

Observations of Annual Walrus (*Odobenus rosmarus divergens*) Migrations in the Nearshore Waters of the Chukotka Peninsula from 1990 to 2012

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ABSTRACT. After the end of the commercial harvest, research regarding the Pacific walrus (*Odobenus rosmarus divergens*) in Russia was reduced and focused on the observation of animals at land-based haul-outs. This paper presents the long-term observations of the distribution, relative abundance, and direction of seasonal movements of walruses in the offshore waters of the Chukotka Peninsula, based on data obtained in 1990–2012. Observations of Pacific walruses and other marine mammals were conducted mainly from April through November, but some were conducted all year round. In some years up to 30 Native Chukotkan observers were employed at this task. Some watched from observation posts in Native villages onshore, and others from motorboats during hunting trips. These observations have shown that walruses are rare in January and February in the nearshore waters of the Chukotka Peninsula. Their numbers begin to increase in March. The northward movement of walruses begins in April, and walruses migrate from the Bering Sea to the Chukchi Sea throughout the summer months and early autumn. Based on observations from posts located directly in front of the southern Bering Strait, I conclude that 106–1055 walruses pass through the Bering Strait from July to September, to the northwest and north. At the haul-outs in the Gulf of Anadyr, the relative number of walruses remains stable during the summer (up to 11 000 individuals at all haul-outs in total based on observers' estimates) and decreases only with the appearance of ice in October–November.

Key words: walrus; *Odobenus rosmarus divergens*; shore-based visual observations; Chukotka Peninsula; Gulf of Anadyr; Chukchi Sea; Bering Sea; migration

RÉSUMÉ. Lorsque la récolte commerciale a pris fin, les recherches concernant le morse du Pacifique (*Odobenus rosmarus divergens*) en Russie ont été réduites à l'observation des animaux aux échoueries terrestres. Cet article présente les observations à long terme en matière de distribution, d'abondance relative et d'orientation des mouvements saisonniers du morse au large de la presqu'île de Tchoukotka, en fonction de données prélevées entre 1990 et 2012. Les observations du morse du Pacifique et d'autres mammifères marins ont principalement été réalisées d'avril à novembre, bien que certaines aient été faites l'année durant. Au cours de certaines années, jusqu'à 30 observateurs tchoukotkas se sont affairés à cette tâche. Dans certains cas, l'observation s'est faite à partir de postes établis dans les villages autochtones, et dans d'autres cas, dans des bateaux à moteur dans le cadre de voyages de chasse. Ces observations ont permis de constater que le morse se fait rare en janvier et en février dans les eaux sublittorales de la presqu'île de Tchoukotka. Le nombre de morses commence à augmenter en mars. En avril, les morses commencent à monter vers le nord, puis ils migrent de la mer de Béring à la mer des Tchoukches pendant les mois d'été et au début de l'automne. D'après les observations faites à partir des postes situés en face de la partie sud du détroit de Béring, nous concluons qu'entre 106 et 1055 morses passent dans le détroit de Béring de juillet à septembre, vers le nord-ouest et le nord. Aux échoueries du golfe d'Anadyr, le nombre relatif de morses reste stable pendant l'été (jusqu'à 11 000 individus dans l'ensemble des échoueries, selon les estimations des observateurs) et ne diminue qu'avec l'apparition de la glace en octobre et en novembre.

Mots clés : morse; *Odobenus rosmarus divergens*; observations visuelles à terre; presqu'île de Tchoukotka; golfe d'Anadyr; mer des Tchoukches; mer de Béring; migration

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АБСТРАКТ. После окончания коммерческого промысла, исследования моржа в нашей стране были сокращены и сосредоточены на наблюдениях животных на береговых лежбищах. В работе предпринята попытка анализа многолетних наблюдений распределения, относительной численности и направления сезонных перемещений моржей в прибрежье Чукотского полуострова, на основе оригинальных данных, полученных в 1990–2012 гг. Наблюдения морже вели одновременно с наблюдениями других видов морских млекопитающих. Работы вели, в основном, с апреля по ноябрь, однако в отдельные годы работы продолжались круглогодично. В работах принимали участие до 30 наблюдателей. Наблюдения вели, преимущественно из поселков расположенных на побережье Чукотского

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полуострова. Часть работ проводилась со зверобойных ботов и лодок во время охотничьих экспедиций. Проведённые исследования показали, что в январе – феврале, в прибрежье Чукотского полуострова, встречи моржей единичны. Их численность начинает увеличиваться в марте. Движение моржей в направлении Берингова пролива и Чукотского моря определяется в апреле. Моржи мигрируют из Берингова моря в Чукотское не только весной, но и на протяжении всех летних месяцев и начала осени. По результатам наблюдений, с пунктов расположенных непосредственно перед южным входом в Берингов пролив, можно заключить, что с июля по сентябрь в Берингов пролив проходит не менее 1000 моржей. В районе лежбищ Анадырского залива относительная численность моржей на протяжении лета остается стабильной и снижается лишь с появлением льда в октябре–ноябре.

Ключевые слова: морж; *Odobenus rosmarus divergens*; береговые наблюдения; Чукотский Полуостров; Анадырский Залив; Чукотское Море; Берингово Море; миграции

INTRODUCTION

The Pacific walrus (*Odobenus rosmarus divergens*) is one of the most conspicuous inhabitants of the Arctic. The walrus spends at least two-thirds of its life in the water, going ashore or on ice only for rest or reproduction (Fay, 1982). This species migrates over long distances because of seasonal changes in sea ice. Based on the analysis of commercial harvesting, Belopolsky (1939) and Nikulin (1940) made significant contributions to the investigation of walrus. Beginning in 1958, numerous aerial studies were conducted both in Russia and in the United States, aimed at estimating the population size (Fedoseev, 1962, 1966, 1982; Gol'tcev, 1968; Fedoseev and Raslivalov, 1986; Gilbert, 1989; Speckman et al., 2011). As a result, information was obtained that clarified the migration activity of walruses. Now it is known that at the end of winter walruses inhabit the Bering Sea from Bristol Bay in the east to the Gulf of Anadyr in the west (Fay, 1982; Fedoseev, 1982; Fay et al., 1997; Speckman et al., 2011). In the spring as the ice melts, the walruses move through the Bering Strait into the Chukchi Sea. By late September, walruses are distributed along the edge of the drifting ice from Cape Barrow, Alaska in the northeast of the Chukchi Sea, to the mouth of the Kolyma River in the west, to the East Siberian Sea (Fay, 1982; Estes and Gol'tcev, 1984; Fedoseev and Raslivalov, 1986; Gilbert, 1989). For the summer, part of the walrus population remains in the Bering Sea near coastal haul-outs in the western part of the Gulf of Anadyr and Arakamchechen Island (Nikulin, 1940; Gol'tcev, 1968; Mymrin et al., 1990) and Bristol Bay (Jay and Hills, 2005). At the end of the summer, when the ice edge is displaced far to the north, the walruses leave the ice and form coastal haul-outs on the northern shore of the Chukotka Peninsula (Gol'tcev, 1968; Kochnev, 2010a; Chakilev et al., 2015), on Wrangel and Herald Islands, (Kochnev, 2010b) and in northwest Alaska. In cold years, when the summer ice edge is not shifted far enough to the north, walruses prefer to stay on the ice. When ice begins to form, the walruses migrate back to the Bering Strait and into the Bering Sea where they form temporary haul-outs on the northern shore of the Chukotka Peninsula, St. Lawrence Island, and the Punuk Islands (Fay, 1982).

Despite the great economic importance of the walrus to the peoples of the North, with the end of the commercial

pelagic marine mammal harvesting, research in Russia has declined and has been focused on observing walruses at onshore haul-outs (Kochnev et al., 2008; Kochnev, 2010a; Kryukova, 2012; Pereverzev and Kochnev, 2012; Chakilev et al., 2015). Simultaneous observations from many observation posts along the shore make it possible to obtain information on the seasonal distribution and migrations of animals, which complements information obtained from other sources. This paper continues a series of publications on marine mammal research in the offshore waters of the Chukotka Peninsula (Melnikov and Zagrebin, 2005; Melnikov et al., 2007; Melnikov, 2014, 2017; Melnikov and Zdor, 2018). I present the long-term observations of the distribution, relative number, and direction of seasonal movements of walruses in the offshore waters of the Chukotka Peninsula based on data obtained in 1990–2012.

