,0	4	-	-	+
78	78	Pil-06	Piltun_Dive	53,15218	143,27087	12.09.2005	9:00	3	17	9	28,7	4	-	-	+
79	79	Pil-07	Piltun_Dive	53,15393	143,27160	12.09.2005	9:40	5	16	11	28,7	4	-	-	+
80	80	Pil-08	Piltun_Dive	53,15588	143,27373	12.09.2005	10:20	7	15	11	27,1	4	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
81	81	Pil-09	Piltun_Dive	53,15717	143,28227	16.07.2005	11:00	10	20	8	28,8	4	-	-	+
82	82	Pil-10	Piltun_Dive	53,15845	143,29080	08.09.2005	11:40	12	16	12	28,8	4	-	-	+
83	83	Pil-11	Piltun_Dive	52,86215	143,33075	08.09.2005	10:00	3	16	12	27,1	4	-	-	+
84	84	Pil-12	Piltun_Dive	52,86225	143,33315	08.09.2005	10:45	5	16	9	27,0	4	-	-	+
85	85	Pil-13	Piltun_Dive	52,86152	143,33487	08.09.2005	11:30	7	16	14	27,0	4	-	-	+
86	86	Pil-14	Piltun_Dive	52,86155	143,33848	08.09.2005	12:15	10	16	9	27,0	4	-	-	+
87	87	Pil-15	Piltun_Dive	52,86090	143,34215	11.09.2005	13:00	12	15	14	27,1	4	-	-	+
88	1	B10-1	Offshore Area	51,90483	143,75867	27.09.2005	8:20	60	13	13	27,2	3	-	-	+
89	2	B10-2	Offshore Area	52,02990	143,75702	02.08.2005	15:40	54	13	13	27,2	3	-	-	+
90	3	B10-3	Offshore Area	52,23667	143,74167	23.09.2005	14:50	48	14	11	29,9	3	-	-	+
91	4	B10-4	Offshore Area	52,34400	143,75567	15.09.2005	15:15	49	16	12	28,8	3	-	-	+
92	5	B1-1	Offshore Area	51,90929	143,37453	27.09.2005	11:00	42	12	12	29,0	3	-	-	+
93	6	B11-1	Offshore Area	51,99207	143,81603	03.08.2005	16:25	59	13	4	28,1	3	-	-	+
94	7	B11-2	Offshore Area	52,14167	143,81000	26.09.2005	16:15	55	12	3	29,0	3	-	-	+
95	8	B11-3	Offshore Area	52,19167	143,83333	23.09.2005	19:50	57	11	4	27,0	3	-	-	+
96	9	B11-4	Offshore Area	52,32333	143,80000	03.08.2005	16:00	54	16	12	28,8	3	-	-	+
97	10	B1-2	Offshore Area	52,13883	143,37486	27.09.2005	14:30	27	12	2	28,6	3	-	-	+
98	11	B12-1	Offshore Area	51,99188	143,87067	03.08.2005	17:10	59	12	5	27,2	3	-	-	+
99	12	B12-2	Offshore Area	52,04922	143,86710	02.08.2005	21:50	49	18	12	28,5	3	-	-	+
100	13	B12-3	Offshore Area	52,20667	143,88167	23.09.2005	15:50	62	14	11	28,7	3	-	-	+
101	14	B12-4	Offshore Area	52,40283	143,85667	23.09.2005	17:00	57	16	12	28,7	3	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
102	15	B1-3	Offshore Area	52,28343	143,37277	02.08.2005	20:50	20	14	12	27,1	3	-	-	+
103	16	B1-4	Offshore Area	52,37134	143,38544	27.09.2005	10:00	19	14	12	28,8	3	-	-	+
104	17	B2-1	Offshore Area	51,99204	143,43393	04.08.2005	12:55	30	13	13	28,8	3	-	-	+
105	18	B2-2	Offshore Area	52,05088	143,43714	26.09.2005	10:25	32	20	14	29,3	3	-	-	+
106	19	B2-3	Offshore Area	52,23843	143,42561	23.09.2005	17:31	25	12	12	27,1	3	-	-	+
107	20	B2-4	Offshore Area	52,29043	143,44043	27.09.2005	20:15	25	14	12	27,0	3	-	-	+
108	21	B3-1	Offshore Area	51,95654	143,45302	27.09.2005	12:10	32	13	13	28,7	3	-	-	+
109	22	B3-2	Offshore Area	52,03439	143,48683	03.08.2005	13:35	35	13	13	27,8	3	-	-	+
110	23	B3-3	Offshore Area	52,15741	143,47234	02.08.2005	13:30	33	20	11	28,8	3	-	-	+
111	24	B3-4	Offshore Area	52,38521	143,46855	15.08.2005	9:20	30	14	12	29,2	3	-	-	+
112	25	B4-1	Offshore Area	51,88916	143,53364	03.08.2005	8:28	35	20	6	27,8	3	-	-	+
113	26	B4-2	Offshore Area	52,14094	143,51761	04.08.2005	12:50	36	20	11	28,8	3	-	-	+
114	27	B4-3	Offshore Area	52,20387	143,48977	02.08.2005	8:40	32	20	11	29,7	3	-	-	+
115	28	B4-4	Offshore Area	52,35516	143,53547	27.09.2005	10:50	30	14	12	29,5	3	-	-	+
116	29	B5-1	Offshore Area	51,96317	143,56883	04.08.2005	11:15	44	13	13	27,1	3	-	-	+
117	30	B5-2	Offshore Area	52,04833	143,56667	26.09.2005	11:25	45	20	13	29,2	3	-	-	+
118	31	B5-3	Offshore Area	52,20500	143,57667	02.08.2005	18:26	37	12	9	27,1	3	-	-	+
119	32	B5-4	Offshore Area	52,33537	143,56677	27.09.2005	11:20	30	14	11	28,9	3	-	-	+
120	33	B6-1	Offshore Area	51,94583	143,66236	27.09.2005	10:47	45	13	13	27,1	3	-	-	+
121	34	B6-2	Offshore Area	52,04333	143,60333	02.08.2005	14:23	45	13	13	27,3	3	-	-	+
122	35	B6-3	Offshore Area	52,27357	143,57338	23.09.2005	12:40	35	14	11	28,8	3	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
123	36	B6-4	Offshore Area	52,35562	143,58208	27.09.2005	19:15	33	14	12	27,0	3	-	-	+
124	37	B7-1	Offshore Area	51,91727	143,62542	27.09.2005	10:15	48	13	7	27,1	3	-	-	+
125	38	B7-2	Offshore Area	52,05107	143,65782	02.08.2005	17:40	61	12	8	27,1	3	-	-	+
126	39	B7-3	Offshore Area	52,23167	143,62333	23.09.2005	13:25	40	13	11	28,8	3	-	-	+
127	40	B7-4	Offshore Area	52,39600	143,65683	27.09.2005	18:35	40	15	12	27,0	3	-	-	+
128	41	B8-1	Offshore Area	51,90322	143,67385	27.09.2005	9:22	57	12	4	27,0	3	-	-	+
129	42	B8-2	Offshore Area	52,04183	143,69787	02.08.2005	14:57	46	13	6	27,0	3	-	-	+
130	43	B8-3	Offshore Area	52,22257	143,66952	23.09.2005	14:10	42	14	11	27,3	3	-	-	+
131	44	B8-4	Offshore Area	52,37033	143,68632	27.09.2005	18:00	43	16	12	27,1	3	-	-	+
132	45	B9-1	Offshore Area	51,94935	143,72643	03.08.2005	8:50	55	13	6	27,1	3	-	-	+
133	46	B9-2	Offshore Area	52,08863	143,74492	03.08.2005	17:40	52	10	3	28,7	3	-	-	+
134	47	B9-3	Offshore Area	52,17253	143,71030	23.09.2005	18:45	49	10	5	28,8	3	-	-	+
135	48	B9-4	Offshore Area	52,31565	143,74612	02.08.2005	14:30	48	16	12	28,0	3	-	-	+
136	1	FP-01	Piltun Area	52,83659	143,36797	30.07.2005	9:00	16	13	6	28,6	3	+	+	+
137	2	FP-03	Piltun Area	52,80220	143,35818	15.09.2005	9:40	11	13	6	26,4	3	+	+	+
138	3	FP-04	Piltun Area	53,28704	143,23721	19.09.2005	14:00	11	17	7	28,5	3	+	+	+
139	4	FP-06	Piltun Area	52,85160	143,35985	25.09.2005	15:15	20	12	12	28,8	3	+	+	+
140	5	FP-07	Piltun Area	53,34500	143,22467	02.08.2005	13:40	24	13	12	29,8	3	+	+	+
141	6	FP-08	Piltun Area	53,20946	143,25965	12.09.2005	10:55	14	17	7	28,9	3	+	+	+
142	7	FP-09	Piltun Area	53,22360	143,25903	11.09.2005	9:09	12	17	9	28,8	3	+	+	+
143	8	FP-10	Piltun Area	53,25163	143,25476	30.07.2005	15:00	11	17	7	28,9	3	+	+	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
144	9	FP-11	Piltun Area	53,28704	143,23721	28.09.2005	14:00	11	17	7	28,9	3	+	+	+
145	10	FP-12	Piltun Area	53,28899	143,28553	18.09.2005	14:30	26	17	7	29,3	3	+	+	+
146	11	FP-12R	Piltun Area	53,28918	143,28622	30.07.2005	13:40	24	13	12	30,0	3	+	+	+
147	12	FP-13	Piltun Area	53,30213	143,28543	18.09.2005	12:50	26	17	7	29,7	3	+	+	+
148	13	FP-13R	Piltun Area	53,30052	143,28856	01.08.2005	14:10	26	13	12	29,9	3	+	+	+
149	14	FP-14	Piltun Area	53,26827	143,30229	28.09.2005	11:10	24	16	12	28,6	3	+	+	+
150	15	FP-14R	Piltun Area	53,26847	143,30240	25.08.2005	10:30	24	14	10	28,7	3	+	+	+
151	16	FP-15	Piltun Area	53,22457	143,28636	25.08.2005	15:50	22	18	9	27,0	3	+	+	+
152	17	FP-16	Piltun Area	53,25483	143,27525	28.09.2005	17:00	20	18	9	27,2	3	+	+	+
153	18	FP-17	Piltun Area	53,30379	143,30923	25.08.2005	18:50	28	20	9	27,0	3	+	+	+
154	19	FP-18	Piltun Area	53,30384	143,30638	25.08.2005	19:20	30	18	9	27,1	3	+	+	+
155	20	FP-19	Piltun Area	53,29284	143,31798	15.09.2005	16:25	28	18	9	27,1	3	+	+	+
156	21	FP-20	Offshore Area	52,00096	143,52076	05.09.2005	12:00	38	12	9	28,9	3	+	-	+
157	22	FP-21	Piltun Area	52,68918	143,33974	16.09.2005	12:15	9	16	12	30,2	3	+	+	+
158	23	FP-22	Piltun Area	52,83583	143,35800	13.08.2005	10:00	17	16	10	30,6	3	+	+	+
159	24	FP2-2	Piltun Area	52,78862	143,37196	27.08.2005	19:11	15	16	6	27,0	3	+	+	+
160	25	FP-23	Piltun Area	53,35000	143,28334	27.08.2005	14:20	33	16	10	27,0	3	+	+	+
161	26	FP-24	Piltun Area	53,38873	143,18403	13.08.2005	15:57	12	15	9	27,1	3	+	+	+
162	27	FP2-4	Piltun Area	52,83865	143,35786	27.08.2005	18:35	17	20	6	27,0	3	+	+	+
163	28	FP-25	Piltun Area	53,35590	143,18883	13.08.2005	15:16	12	15	9	27,0	3	+	+	+
164	29	FP2-5	Piltun Area	52,85108	143,35527	31.08.2005	18:14	15	24	6	27,1	3	+	+	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
165	30	FP-26	Piltun Area	52,98593	143,35190	31.08.2005	11:00	25	12	9	27,2	3	+	+	+
166	31	FP-27	Piltun Area	52,98803	143,35280	13.08.2005	11:20	29	12	9	29,0	3	+	+	+
167	32	FP2-7	Piltun Area	52,91782	143,34156	01.08.2005	17:28	15	24	6	29,9	3	+	+	+
168	33	FP-28	Piltun Area	53,50812	143,16671	01.08.2005	9:15	29	12	12	27,6	3	+	+	+
169	34	FP-29	Piltun Area	53,34233	143,26745	05.08.2005	11:10	27	14	10	27,3	3	+	+	+
170	35	FP-30	Offshore Area	51,98642	143,53342	05.09.2005	13:20	39	12	12	28,9	3	-	-	+
171	36	FP-31	Offshore Area	52,00150	143,55217	05.09.2005	14:00	41	12	12	28,8	3	-	-	+
172	37	FP-32	Piltun Area	52,69271	143,35167	19.09.2005	11:45	12	16	12	30,7	3	+	+	+
173	38	FP-33	Piltun Area	53,13872	143,33404	19.09.2005	12:50	23	13	12	28,8	3	+	+	+
174	39	FP-34	Piltun Area	53,20051	143,27190	19.09.2005	12:05	11	16	12	28,7	3	+	+	+
175	40	FP-35	Piltun Area	53,20320	143,28403	19.09.2005	11:20	15	13	12	28,6	3	+	+	+
176	41	FP-36	Piltun Area	52,68718	143,33815	19.09.2005	18:30	18	13	11	28,8	3	+	+	+
177	42	FP-37	Piltun Area	52,68763	143,33594	18.09.2005	19:20	19	11	8	28,7	3	+	+	+
178	43	FP-38	Piltun Area	53,29024	143,28710	19.09.2005	14:50	25	13	12	30,1	3	+	+	+
179	44	FP-39	Piltun Area	52,92030	143,34017	30.07.2005	16:15	12	12	12	28,8	3	+	+	+
180	45	FP-40	Piltun Area	53,02167	143,32367	19.09.2005	18:30	18	11	11	29,4	3	-	+	+
181	46	FP-41	Piltun Area	53,06882	143,31896	19.09.2005	19:20	19	10	9	24,6	3	-	+	+
182	47	FP-42	Piltun Area	52,93851	143,33791	23.09.2005	16:45	13	12	12	28,9	3	-	+	+
183	48	FP-43	Piltun Area	52,28782	143,70545	19.09.2005	13:20	45	16	12	27,8	3	-	+	+
184	49	FP-44	Piltun Area	52,94275	143,33533	19.09.2005	17:10	12	11	6	28,7	3	-	+	+
185	50	FP-45	Piltun Area	53,00190	143,35100	23.09.2005	18:10	19	11	11	28,8	3	-	+	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
186	51	FP-46	Piltun Area	53,06105	143,36667	19.09.2005	13:20	45	16	12	27,0	3	-	+	+
187	52	FP-47	Piltun Area	53,02167	143,32367	19.09.2005	18:30	18	11	11	28,0	3	-	+	+
188	53	FP-48	Piltun Area	53,06882	143,31896	19.09.2005	19:20	19	10	10	28,1	3	-	+	+
189	54	FP-49	Piltun Area	53,05828	143,28872	19.09.2005	18:30	18	11	11	28,8	3	-	+	+
190	55	FP-50	Piltun Area	53,06217	143,26487	23.09.2005	19:20	19	10	9	28,7	3	-	+	+
191	56	FP-51	Offshore Area	52,29219	143,69263	23.09.2005	13:45	43	16	12	27,1	3	-	-	+
192	57	FP-52	Offshore Area	52,28782	143,70545	23.09.2005	13:20	45	16	12	27,9	3	-	-	+
193	58	FP-53	Piltun Area	52,28345	143,71827	19.09.2005	18:30	18	11	11	27,8	3	-	+	+
194	59	FP-54	Piltun Area	53,19839	143,26676	25.09.2005	19:20	19	10	8	27,1	3	-	+	+
195	60	FP-58	Piltun Area	53,30196	143,24320	25.09.2005	17:55	19	16	12	27,1	3	-	+	+
196	61	FP-59	Piltun Area	53,30878	143,32375	09.09.2005	17:30	12	16	12	27,1	3	-	+	+
197	62	FP-60	Piltun Area	53,28960	143,25025	19.09.2005	18:30	16	16	12	27,1	3	-	+	+
198	63	FP-61D	Piltun_Dive	52,84148	143,34151	19.09.2005	12:50	8	11	8	27,1	4	-	+	+
199	64	FP-62D	Piltun_Dive	52,85185	143,33831	19.09.2005	12:05	7	13	9	27,1	4	-	+	+
200	65	FP-63D	Piltun_Dive	52,85196	143,33786	19.09.2005	11:20	7	11	9	27,1	4	-	+	+
201	66	FP-64D	Piltun_Dive	52,85230	143,33745	19.09.2005	18:30	6	15	10	28,8	4	-	+	+
202	67	FP-65D	Piltun_Dive	52,85283	143,33692	18.09.2005	19:20	6	15	8	27,0	4	-	+	+
203	68	FP-66D	Piltun_Dive	52,85468	143,33510	19.09.2005	14:50	6	13	10	29,5	4	-	+	+
204	69	FP-67D	Piltun_Dive	53,15740	143,28474	19.09.2005	16:15	10	12	9	27,0	4	-	+	+
205	70	FP-68D	Piltun_Dive	53,15638	143,27055	02.08.2005	18:30	5	11	10	27,1	4	-	+	+
206	71	FP-69	Offshore Area	52,22332	143,68381	05.10.2005	12:08	43	11	11	28,7	3	-	-	+

