Seasonal changes in distribution, abundance and numbers of waders in relation to lemming population cycles in the west Siberian tundra

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Results from the monitoring of numbers of waders and lemmings are presented for the west Siberian tundra based on studies undertaken at five sites between 1986 and 1990. Bird counts were made from the second half of June until the end of August. When favourable wader breeding conditions occur (*i.e.* in those years with peak lemming numbers) the extent of the early departure of waders during the first half of summer is minimal and intense migration occurs only in the post-breeding period. In unfavourable seasons, *i.e.* during the sharp decline of lemming numbers, intense departure takes place in the first half of summer, while post-breeding migration is rather weak, if there are no birds moving from neighbouring areas. During the breeding period the total number of waders in tundras of the west Siberian plain is about 19-20 million individuals, 27% of these birds inhabiting the arctic tundra subzone, 43%, 14%, and 16% occurring respectively in the northern, middle, and southern parts of the subarctic tundra subzone. In the post-breeding period the total number of waders in the region increases approximately to 27 million individuals: 67% of these occur in the arctic tundra subzone, 15%, 5%, and 13% - occurring respectively in the northern, middle, and southern parts of subarctic tundras. Therefore, the number of waders in the post-breeding period increases in the arctic tundras, and decreases in the subarctic tundras. In the subarctic tundras rapid emigration of birds to both the northern and southern areas occurs even in those years with high breeding success.

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Приведены результаты мониторинга численности куликов и леммингов в тундрах Западной Сибири на основе исследований, проведенных в пяти местах в период с 1986 по 1990 гг. Учеты птиц проводились со второй половины июня до конца августа. Во время благоприятных условий для гнездования куликов (т.е. в годы с пиком численности леммингов), степень раннего отлета куликов во время первой половины лета минимальна и интенсивная миграция проходит только в послегнездовой период. В неблагоприятные сезоны, т.е. во время резкого спада численности леммингов, наоборот интенсивный отлет происходит в первой половине лета, тогда как послегнездовая миграция довольно слаба, (в случае, если нет перемещений птиц из соседних регионов). В гнездовой период общее число куликов в тундрах западносибирской равнины насчитывает 19-20 миллионов особей, притом 27% этих птиц населяют подзону арктических тундр, а соответственно 43%, 14%, и 16% обитают в северной, средней и южной частях подзоны субарктических тундр. В послегнездовой период общее число куликов в регионе достигает приблизительно 27 миллионов особей: из них 67% встречаются в подзоне арктических тундр, и соответственно 15%, 5%, и 13% в северной, средней и южной частях субарктических тундр. Следовательно, численность куликов в послегнездовой период возрастает в арктических тундрах и сокращается в субарктических тундрах. В субарктических тундрах быстрый отлет в северный и южный регионы происходит даже в годы с высоким успехом размножения.

Introduction

The correlation between breeding success, particularly that of waders, with the numbers of tundra lemmings was first noticed by Larson (1960), later also by Ryabitsev *et. al.* (1976), and Roselaar (1979). A number of publications where this relationship has been discussed in detail have appeared recently (Summers & Underhill 1987; Martin & Baird 1988; Mason 1989; Underhill *et. al.* 1989; Kalyakin 1992). The highest breeding success is usually recorded in seasons with peak numbers of lemmings, as at this time the predators are feeding mostly on lemmings. The lowest reproductive success is observed the following year, *i.e.* at the time of a sharp decrease in lemming populations. As a result, the predators which have increased their numbers due to high breeding success the year before are compelled to switch to feeding on birds, their eggs and chicks. The next year (that before the next lemming peak) the predator population is reduced and usually birds show a medium breeding success.

Weather conditions on the breeding grounds certainly also influence the reproductive success of tundra birds (Summers & Underhill 1987). When the weather is favourable and predators are absent the breeding success can be very high, even in the year before peak lemming numbers (but as a rule not higher than a peak year). A high breeding success of waders was observed in 1990 the year before peak numbers of lemmings at the Taimyr Peninsula (Yurlov 1993).