MATERIALS AND METHODS

In some years up to 30 (mean = 14) Native Chukotka observers were employed to count walruses and other marine mammals. Only one or two observers were involved in the beginning and at the end of the work (Table 1). Some watched from observation posts in villages (Fig. 1) and others from small motorboats. Observations were conducted mainly from April through November, but some were conducted all year round.

Observations were made using binoculars, with the observers taking note of the elevation of the observation perch, the duration of observations, the observation conditions (direction and speed of wind, visibility, presence or absence of whitecaps, the percentage of ice cover, the number of marine mammals sighted, their approximate distance from shore, and their swim direction). Of the sighting data associated with each count, only swim direction and percentage of ice cover was used, whether the animals were in the water, on shore, or on the ice. The number of animals that were on land-based haul-outs or in the water near a haul-out was estimated as a general group; they were lumped as a total without distinction between animals on land and in the water. The presence of female walruses could be determined if they were on the ice or on the shore and if they were accompanied by calves. All variables were assessed subjectively by the observers. The

TABLE 1. Duration of walrus observations in the nearshore waters of the Chukotka Peninsula.

Year	Number of observers	Start date	End date	Total observation days
1990	1	14 June	1 December	77
1991	1	30 June	10 December	78
1992	3	30 May	29 November	217
1993	5	5 May	30 November	589
1994	26	1 April	27 December	4180
1995	28	1 June	31 December	5288
1996	30	1 January	30 November	5537
1998	9	1 April	30 December	1516
1999	19	1 April	30 November	3318
2000	20	1 April	30 December	4300
2002	29	1 March	30 November	4674
2003	29	1 March	28 November	4262
2004	9	1 April	28 December	662
2005	20	1 April	26 September	1512
2010	2	28 May	30 November	120
2011	3	18 May	28 November	145
2012	2	1 May	13 December	229

most extensive research efforts occurred in 1994–96, and then in 2000, 2002, 2003, and 2005 (Table 1).

Recording the length of time an observer conducted observations on any particular day turned out to be a difficult organizational issue. It would take only 30 minutes of actual observation time to determine the number of animals in the sector of observation and what species they were. Yet most of the observers working in the villages listed the duration of their observations as the length of the working day, which obviously bore little relation to reality since observations were conducted sporadically. For these reasons, observers found it hard to decide on observation time, with some recording the time spent looking through binoculars, others the time spent on the shore, and still others the length of the working day. Observers sitting in a boat during a hunting expedition may have been hampered by a low vantage point limiting their field of vision, but on the other hand they were constantly on the move, and all

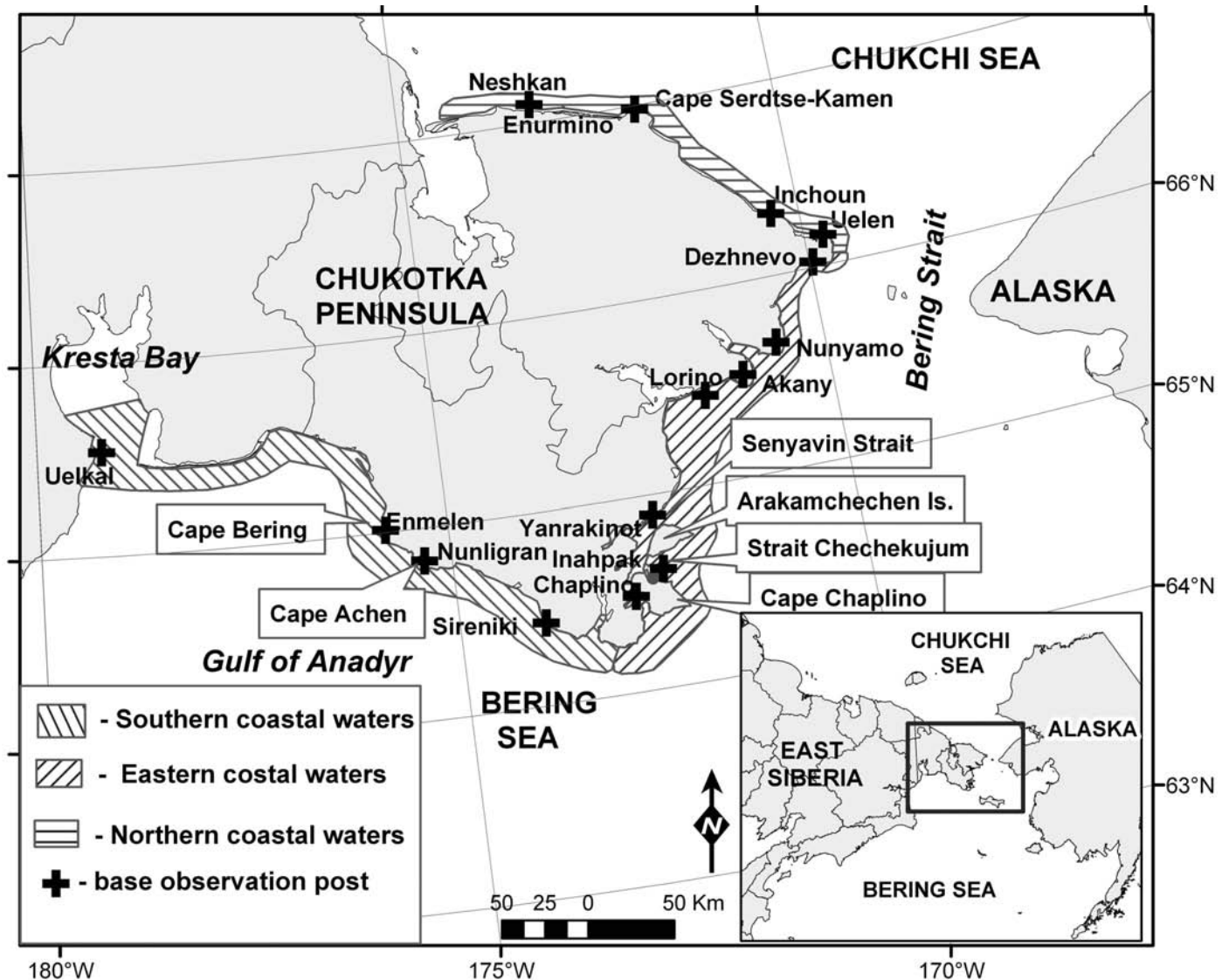


FIG. 1. Study area showing the base observation posts from which walrus were observed along the Chukotka coast. Because of spatial differences in conditions, the data obtained from individual observation points were analyzed by area: Gulf of Anadyr, Bering Sea, and Chukchi Sea.

members of the crew watched out for marine mammals, often from dawn until dark. Information however, that was recorded in the logbook only at the end of the working day was always integrated, and the observers usually put the length of time they spent at sea as their observation time, which was often as long as 18 hours. But even during hunting trips, observations were not conducted steadily throughout the day. The observers' attention was interrupted by actual hunting activity and the work connected with getting the harvested animals back to shore. For these reasons, I considered a good or fair visibility observer-day as a single observation, without regard to the duration or intensity of the search. Our fundamental unit for analysis was therefore the number of walrus per day.

It is important to point out that in spring and summer, day length is 24 hours, but in autumn it is only four hours.

During analysis, the data were summarized as number of walrus per number of observation days for each village, region, or period of time. Since most villages in neighbouring areas had several observers working independently of one another, the data from all the observers in one area were averaged. Because of spatial differences in conditions, the analysis was carried out in three separate areas from south to north: 1) the Gulf of Anadyr and the southern Chukotka Peninsula, 2) the Bering Sea and eastern Chukotka Peninsula, including the northwestern waters of the Bering Sea and the Bering Strait, and 3) the Chukchi Sea and the northern Chukotka Peninsula (Fig. 1).