Item	Number	Station	Area	Coordinates (decimal form)		Date	Time	Depth (m)	Temperature (ºC)		Salinity	Bottom Grab Sampler	Epibenthic Net	Bongo Net	Granulometry
				longitude	latitude				Air	Water					
207	72	FP-70	Offshore Area	52,22506	143,68605	05.10.2005	12:40	43	11	11	28,1	3	-	-	+
208	73	FP-71	Offshore Area	52,22406	143,68898	05.10.2005	13:15	43	11	11	28,1	3	-	-	+
209	74	FP-72	Piltun Area	52,36683	143,23606	21.07.2005	18:25	25	20	11	30,7	3	-	-	+
210	75	FP-73	Piltun Area	52,93363	143,40661	11.08.2005	8:25	26	18	9	27,0	3	-	-	+
211	76	FP-74	Piltun Area	52,35820	143,71273	12.09.2005	15:50	16	10	8	28,8	3	-	-	+
212	77	FP-75	Piltun Area	53,28328	143,25035	12.09.2005	16:25	23	11	9	30,0	3	-	-	+
213	78	FP-76	Piltun Area	53,16048	143,29392	12.09.2005	17:00	15	11	9	30,2	3	-	-	+
214	79	FP-77	Piltun Area	53,18775	143,27536	12.09.2005	17:30	21	11	9	29,9	3	-	-	+
215	80	FP-78	Piltun Area	53,27358	143,29183	12.09.2005	17:55	16	11	9	30,2	3	-	-	+
216	81	FP-79	Piltun Area	53,30145	143,23993	09.09.2005	18:30	15	17	12	28,8	3	-	-	+
217	82	FP-80	Piltun Area	53,33117	143,24300	12.09.2005	18:50	20	16	12	29,0	3	-	-	+
218	83	FP-81	Piltun Area	52,29407	143,82708	28.09.2005	19:20	20	12	11	28,6	3	-	-	+
219	84	FP-05N	North Area	54,35712	142,58738	19.09.2005	8:58	29	17	11	29,0	4	+	+	+
220	85	FP-07N	North Area	54,36766	142,55761	30.07.2005	10:56	34	17	11	28,5	4	+	+	+
221	86	FP-08N	North Area	54,35239	142,58847	30.07.2005	11:23	27	17	14	27,2	4	+	+	+
222	87	FP-11N	North Area	54,35629	142,56792	30.07.2005	13:15	30	17	14	27,0	4	+	+	+
223	88	FP-14N	North Area	54,35815	142,56904	19.09.2005	12:40	30	17	9	27,0	4	+	+	+
224	89	FP-16N	North Area	54,36946	142,54233	25.08.2005	13:07	37	17	14	27,0	4	+	+	+
225	90	FP-20N	North Area	54,37465	142,60774	16.09.2005	13:38	31	17	14	27,0	4	+	+	+

APPENDIX 3. Granulometric Composition of Bottom Sediments.

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
1	1	1-1M	Piltun	52,80484	143,35556	11	0,0	0,0	0,2	1,2	11,2	21,4	**62,9**	3,1	0,0	0,0	Sf
2	2	1-1MR	Piltun	52,80506	143,38618	11	0,0	0,0	6,4	13,9	28,1	43,7	2,2	2,2	3,2	0,3	Smc
3	3	1-1N	Piltun	52,87411	143,35229	15	0,0	0,0	0,0	0,4	6,9	27,4	**62,0**	3,3	0,0	0,0	Sf
4	4	1-1NR	Piltun	52,87291	143,34133	15	0,0	0,0	0,0	0,0	20,6	**62,9**	12,4	3,0	0,5	0,6	Sm
5	5	1-1S	Piltun	52,72129	143,35270	13	0,0	0,0	0,2	0,9	1,3	14,5	**75,4**	7,7	0,0	0,0	Sf
6	6	1-2M	Piltun	52,99199	143,37221	27	0,0	0,0	0,6	4,4	8,6	27,0	**55,4**	4,0	0,0	0,0	Sf
7	7	1-2N	Piltun	53,02071	143,32214	17	1,3	0,0	1,0	1,5	3,0	23,2	**65,8**	4,2	0,0	0,0	Sf
8	8	1-2S	Piltun	52,94050	143,32833	11	0,3	0,0	4,7	1,1	3,0	15,3	**70,1**	5,5	0,0	0,0	Sf
9	9	2-1M	Piltun	52,83437	143,37110	15	0,0	0,0	0,7	1,9	7,1	43,0	43,9	3,4	0,0	0,0	Smc
10	10	2-1N	Piltun	52,85226	143,35000	15	0,0	0,5	0,1	2,6	4,0	20,1	**67,8**	4,9	0,0	0,0	Sf
11	11	2-1NR	Piltun	52,85194	143,35694	15	0,0	0,0	0,9	8,1	41,2	33,7	3,2	5,6	7,3	0,0	Smc
12	12	2-1S	Piltun	52,76922	143,35492	11	0,0	0,0	0,5	3,8	7,1	30,9	**52,6**	5,1	0,0	0,0	Sf
13	13	2-2M	Piltun	52,97416	143,35742	15	0,0	0,0	0,0	0,8	1,4	9,5	**83,9**	4,4	0,0	0,0	Sf
14	14	2-2MR	Piltun	52,83394	143,37037	15	0,0	0,0	0,0	0,0	4,3	47,1	43,6	2,3	0,1	2,6	Smc
15	15	2-2N	Piltun	53,00221	143,33544	15	0,0	0,0	0,0	0,4	2,9	36,4	**56,9**	3,4	0,0	0,0	Sf
16	16	2-2S	Piltun	52,93393	143,35355	19	0,0	0,0	0,0	0,3	1,3	28,7	**66,0**	3,7	0,0	0,0	Sf
17	17	2-3M	Piltun	53,13412	143,30280	14	0,0	0,0	0,0	0,3	0,5	16,9	**76,6**	5,7	0,0	0,0	Sf
18	18	2-3N	Piltun	53,17047	143,29145	14	0,0	0,0	0,5	2,4	3,4	9,0	**78,8**	5,9	0,0	0,0	Sf
19	19	2-3S	Piltun	53,10700	143,31747	15	0,0	0,0	0,0	0,1	0,7	16,2	**79,5**	3,5	0,0	0,0	Sf
20	20	2-4M	Piltun	53,26467	143,26283	24	0,0	0,8	7,3	19,7	5,4	24,0	40,8	2,0	0,0	0,0	Smc
21	21	2-4N	Piltun	53,29850	143,25517	15	0,0	0,0	0,2	0,9	2,9	28,5	**64,0**	3,5	0,0	0,0	Sf
22	22	2-4S	Piltun	53,21827	143,28788	20	0,0	0,0	2,1	20,3	8,4	22,4	44,4	2,4	0,0	0,0	Smc

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
23	23	2-5M	Piltun	53,40417	143,20290	22	0,0	0,0	1,0	5,4	13,2	**57,6**	22,3	0,5	0,0	0,0	Sm
24	24	2-5N	Piltun	53,48598	143,13945	19	0,0	9,9	18,9	20,8	23,7	17,3	6,9	2,5	0,0	0,0	ScmGr
25	25	2-5S	Piltun	53,35729	143,23428	23	0,0	0,0	0,0	0,4	1,3	34,0	**61,8**	2,5	0,0	0,0	Sf
26	26	3-1M	Piltun	52,80566	143,38659	18	16,8	7,5	3,5	1,2	31,6	24,3	12,5	2,6	0,0	0,0	Scmr
27	27	3-1N	Piltun	52,83427	143,40625	26	0,0	0,0	1,0	5,1	9,6	30,7	**50,2**	3,4	0,0	0,0	Sf
28	28	3-1S	Piltun	52,73480	143,38493	20	0,0	0,0	0,0	24,6	10,4	42,2	20,4	2,4	0,0	0,0	Smc
29	29	3-2M	Piltun	52,95469	143,37072	25	0,0	0,0	0,0	0,9	2,8	16,3	**78,8**	1,2	0,0	0,0	Sf
30	30	3-2MR	Piltun	52,95435	143,37034	25	0,5	0,0	0,2	1,3	1,8	16,7	**68,3**	2,8	8,3	0,0	Sf
31	31	3-2N	Piltun	53,00684	143,37116	25	4,8	0,0	0,0	1,1	12,6	14,7	**64,1**	2,7	0,0	0,0	Sf
32	32	3-2NR	Piltun	53,05933	143,37198	25	0,0	0,0	0,0	0,4	14,4	44,8	38,9	0,5	0,0	1,0	Smc
33	33	3-2S	Piltun	52,89213	143,39300	25	0,0	0,3	13,0	20,0	4,5	40,5	21,1	0,6	0,0	0,0	Smc
34	34	3-3M	Piltun	53,00418	143,35341	27	0,0	1,1	11,0	19,1	9,9	34,4	22,2	2,3	0,0	0,0	Smc
35	35	3-3N	Piltun	53,20445	143,33823	28	2,4	5,4	5,8	9,9	22,5	26,8	25,4	1,8	0,0	0,0	Smc
36	36	3-3S	Piltun	53,09223	143,35636	25	0,3	0,0	0,6	4,4	4,1	28,8	**58,9**	2,9	0,0	0,0	Sf
37	37	3-4M	Piltun	53,25549	143,31963	25	0,0	0,0	1,8	3,1	8,1	39,2	46,4	1,4	0,0	0,0	Smc
38	38	3-4N	Piltun	53,32242	143,28655	30	4,8	14,3	10,0	6,4	3,4	22,5	37,8	0,8	0,0	0,0	Smc
39	39	3-4S	Piltun	53,06000	143,30628	25	0,0	0,0	0,0	0,8	9,5	28,1	**54,8**	6,8	0,0	0,0	Sf
40	40	3-5M	Piltun	53,42010	143,17423	23	0,0	7,8	13,4	13,9	4,0	11,6	47,3	2,9	0,0	0,0	Smc
41	41	3-5N	Piltun	53,48669	143,17523	32	0,0	14,3	10,0	9,0	13,3	22,1	30,9	2,0	0,0	0,0	Smc
42	42	3-5S	Piltun	53,37136	143,24332	27	7,9	21,9	13,3	1,9	5,1	9,8	38,9	1,2	0,0	0,0	SfGr
43	43	4-1M	Piltun	52,82365	143,43540	25	0,0	0,0	0,4	2,9	6,0	38,3	**50,9**	1,5	0,0	0,0	Sf
44	44	4-1N	Piltun	52,85108	143,42516	22	0,0	0,0	0,6	7,6	2,3	3,2	**75,3**	11,0	0,0	0,0	Sf
45	45	4-1NR	Piltun	52,84289	143,43539	22	0,6	0,0	0,2	1,0	0,6	10,0	**77,7**	1,3	2,1	6,6	Sf