Three-year Lemming cycles are usually observed in the tundra zone of the west Siberian plain and these fluctuations are usually synchronous over the whole region. In recent years peaks were observed in 1985, 1988 and 1991, depressions in 1986 and 1989, and low numbers and the beginning of lemming population increases in 1987 and 1990.

Materials and Methods

Most data were obtained at five study areas during the summers of 1986-1990 (Figure 1). Bird counts were made both at inland habitats and along river-banks, lake shores and marine bays from the second half of June until the end of August. Census data were averaged separately for the period from the second half of June to the end of July (the breeding period, or the first half of summer), and for August (the post-breeding period, or the second half of summer). Data collection and processing were conducted according to the published methods (Ravkin 1967, 1991).[1] In the analysis of numbers and average densities we have also used some published materials (Kucheruk *et. al.* 1975; Ryzhanovsky *et. al.* 1978; Danilov *et. al.* 1984) and unpublished data supplied by V.G. Kozin, V.A. Yudkin, V.M. Anufriev and E.S. Ravkin which was collected at the Tazovsky Peninsula (1990, 1991), southern Yamal (1980) and the east bank of the Yenisey river (1978). All the passage birds records

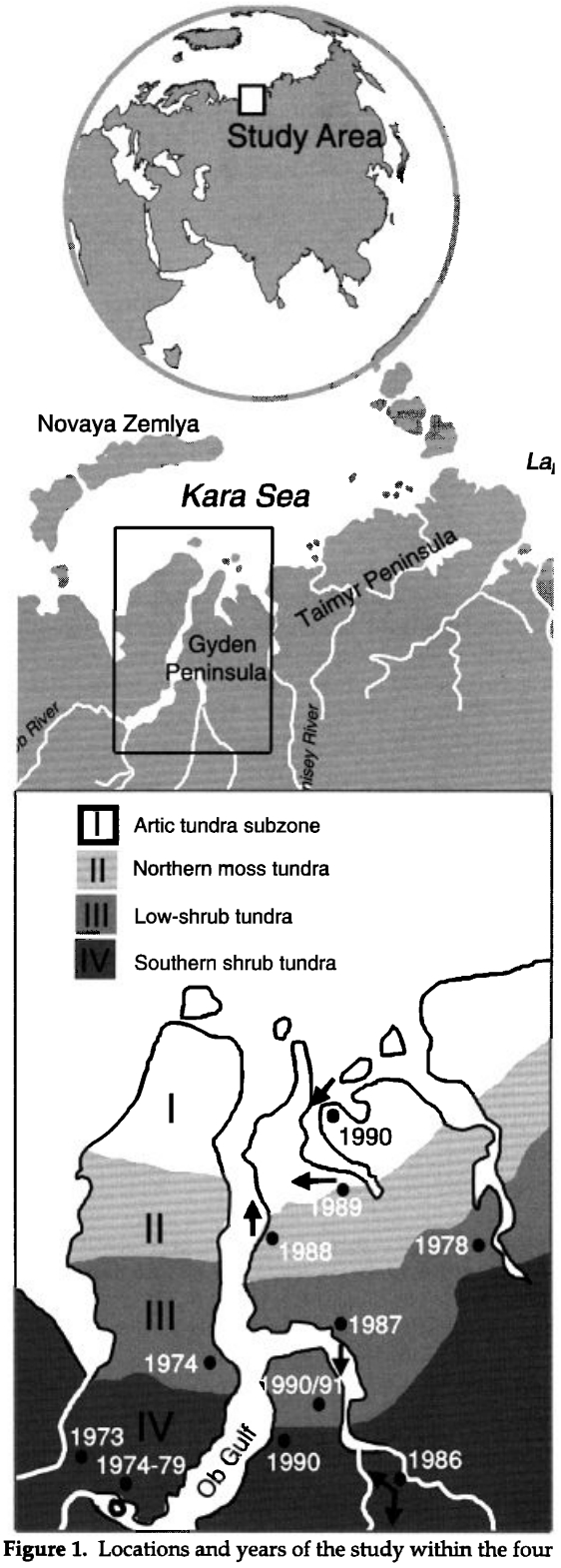

Figure 1. Locations and years of the study within the four arctic and sub-arctic vegetation subzones in the study area. Arrows show the main directions of wader migration observed in June-July.

were used to estimate the intensity of waders visual migration regardless of whether they were observed on the census routes.