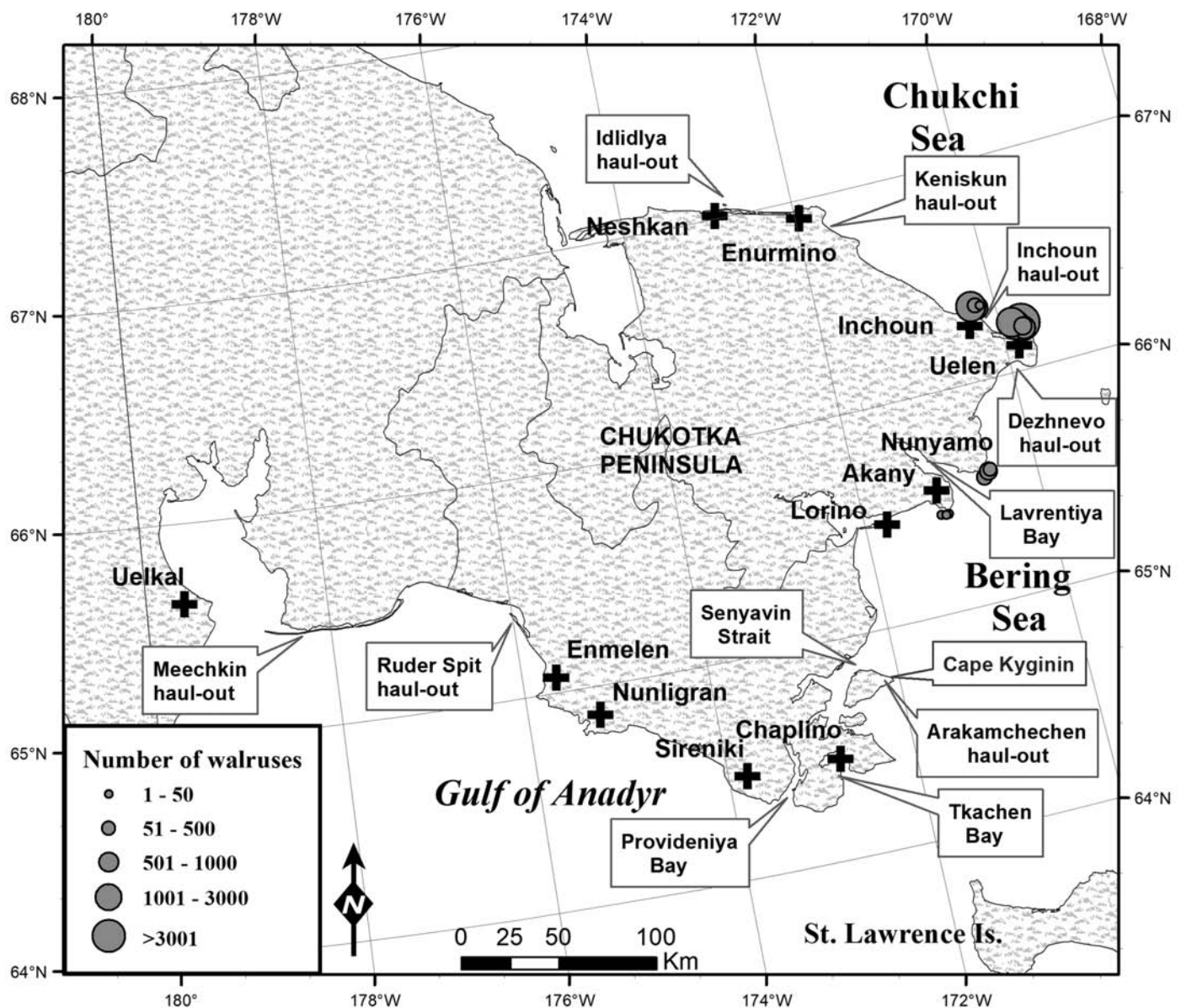


FIG. 2. Distribution of walrus in December 1995, which was the year when the highest number of walrus were counted. The crosses mark the locations of village observation posts along the coast. Major walrus land haul-outs and some coastal features are also identified.

RESULTS

Walrus Distribution: December–February

Gulf of Anadyr: In the northern Gulf of Anadyr, walrus were seen in December 1998, 2000, and 2004. These were single animals and small groups of up to 50 individuals. Only once, in December 2000, was a herd of 120 animals registered on the ice. In January–February (all years) sightings of walrus were also rare here.

Bering Sea: In the northwest Bering Sea, walrus were encountered in December 1995, 1996, and 2000. The greatest number were seen in December 1995 when up to 200 walrus were counted on drifting ice. Later, in January–February (all years), walrus presence in the area was sporadic.

Chukchi Sea: In December the formation of ice in the Chukchi Sea usually ends. The sea is usually covered with ice and the ice edge has advanced into the Bering Strait. In typical years, most walrus have left the Chukchi Sea by December. However, in warm years animals remain in southern parts of the Chukchi Sea until mid-December. In 1994 and 2008 in the northwest Bering Strait, single individuals and small groups of walrus were counted on the edge of the drifting ice. In 1995 there were exceptionally large groups of walrus (Fig. 2). In the latter case, the observer reported that the estimate was approximate since the herds occupied an ice strip about 10 km in length. In all years of observation between January and March, no walrus were seen in the Chukchi Sea.

Walrus Distribution and Migration: March–June

Gulf of Anadyr: Typically by March, the number of walrus increased significantly (Figs. 3a, 4); however the increase in numbers did not occur annually. In 1994, 1996, 2002, and 2003, observers saw only single animals and small groups, consisting of mostly females with calves. The most numerous walrus were seen in 1995 when March herds of 600 to 1000 individuals were observed on the ice, both in the northwestern and northeastern parts of the gulf (Fig. 3a). Almost all walrus (98%) were on the ice (Table 2). It should be noted that the animals that were in the water moved to the west, into the gulf.

In April walrus began to gather in the Ruder Spit haul-out area. By April 2000, when the ice was absent in this area, approximately 3000 walrus were counted on the shore and in the water near haul-outs. In general for all years of observation, the number of walrus in the northern part of the Gulf of Anadyr decreased in April as compared to March (Fig. 4). Observers recorded mainly single animals and small groups of up to 100 individuals. In the area of Sireniki village, 25% of the animals that were in the water moved east. Ice drift occurred in the same direction. On the ice 70–80% of the walrus were counted.

In May for all years of observation, the number of walrus remained at the same level as it had in April

(Fig. 4). As in the previous month, the animals were seen mainly in small groups and singly; 32% of the walrus were in the water and of these, 62% were headed out of the gulf. Females with calves made up most of the 35% of walrus recorded on the ice (Table 2). On 21 May 1994 in the absence of ice, up to 4000 walrus accumulated around the Ruder Spit haul-out area. Later, some of them went ashore.

In June, walrus were concentrated at nearshore haul-outs in the northwestern part of the gulf. Walrus formed aggregations of up to 3000 individuals on the ice adjacent to the haul-out or in Ruder Spit haul-out area. If the ice was absent, the animals went ashore. In the water outside the haul-out, the animals moved mainly along the coast. In the northeastern part of the gulf, walrus were seen singly and in small groups of up to 50 individuals, all moving along the coast to the exit of the gulf.

Bering Sea: In March walrus were seen only in 1995, 2002, and 2003. In 1995 and 2002, these sightings were of single individuals and micro groups of up to five individuals. On 13 and 14 March 2003, up to 200 females with calves were observed on the ice in the area of Tkachen Bay. In March, only 6% of walrus were recorded on the ice and 55% in water (Table 3).

By April the presence of walrus off the eastern shore of Chukotka is slightly reduced (Fig. 5). Single animals and small groups of up to 50 individuals were observed, mainly in the area of the Tkachen and Provideniya Bays.

In May for all years of observation, small groups of up to 50 walrus appear along the entire eastern shore of the Chukotka Peninsula (Figs. 3c, 5). About 48% of the animals were on the ice during this period in small herds of up to 50 individuals (Table 3). Rarely, 100 individuals were observed on the broken ice. The most numerous walrus were at the southwestern Bering Strait. Here both in the water and on the ice, groups of up to 200–300 individuals were seen every year, sometimes with aggregations of 700–1000 animals (Fig. 3c). Observers reported the presence of females with calves on the ice. Among the animals in the water, 31% moved into the Bering Strait.