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
46	46	4-1S	Piltun	52,76793	143,41999	16	0,0	0,0	1,1	1,4	5,3	43,7	43,0	5,5	0,0	0,0	Smc
47	47	4-2M	Piltun	52,96970	143,39291	25	0,0	0,7	6,8	10,2	12,4	14,5	**53,4**	2,0	0,0	0,0	Sf
48	48	4-2N	Piltun	53,00852	143,40845	24	0,0	0,0	0,0	2,9	7,3	23,7	**64,0**	2,1	0,0	0,0	Sf
49	49	4-2S	Piltun	52,87500	143,41400	26	15,3	12,2	10,4	1,1	6,2	8,6	40,7	9,7	0,0	0,0	SfGr
50	50	4-3M	Piltun	53,11530	143,37550	33	0,0	9,2	10,3	7,7	2,7	20,4	48,0	1,7	0,0	0,0	Smc
51	51	4-3N	Piltun	53,20516	143,35740	30	0,0	3,6	7,9	13,6	7,4	25,3	37,8	4,4	0,0	0,0	Smc
52	52	4-3S	Piltun	53,05576	143,38571	28	0,0	0,0	1,1	3,5	11,5	43,8	39,7	0,4	0,0	0,0	Smc
53	53	4-4M	Piltun	53,28683	143,33657	23	2,3	6,3	14,2	15,4	6,5	26,9	27,2	1,2	0,0	0,0	Smc
54	54	4-4N	Piltun	53,33846	143,29265	33	0,0	1,8	10,9	15,4	5,1	20,8	36,4	9,6	0,0	0,0	Smc
55	55	4-4S	Piltun	53,22168	143,33653	30	0,0	0,0	2,6	4,3	10,8	26,4	**54,6**	1,3	0,0	0,0	Sf
56	56	4-5M	Piltun	53,42396	143,24173	35	0,0	0,9	6,8	15,8	20,3	30,4	24,4	1,4	0,0	0,0	Smc
57	57	4-5N	Piltun	53,50424	143,20892	37	0,0	0,0	1,2	7,2	7,3	15,0	**65,6**	3,7	0,0	0,0	Sf
58	58	4-5S	Piltun	53,38645	143,28769	35	0,0	2,1	12,2	22,9	14,3	15,1	29,2	4,2	0,0	0,0	SfGr
59	59	Z-01	Piltun	52,55130	143,43503	19	0,0	0,0	0,0	0,0	3,3	**53,3**	34,4	7,3	1,0	0,7	Sm
60	60	Z-02	Piltun	52,61818	143,44069	22	0,0	0,0	27,3	30,7	3,8	7,7	14,3	7,4	5,3	3,5	Gr
61	61	Z-03	Piltun	52,68343	143,41682	25	0,0	0,0	1,1	0,2	0,2	25,9	**71,5**	0,6	0,0	0,5	Sf
62	62	Z-04	Piltun	52,74261	143,42343	25	0,0	0,0	2,6	4,0	21,5	43,1	24,4	3,7	0,7	0,0	Smc
63	63	Z-05	Piltun	52,81712	143,40781	22	0,0	0,0	0,0	0,3	3,4	34,3	47,0	8,9	0,2	5,9	Smc
64	64	Z-06	Piltun	52,87421	143,39152	23	0,8	0,2	0,7	0,9	11,4	37,6	31,2	9,6	7,0	0,6	Smc
65	65	Z-07	Piltun	52,93969	143,35709	22	0,0	0,0	0,0	0,0	2,0	44,6	**51,3**	1,2	0,9	0,0	Sf
66	66	Z-08	Piltun	53,00703	143,35511	22	0,0	0,0	0,0	0,5	4,4	**86,6**	6,6	1,9	0,0	0,0	Sm
67	67	Z-09	Piltun	53,06973	143,35000	28	0,0	0,0	0,0	0,2	0,1	1,6	**93,4**	2,9	1,2	0,6	Sf
68	68	Z-10	Piltun	53,13423	143,32053	22	0,0	0,0	0,0	0,1	2,4	7,6	**89,1**	0,3	0,5	0,0	Sf

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
69	69	Z-11	Piltun	53,20063	143,30092	20	0,0	0,0	0,0	0,0	2,3	**67,0**	28,3	1,9	0,2	0,3	Sm
70	70	Z-12	Piltun	53,26690	143,27355	21	0,0	0,0	9,1	5,6	1,7	23,8	**58,5**	0,7	0,6	0,0	Sf
71	71	Z-13	Piltun	53,32644	143,25284	23	0,0	0,0	0,0	0,0	32,6	**50,1**	11,9	4,6	0,8	0,0	Sm
72	72	Z-14	Piltun	53,39046	143,22769	30	0,0	0,0	0,0	0,2	13,5	18,9	**65,3**	1,2	0,9	0,0	Sf
73	73	Pil-01	Piltun	53,37955	143,17338	3	0,0	0,5	0,5	3,2	9,6	0,3	**85,1**	0,0	0,0	0,8	Sf
74	74	Pil-02	Piltun	53,37985	143,17515	5	0,0	0,0	0,0	0,0	0,2	1,4	**97,9**	0,5	0,0	0,0	Sf
75	75	Pil-03	Piltun	53,38137	143,18347	7	0,0	0,0	0,0	0,0	2,7	43,0	46,1	4,6	3,6	0,0	Smc
76	76	Pil-04	Piltun	53,38050	143,19192	10	1,4	0,0	0,7	1,8	5,5	**55,9**	29,3	4,8	0,1	0,5	Sm
77	77	Pil-05	Piltun	53,37963	143,20037	12	0,0	0,0	0,0	0,8	1,7	25,7	**71,7**	0,1	0,0	0,0	Sf
78	78	Pil-06	Piltun	53,15218	143,27087	3	1,8	0,5	5,5	9,1	**52,4**	4,2	10,9	0,9	0,6	14,1	Sc
79	79	Pil-07	Piltun	53,15393	143,27160	5	0,0	0,0	0,0	0,2	6,1	**75,8**	16,7	0,8	0,4	0,0	Sm
80	80	Pil-08	Piltun	53,15588	143,27373	7	0,0	0,0	0,0	0,2	0,3	1,9	**96,9**	0,7	0,0	0,0	Sf
81	81	Pil-09	Piltun	53,15717	143,28227	10	0,4	0,0	0,7	0,7	0,2	39,3	**54,5**	3,9	0,3	0,0	Sf
82	82	Pil-10	Piltun	53,15845	143,29080	12	0,0	0,0	0,0	0,0	4,5	42,6	45,6	2,8	3,4	1,1	Smc
83	83	Pil-11	Piltun	52,86215	143,33075	3	0,0	0,0	0,0	0,5	2,0	29,6	**61,3**	4,1	0,0	2,5	Sf
84	84	Pil-12	Piltun	52,86225	143,33315	5	0,0	1,1	11,0	25,5	13,3	19,0	15,4	12,4	2,3	0,0	ScmGr
85	85	Pil-13	Piltun	52,86152	143,33487	7	0,8	0,0	0,8	2,4	0,4	14,0	**66,8**	1,7	1,8	11,3	Sf
86	86	Pil-14	Piltun	52,86155	143,33848	10	0,0	0,0	0,0	0,0	0,3	2,6	**89,0**	5,4	2,1	0,6	Sf
87	87	Pil-15	Piltun	52,86090	143,34215	12	0,0	0,0	0,0	0,3	2,0	24,7	**66,7**	4,3	1,2	0,8	Sf
88	1	B10-1	Offshore	51,90483	143,75867	60	0,0	0,0	0,0	0,6	1,4	15,6	**80,4**	1,0	1,0	0,0	Sf
89	2	B10-2	Offshore	52,02990	143,75702	54	2,6	0,0	0,0	0,4	0,3	32,0	**63,0**	0,1	0,8	0,8	Sf
90	3	B10-3	Offshore	52,23667	143,74167	48	0,0	1,6	0,8	0,2	0,0	13,5	**83,5**	0,4	0,0	0,0	Sf
91	4	B10-4	Offshore	52,34400	143,75567	49	0,0	0,0	0,1	0,2	1,0	15,3	**82,8**	0,6	0,0	0,0	Sf

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
92	5	B1-1	Offshore	51,90929	143,37453	42	1,7	0,0	0,0	5,3	5,5	**54,1**	31,8	0,6	0,7	0,3	Sm
93	6	B11-1	Offshore	51,99207	143,81603	59	0,0	0,0	0,0	0,0	0,0	9,4	**56,9**	13,6	7,1	13,0	Sf
94	7	B11-2	Offshore	52,14167	143,81000	55	0,0	0,0	0,0	0,0	0,0	3,3	**66,5**	4,2	11,9	14,1	Sf
95	8	B11-3	Offshore	52,19167	143,83333	57	0,0	0,0	0,0	0,0	1,2	19,3	**57,3**	2,8	8,3	11,1	Sf
96	9	B11-4	Offshore	52,32333	143,80000	54	6,3	8,4	23,1	21,4	18,2	16,4	4,1	0,5	0,9	0,7	GrSc
97	10	B1-2	Offshore	52,13883	143,37486	27	0,0	1,9	2,5	4,8	2,5	17,2	**69,8**	0,3	1,0	0,0	Sf
98	11	B12-1	Offshore	51,99188	143,87067	59	0,0	0,0	0,0	0,1	0,0	0,6	**70,6**	10,2	4,2	14,3	Sf
99	12	B12-2	Offshore	52,04922	143,86710	49	0,0	0,0	0,0	0,0	1,8	27,0	**65,8**	3,9	0,8	0,7	Sf
100	13	B12-3	Offshore	52,20667	143,88167	62	0,0	0,0	0,0	0,0	2,0	28,4	49,0	5,5	6,8	8,3	Smc
101	14	B12-4	Offshore	52,40283	143,85667	57	0,2	0,0	0,3	3,5	9,0	24,3	**52,9**	5,4	1,9	2,5	Sf
102	15	B1-3	Offshore	52,28343	143,37277	20	0,0	0,0	0,0	0,3	11,5	22,0	**63,3**	2,6	0,3	0,0	Sf
103	16	B1-4	Offshore	52,37134	143,38544	19	0,3	0,0	2,4	5,6	13,2	24,4	**50,0**	2,1	0,9	1,1	Sf
104	17	B2-1	Offshore	51,99204	143,43393	30	0,5	0,0	0,3	0,1	5,2	14,5	**75,9**	1,3	2,2	0,0	Sf
105	18	B2-2	Offshore	52,05088	143,43714	32	0,0	0,0	2,5	13,3	9,7	22,3	36,5	12,4	2,3	1,0	Smc
106	19	B2-3	Offshore	52,23843	143,42561	25	1,1	0,5	0,1	1,5	10,6	16,4	**65,5**	3,9	0,3	0,1	Sf
107	20	B2-4	Offshore	52,29043	143,44043	25	0,5	0,0	0,0	0,3	2,0	33,4	**53,0**	7,9	1,1	1,8	Sf
108	21	B3-1	Offshore	51,95654	143,45302	32	0,6	0,0	0,3	4,4	13,1	21,0	45,2	12,0	2,4	1,0	Smc
109	22	B3-2	Offshore	52,03439	143,48683	35	0,0	0,0	0,0	1,1	2,6	39,4	40,6	11,2	3,1	2,0	Sfc
110	23	B3-3	Offshore	52,15741	143,47234	33	0,0	0,0	0,0	0,1	10,3	17,7	**60,3**	7,3	1,4	2,9	Sf
111	24	B3-4	Offshore	52,38521	143,46855	30	1,2	0,5	5,5	9,1	9,6	25,1	32,1	2,2	3,3	11,4	Smc
112	25	B4-1	Offshore	51,88916	143,53364	35	2,3	6,3	14,2	15,7	8,1	10,0	42,6	0,3	0,0	0,5	SfGr
113	26	B4-2	Offshore	52,14094	143,51761	36	0,0	0,0	0,3	0,2	0,4	3,3	**85,0**	5,4	2,9	2,5	Sf
114	27	B4-3	Offshore	52,20387	143,48977	32	0,0	0,0	1,8	3,1	2,8	24,6	**60,7**	3,7	1,8	1,5	Sf