Average densities and numbers of waders were calculated taking into account the extent of different habitats. These data were taken from the map "Vegetation of West-Siberian Plain" (scale

1:1,500,000; GUGK 1976). According to the geobotanical division presented in this map, two subzones are recognised within the tundra zone: arctic and subarctic tundras. The latter is divided into three subzones: 1) northern moss tundras, 2) low-shrub tundras, and 3) southern shrub tundras (Figure 1).

Results

Waders start departure back to their winter quarters not long after their arrival on the breeding grounds. In June and July, according to visual observations, these movements are hardly noticeable (Figure 2), and the best way to outline the emigration of waders is the comparison of data from regular wader counts on transect routes (Figure 3).

The total density of waders during the breeding period in southern shrub subarctic tundras in summer 1986 (when a strong depression of lemming numbers occurred) was close to the average density for the whole long-term study, while in the post-breeding period in 1986 these densities were twice lower (Table 1). Ruff *Philomachus pugnax*, Temminck's Stint *Calidris temminckii* and Golden Plover *Pluvialis apricaria* prevailed among those few birds observed passing in July and August.

In 1987 in the low-shrub subarctic tundras, when lemming abundance was low but had started to increase, the total density of waders declined during the first half of summer due to the partial departure of Ruff. Later, in the second half of July, total wader abundance changed only slightly. Visual migrations that year were very weak, only in the last five days of August were intense movements of waders recorded along the Tazovskaya Gulf coasts. Dunlin *Calidris alpina*, Temminck's Stint and some other small sandpipers (*Calidris* spp.) were the most frequently seen migrating waders.

During the breeding period the largest densities and numbers of waders were recorded in the subzonal belt of northern moss subarctic tundra. There, the largest densities and numbers were found at the beginning of the breeding season 1989 - *i.e.* the year after the season of high breeding success due to peak lemming numbers (1988). In the period from 15 June to 15 July, total density of waders in 1989 was in 2.6 times higher than in the same period in 1988[2]

Seasonal density dynamics in waders also differed between those two contrasting years (Figure 3). In 1988 total wader density slightly decreased during the second half of June due to the seasonal decline in densities of Curlew Sandpiper *Calidris ferruginea*, Pintail Snipe *Gallinago stenura* and Pacific Golden Plover *Pluvialis fulva*. In the second half of July the total wader density increased by 2.2 times after successful breeding, mostly due to Pacific Golden Plover, Little Stint *Calidris minuta* and Ruff. A gradual decline of wader density later occurred again, as post-breeding movements of birds started (during the first half of August, Pacific Golden Plovers and some Little Stints, then also Ringed Plovers *Charadrius hiaticula* departed). Nevertheless, the total density of waders remained rather high during the second half of August, compared with the other subarctic subzones of the region.

In 1989 an intense departure of waders occurred during the second half of June and first half of July due to an unfavourable situation for breeding (high predator pressure, mostly of Arctic Fox *Alopex lagopus*). At first many Little Stints and Red-necked Phalaropes *Phalaropus lobatus* disappeared, but departure was less pronounced in Temminck's