In late June 1996, the first instance of walrus on the shore haul-out of Arakamchechen Island was recorded. Walrus, singly and in groups of up to 50 individuals, either moved along the coast to the north and northeast or drifted on broken ice in the same direction. To the north in the area of Akany and Nunyamo, 11% of the walrus remained in the water, moving towards the Bering Strait 100–200 m from the coast, sometimes in the surf zone. Herds on the ice in this period contained about 57% of the observed animals (Table 3). Several dozen to several hundred individual walrus were counted in herds on the ice.

Chukchi Sea: In the Chukchi Sea, the first walrus appeared in April near Uelen village in the northern Bering Strait. They were seen here in 1996, 2002, and 2009 as single animals and in groups of up to six individuals. In May 1996, 2000, and 2002, single animals and groups of 10–20 walrus were observed in the Cape Inchoun area.

TABLE 2. Number and percent of walrus counted in the northern part of the Gulf of Anadyr from 1994 to 2012. Walrus were counted in the water, on shore, on sea ice, or in unspecified locations.

Month	In water		On shore		On sea ice		Unspecified ¹	
	#	%	#	%	#	%	#	%
March	60	1	0	0	7294	98	64	1
April	384	5	1200	15	4042	52	2205	28
May	838	32	0	0	916	35	833	32
June	1191	6	14980	71	4391	21	519	2
July	4739	31	2140	14	45	0	8160	54
August	13574	25	6330	12	0	0	34297	63
September	6471	12	13642	26	3	0	31679	61
October	1718	29	2000	34	0	0	2196	37
November	144	11	0	0	0	0	1171	89
December	0	0	0	0	143	3	4029	97

¹ missing data

TABLE 3. Number and percent of walrus counted each month in the Bering Sea from 1994 to 2012. Walrus were counted in the water, on shore, on sea ice, or in unspecified locations in the eastern offshore waters of the Chukotka Peninsula.

Month	In water		On shore		On sea ice		Unspecified ¹	
	#	%	#	%	#	%	#	%
March	450	55	0	0	50	6	315	39
April	24	13	0	0	128	70	30	17
May	893	31	0	0	1384	48	611	21
June	754	11	844	12	3854	86	1352	20
July	1095	4	8837	33	1690	6	15302	57
August	3899	12	7860	23	0	0	22214	65
September	6635	23	7550	27	62	22	14247	50
October	1757	11	9670	61	30	0	4367	28
November	87	3	540	19	15	1	2173	77
December	0	0	0	0	215	32	467	68

¹ missing data

TABLE 4. Number and percent of walrus counted each month in the Chukchi Sea from 1994 to 2012. Walrus were counted in the water, on shore, on sea ice, and in unspecified locations in the northern offshore waters of the Chukotka Peninsula.

Month	In water		On shore		On sea ice		Unspecified ¹	
	#	%	#	%	#	%	#	%
May	50	3	0	0	1617	87	190	10
June	2763	12	0	0	17538	74	3446	15
July	2116	7	1506	5	24009	75	4541	14
August	17049	31	3367	6	766	1	33327	61
September	54413	23	148423	63	3556	2	29861	13
October	27341	10	165841	60	21318	8	61855	22
November	10466	8	49543	39	45178	36	20513	16
December	1464	9	0	0	13140	79	2116	13

¹ missing data

In 2002, a single walrus was also seen near Neshkan village. In June, walrus herds on drifting ice became numerous along the entire northern coast of the Chukotka Peninsula. During this period, 86% of walruses were seen on the ice (Fig. 3d, Table 4). Herds on the ice numbering from 300–3000 individuals were recorded in the area of the Inchoun, Neshkan, and Enurmino villages in 1990, 1991, 1996, 1999, and 2003. On average in the Chukchi Sea across all years, 20.9 individuals were counted per observation in June (max. 3000).

Walrus Distribution: July–September

Gulf of Anadyr: In July of all years of observation, walruses were starting to concentrate near Ruder Spit and Meechkin coastal haul-out areas (Figs. 4, 6a). An average of 14% of the animals were counted on the shore. There was almost no sea ice in the area at that time. According to rough estimates by observers, at the Ruder Spit haul-out area in July there were anywhere from several dozen to 2000 walruses, and at the Meechkin haul-out there were up to 700. In the area of the Meechkin haul-out, walruses were

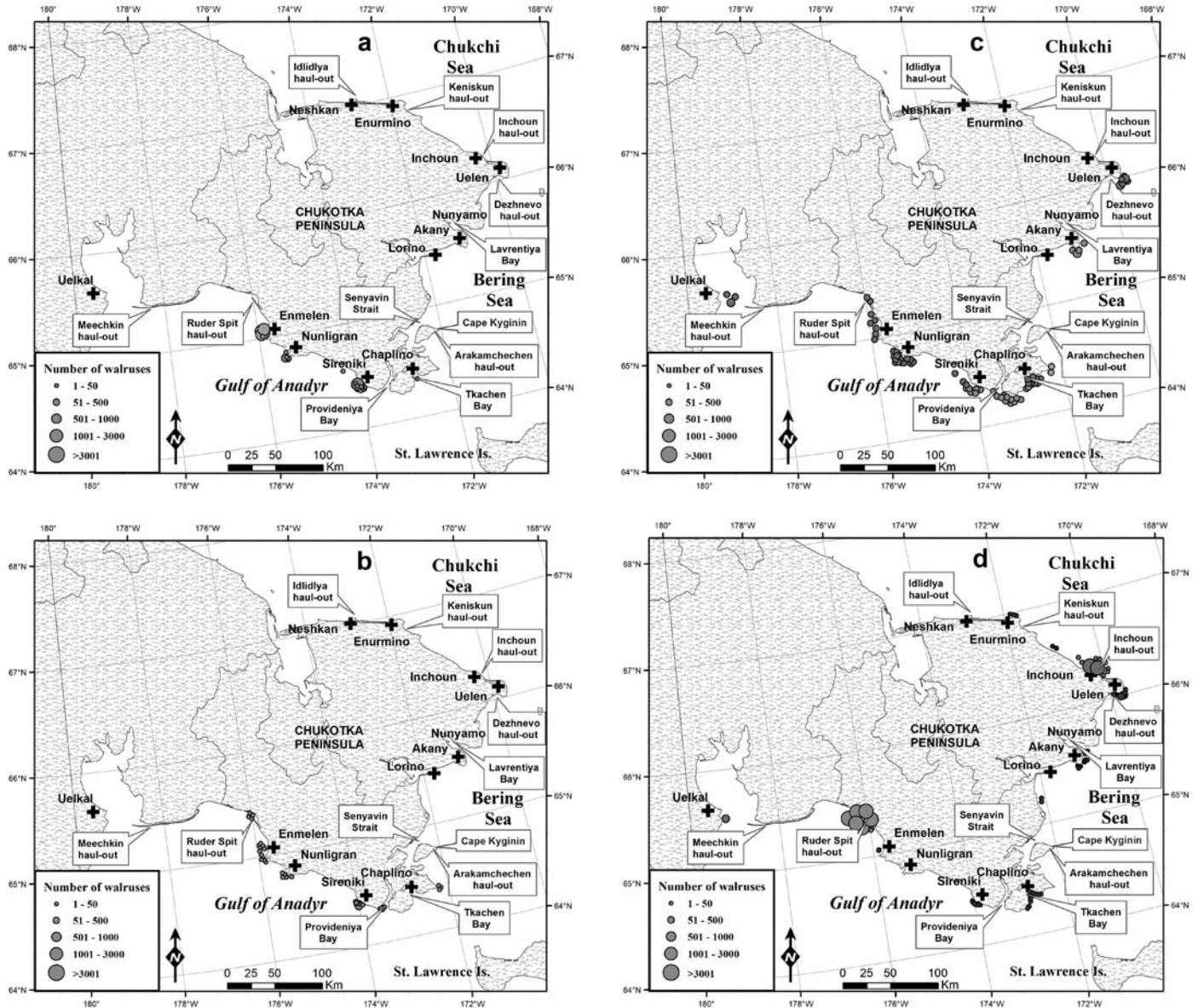


FIG. 3. Walrus distribution in the coastal waters of the Chukchi Peninsula from March–June 1995: a) March 1995, b) April 1995, c) May 1995, and d) June 1995.

seen both leaving the haul-out and returning to it. In the area of the Ruder Spit haul-out and Bering Cape, animals moved mainly near and along the coast in small groups of 2–10 walrus. Sometimes there were aggregations of 500–1000 individuals. Walrus preferred to be near the shore, probably because of the constant presence of killer whales.