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
115	28	B4-4	Offshore	52,35516	143,53547	30	0,0	0,0	0,0	0,2	1,6	24,3	**73,0**	0,9	0,0	0,0	Sf
116	29	B5-1	Offshore	51,96317	143,56883	44	0,3	0,0	2,4	5,6	13,2	24,4	**50,2**	2,1	0,9	1,1	Sf
117	30	B5-2	Offshore	52,04833	143,56667	45	0,9	0,0	1,8	3,5	2,3	12,2	**69,3**	4,8	1,3	3,9	Sf
118	31	B5-3	Offshore	52,20500	143,57667	37	0,0	0,1	2,4	12,5	15,2	28,1	36,0	5,3	0,4	0,0	Smc
119	32	B5-4	Offshore	52,33537	143,56677	30	0,0	0,0	0,0	0,0	0,3	24,4	**66,1**	7,3	1,0	0,9	Sf
120	33	B6-1	Offshore	51,94583	143,66236	45	0,3	0,0	4,7	3,0	3,0	16,5	**69,9**	1,9	0,5	0,2	Sf
121	34	B6-2	Offshore	52,04333	143,60333	45	0,2	0,0	0,2	0,6	0,5	12,2	**82,2**	2,7	0,5	0,9	Sf
122	35	B6-3	Offshore	52,27357	143,57338	35	0,3	0,0	0,1	0,2	1,1	20,9	**66,8**	4,1	2,2	4,3	Sf
123	36	B6-4	Offshore	52,35562	143,58208	33	1,6	0,0	0,0	0,5	0,6	8,3	**83,9**	3,2	1,3	0,6	Sf
124	37	B7-1	Offshore	51,91727	143,62542	48	0,0	0,0	0,0	0,1	0,2	17,0	**77,3**	3,2	0,7	1,5	Sf
125	38	B7-2	Offshore	52,05107	143,65782	61	0,0	0,0	0,1	0,3	0,6	13,4	**76,4**	4,3	1,2	3,7	Sf
126	39	B7-3	Offshore	52,23167	143,62333	40	0,0	0,0	0,0	0,0	0,6	22,1	**73,2**	2,5	0,9	0,7	Sf
127	40	B7-4	Offshore	52,39600	143,65683	40	0,0	0,0	0,1	0,5	1,8	25,1	**70,0**	1,7	0,4	0,4	Sf
128	41	B8-1	Offshore	51,90322	143,67385	57	0,3	0,0	0,6	4,5	5,3	32,8	**55,5**	0,6	0,4	0,0	Sf
129	42	B8-2	Offshore	52,04183	143,69787	46	0,0	0,0	0,3	0,2	0,7	13,6	**82,0**	2,8	0,4	0,0	Sf
130	43	B8-3	Offshore	52,22257	143,66952	42	0,0	0,0	0,0	0,3	1,1	8,4	**88,1**	1,9	0,2	0,0	Sf
131	44	B8-4	Offshore	52,37033	143,68632	43	2,4	5,4	5,8	10,4	14,0	37,5	17,3	2,1	2,7	2,4	Smcf
132	45	B9-1	Offshore	51,94935	143,72643	55	0,0	0,0	0,1	0,2	0,3	3,1	**79,6**	6,1	3,5	7,1	Sf
133	46	B9-2	Offshore	52,08863	143,74492	52	0,2	0,0	0,3	1,8	5,5	24,3	**63,5**	2,6	1,3	0,5	Sf
134	47	B9-3	Offshore	52,17253	143,71030	49	0,0	0,0	0,0	0,3	0,8	3,4	**92,1**	2,5	0,9	0,0	Sf
135	48	B9-4	Offshore	52,31565	143,74612	48	2,6	7,3	4,5	1,5	1,3	9,6	**68,0**	2,1	1,6	1,5	Sf
136	1	FP-01	Piltun	52,83659	143,36797	16	0,0	0,0	0,0	0,9	1,6	26,8	**69,5**	0,7	0,5	0,0	Sf
137	2	FP-03	Piltun	52,80220	143,35818	11	0,0	0,0	0,0	0,2	1,0	15,3	**76,9**	3,9	0,3	2,4	Sf

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
138	3	FP-04	Piltun	53,28704	143,23721	11	0,0	0,0	0,0	0,0	25,9	**53,9**	10,1	5,9	4,2	0,0	Sm
139	4	FP-06	Piltun	52,85160	143,35985	20	0,7	0,0	0,3	3,3	2,3	**54,5**	28,3	9,8	0,3	0,4	Sm
140	5	FP-07	Piltun	53,34500	143,22467	24	0,0	0,0	0,0	0,0	3,6	37,7	45,3	0,4	0,0	13,0	Smc
141	6	FP-08	Piltun	53,20946	143,25965	14	0,0	0,0	0,9	0,1	0,6	4,8	**85,8**	6,6	1,2	0,0	Sf
142	7	FP-09	Piltun	53,22360	143,25903	12	0,0	0,0	0,0	0,1	1,3	21,7	**76,3**	0,4	0,2	0,0	Sf
143	8	FP-10	Piltun	53,25163	143,25476	11	0,0	0,0	0,0	0,7	0,6	25,2	**56,9**	4,0	12,6	0,0	Sf
144	9	FP-11	Piltun	53,28704	143,23721	11	0,0	0,0	1,7	11,6	6,8	35,5	32,6	2,8	8,3	0,7	Smc
145	10	FP-12	Piltun	53,28899	143,28553	26	0,0	0,0	0,0	0,0	1,3	4,0	**83,8**	5,8	1,2	3,9	Sf
146	11	FP-12R	Piltun	53,28918	143,28622	24	0,0	0,0	0,0	0,0	3,2	44,2	47,9	4,1	0,0	0,6	Smc
147	12	FP-13	Piltun	53,30213	143,28543	26	0,0	0,1	0,6	28,7	17,1	40,7	12,7	0,1	0,0	0,0	SmGr
148	13	FP-13R	Piltun	53,30052	143,28856	26	0,0	0,0	0,0	0,0	4,2	20,2	**71,4**	2,0	0,2	2,0	Sf
149	14	FP-14	Piltun	53,26827	143,30229	24	0,0	0,0	0,0	0,0	0,9	6,8	**84,6**	0,4	3,3	4,0	Sf
150	15	FP-14R	Piltun	53,26847	143,30240	24	0,0	0,1	0,4	5,8	19,0	49,8	19,9	3,6	1,5	0,0	Scmf
151	16	FP-15	Piltun	53,22457	143,28636	22	0,0	0,0	0,0	0,4	24,1	**67,2**	7,3	0,0	0,0	1,0	Sm
152	17	FP-16	Piltun	53,25483	143,27525	20	0,0	0,0	0,0	0,0	7,0	**66,2**	24,2	2,4	0,2	0,0	Sm
153	18	FP-17	Piltun	53,30379	143,30923	28	0,0	0,0	0,0	0,0	1,2	7,2	**84,4**	0,6	6,6	0,0	Sf
154	19	FP-18	Piltun	53,30384	143,30638	30	0,0	0,0	0,0	0,3	1,2	5,2	**91,2**	0,1	0,0	2,0	Sf
155	20	FP-19	Piltun	53,29284	143,31798	28	0,0	0,0	0,0	0,0	0,6	1,4	**82,3**	13,8	1,9	0,0	Sf
156	21	FP-20	Offshore	52,00096	143,52076	38	4,9	14,3	10,0	6,6	8,8	17,1	28,6	7,3	2,1	0,4	Smc
157	22	FP-21	Piltun	52,68918	143,33974	9	0,0	0,0	0,0	0,4	2,0	25,6	**66,7**	5,3	0,0	0,0	Sf
158	23	FP-22	Piltun	52,83583	143,35800	17	0,0	0,0	0,0	0,2	2,2	28,2	**69,1**	0,0	0,3	0,0	Sf
159	24	FP2-2	Piltun	52,78862	143,37196	15	0,0	0,0	0,0	0,3	22,8	3,7	**69,7**	0,2	2,2	1,1	Sf
160	25	FP-23	Piltun	53,35000	143,28334	33	0,0	0,0	0,0	0,0	1,0	41,5	49,5	4,8	2,0	1,2	Smc

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
161	26	FP-24	Piltun	53,38873	143,18403	12	0,0	0,0	0,0	0,0	26,4	**64,6**	7,4	1,6	0,0	0,0	Sm
162	27	FP2-4	Piltun	52,83865	143,35786	17	0,0	0,0	0,0	0,0	34,9	**50,8**	4,3	8,9	1,1	0,0	Sm
163	28	FP-25	Piltun	53,35590	143,18883	12	0,1	9,2	10,3	8,5	1,2	15,1	**52,7**	2,6	0,3	0,0	Sf
164	29	FP2-5	Piltun	52,85108	143,35527	15	0,0	0,0	0,0	0,0	4,6	33,8	**57,0**	2,2	1,1	1,3	Sf
165	30	FP-26	Piltun	52,98593	143,35190	25	0,0	0,0	2,5	12,4	0,0	0,1	**83,2**	1,8	0,0	0,0	Sf
166	31	FP-27	Piltun	52,98803	143,35280	29	0,0	0,0	0,0	0,2	1,8	27,8	**69,2**	0,4	0,6	0,0	Sf
167	32	FP2-7	Piltun	52,91782	143,34156	15	0,0	0,0	0,0	0,8	0,6	10,1	**85,6**	1,4	0,5	1,0	Sf
168	33	FP-28	Piltun	53,50812	143,16671	29	0,0	0,0	0,0	0,5	34,1	**55,9**	6,3	2,1	0,1	1,0	Sm
169	34	FP-29	Piltun	53,34233	143,26745	27	0,0	0,0	0,0	0,7	2,8	0,2	**90,9**	2,5	2,9	0,0	Sf
170	35	FP-30	Offshore	51,98642	143,53342	39	0,5	0,0	0,1	1,4	13,2	24,4	32,4	27,2	0,8	0,0	SfmAl
171	36	FP-31	Offshore	52,00150	143,55217	41	0,0	0,3	13,0	26,6	19,1	15,0	12,5	9,8	3,8	0,0	ScmGr
172	37	FP-32	Piltun	52,69271	143,35167	12	0,0	0,0	0,0	0,0	16,2	**62,1**	7,4	8,4	2,4	3,5	Sm
173	38	FP-33	Piltun	53,13872	143,33404	23	0,0	0,0	0,0	0,0	1,0	7,5	**91,4**	0,1	0,0	0,0	Sf
174	39	FP-34	Piltun	53,20051	143,27190	11	0,0	0,0	0,0	0,0	3,6	42,2	47,1	1,7	1,0	4,4	Smc
175	40	FP-35	Piltun	53,20320	143,28403	15	0,6	0,0	0,1	1,0	0,8	27,2	**68,6**	1,7	0,1	0,0	Sf
176	41	FP-36	Piltun	52,68718	143,33815	18	0,0	0,0	0,0	0,7	26,4	**54,0**	17,3	1,6	0,0	0,0	Sm
177	42	FP-37	Piltun	52,68763	143,33594	19	0,0	0,0	0,0	1,5	11,4	**52,7**	31,2	1,9	0,7	0,6	Sm
178	43	FP-38	Piltun	53,29024	143,28710	25	0,0	0,0	0,0	0,1	28,4	**58,9**	4,1	1,2	0,0	7,3	Sm
179	44	FP-39	Piltun	52,92030	143,34017	12	0,0	0,0	0,0	0,0	42,8	35,7	5,7	5,6	7,3	2,9	Scm
180	45	FP-40	Piltun	53,02167	143,32367	18	0,0	0,0	0,0	0,0	1,1	9,7	**60,8**	7,9	1,1	19,4	Sf
181	46	FP-41	Piltun	53,06882	143,31896	19	0,0	0,0	0,0	0,0	3,1	**82,0**	10,2	2,7	1,3	0,7	Sm
182	47	FP-42	Piltun	52,93851	143,33791	13	0,0	0,0	0,9	0,1	0,8	3,4	**79,8**	4,3	2,4	8,3	Sf
183	48	FP-43	Piltun	52,28782	143,70545	45	0,0	0,0	0,0	1,4	1,6	25,7	**70,7**	0,5	0,1	0,0	Sf