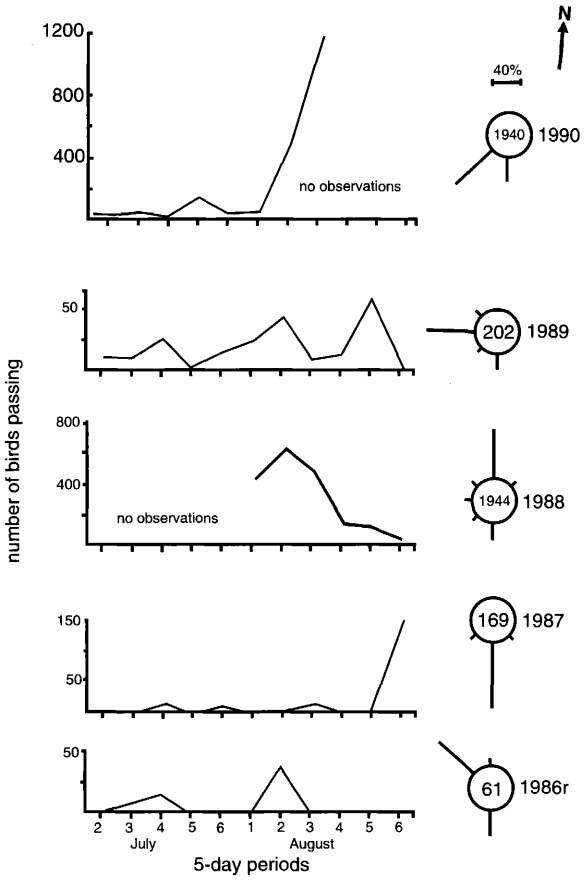

Figure 2. Timing and directions of wader migration in different areas of the tundra zone of West-Siberian Plain. Numbers in circles are the total number of birds recorded on migration, with numbers moving in each direction shown by the length of the line from the circle.

[1]This method has been derived forest passerines and has not been checked (although widely used in Russia) for waders. Therefore the results on wader densities (expressed further in ind./km²) should be interpreted with caution. Editors

[2]The high density of waders in the central and probably southern belts of the regional tundra in 1989 can be explained also by extremely unfavourable weather for birds breeding (very late and cold summer) at least at the Taimyr and nearby region (P. Prokosh & H. Hötker 1989. *Wadden Sea Newsletter* 2: 36-38) which prevented dispersion of birds in that direction. Editors.

Table 1. Seasonal changes of wader numbers in tundra zone of West-Siberian Plain in connection with lemming cycles.

Tundra subzone	Year(s)	Average wader abundance (ind./km²)		Minimum no. of birds		Lemming abundance	Combined data for 1971-1991 Average wader abundance (ind./km²)		Minimum no. of birds	
		early summer	late summer	early summer	late summer		early summer	late summer	early summer	late summer
Subarctic tundra	1986-89	62	31	15.1	7.6		57	35	14.0	8.9
Southern shrub subzonal belt	1986	33	18	3.1	1.6	Very small	33	37	3.1	3.5
Low-shrub subzonal belt	1987	55	25	3.8	1.7	Small	37	18	2.6	1.3
Northern moss belt	1988	99	91	8.0	7.3	Very large	102	49	8.2	4.1
Northern moss belt	1989	107	13	8.5	1.1	Small				
Northern moss belt	1988-89	103	52	8.2	4.2					
Arctic tundra	1990	88	314	5.2	18.2	Moderate	87	311	5.2	18.2
Total for tundra zone	1986-1990	67	85	20.3	25.8		63	91	19.2	27.0

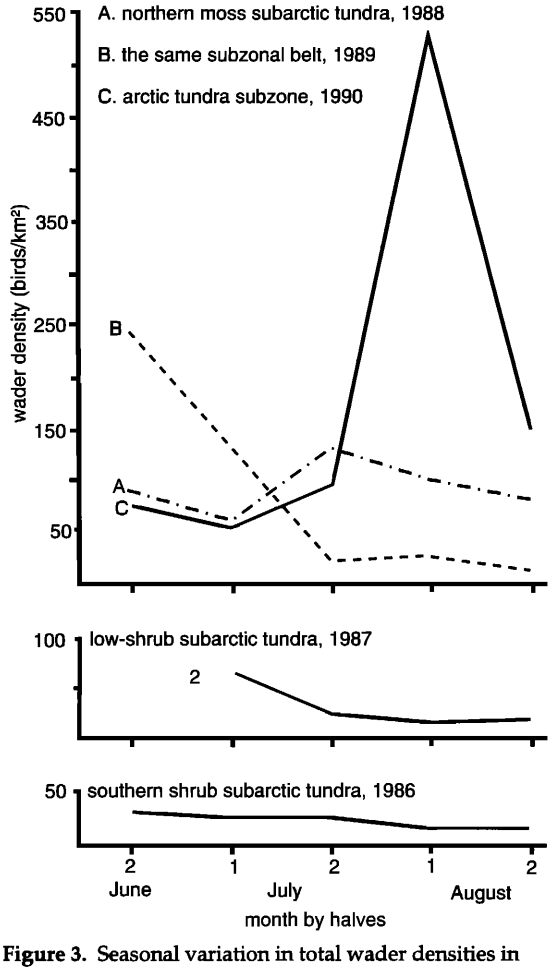

Figure 3. Seasonal variation in total wader densities in different areas of West-Siberian Plain.