Near the village of Nunligran, the number of walrus increased from 7 to 25 on average per observation in July compared to June. Herds of up to 50 individuals moved near the coast towards the exit of the gulf, where 90% of the walrus were headed. At the eastern end of the Gulf of Anadyr, groups of 2–30 walrus moved to the east and then to the north around Cape Yakun. Up to 100 walrus were counted here per day.

On average for all years in August in the western part of the Gulf of Anadyr, 25% of the walrus were on haul-outs. According to rough observer estimates, about 5000

individuals were located on the Ruder Spit haul-out area (7 August 2002) and up to 6000 on the Meechkin haul-out (10 August 2003). In order to avoid killer whales when moving and feeding, the walrus preferred to stay near the shore. During this period, individuals and groups of up to 15 killer whales almost constantly patrolled the walrus haul-out area. In the Nunligran area the walrus sometimes formed aggregations of up to 4000 individuals. In the northwestern Gulf of Anadyr, the walrus did not show a distinct direction of movement. In the Nunligran village area (Cape Achen), almost all walrus (98%) continued to move towards the exit from the Gulf of Anadyr in small groups near the coast. Near the village of Sireniki, almost all walrus left the gulf. Nevertheless, despite the constant outflow, the average number of walrus in the northern part of the gulf increased markedly from 87 per day (max 1000 in 2000 and 2005) in July, to 109 (max 6000 in 2003) in August.

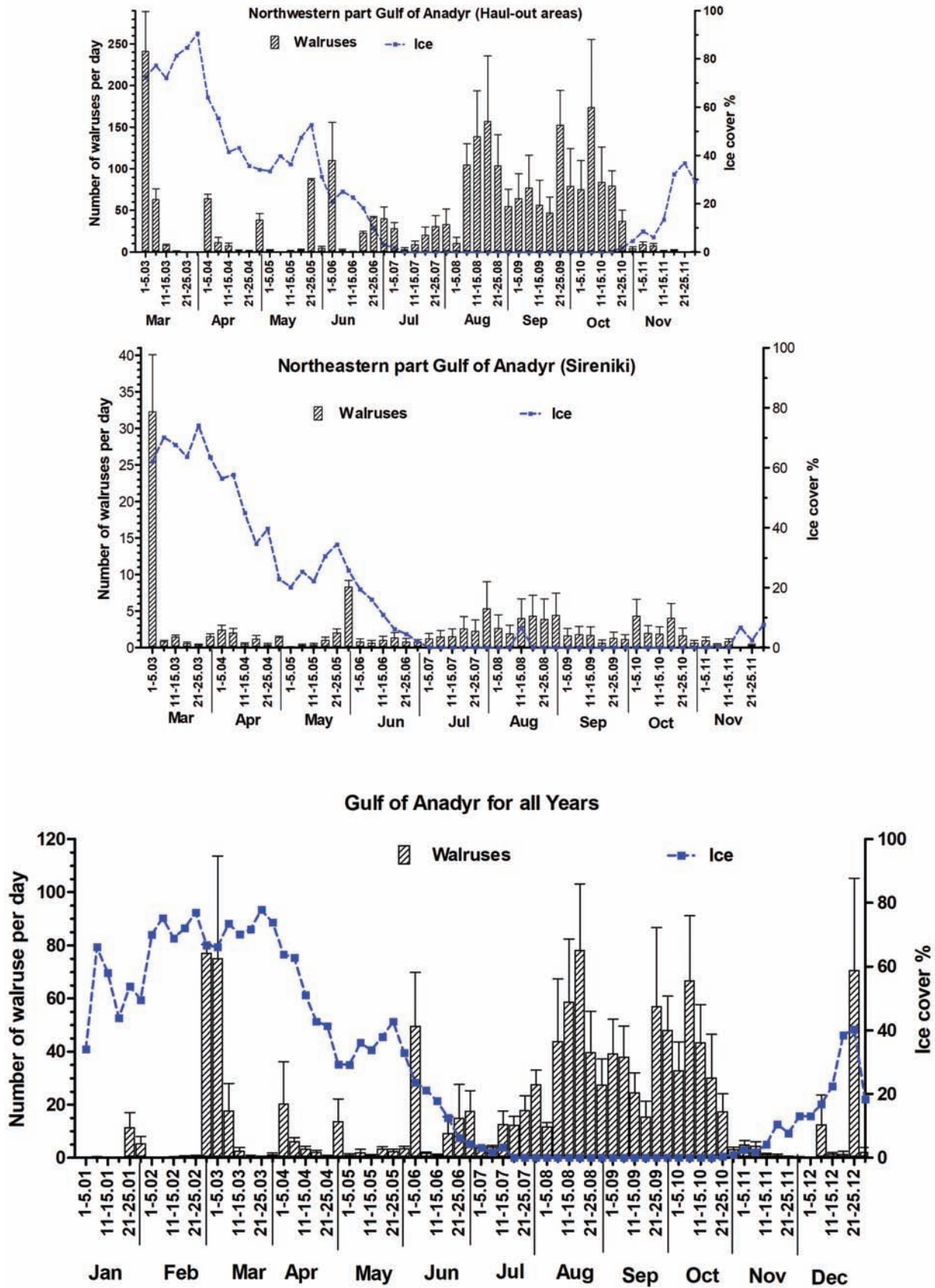


FIG. 4. Numbers of walrus observed in the waters of the Gulf of Anadyr. The top graph shows the number of walrus observed in the southern offshore waters of the Chukotka Peninsula haul-out areas of Ruder Spit and Meechkin. The middle graph shows the numbers from the northeastern area near Sireniki. The bottom graph shows all years of observation averaged. Each bar represents five to six days. Percentage of ice coverage on all visible water is shown in blue. All data were provided by observers.