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
184	49	FP-44	Piltun	52,94275	143,33533	12	0,4	0,0	0,5	3,9	0,0	0,3	**92,5**	1,9	0,5	0,0	Sf
185	50	FP-45	Piltun	53,00190	143,35100	19	0,0	0,0	0,3	5,1	32,3	40,2	18,8	1,9	1,4	0,0	Smc
186	51	FP-46	Piltun	53,06105	143,36667	45	0,8	0,0	1,8	3,5	0,0	18,2	**59,2**	9,6	7,0	0,0	Sf
187	52	FP-47	Piltun	53,02167	143,32367	18	0,0	0,0	1,0	5,4	10,5	**52,8**	21,9	7,9	0,5	0,0	Sm
188	53	FP-48	Piltun	53,06882	143,31896	19	0,0	0,0	0,0	0,5	2,7	9,0	**80,6**	7,0	0,2	0,0	Sf
189	54	FP-49	Piltun	53,05828	143,28872	18	3,7	1,6	6,0	7,6	0,5	1,7	**74,5**	3,4	0,9	0,0	Sf
190	55	FP-50	Piltun	53,06217	143,26487	19	0,0	0,0	0,6	4,9	7,4	7,5	**77,6**	0,5	0,9	0,6	Sf
191	56	FP-51	Offshore	52,29219	143,69263	43	1,9	0,0	3,6	6,8	16,4	35,2	27,6	6,3	2,2	0,0	Smc
192	57	FP-52	Offshore	52,28782	143,70545	45	0,0	0,0	0,0	0,1	3,3	33,0	**59,0**	3,2	0,7	0,7	Sf
193	58	FP-53	Piltun	52,28345	143,71827	18	0,0	0,0	0,0	0,0	0,4	9,3	**88,8**	0,3	0,5	0,7	Sf
194	59	FP-54	Piltun	53,19839	143,26676	19	0,0	0,0	0,0	0,0	4,3	33,9	47,4	4,9	0,4	9,1	Smc
195	60	FP-58	Piltun	53,30196	143,24320	19	0,0	0,0	0,0	0,0	1,3	5,7	**81,1**	0,7	0,0	11,2	Sf
196	61	FP-59	Piltun	53,30878	143,32375	12	0,0	0,0	0,0	0,3	0,2	1,4	**95,8**	2,3	0,0	0,0	Sf
197	62	FP-60	Piltun	53,28960	143,25025	16	0,0	0,0	0,0	0,0	20,9	**69,6**	5,9	0,3	1,3	2,0	Sm
198	63	FP-61D	Piltun	52,84148	143,34151	8	0,0	0,1	0,9	10,8	1,9	29,1	**52,6**	1,8	0,9	1,8	Sf
199	64	FP-62D	Piltun	52,85185	143,33831	7	0,0	0,0	0,0	0,0	3,4	36,4	**51,3**	7,2	1,7	0,0	Sf
200	65	FP-63D	Piltun	52,85196	143,33786	7	0,5	0,1	0,8	0,8	5,5	24,3	**64,6**	2,5	0,8	0,0	Sf
201	66	FP-64D	Piltun	52,85230	143,33745	6	0,0	0,0	0,0	0,6	0,0	1,1	**91,9**	5,0	1,4	0,0	Sf
202	67	FP-65D	Piltun	52,85283	143,33692	6	0,0	0,0	0,0	0,3	2,0	22,6	**60,7**	0,3	0,0	14,1	Sf
203	68	FP-66D	Piltun	52,85468	143,33510	6	0,0	0,0	0,0	0,1	4,4	**77,0**	16,7	1,0	0,8	0,0	Sm
204	69	FP-67D	Piltun	53,15740	143,28474	10	0,0	0,0	0,0	0,0	0,4	2,7	**90,2**	6,4	0,3	0,0	Sf
205	70	FP-68D	Piltun	53,15638	143,27055	5	0,0	0,0	0,0	0,3	17,6	32,1	42,8	2,2	3,3	1,7	Smc
206	71	FP-69	Offshore	52,22332	143,68381	43	0,0	0,0	0,0	0,1	3,1	49,2	42,6	2,3	1,0	1,7	Smc

Item	Number	Station	Area	Coordinates (decimal form)		Depth, m	Bottom Type										Bottom Code
							Peb	Grc	Grm	Grf	Sc	Sm	Sf	Ac	Af	Pec	
							Size of Prevalent Fraction, mm										
				longitude	latitude		> 10	10-5	5-2	2-1	1-0,5	0,5-0,25	0,25-0,1	0,1-0,05	0,05-0,01	< 0,01	
207	72	FP-70	Offshore	52,22506	143,68605	43	16,8	7,5	3,5	1,6	7,4	31,5	29,8	0,5	0,9	0,5	Smc
208	73	FP-71	Offshore	52,22406	143,68898	43	0,0	0,0	0,0	0,0	8,1	39,8	40,1	7,4	3,4	1,2	Smc
209	74	FP-72	Piltun	52,36683	143,23606	25	0,0	0,0	0,0	1,0	0,1	1,2	**82,6**	9,2	5,9	0,0	Sf
210	75	FP-73	Piltun	52,93363	143,40661	26	0,0	0,0	0,0	0,0	4,7	37,6	49,7	0,5	0,9	6,6	Smc
211	76	FP-74	Piltun	52,35820	143,71273	16	0,0	0,3	1,6	9,8	0,1	2,7	**82,9**	2,4	0,2	0,0	Sf
212	77	FP-75	Piltun	53,28328	143,25035	23	0,0	0,0	0,0	0,0	1,6	25,7	**72,0**	0,3	0,4	0,0	Sf
213	78	FP-76	Piltun	53,16048	143,29392	15	0,5	0,7	6,8	10,8	1,8	27,8	**51,0**	0,2	0,4	0,0	Sf
214	79	FP-77	Piltun	53,18775	143,27536	21	0,0	0,0	0,0	0,5	5,8	**55,5**	26,0	4,7	7,5	0,0	Sm
215	80	FP-78	Piltun	53,27358	143,29183	16	0,0	0,0	0,0	0,5	14,2	42,6	39,8	0,4	1,4	1,1	Smc
216	81	FP-79	Piltun	53,30145	143,23993	15	4,6	0,0	0,0	1,2	1,8	30,3	**60,6**	0,5	0,4	0,6	Sf
217	82	FP-80	Piltun	53,33117	143,24300	20	0,0	0,0	0,0	0,0	0,0	0,2	**99,3**	0,3	0,0	0,2	Sf
218	83	FP-81	Piltun	52,29407	143,82708	20	0,0	0,0	0,0	0,0	8,1	44,8	42,7	2,0	0,8	1,6	Smc
219	84	FP-05N	North	54,35712	142,58738	29	0,0	0,0	0,0	0,0	26,6	45,7	5,5	0,1	0,0	22,1	Smc
220	85	FP-07N	North	54,36766	142,55761	34	0,0	0,0	0,0	0,0	29,3	**53,7**	5,6	0,0	0,0	11,4	Sm
221	86	FP-08N	North	54,35239	142,58847	27	0,0	0,0	0,0	0,0	2,8	37,0	**59,5**	0,2	0,0	0,5	Sf
222	87	FP-11N	North	54,35629	142,56792	30	0,0	0,0	0,0	0,9	19,8	34,8	15,2	24,6	4,7	0,0	Smcf
223	88	FP-14N	North	54,35815	142,56904	30	0,0	0,0	0,0	0,0	3,4	41,7	31,3	0,1	0,7	22,8	Smc
224	89	FP-16N	North	54,36946	142,54233	37	0,0	0,0	0,0	0,0	22,3	32,8	10,4	13,5	9,8	11,2	Smc
225	90	FP-20N	North	54,37465	142,60774	31	0,0	0,0	0,0	0,0	2,5	39,1	19,7	13,6	7,1	18,0	Smc

APPENDIX 4. Concentrations of Petroleum Hydrocarbons (mcg/g dry sediment) and 10 Toxic Metals (mcg/g dry sediment) in Bottom Sediments of the Piltun and Offshore areas based on 2005 Field Study Results.

Station	Depth	Concentrations of Substances in Bottom Sediments, mcg/g dry sediment										
		PH	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Pb	Zn
1-1S	13	2,46	1444	1,66	10,23	0,160	3,35	3,20	6496	0,0110	0,00	8,60
1-2N	16	2,38	2408	0,95	16,77	0,040	20,75	3,00	4515	0,0002	0,00	7,00
2-1M	16	2,44	1887	1,39	2,14	0,001	7,40	0,96	6128	0,0002	0,00	6,40
2-1N	16	2,3	1783	0,88	2,18	0,022	33,20	1,64	5388	0,0038	0,00	5,60
2-1NR	16	1,44	1129	1,53	3,25	0,090	12,92	0,79	6345	0,0002	0,00	6,40
2-2M	23	4,04	2216	1,75	4,00	0,001	6,63	1,90	7280	0,0002	0,00	7,00
2-2N	15	1,59	923	0,91	2,33	0,001	8,17	1,62	1988	0,0190	0,00	3,60
2-2S	21	1,85	1671	0,69	4,42	0,001	6,63	1,30	4396	0,0002	0,00	8,60
2-3M	16	1,95	1235	1,66	5,83	0,001	8,94	5,00	6131	0,0020	0,01	12,60
2-3N	15	1,82	1654	1,15	2,33	0,078	1,61	1,50	6536	0,0003	0,01	7,40
2-3S	15	2,01	927	2,21	1,90	0,096	12,24	0,85	4838	0,0026	0,01	4,20
2-4M	15	1,48	634	0,00	2,48	0,096	1,61	3,20	7271	0,0002	0,01	7,80
2-4S	20	1,32	317	2,07	2,71	0,048	13,75	2,20	5357	0,0002	0,03	3,60
2-5N	17	2,17	1373	0,69	5,83	0,037	12,65	1,64	5957	0,0002	0,03	12,80
2-5S	22	2,23	1754	0,96	2,79	0,001	5,69	1,98	6160	0,0034	0,03	12,60
3-1M	18	2,59	1693	1,35	3,13	0,036	7,98	1,30	4929	0,0008	0,03	7,80
3-1N	24	2,41	1815	1,35	20,42	0,006	13,90	0,98	2175	0,0002	0,12	10,60
3-2M	27	2,68	750	0,50	2,14	0,077	8,50	2,20	3489	0,0002	0,12	7,12
3-2N	27	2,22	2154	1,05	4,51	0,001	3,35	0,86	3088	0,0008	0,24	8,60
3-3M	28	1,87	1654	0,69	3,61	0,130	7,47	3,60	1390	0,0020	0,26	0,88
3-3S	25	1,96	2050	1,15	1,78	0,080	13,28	3,00	6338	0,0026	0,30	5,60
3-4M	23	1,21	2345	1,35	4,89	0,001	10,99	1,64	4505	0,0002	0,30	7,40
3-4S	26	2,36	2227	0,83	2,75	0,096	7,40	6,60	5695	0,0013	0,48	8,60
3-5S	25	2,29	2013	1,39	2,71	0,045	9,13	2,20	4929	0,0002	0,48	7,00
4-1M	25	1,71	1810	1,46	1,85	0,081	8,94	2,20	6339	0,0002	0,48	7,80
4-1N	22	2,15	1543	1,15	4,65	0,001	26,97	2,60	4120	0,0110	0,48	4,20
4-1S	16	1,19	2125	1,66	2,18	0,078	10,99	2,60	6220	0,0035	0,68	13,40
4-2M	27	1,29	1240	0,69	4,42	0,025	15,10	2,60	5957	0,0030	0,68	5,60
4-2S	22	1,93	750	0,69	3,66	0,080	12,24	2,20	6805	0,0002	0,84	8,60
4-3M	28	0,86	2216	1,37	3,58	0,088	9,71	1,30	5150	0,0020	0,84	7,80
4-3N	28	2,09	1228	1,78	4,37	0,006	7,47	2,51	5687	0,0002	1,01	5,60
4-4N	28	1,43	2013	0,85	4,51	0,008	9,13	0,96	5061	0,0002	1,02	13,40
4-4S	29	1,67	2216	2,21	2,90	0,025	6,05	1,45	4837	0,0020	1,02	5,60
4-5M	33	1,32	1705	1,55	5,12	0,016	8,71	2,20	3212	0,0015	1,06	5,21
Pil-01	3	1,67	1027	0,91	0,96	0,170	13,75	2,60	5597	0,0002	1,06	7,00
Pil-02	5	1,72	1205	0,91	3,45	0,270	8,50	6,60	6345	0,0002	1,10	7,80
Pil-04	10	2,02	365	1,39	1,90	0,001	13,90	2,44	6132	0,0002	1,10	5,00
Pil-06	3	1,51	1230	0,66	3,01	0,001	31,12	1,42	6809	0,0019	1,11	9,20
Pil-07	5	1,75	671	1,75	5,92	0,001	10,48	3,00	4323	0,0002	1,12	5,46
Pil-09	10	1,92	2477	0,89	2,48	0,032	4,50	1,50	7580	0,0002	1,12	4,80
Pil-11	3	1,21	1655	0,92	3,61	0,036	9,54	1,42	6139	0,0016	1,14	7,79
Pil-12	5	2,05	1455	0,80	5,37	0,040	4,70	2,40	3212	0,0002	1,14	6,60
Pil-14	10	2,22	1260	1,22	2,79	0,074	20,75	0,86	6160	0,0002	1,14	7,00
B10-2	56	1,63	1350	1,39	4,00	0,001	32,42	2,51	6139	0,0002	1,14	13,40
B10-3	53	1,58	1605	0,88	4,51	0,074	8,50	4,60	5131	0,0002	1,20	8,60
B11-2	55	1,54	1115	1,37	2,57	0,080	7,40	3,00	7270	0,0125	1,20	6,40
B11-4	55	1,85	1551	0,50	3,13	0,001	8,92	2,40	6219	0,0024	1,20	7,00

Station	Depth	Concentrations of Substances in Bottom Sediments, mcg/g dry sediment										
		PH	**Al**	**As**	**Ba**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**Pb**	**Zn**
B12-1	61	2,06	1150	0,83	3,61	0,008	8,92	3,00	6339	0,0002	1,23	1,98
B12-2	62	2,15	820	0,99	3,45	0,001	13,07	2,20	5955	0,0035	1,13	3,60
B12-3	63	1,75	1320	0,50	1,95	0,001	12,24	6,60	7090	0,0002	1,32	9,50
B12-4	59	1,63	634	1,38	4,00	0,005	13,90	2,25	6145	0,0022	1,32	10,60
B5-3	37	2,34	2012	0,89	4,37	0,036	13,75	1,90	2340	0,0002	1,42	7,80
B5-4	29	2,17	1542	1,58	4,42	0,001	31,12	1,64	5687	0,0002	1,42	5,00
B6-2	47	1,94	1407	1,61	1,90	0,001	8,71	3,20	6345	0,0002	1,64	3,60
Z-01	19	2,11	1701	1,23	5,12	0,048	7,40	1,42	6139	0,0019	1,64	3,60
Z-02	22	1,77	1340	1,25	2,35	0,170	8,30	3,00	7110	0,0002	1,70	15,10
Z-03	25	1,54	2237	0,96	2,90	0,130	13,75	2,51	4836	0,0002	1,70	5,90
FP-05N	29	2,49	1380	0,49	10,23	0,130	8,50	3,40	6495	0,0230	1,70	9,00
FP-07N	34	1,81	1678	1,04	1,90	0,076	28,57	2,60	2340	0,0002	1,80	6,40
FP-08N	27	1,63	710	0,89	4,89	0,130	6,24	2,51	6645	0,0018	1,90	9,80
	Mean	**1,98**	**1496**	**1,15**	**4,12**	**0,050**	**11,70**	**2,41**	**5420**	**0,0022**	**0,75**	**7,35**
	St. Dev.	0,05	68	0,06	0,42	0,010	0,96	0,17	188	0,0006	0,08	0,39
	MIN	0,86	317	0,00	0,96	0,000	1,61	0,79	1390	0,0002	0,00	1,98
	MAX	4,04	2477	2,21	20,42	0,270	33,20	6,60	7580	0,0230	1,90	15,10

APPENDIX 5. Taxonomic List of Benthic and Nektobenthic Species Observed in the Piltun and Offshore areas in 2001-2005.