Stints, Dunlins and Pacific Golden Plovers. Later, mostly Ruffs were departing and migration of Red-necked Phalaropes, Dunlins and Little Stints continued. After the second half of July through to the second half of August the total density of waders in northern moss tundra subzone was similar to that in southern shrub tundras. On average, the density of waders from the second half of July until the end of August 1988 was 4.4 times higher than in 1989. In 1989 the total wader density and their numbers decreased after the first half of summer by *c.* 7.6-7.7 times, while in 1988 the density remained rather constant. The expected post-breeding density increase was rather slight that year and as waders quickly started post-breeding departure their numbers in the study area lowered rapidly.

Intensity, directions and other aspects of summer movements differed greatly between 1988 and 1989 according to observations (Figure 2). The intensity of post-breeding movements in 1988 was 10 times higher than in 1989. In 1988 the migration peak occurred between 1-15 August, while in 1989 migration was rather weak and two periods of emigration activity were observed between 5-10 and 21-25 August. Most waders migrated along the shores of marine bays: in 1988 to the north along the Ob Gulf coast, and in 1989 to the west along the Gydanskaya Gulf coast. Ruffs and Little Stints prevailed among migrants in August 1988 (respectively 61% and 12%), numbers of Dunlin (9%) and Pacific Golden Plover (8%) were less, and of Curlew Sandpiper, Ringed Plover, Red-necked Phalarope and Temminck's Stint - even less (1-2%). In 1989 Ruffs, Pacific Golden Plovers and Red-necked Phalaropes prevailed on migration (respectively 51%, 16% and 11%). In both years migration dynamics were determined mostly by the intensity of passage in Ruff.

In 1990 the studies were conducted in the arctic tundras. During that year numbers of lemmings were low but had started to increase, the densities and numbers of waders during the breeding season were larger than in the southern shrub and low-shrub subarctic tundra subzones, but lower than in the northern moss subarctic subzone. Intense post-breeding migration of waders in south-western and

Table 2. Distribution and average abundance of waders in tundra zone of the west Siberian Plain in 1971-1991 (ind./km²).