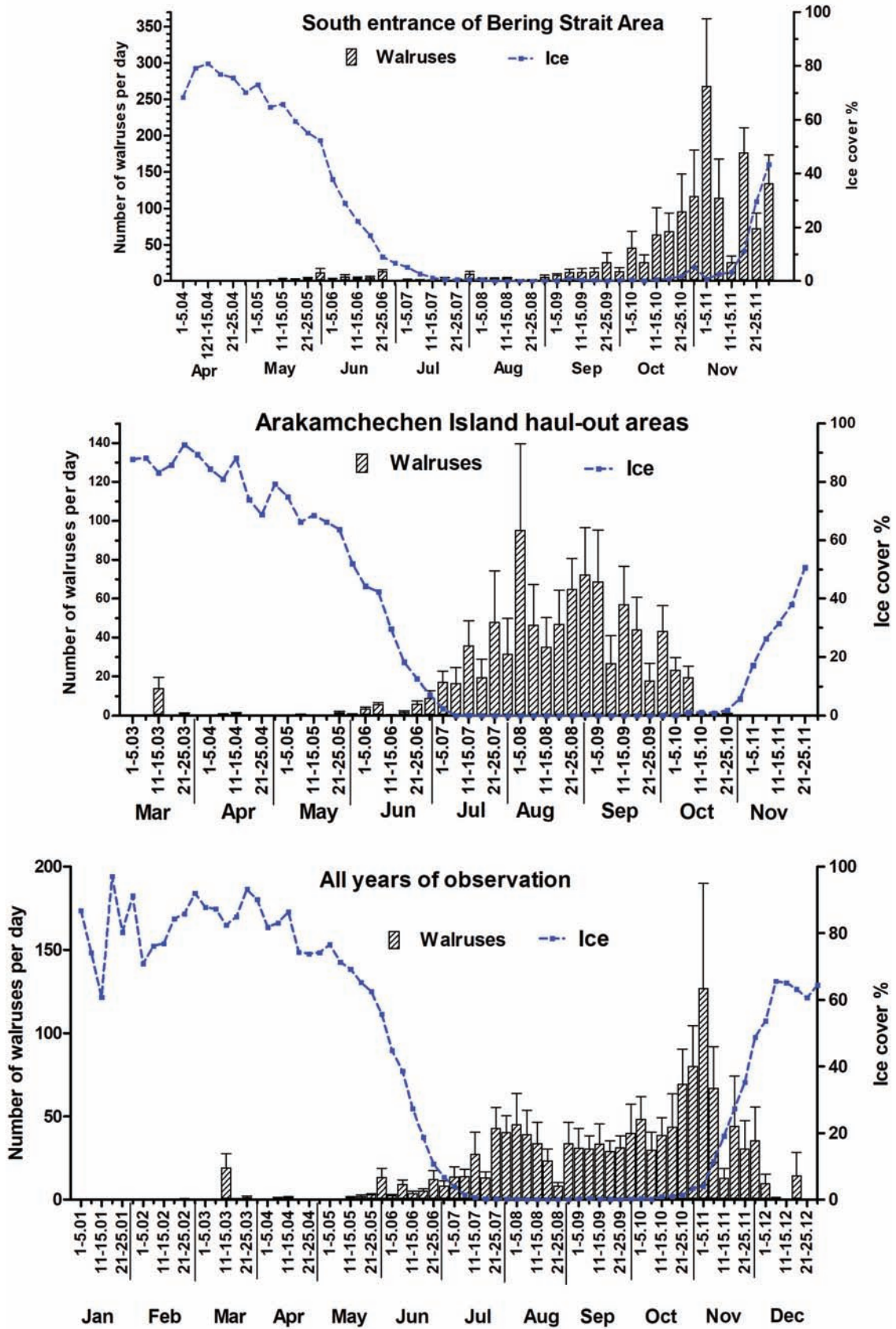


FIG. 5. Numbers of walrus observed in the Bering Sea, eastern coastal area of the Chukotka Peninsula for all years of observation. The top graph shows the area near the south entrance of the Bering Strait. The middle graph shows the Arakamchechen Island haul-out are. The bottom graph shows all years of observation averaged. Each bar represents five to six days. Percentage of ice coverage on all visible water is shown in blue. All data were provided by observers.

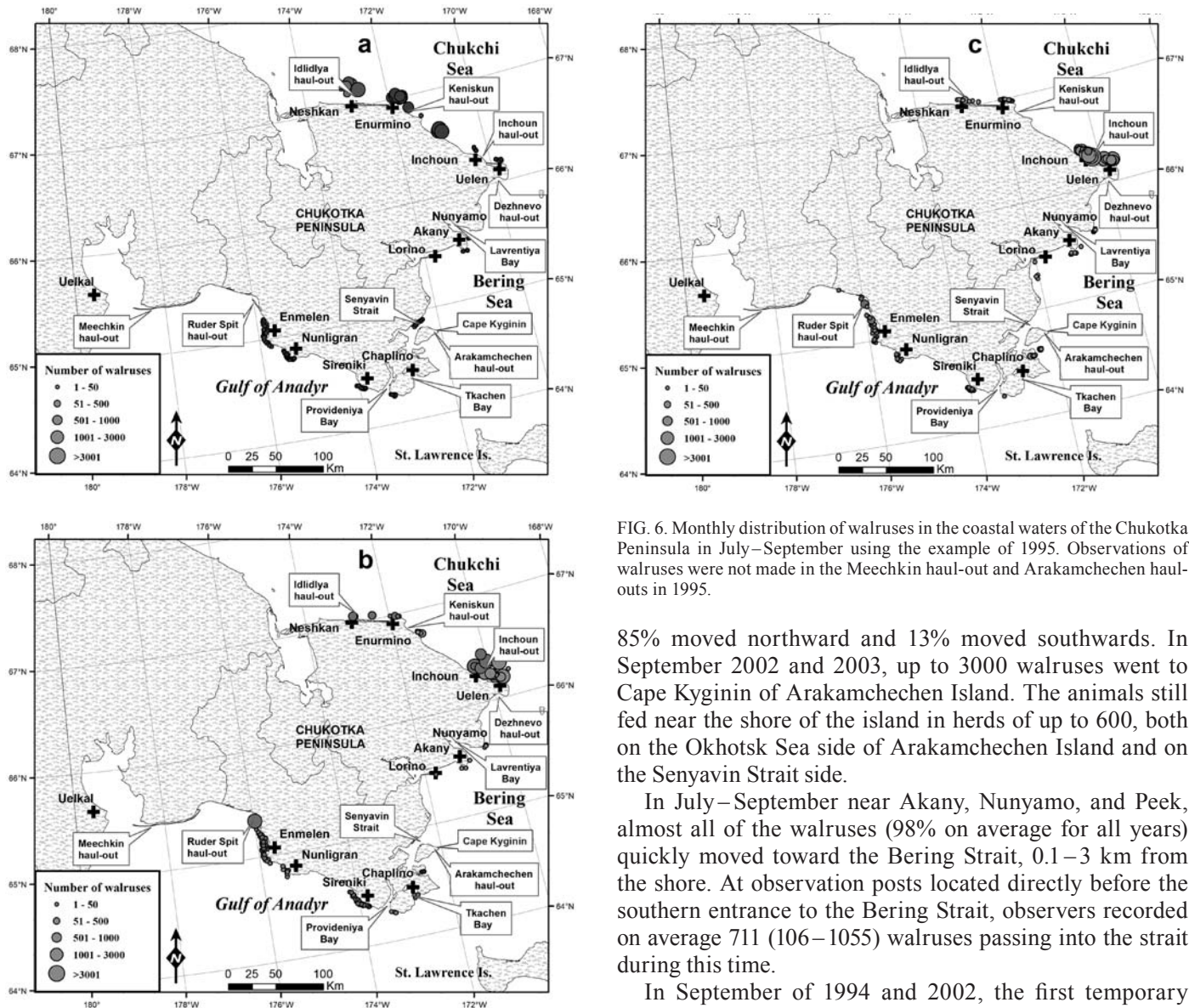


FIG. 6. Monthly distribution of walrus in the coastal waters of the Chukotka Peninsula in July–September using the example of 1995. Observations of walrus were not made in the Meechkin haul-out and Arakamchechen haul-outs in 1995.

On average for all years in September in the northwestern Gulf of Anadyr, 26% of the walrus were observed on haul-outs or in the water nearby (Table 2). Walrus were sighted in groups of 100–2000 animals. Large aggregations of animals were recorded, mainly in the area of Cape Bering, about 1–5 km from the shore. On 23 September 1994, walrus formed a haul-out of about 5000 individuals under the coastal cliff near Lake Yakeler. On average for all years in September near the village of Sireniki, 96% of the animals quickly left the gulf in small groups.

Bering Sea: In July 1999, there was a mass haul-out of up to 2500 walrus on the shore of Arakamchechen Island. The walrus came out on shore not only on Cape Kyginin where a stable coastal haul-out existed, but also on the eastern and western shores of Arakamchechen Island, which formed a temporary coastal haul-out, as well as on Nuniangan Island, a small island to south of Arakamchechen Island. On the shore, 33% of the walrus were counted (Table 3). Of the animals in the water,

85% moved northward and 13% moved southwards. In September 2002 and 2003, up to 3000 walrus went to Cape Kyginin of Arakamchechen Island. The animals still fed near the shore of the island in herds of up to 600, both on the Okhotsk Sea side of Arakamchechen Island and on the Senyavin Strait side.

In July–September near Akany, Nunyamo, and Peek, almost all of the walrus (98% on average for all years) quickly moved toward the Bering Strait, 0.1–3 km from the shore. At observation posts located directly before the southern entrance to the Bering Strait, observers recorded on average 711 (106–1055) walrus passing into the strait during this time.

In September of 1994 and 2002, the first temporary haul-outs of walrus were recorded at Capes Nunyamo, Yandogay, Peek, and in Dezhnevo Bay. The number of walrus on these coastal haul-outs ranged from a few dozen up to 500. On average about 27% of the animals were on the shore (Table 3).

Chukchi Sea: For July of all years of observation on average at the north Bering Strait, 64% of the walrus quickly moved to the north, while the rest migrated along the coast to the northwest. Seventy-five percent of the animals were counted on the ice (Table 4). July was the first month that walrus came out on the Inchoun haul-out. The first 30 walrus to come ashore on Inchoun Cape were recorded on 17 July 2003.