Item	Species Count	Taxon/Species Name	Code
		Actiniaria – sea anemones*	
1	1	*Epiactis lewisi*	Act
212	2	*Halcampoides purpurea*	Act
		Amphipoda - amphipod crustaceans	
2	1	*Acanthostepheia behringiensis*	Am
172	2	*Acanthostepheia malmgreni*	Am
173	3	*Ampelisca eoa*	Am
3	4	*Ampelisca eschrichti*	Am
188	5	*Ampelisca macrocephala*	Am
4	6	*Anisogamcarus pugettensis*	Am
174	7	*Anisogamcarus schmidti*	Am
189	8	*Anonyx compactus*	Am
5	9	*Anonyx kurilicus*	Am
190	10	*Anonyx lilljeborgi*	Am
6	11	*Anonyx nugax pacificus*	Am
7	12	*Anonyx ochoticus*	Am
191	13	*Anonyx pavlovskii*	Am
8	14	*Anonyx sp.*	Am
192	15	*Atylus carinatus*	Am
9	16	*Atylus collingi*	Am
175	17	*Bathymedon langsdorfi*	Am
10	18	*Bathymedon obtusifrons*	Am
193	19	*Bathymedon sp.*	Am
194	20	*Bathymedon subcarinatus*	Am
11	21	*Bathymedon tilessii*	Am
12	22	*Boeckosimus derjugini*	Am
176	23	*Boeckosimus simus*	Am
195	24	*Boeckosinus krassini*	Am
177	25	*Byblis erythrops*	Am
13	26	*Caprella cristibrachium*	Am
196	27	*Dulichia spinosissima*	Am
14	28	*Eogamcarus schmidti*	Am
15	29	*Eohaustorius eous eous*	Am
16	30	*Ericthonius tolly*	Am
197	31	*Eyakia simplex*	Am
178	32	*Harpiniopsis kobjakovae*	Am
198	33	*Harpiniopsis similis*	Am
199	34	*Harpiniopsis simplex*	Am
179	35	*Hippomedon denticulatus orientalis*	Am
200	36	*Ischyrocerus anguipes*	Am
17	37	*Ischyrocerus chamiossi*	Am
201	38	*Ischyrocerus cristatus*	Am

Item	Species Count	Taxon/Species Name	Code
18	39	*Ischyrocerus elongatus*	Am
19	40	*Ischyrocerus kraschenìnnikovi*	Am
20	41	*Ischyrocerus sp.*	Am
202	42	*Jyrrhoe crenulata*	Am
180	43	*Lembos arcticus*	Am
203	44	*Lepidepecreum kasatka*	Am
21	45	*Maera loveni*	Am
22	46	*Melita sp.*	Am
23	47	*Melitoides makarovi*	Am
24	48	*Metopa clypeata*	Am
25	49	*Metopa layi*	Am
26	50	*Metopa majuscula*	Am
27	51	*Metopa sp.*	Am
28	52	*Metopa spitzbergensis*	Am
29	53	*Monoculodes crassirostris*	Am
30	54	*Monoculodes sp.*	Am
31	55	*Monoculodes zernovi*	Am
181	56	*Onisimus krassini*	Am
32	57	*Orchomene gurjanovae*	Am
33	58	*Orchomenella japonica*	Am
204	59	*Orchomenella nana*	Am
34	60	*Orchomenella pinguis*	Am
205	61	*Paraphoxus simplex*	Am
35	62	*Parapleustes tricuspis*	Am
182	63	*Parapleustes vasinae*	Am
183	64	*Paronesimus barentsi*	Am
36	65	*Photis baekmannae*	Am
206	66	*Photis fischmanni*	Am
37	67	*Photis reinchardi*	Am
38	68	*Photis sp.*	Am
207	69	*Pleustomesus japonicoides*	Am
39	70	*Pleusymtes sp.*	Am
208	71	*Pleusymtes sp.*	Am
40	72	*Pleusymtes vasinae*	Am
209	73	*Podoceropsis nitida*	Am
41	74	*Pontharpinia longirostris*	Am
42	75	*Pontharpinia nasuta*	Am
43	76	*Pontharpinia robusta*	Am
44	77	*Pontoporeia affinis*	Am
210	78	*Protomedeia epimerata*	Am
48	79	*Protomedeia fasciata.*	Am
45	80	*Protomedeia macrocarpa*	Am
46	81	*Protomedeia microdactila*	Am
47	82	*Protomedeia popovi*	Am
211	83	*Protomedeia sp.*	Am

Item	Species Count	Taxon/Species Name	Code
49	84	*Psamconyx kudrjaschovi*	Am
50	85	*Rhachotropis oculata*	Am
51	86	*Synchelidium gurjanovae*	Am
52	87	*Wecomedon minusculus*	Am
184	88	*Wecomedon wirketis*	Am
53	89	*Weswoodilla sp.*	Am
54	90	*Weswoodilla sp.1*	Am
		Ascidiacea – ascidians	
185	1	*Ascidia vegae*	Asc
55	2	*Pelonaia corrugata*	Asc
		Bivalvia - bivalve mollusks	
56	1	*Arvella japonica*	Bi
57	2	*Arvella manshurica*	Bi
213	3	*Astarte arctica*	Bi
214	4	*Astarte sp.*	Bi
58	5	*Crenella decussata decussata*	Bi
215	6	*Diplodonta aleutica*	Bi
216	7	*Ennucula fenuis*	Bi
59	8	*Hiatella arctica*	Bi
60	9	*Liocyma fluctuosa*	Bi
61	10	*Macoma balthica*	Bi
62	11	*Macoma calcarea*	Bi
217	12	*Macoma cuneipyga*	Bi
218	13	*Macoma golikovi*	Bi
63	14	*Macoma lama*	Bi
64	15	*Macoma middendorffi*	Bi
65	16	*Macoma sp.*	Bi
66	17	*Mactromeris polynyma = Spisula voji*	Bi
67	18	*Megangulus luteus = Peronidia lutea*	Bi
68	19	*Musculus niger*	Bi
219	20	*Musculus sp.*	Bi
69	21	*Mya (Mya) priapus*	Bi
70	22	*Mya sp.*	Bi
220	23	*Mya truncata*	Bi
71	24	*Mysella planata*	Bi
72	25	*Mysella gurjanovae*	Bi
73	26	*Mysella kurilensis*	Bi
74	27	*Panomya sp. (juv.)*	Bi
75	28	*Serripes groenlandicus*	Bi
76	29	*Siliqua alta*	Bi
186	30	*Spisula sachalinensis*	Bi
221	31	*Thracia myopsis*	Bi
77	32	*Tridonta borealis*	Bi
78	33	*Tridonta montaqui*	Bi
79	34	*Tridonta rollandi*	Bi

Item	Species Count	Taxon/Species Name	Code
80	35	*Vilasina vernicosa*	Bi
81	36	*Yoldia (Cnesterium) seminuda*	Bi
82	37	*Yoldia (Yoldia) myalis*	Bi
		Cirripedia - barnacles*	
83	1	*Chthamalus dalli*	Ci
84	2	*Solidobalanus hesperius*	Ci
85	3	*Balanus cariosus*	Ci
		Cumacea - cumaceans	
86	1	*Diastylis bidentata*	Cu
87	2	*Diastylopsis dowsoni*	Cu
88	3	*Lamprops quadriplicata*	Cu
		Decapoda - decapod crustaceans	
89	1	*Hyas coarctatus (juv.)*	De
90	2	*Pagurus ochotensis*	De
91	3	*Pagurus pubescens*	De
92	4	*Crangon septemspinosa*	De
93	5	*Telmessus cheiragonus*	De
		Echinoidea - sea urchins	
94	1	*Echinarachnius parma*	Ech
		Euphausiacea - krills	
95	1	*Thysanoessa raschii*	Euph
		Gastropoda – gastropod mollusks	
222	1	*Ancistroleis beringianus*	Ga
223	2	*Buccinum lichkeanum*	Ga
96	3	*Buccinum middendorffi*	Ga
97	4	*Buccinum percrassum*	Ga
98	5	*Buccinum sakhalinense*	Ga
224	6	*Cryptonatica aleutica*	Ga
99	7	*Cryptonatica clausa*	Ga
100	8	*Cryptonatica janthostoma*	Ga
225	9	*Cylichna alba*	Ga
101	10	*Cylichna consobrina*	Ga
102	11	*Lunatia pallida*	Ga
103	12	*Neptunea bulbacea*	Ga
104	13	*Piliscus radiatus*	Ga
105	14	*Pseudolimesus nassula*	Ga
106	15	*Solariella obscura intermedia*	Ga
		Holoturioidea – sea cucumbers	
254		*Chiridota ochotensis*	Ho
		Hydroidea – hydroids*	
107	1	*Abietinaria thujarioides*	Hy
108	2	*Calicella syringa*	Hy
109	3	*Campanularia volubilis*	Hy
110	4	*Halecium reversum*	Hy

Item	Species Count	Taxon/Species Name	Code
111	5	*Lafoea fruticosa*	Hy
112	6	*Obelia longissima*	Hy
113	7	*Sertularella plumosa*	Hy
114	8	*Sertularella similis*	Hy
115	9	*Sertularella tricuspidata*	Hy
116	10	*Sertularella gigantea*	Hy
117	11	*Sertularia similis*	Hy
118	12	*Thuiaria breitfussi*	Hy
119	13	*Thuiaria cylindrica*	Hy
120	14	*Thuiaria gonorhiza*	Hy
121	15	*Thuiaria triserialis*	Hy
		Isopoda - isopod crustaceans	
122	1	*Saduria entomon*	Is
123	2	*Synidotea bicuspida*	Is
124	3	*Synidotea cinerea*	Is
		Mysidacea - mysids	
125	1	*Tenagomysis orientalis*	My
		Ophiuroidea - brittle stars	
126	1	*Ophiura sarsi*	Oph
127	2	*Stegophiura nodosa*	Oph
		Pantopoda - sea spiders	
128	1	*Nymphon striatum*	Pa
		Polychaeta - bristle worms	
129	1	*Ampharete acutifrons*	Po
226	2	*Ampharete crassiseta*	Po
227	3	*Ampharete finmarchica*	Po
130	4	*Ampharete goesi*	Po
228	5	*Ampharete lindstromi*	Po
131	6	*Arabella iricolor*	Po
132	7	*Autolytus prismaticus*	Po
133	8	*Capitella capitata*	Po
134	9	*Chaetozone setosa*	Po
135	10	*Chone teres*	Po
136	11	*Cistenides granulata*	Po
137	12	*Cistenides soldatovi*	Po
138	13	*Demonax fullo*	*Po*
139	14	*Eteone longa*	Po
229	15	*Eteone sp.*	Po
230	16	*Euchone analis*	Po
140	17	*Eumida sanguinea*	Po
141	18	*Euzonus sp.*	Po
231	19	*Exogone gemcifera*	Po
142	20	*Glycera capitata*	Po
143	21	*Glycinde armigera*	Po
144	22	*Goniada maculata*	*Po*

Item	Species Count	Taxon/Species Name	Code
145	23	*Harmothoe imbricata*	Po
146	24	*Idanthyrsus armatus*	Po
232	25	*Laphania boecki*	Po
147	26	*Lumbrineris bifurcata*	Po
233	27	*Lumbrineris heteropoda*	Po
148	28	*Lumbrineris japonica*	Po
149	29	*Lumbrineris minuta*	Po
150	30	*Lumbrineris sp.*	Po
151	31	*Magelona sachalinensis*	*Po*
234	32	*Mediomastus californiensis*	Po
152	33	*Melinna cristata*	Po
235	34	*Microclymene pacifica*	Po
236	35	*Nephthys californiensis*	Po
237	36	*Nephthys longosetosa*	Po
153	37	*Nephtys caeca*	Po
154	38	*Nephtys ciliata*	Po
155	39	*Nephtys longosetosa*	Po
238	40	*Nicomache sp.*	*Po*
239	41	*Onuphis geophiliformis*	Po
157	42	*Onuphis iridescens*	Po
158	43	*Onuphis shirikishinaiensis*	Po
240	44	*Onuphis sp.*	Po
159	45	*Ophelia limacina*	Po
241	46	*Paradiopatra fauchaldi*	Po
160	47	*Pectinaria sp.*	Po
242	48	*Pholoe longa*	Po
243	49	*Phyllodoce (Anaitides) maculata*	Po
161	50	*Phyllodoce groenlandica*	Po
244	51	*Phyllodoce sp.*	Po
245	52	*Pista cristata*	Po
246	53	*Polydora cardalia*	Po
247	54	*Polydora sp.*	Po
248	55	*Potamilla reniformis*	Po
162	56	*Potamilla torelli*	Po
163	57	*Praxillella praetermissa*	Po
249	58	*Proclea graffi*	Po
164	59	*Scalibregma inflatum*	Po
250	60	*Scolelepis sp.*	Po
165	61	*Scoloplos armiger*	Po
251	62	*Sphaerosyllis hirsuta*	Po
166	63	*Spio filicornis*	Po
252	64	*Spio sp.*	Po
167	65	*Spiophanes bombyx*	Po
168	66	*Travisia forbesii*	Po
169	67	*Travisia sp.*	Po

Item	Species Count	Taxon/Species Name	Code
253	68	*Typosyllis oerstedi*	Po
		Sipunculida - peanut worms	
170	1	*Phascolosoma japonicum*	Si
187	2	*Phascolosoma margaritacea*	Si
		Spongia – sponges*	
171	1	*Halichondria panicea*	Sp
		Pisces - fish	
	1	*Amcodytes hexapterus*	*Pi*

APPENDIX 6. Quantitative Characteristics of Benthos at Stations in the Piltun Area (colony density - A, spec./m^2; biomass - B, g/m^2).