Near the villages of Enurmino and Neshkan in July, there were 30 individuals per day on average across all years. Drifting ice held 96%–97% of the walrus. During this period observers in whaleboats saw extensive herds of up to 3000 individuals on the ice 10–30 km offshore (Fig. 6). Walrus were usually located in groups of up to 100 individuals at a distance of 0.2–0.5 km from one another

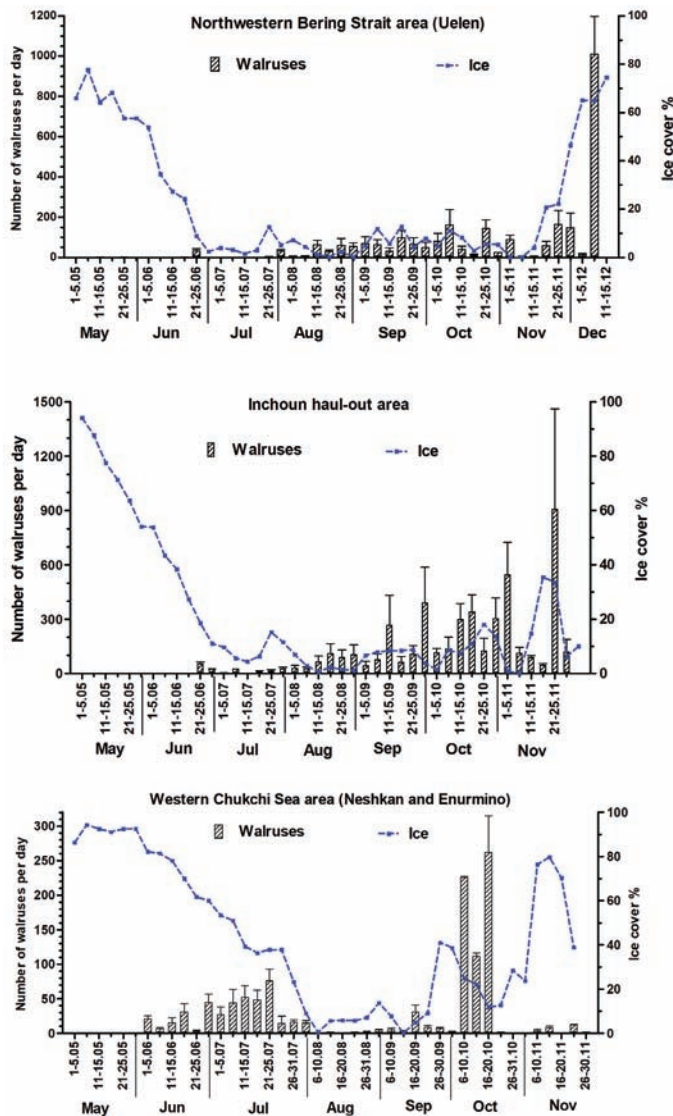


FIG. 7. Numbers of walrus observed in the Chukchi Sea, northern coastal area of the Chukotka Peninsula for all years of observation. The top graph shows the northwestern entrance of the Bering Strait area. The middle graph shows the Inchoun haul-out area. The bottom graph shows all years of observation (averaged). Each bar represents five to six days. Percentage of ice coverage on all visible water is shown in blue. All data were provided by observers.

and occupied an ice edge up to 2 km wide. The animals that were in the water had no distinct direction of movement. In the absence of ice, walrus went to the Idlidlya haul-out. In September, the number of observed walrus increased 2.5 times compared to in August and 4 times compared to in July. In September the walrus began moving to the east in small groups toward the haul-out in Keniskun Bay near Cape Serdtse-Kamen.

In September, walrus approached the Inchoun haul-out both from the west and east. In late September, walrus began to arrive on the Enmytagin haul-out located north of Inchoun. Here in late September 1996, observers counted up to 2000 walrus. Animals in the water moved both north (50%) and south to the Bering Strait (40%). In the absence of ice and in calm weather, observers saw large

groups of walrus (up to 1500) sleeping and feeding in the water across the horizon.

Walrus Distribution: October–November

In October with the beginning of the formation of ice, the movement of walrus from the Chukchi Sea into the Bering Sea began (Fig. 7). Therefore, the three areas are discussed in reverse order.

Chukchi Sea: Near Neshkan village the vast majority of the walrus were counted on the haul-out of Idlidlya Island, where up to 6000 were observed in October 1995. There, 97% of the animals in the water moved east. In the area of Enurmino village (Fig. 8a), walrus migrated to the east in large groups at a distance of 0.1–2 km from the shore. Sometimes it was a continuous stream of swimming animals. Up to 2000 walrus passed to the east during the four hours of daylight.

Every year in October walrus hauled out on shore to the north of Inchoun. Sixty percent of the walrus were observed on shore haul-outs and 8% on ice in the Inchoun area. At this haul-out observers counted up to 10 000 walrus on 16 October 1996. The vast majority of animals in the water moved to the west, not to the east, likely to follow the fall migration. In the Uelen area, 70% of the walrus in the water moved towards the Bering Strait. At the same time, about 30% of the animals left the strait. Some of the animals headed to the west towards the Inchoun haul-out. During calm weather in the absence of ice, large groups of walrus slept on the surface of the water.

Typically each year in November in the southern part of the Chukchi Sea, there was an intensive ice formation. In the Neshkan–Enurmino area, the relative numbers of walrus decreased (Fig. 8b). While in October there had been 55 individuals per day in this location, there were only six in November. If pack ice had not yet been established, 80% of the walrus drifted on ice. All animals that were in the water moved to the east.

Around Inchoun village, 39% of the walrus were counted on the ice and 36% on coastal haul-outs. If ice near the shore was absent, 30% of the animals moved towards the Bering Strait and 70% moved toward the north. Near Cape Uelen, the majority of walrus were counted on the ice. At the same time, observers noted that there were many females with calves among the walrus both in the water and on the ice. Ninety-three percent of the walrus headed to the Bering Strait and 7% moved north and west.

Bering Sea: In October at the southern end of the Bering Strait, walrus formed temporary coastal haul-outs on shore at Cape Peek and Dezhnevo Bay. The number of walrus in such haul-outs ranged from several hundred to 3000 individuals. Females with calves preferred to lie separately from other walrus. When the ice appeared, not all of the walrus moved onto it; some of the animals remained on the shore. There was no pronounced direction of movement of the walrus in the water.

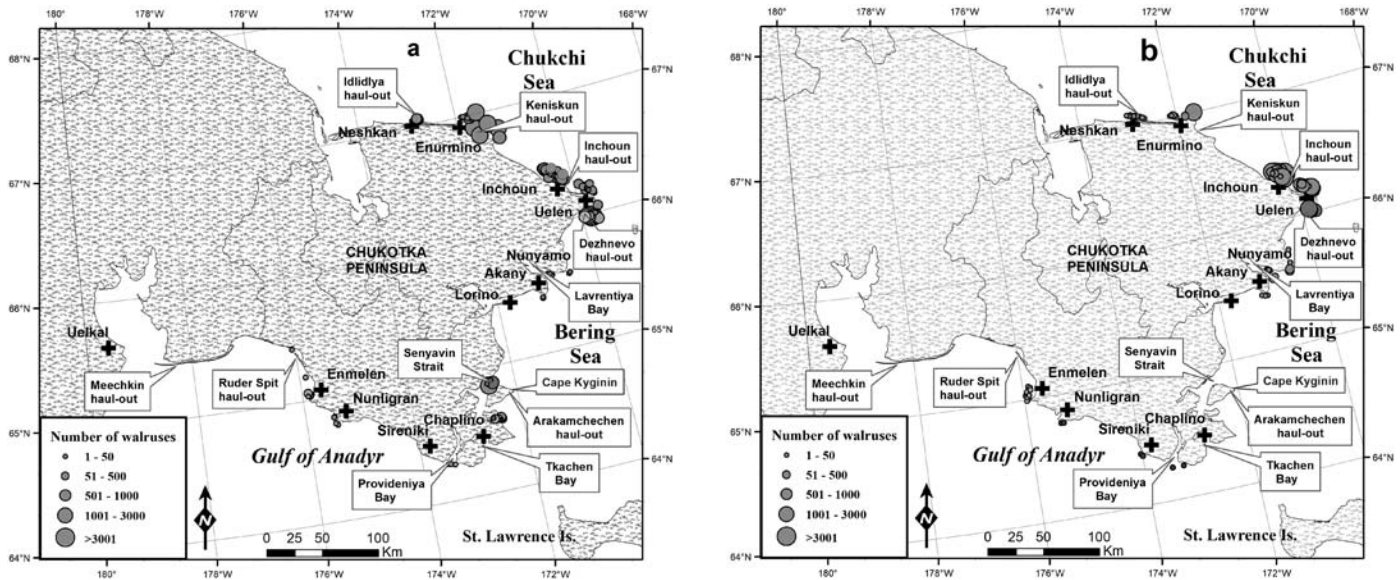


FIG. 8. Monthly distribution of walrus in the coastal waters of the Chukotka Peninsula in autumn using the example of 1995. Observations were not made at haul-outs in November 1995.

In the Lavrentiya Bay area in October, the walrus formed a temporary haul-out on Cape Nunyamo. Usually there were only a few dozen individuals; however, in some years, many more were counted. For instance, on 15 October 1999 800 walrus were observed on shore. About a third of the animals (28%) still moved in a northeasterly direction.

In the Arakamchechen Island area, walrus were seen mainly on coastal haul-outs in October, and 500–2000 individuals were counted. On Nuniangan Island, up to 1000 were observed. In the Chechekuyum Strait, up to 300 walrus were observed in the water.

Gulf of Anadyr. Near the village of Sireniki, observers saw small groups (five on average) and single walrus every autumn, 96% of which moved to the east and northeast. By October near Nunligran village, the number of walrus decreased markedly. In the northwestern part of the gulf where shore haul-outs are located, observers recorded a few individuals up to herds of several thousand animals that were feeding near the shore or moving along it. Sometimes walrus in a dense column of roughly 3000 individuals quickly passed along the coast to the south or southeast. By November, no walrus were recorded on the shore haul-outs in this area.

DISCUSSION

For a long time, the winter distribution of walrus was presumptive because of a lack of wintertime walrus habitation studies. Belopolsky (1939) believed that the wintering area of walrus was located in the northern part of the Bering Sea. He noted that the Chukchi from Bering Cape and Cape Chaplin sometimes harvested walrus 20–30 km offshore in January and February. He assumed

that in winter walrus were concentrated in the area of St. Lawrence Island. Nikulin (1940) also believed that walrus inhabited the shallow zone of the northern part of the Bering Sea in winter, and noted that Chukotka hunters believed that there was a large aggregation of walrus near St. Lawrence Island, 50–60 km from the mainland shore of Chukotka. To date, there remains an incomplete understanding of the distribution of walrus in winter. According to the literature, single walrus can remain for the winter in the Chukchi Sea (Fay, 1982). Walrus have been seen in January mainly in the St. Lawrence Island area, but also in Bristol and Kuskokwim Bays in the area of Nunivak and Nelson Islands, and also in the area of Port Moller. On the Russian side, walrus have been seen in the area of the ice front to the east of Cape Navarin, as well as south and west of St. Matthew's Island, Alaska, USA (Brueggeman and Grotefendt, 1984).

Our data showed that in December when the ice formed late, walrus still continued to move from the Chukchi Sea to the Bering Sea. In January–February, these animals were almost absent in the coastal area of the Chukotka Peninsula and encounters with them were rare.

In March 1987, walrus were encountered throughout the entirety of the Gulf of Anadyr. The highest concentrations were observed in the southeastern, northern, and western parts of the gulf (Mymrin et al., 1990). Literature sources point out the large variability of encounters with walrus on ice, as well as the size of walrus groups (Estes and Gol'tcev, 1984; Mymrin et al., 1990).

In the northern Gulf of Anadyr, the number of walrus observed increased in March compared to February, but this does not occur annually. During March, observers recorded animals only on ice. In March, in the eastern shore waters of Chukotka, the number of observed walrus increased

70%. In most cases these were only single animals and small groups.

It has long been known that walrus are seasonal migrants (Belopolsky, 1939; Nikulin, 1940). The beginning of the walrus migration to the north was noted as early as March by Heptner et al. (1976) and Fay (1982). In March, our observers did not register any movement of walrus in the direction of the Bering Strait from Anadyr Bay or the eastern shore of Chukotka. Moreover, walrus moved along the coast to the south in the direction of the Gulf of Anadyr. Observers began reporting the movement of walrus in the direction of the Bering Strait in April.

Walrus moved to the north not only during the spring, but throughout the summer months and even in early autumn. During the summer, our data showed that the relative number of walrus in the northern part of the Gulf of Anadyr gradually increased, despite the constant movement of animals from the Gulf (Table 2). This increase in numbers can be explained by the possible approach of walrus from the southern regions of the Bering Sea. Walrus leave the Bering Sea travelling toward the Chukchi Sea not only in summer, but also in early autumn. Observers reported that walrus move mostly at night, and it is likely that our observers also missed animals migrating during stormy weather. Therefore, I assume that the movement of walrus in the Chukchi Sea from July to September was much greater than registered by observers.

Most researchers explain the migration to the north by the strong attachment of the walrus to the ice, especially females with calves (Nikulin, 1940; Fedoseev, 1962, 1982; Tomilin and Kibalchich, 1975). On ice, walrus can rest on a solid substrate where they have almost no enemies (Fay, 1982). Therefore, it is natural to assume that in the summer walrus move to the edge of the drifting ice. However, in the second half of the summer and in early autumn, the ice edge is located far to the north of the Chukchi Sea. In order to reach the ice edge, a great deal of energy is necessary.

In recent years, there has been an increasing number of reports of the formation of very large coastal haul-outs of walrus between capes Serdtse-Kamen and Inkigur (Kochnev, 2010a; Chakilev et al., 2015). The haul-out in the area of Cape Serdtse-Kamen dates to at least the 1930s (Nikulin, 1940; Gol'tcev, 1968; Fedoseev and Raslivalov, 1986); however, the large number of walrus seen recently was not previously mentioned. It has been suggested that the large number of walrus on the haul-out is due to the warming of the Arctic and the drift of ice far to the north (Kochnev, 2010a).

The data from this study suggest that in the summer and early autumn, walrus leave the Gulf of Anadyr, move along the coast of Chukotka and after passing through the Bering Strait, either head north or northwest in the direction of shore haul-outs on the Inchoun and Inkigur Capes and further to Serdtse-Kamen. In addition, starting in September, walrus swim en masse east along the shore from the Long Strait and Kolyuchin Island to Cape Serdtse-Kamen. They also head in the same direction from Wrangel

Island (Fedoseev, 1962). Moreover, according to the results of satellite tagging (Jay et al., 2012), walrus move from the northeast of the Chukchi Sea in the Cape Serdtse-Kamen area. Consequently, walrus migrate not only from the western and northeastern parts of the Chukchi Sea, but also from the Bering Sea.

In 2004, an unusual abundance of macrobenthos was found in the southeastern part of the Chukchi Sea (Sirenko and Gagaev, 2007) where the clam *Macoma calcaria*, a favourite food of the walrus, dominated large areas. It can therefore be assumed that the purpose of the summer and autumn movements of walrus in the Chukchi Sea is to feed at fields with an unusually high abundance of molluscs.

CONCLUSION

At the beginning of winter in December, when the ice forms late, walrus continue to migrate from the Chukchi Sea. Later, in January and February walrus are almost absent off the shore of the Chukotka Peninsula. The number of walrus in the coastal waters of the Chukotka Peninsula begins to increase during March. There is large inter-annual variability in the number of walrus in these areas.

Walrus begin to move in the direction of the Bering Strait in April. Animals migrate from the Bering Sea to the Chukchi Sea not only during the spring, but throughout the summer months and early autumn. According to the observations from the posts located at the southern entrance of the Bering Strait from July to September, at least 1000 walrus pass into the Chukchi Sea.

By the autumn, walrus migrate in the direction of the northeastern nearshore waters of the Chukotka Peninsula not only from the western and northeastern parts of the Chukchi Sea, but also from the Bering Sea. It can be assumed that the purpose of the summer and autumn migration of walrus is not only to reach shore haul-outs, but mostly to find fields with a high abundance of molluscs that are located from the southern part of the Chukchi Sea to the north of Cape Serdtse-Kamen.

In the northwestern part of the Gulf of Anadyr, in the area of the haul-outs, the relative number of walrus during the summer remains stable and decreases only with the appearance of ice in October–November.

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