Taxonomic Group	Station											
	1-1M		1-1MR		1-1N		1-1NR		1-1S		1-2N	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	4175	93,83	283	15,37	1730	69,25	2718	75,52	1402	52,53	100	3,61
Bivalvia	270	13,87	3115	256,6	35	82,54	12	7,16	80	93,38	12	78,38
Cumacea	27	0,45	0	0,00	60	0,96	98	1,89	100	1,78	0	0,00
Echinoidea	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	2	0,15	22	1,39	3	0,42	0	0,00	2	0,25	2	2,17
Isopoda	505	6,43	5	9,20	18	1,16	333	4,72	38	0,97	5	0,11
Pisces	5	15,97	0	0,00	7	22,92	0	0,00	0	0,00	7	25,57
Polychaeta	18	1,64	37	18,90	3	1,22	85	1,77	8	1,27	7	0,37
Rest	0	4,68	0	1,65	0	0	0	0,03	0	0	0	0
Всего	5001	137,0	3461	303,1	1856	178,4	3246	91,09	1630	150,1	131	110,2

Taxonomic Group	Station											
	2-1M		2-1MR		2-1N		2-1NR		2-1S		2-1SR	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	2233	84,50	1858	86,85	1890	111,3	585	22,90	2470	63,63	10590	98,18
Bivalvia	5	45,03	0	0,00	25	36,32	27	31,06	33	30,95	53	27,23
Cumacea	12	0,18	0	0,00	340	7,63	0	0,00	167	3,63	430	6,35
Echinoidea	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	2	0,02	2	0,01	5	4,10	0	0,00	0	0,00	0	0,00
Isopoda	85	4,20	5	0,53	325	14,75	35	2,90	20	1,00	115	5,55
Pisces	13	49,18	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00
Polychaeta	67	2,51	5	3,65	5	4,27	18	2,79	0	0,00	10	3,95
Rest	0	0,77	0	0	0	0	0	0	0	3,49	0	5,05
Всего	2416	186,3	1870	91,04	2590	178,4	665	59,65	2690	102,7	11198	146,3

Taxonomic Group	Station											
	2-2M		2-2N		2-2S		2-3M		2-3N		2-3S	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	3600	69,90	1648	83,12	185	3,90	705	27,88	365	38,28	312	22,54
Bivalvia	85	0,90	18	5,38	33	51,83	8	28,54	20	17,30	13	46,77
Cumacea	50	0,87	200	2,70	13	0,12	35	0,02	38	0,08	2	0,03
Echinoidea	0	0,00	22	124,92	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	0	0,00	0	0,00	13	0,20	3	0,33	8	0,95	0	0,00
Isopoda	172	21,50	187	28,45	18	0,12	102	3,75	220	17,10	135	4,80
Pisces	3	13,18	5	13,50	0	0,00	0	0,00	0	0,00	0	0,00
Polychaeta	0	0,07	17	3,75	35	1,42	8	0,66	0	0,00	2	0,06
Rest	0	0,05	0	12,69	0	2,42	0	2,8	0	0,23	0	1,84
Всего	3910	106,48	2096	274,51	298	60	861	63,98	650	73,93	463	76,04

Taxonomic Group	Station											
	2-4M		2-4N		2-4S		2-5M		2-5N		2-5S	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	2835	99,48	410	40,77	2078	110,7	203	31,85	177	19,25	382	2,12

Bivalvia	20	4,11	0	0,00	10	8,00	120	463,5	90	284,1	40	302,7
Cumacea	63	0,55	50	0,03	83	0,05	525	0,72	15	0,00	3618	5,69
Echinoidea	0	0,00	0	0,00	0	0,00	228	840,8	23	186,4	48	620,8
Gastropoda	0	0,00	0	0,00	2	0,30	5	28,38	3	18,08	2	26,67
Isopoda	463	9,04	38	34,60	107	20,18	2	0,13	20	2,50	0	0,00
Pisces	7	8,52	0	0,00	0	0,00	20	156,0	3	25,25	3	26,50
Polychaeta	43	2,12	0	0,00	47	4,43	77	25,58	50	27,64	45	9,02
Rest	0	0,89	0	5,05	0	7,95	0	4,28	0	1,44	0	2,7
Всего	3431	124,7	498	80,45	2326	151,6	1180	1551,3	381	564,8	4138	996,2

Taxonomic Group	Station											
	3-1M		3-1N		3-1S		3-2M		3-2N		3-2S	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	7	1,23	7	1,74	7	0,52	10	0,14	192	30,05	92	2,67
Bivalvia	8	50,70	107	0,35	63	161,68	7	36,65	37	19,61	0	0,00
Cumacea	33	0,16	0	0,00	3	0,00	0	0,00	22	0,39	2	0,04
Echinoidea	10	62,00	18	298,35	0	0,00	10	48,98	163	1531,15	243	224,32
Gastropoda	5	0,27	7	0,68	0	0,00	0	0,00	2	0,12	0	0,00
Isopoda	25	4,70	0	0,00	12	7,68	3	3,99	3	0,01	2	19,52
Pisces	2	2,50	0	0,00	0	0,00	2	3,52	5	30,72	0	0,00
Polychaeta	17	2,27	13	2,81	10	0,42	23	3,72	37	6,61	12	4,89
Rest	0	0	0	0	0	0	0	0	0	0	0	0
Всего	106	123,82	151	303,93	95	170,3	55	96,99	460	1618,65	350	251,43

Taxonomic Group	Station											
	3-3N		3-3S		3-4M		3-4S		3-5N		4-1M	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	518	10,77	113	27,91	5	1,98	15	3,99	8828	50,85	13	0,97
Bivalvia	0	0,00	27	67,70	85	0,38	5	10,24	22	17,43	2	1,55
Cumacea	0	0,00	225	0,54	7	0,02	2	0,03	60312	106,21	5	0,01
Echinoidea	355	521,27	535	1080,8	72	325,45	172	996,60	187	544,3	313	1521,5
Gastropoda	8	33,69	2	3,50	2	0,11	2	2,40	3	2,00	0	0,00
Isopoda	7	8,32	0	0,00	0	0,00	5	9,87	2	0,01	0	0,00
Pisces	10	59,33	5	49,83	3	5,62	0	0,00	12	87,00	3	20,85
Polychaeta	12	7,20	75	9,83	27	67,11	8	1,55	112	21,08	27	13,80
Rest	0	3,32	0	6,92	0	9,23	0	0,05	0	0,72	0	3,39
Всего	910	643,9	981	1247	200	409,9	208	1024,73	69476	829,64	363	1562,1

Taxonomic Group	Station											
	4-1N		4-1NR		4-1S		4-2M		4-2N		4-2S	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	1025	14,87	140	3,09	183	29,06	52	7,09	70	15,83	58	6,14
Bivalvia	317	32,64	33	143,38	7	73,61	75	86,27	2	35,58	260	0,22
Cumacea	27	0,25	2330	20,42	5	0,06	15	0,08	3	0,00	955	5,45
Echinoidea	130	587,57	68	335,15	32	162,63	82	204,15	28	190,02	0	0,00
Gastropoda	2	14,25	2	1,41	2	0,15	2	0,16	0	0,00	5	13,89

Isopoda	3	11,41	0	0,00	2	0,03	70	4,92	3	4,92	0	0,00
Pisces	3	5,33	0	0,00	2	11,77	0	235,82	2	9,63	0	0,00
Polychaeta	57	21,74	92	61,17	15	5,98	58	2,62	23	8,18	32	47,52
Rest	0	0	0	0	0	0	0	0	0	0	0	0
Всего	1563	688,06	2665	564,62	246	283,3	353	541,1	131	264,17	1310	73,23

Taxonomic Group	Station							
	4-3M		4-3N		4-4N		4-4S	
	A	B	A	B	A	B	A	B
Amphipoda	7	1,74	113	18,22	1120	31,96	108	10,55
Bivalvia	0	0,00	93	10,74	30	0,29	7	47,40
Cumacea	0	0,00	315	0,52	110	0,13	1868	1,97
Echinoidea	28	240,60	205	720,98	123	482,37	5	0,39
Gastropoda	0	0,00	2	31,25	0	0,00	0	0,00
Isopoda	153	4,77	0	0,00	0	0,00	10	16,63
Pisces	8	30,30	2	3,12	0	0,00	7	73,03
Polychaeta	17	3,82	27	62,28	23	10,55	105	6,30
Rest	0	0	0	0	0	0	0	0
Всего	213	281,22	756	847,1	1406	525,3	2110	156,27

APPENDIX 7. Quantitative Characteristics of Benthos at Stations in the Offshore Area (colony density - A, spec./m^2; biomass - B, g/m^2).

Taxonomic Group	Station											
	B1-1		B1-2		B1-3		B1-4		B2-1		B2-2	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	855	30,39	1590	27,46	2100	32,76	560	19,13	10237	63,10	2217	44,20
Actinia	13	24,70	0	0,00	5	17,83	3	1,43	3	6,80	10	18,93
Bivalvia	12	25,39	27	426,9	13	199,0	7	0,03	12	20,02	22	44,04
Cumacea	2512	8,44	93360	86,98	15302	53,65	8	0,05	11602	71,77	71667	171,3
Decapoda	15	44,06	0	0,00	0	0,00	0	0,00	2	0,10	2	2,72
Echinoidea	0	0,00	0	0,00	5	1,76	18	101,0	0	0,00	0	0,00
Gastropoda	5	19,46	5	3,15	7	19,90	0	0,00	18	31,90	8	0,09
Holoturia	0	0,00	0	0,00	0	0,00	0	0,00	3	0,05	7	0,78
Nemertina	0	0,00	0	0,00	0	0,00	0	0,00	13	0,21	3	1,85
Polycheta	17	11,90	37	12,54	38	10,13	3	0,20	243	4,34	208	6,07
REST	3	6,08	2	11,37	0	0,00	8	3,60	12	0,22	100	0,05
Всего	3431	170,41	95020	568,47	17470	335,07	608	125,47	22145	198,5	74243	290,1

Taxonomic Group	Station											
	B2-3		B2-4		B3-1		B3-2		B3-3		B3-4	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	253	42,49	1413	34,30	22626	301,1	34708	536,4	7443	86,47	1803	30,13
Actinia	0	0,00	0	0,00	2	2,20	5	0,03	8	45,07	35	51,63
Bivalvia	20	288,3	27	42,58	7	0,22	13	2,23	12	110,0	3	34,85
Cumacea	39333	70,5	55200	123,3	6041	41,5	5650	62,03	12020	114,1	9255	87,5
Decapoda	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00
Echinoidea	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	2	0,06	0	0,00	5	7,31	3	9,67	3	12,65	2	6,30
Holoturia	0	0,00	0	0,00	7	0,02	47	1,18	0	0,00	0	0,00
Nemertina	2	0,13	0	0,00	20	0,17	22	0,06	0	0,00	0	0,00
Polycheta	27	13,00	10	2,99	278	3,22	102	4,92	0	9,28	0	8,10
REST	30	16,31	10	0,34	33	0,03	18	0,14	0	0,03	2	16,54
Всего	39666	430,85	56660	203,56	29018	355,88	40568	616,68	19486	377,62	11100	235,06

Taxonomic Group	Station											
	B4-1		B4-2		B4-3		B4-4		B5-1		B5-2	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	26240	277,21	4183	36,25	2133	74,02	460	20,47	2535	309,63	2848	311,93
Actinia	2	10,98	8	24,85	8	15,68	0	0,00	72	222,9	30	83,20
Bivalvia	48	248,6	8	55,62	12	51,27	58	102,5	8	30,68	10	67,95
Cumacea	1520	14,26	51330	67,78	45417	120,3	15283	104,1	343	3,45	2293	19,82
Decapoda	2	6,85	0	0,00	0	0,00	0	0,00	3	1,43	8	41,37
Echinoidea	0	0,00	0	0,00	0	0,00	77	520,6	0	0,00	0	0,00
Gastropoda	3	1,84	5	8,22	0	0,00	2	0,30	2	0,26	2	3,10
Holoturia	15	8,90	68	1,67	0	0,00	0	0,00	13	30,50	0	0,00
Nemertina	10	0,44	0	0,00	0	0,00	0	0,00	3	0,85	0	0,00
Polycheta	952	16,12	10	4,68	20	30,92	22	4,10	90	37,96	55	23,58
REST	0	1,14	688	17,63	67	0,41	0	0,00	140	0,25	0	0,00
Всего	28798	589,84	56301	216,7	47656	292,66	15901	752,22	3211	638,15	5246	550,96

Taxonomic Group	Station											
	B5-3		B5-4		B6-1		B6-2		B6-3		B7-1	
	A	B	A	B	A	B	A	B	A	B	A	B

Amphipoda	1968	80,12	1137	37,62	29225	1334,6	3013	247,52	1320	67,38	3330	132,33
Actinia	43	117,4	0	0,00	97	396,9	27	147,1	10	14,77	48	81,27
Bivalvia	5	9,06	17	378,0	20	47,17	22	79,40	13	55,35	47	45,63
Cumacea	26033	114,9	5852	81,94	20	0,25	6090	46,03	8833	74,07	23010	182,3
Decapoda	0	0,00	0	0,00	7	18,30	0	0,00	0	0,00	0	0,00
Echinoidea	0	0,00	128	1238,	0	0,00	0	0,00	25	107,7	0	0,00
Gastropoda	3	4,93	5	31,30	3	1,07	0	0,00	17	5,85	0	0,00
Holoturia	5	4,28	0	0,00	0	0,00	3	3,43	43	8,82	20	35,43
Nemertina	0	0,00	2	0,03	3	0,00	3	0,31	0	0,00	17	0,55
Polycheta	65	13,48	5	1,19	115	26,67	35	7,23	45	11,18	272	85,70
REST	0	0,00	0	0,00	2	0,21	0	0,10	0,00	0,00	3	1,25
Всего	28123	344,19	7145	1768,3	29506	1827,6	9193	531,17	10306	345,14	26765	577,65

Taxonomic Group	Station											
	B7-2		B7-4		B8-1		B8-2		B8-3		B8-4	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	4302	296,77	233	18,96	6580	301,08	4207	294,81	6777	412,67	5438	214,28
Actinia	0	0,00	88	102,5	7	24,92	17	91,52	170	259,7	110	226,7
Bivalvia	23	142,9	13	0,12	40	264,7	5	0,25	22	37,65	62	53,48
Cumacea	10	0,02	1922	20,13	17	0,13	467	12,55	14300	99,40	905	8,23
Decapoda	3	32,52	0	0,00	0	0,00	0	0,00	3	16,83	2	5,20
Echinoidea	0	0,00	8	129,08	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	3	1,07	0	0,00	5	19,82	0	0,00	0	0,00	12	1,37
Holoturia	22	60,62	0	0,00	2	5,36	2	7,03	0	0,00	0	0,00
Nemertina	42	5,57	0	0,00	8	0,21	5	0,12	2	1,83	0	0,00
Polycheta	107	54,03	5	8,52	102	26,65	90	28,45	7	13,14	190	28,43
REST	243	0,37	5	0,01	0	0,00	0	0,01	2	1,27	7	0,02
Всего	4768	598,44	2275	279,33	6768	643,51	4791	434,73	21281	842,5	6730	541,14

Taxonomic Group	Station											
	B9-1		B9-2		B9-3		B9-4		B10-1		B10-2	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	6217	528,17	14850	323,67	7545	326,28	70	3,45	5805	381,15	4108	368,60
Actinia	22	56,52	22	107,13	188	197,42	105	115,50	30	155,37	23	73,10
Bivalvia	17	102,58	27	203,70	20	5,90	13	83,77	25	178,65	17	38,17
Cumacea	8	0,09	25290	52,15	7415	83,08	123	1,62	25	0,43	20	0,12
Decapoda	3	26,70	0	0,00	12	28,72	0	0,00	2	3,88	3	3,78
Echinoidea	0	0,00	0	0,00	0	0,00	37	554,38	0	0,00	0	0,00
Gastropoda	23	45,93	13	14,52	2	0,95	3	0,12	5	3,55	5	0,23
Holoturia	3	10,90	10	54,25	3	1,58	2	0,45	0	0,00	13	37,06
Nemertina	0	0,00	10	3,30	0	0,00	0	0,00	0	0,00	33	14,35
Polycheta	125	80,30	908	67,05	210	26,33	7	1,78	48	13,80	212	31,06
REST	0	0,00	0	0,08	133	0,07	0	0,00	0	0,00	0	0,00
Всего	6475	864,45	41290	870,91	15530	670,8	360	761,07	5953	739,77	4498	585,57

Taxonomic Group	Station											
	B10-3		B10-4		B11-1		B11-2		B11-3		B12-1	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	1718	149,28	147	13,09	2515	313,98	703	100,05	2012	225,15	1410	209,33
Actinia	25	102,02	75	101,20	13	87,67	18	37,23	10	20,90	0	0,00
Bivalvia	17	24,65	7	5,47	13	153,02	12	159,33	7	84,75	33	28,45
Cumacea	868	11,00	1112	14,02	3	0,05	5	0,02	7562	85,40	3	0,01
Decapoda	3	1,53	2	25,73	5	5,33	5	60,50	7	26,35	8	9,70

Echinoidea	0	0,00	35	565,25	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	0	0,00	0	0,00	5	24,27	0	0,00	3	16,95	0	0,00
Holoturia	7	11,67	52	33,32	28	75,87	18	55,85	5	6,55	3	6,48
Nemertina	0	0,00	0	0,00	42	19,80	5	2,77	5	0,55	0	0,00
Polycheta	22	3,07	25	21,12	147	61,52	117	66,43	108	103,95	92	40,25
REST	0	0,01	0	0,00	0	0,08	2	0,18	0	0,00	18	0,14
Всего	2660	303,23	1453	779,19	2978	924,66	1011	602,75	9910	690,87	1570	294,71

APPENDIX 8. Quantitative Characteristics of Benthos at Gray Whale Feeding Points in the Piltun Area (colony density - A, spec./m^2; biomass - B, g/m^2).

Taxonomic Group	Station											
	FP-01		FP-2-2		FP-03		FP-04		FP-05		FP-06	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	745	40,2	948	45,1	8657	76,8	3597	90,8	3418	117,2	500	19,9
Bivalvia	2	0,04	23	4,20	132	16,1	238	19,5	25	3,25	118	77,5
Cumacea	0	0,00	78	0,07	27	0,30	175	3,84	192	5,54	3	0,07
Echinoidea	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00
Euphasiacea	58	1,29	0	0,00	17	0,41	7	0,27	10	0,34	0	0,00
Gastropoda	3	0,19	7	0,21	0	0,00	7	0,58	3	1,98	0	0,00
Isopoda	2	0,01	35	2,02	32	1,13	152	17,3	875	40,1	70	21,6
Pisces	8	42,1	0	0,00	10	41,0	2	13,3	0	0,00	0	0,00
Polychaeta	5	1,08	0	0,00	3	0,03	77	9,57	360	12,6	22	2,40
Всего	823	84,93	1091	51,54	8876	135,8	4253	155,2	4883	181	713	121,5

Taxonomic Group	Station											
	FP-08		FP-09		FP-10		FP-11		FP-12		FP-12R	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	4587	124,1	3780	83,88	1472	67,18	6832	89,12	123	25,28	218	52,20
Bivalvia	48	81,27	63	92,80	22	13,67	8	7,37	3	2,17	3	56,34
Cumacea	70	1,40	47	0,42	7	0,08	13	0,14	115	1,15	0	0,00
Echinoidea	0	0,00	0	0,00	0	0,00	0	0,00	148	201,3	107	748,3
Euphasiacea	10	0,20	57	1,32	5	0,10	32	0,75	0	0,00	3	0,12
Gastropoda	0	0,00	0	0,00	2	0,17	0	0,00	0	0,00	2	1,43
Isopoda	848	21,58	1430	32,83	32	1,62	28	1,48	10	0,15	0	0,00
Pisces	5	26,62	32	159,3	2	8,67	17	111,2	43	400,7	0	0,00
Polychaeta	143	2,69	822	11,87	12	2,10	28	3,40	47	9,77	28	8,31
Всего	5711	257,9	6230	382,4	1551	93,57	6958	213,4	490	640,6	361	866,7

Taxonomic Group	Station											
	FP-13R		FP-14		FP-14R		FP-17		FP-21		FP-22	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	252	36,84	127	33,25	88	20,14	1540	40,16	2712	75,53	2630	105,3
Bivalvia	18	0,15	5	0,93	3	5,77	3	31,10	13	28,10	1478	60,40
Cumacea	103	0,80	40	0,23	0	0,00	0	0,00	28	0,11	142	3,89
Echinoidea	54	450,0	270	369,3	127	523,3	13	9,83	0	0	0	0,00
Euphasiacea	3	0,09	0	0,00	0	0,00	2	0,04	0	0	3	0,24
Gastropoda	1	0,02	2	14,60	0	0,00	3	27,92	0	0	0	0,00
Isopoda	0	0,00	0	0,00	0	0,00	5	25,18	3	1,67	20	1,67
Pisces	5	43,39	42	261,0	2	19,37	0	0,00	0	0	0	0,00
Polychaeta	55	7,41	30	5,27	12	2,75	0	0,00	222	20,57	7	1,51
Всего	490	538,7	515	684,7	231	571,3	1566	134,2	2978	125,9	4280	173,0

Taxonomic Group	Station					
	FP-23	FP-29	FP-32	FP-34	FP-35	FP-36

	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	5168	85,55	405	31,28	2262	82,10	1763	51,19	357	23,78	6065	132,4
Bivalvia	12	10,03	197	47,90	2	7,35	37	112,0	22	75,30	3	15,50
Cumacea	95	1,14	7007	35,88	3	0,03	15	0,35	3	0,02	225	0,54
Echinoidea	58	256,5	5	25,53	2	0,57	0	0,00	0	0,00	0	0
Euphasiacea	0	0,00	25	0,29	2	0,05	2	0,00	0	0,00	0	0
Gastropoda	0	0,00	8	29,76	3	1,35	0	0,00	2	0,20	2	3,50
Isopoda	348	4,85	3	0,00	3	0,41	227	11,02	60	3,92	5	4,30
Pisces	32	159,3	0	0,00	0	0	2	8,54	0	0,00	0	0
Polychaeta	48	3,52	60	21,14	27	4,75	68	28,67	17	16,08	75	9,83
Всего	5761	520,9	7710	191,7	2303	96,62	2113	211,7	460	119,3	6375	166,1

Taxonomic Group	Station											
	FP-37		FP-38		FP-39		FP-42		FP-44		FP-48	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	2033	117,3	80	23,04	1460	58,15	1990	118,4	1120	53,32	757	56,96
Bivalvia	8	2,42	8	0,08	35	23,45	80	123,5	75	54,77	17	28,53
Cumacea	225	0,08	3	0,01	118	3,19	12	0,25	10	0,15	2	0,04
Echinoidea	0	0	218	263,3	0	0,00	0	0,00	0	0,00	0	0,00
Euphasiacea	0	0	10	0,02	0	0,00	0	0,00	0	0,00	0	0,00
Gastropoda	2	3,50	0	0,00	0	0,00	7	6,10	2	0,15	0	0,00
Isopoda	12	1,88	3	40,60	423	18,64	113	7,05	105	6,13	233	8,78
Pisces	0	0	7	83,73	0	0,00	0	0,00	0	0,00	0	0,00
Polychaeta	2	0,09	17	3,02	237	13,11	43	17,25	12	2,98	7	0,37
Всего	2281	125,3	346	413,8	2273	116,5	2245	272,6	1323	117,5	1015	94,68

Taxonomic Group	Station											
	FP-58		FP-59		FP-60		FP-62		FP-63		FP-64	
	A	B	A	B	A	B	A	B	A	B	A	B
Amphipoda	955	49,37	2412	95,35	1262	60,67	3258	59,35	4620	33,93	6470	48,07
Bivalvia	2	0,34	20	21,13	20	103,2	2	8,13	3	6,43	0	0,00
Cumacea	0	0,00	13	0,03	0	0,00	2	0,00	2	0,02	3	0,04
Echinoidea	0	0,00	0	0,00	2	11,93	0	0,00	0	0,00	0	0,00
Euphasiacea	0	0,00	0	0,00	0	0,00	0	0,00	2	0,03	0	0,00
Gastropoda	0	0,00	2	0,18	0	0,00	0	0,00	0	0,00	0	0,00
Isopoda	33	26,59	735	13,66	32	2,63	30	0,69	15	0,50	57	2,28
Pisces	17	9,07	0	0,00	0	0,00	2	15,30	0	0,00	0	0,00
Polychaeta	32	3,47	173	2,73	15	14,82	0	0,00	3	1,08	0	0,00
Всего	1038	88,83	3355	133,0	1330	193,3	3293	83,47	4645	41,98	6530	50,39

Taxonomic Group	Station			
	FP-65		FP-65	
	A	B	A	B
Amphipoda	2570	81,78	1687	75,67
Bivalvia	2	0,04	0	0,00
Cumacea	13	0,14	0	0,00
Echinoidea	0	0,00	0	0,00
Euphasiacea	0	0,00	0	0,00
Gastropoda	0	0,00	0	0,00
Isopoda	12	0,80	12	0,83
Pisces	0	0,00	0	0,00
Polychaeta	0	0,00	0	0,00
Всего	2596	82,76	1698	76,49