	Southern shrub tundra		Low-shrub beltt		Northern moss tundra		Average for sub-arctic tundra		Arctic tundra		Average for whole tundra zone	
	e.s.	l.s.	e.s.	l.s.	e.s.	l.s.	e.s.	l.s.	e.s.	l.s.	e.s.	l.s.
Total	33	37	37	18	102	49	57	35	87	311	63	91
Common Sandpiper *Actitis hypoleucos*	<0.008	-	-	-	-	-	<0.003	-	-	-	<0.002	-
Greenshank *Tringa nebularia*	-	0.006	-	-	-	-	-	0.002	-	-	-	0.002
Whimbrel *Numenius phaeopus*	0.6	0.3	0.08	-	-	-	0.3	0.1	-	-	0.2	0.09
Terek Sandpiper *Xenus cinereus*	0.2	0.003	0.2	0.06	-	-	0.1	0.02	-	-	0.1	0.01
Golden Plover *Pluvialis apricaria*	1.0	0.9	1.0	0.7	-	-	0.7	0.5	-	-	0.5	0.4
Jack Snipe *Lymnocryptes minimus*	0.2	0.3	0.9	0.1	0.3	-	0.4	0.1	-	-	0.3	0.1
Wood Sandpiper *Tringa glareola*	8.0	8.0	5.0	2.0	0.2	0.1	5.0	4.0	-	-	4.0	3.0
Common Snipe *Gallinago gallinago*	0.6	0.007	2.0	0.7	1.0	0.6	1.0	0.4	-	-	0.9	0.3
Pintail Snipe *Gallinago stenura*	0.3	0.6	0.7	0.3	3.0	1.0	1.0	0.6	-	-	1.0	0.5
Red-necked Phalarope *Phalaropus lobatus*	11.0	3.0	9.0	5.0	10.0	3.0	10.0	4.0	8.0	19.0	10.0	7.0
Temminck's Stint *Calidris temminckii*	0.3	0.1	4.0	3.0	2.0	0.5	2.0	1.0	3.0	27.0	2.0	6.0
Ruff *Philomachus pugnax*	10.0	23.0	9.0	4.0	20.0	11.0	13.0	14.0	1.0	70.0	11.0	25.0
Ringed Plover *Charadrius hiaticula*	0.03	0.2	0.3	0.2	1.0	2.0	0.4	0.8	3.0	0.6	0.9	0.8
Little Stint *Calidris minuta*	0.01	<0.008	2.0	0.1	34.0	16.0	12.0	5.0	46.0	85.0	18.0	21.0
Bar-tailed Godwit *Limosa lapponica*	0.2	0.1	0.7	-	0.04	0.08	0.3	0.06	0.05	0.06	0.2	0.2
Pacific Golden Plover *Pluvialis fulva*	0.01	0.05	0.3	0.3	17.0	13.0	6.0	4.0	0.9	31.0	5.0	10.0
Dunlin *Calidris alpina*	0.06	0.02	1.0	1.0	9.0	1.0	3.0	0.6	5.0	31.0	4.0	7.0
Spotted Redshank *Tringa erythropus*	0.005	0.1	0.3	0.03	-	0.09	0.09	0.08	0.02	0.05	0.07	0.07
Grey Plover *Pluvialis squatarola*	0.008	0.001	0.3	0.2	0.08	0.03	0.1	0.07	5.0	3.0	1.0	0.6
Curlew Sandpiper *Calidris ferruginea*	-	-	0.001	-	4	0.2	1.0	0.07	11.0	41.0	3.0	8.0
Sanderling *Calidris alba*	-	-	0.02	-	-	0.006	0.006	-	0.008	0.8	0.006	0.2
Turnstone *Arenaria interpres*	-	-	0.008	-	0.001	0.003	0.003	0.001	3.0	2.0	0.6	0.4
Pectoral Sandpiper *Calidris melanotos*	-	-	0.2	-	0.3	-	0.2	-	0.4	<0.001	0.2	<0.002
Great Snipe *Gallinago media*	-	-	-	-	0.02	0.03	0.007	0.01	-	-	0.005	0.008
Dotterel *Charadrius morinellus*	-	-	-	-	<0.002	-	<0.007	-	0.6	-	0.1	-
Grey Phalarope *Phalaropus fulicarius*	-	-	-	-	-	-	-	-	0.3	0.02	0.06	0.004

e.s. early summer l.s. late summer

southern directions took place between 6-15 August. From observations, Little Stint and Ruff prevailed (41% and 31%), with numbers of Curlew Sandpipers (9%), Dunlins (4%), and other waders being less. Average densities and numbers of waders in August were 3.5 times higher than in the breeding period; probably connected with immigration of birds from southern areas.

Discussion

From the data presented it can be seen that when favourable breeding conditions occur (*i.e.* in those years with peak lemming numbers) the extent of the early departure of waders during the first half of summer is minimal and intense migration occurs only in the post-breeding period. In unfavourable seasons, *i.e.* during the sharp decline of lemming numbers, intense departure takes place in the first half of summer, while post-breeding migration is rather weak, if there are no birds moving from neighbouring areas.

A peak of post-breeding migration was observed in August; the exact dates varied between years depending on the phenology of the breeding season. Thus, after the early summer of 1988, most migration occurred between 6-10 August. In 1990 the summer was rather late and most waders migrated between 11-15 August (this was probably connected also with zonal differences in dates of breeding). In 1987, when the summer was unusually late, most migrating waders passed between 25-30 August.

As to the directions of post-breeding movements, it is known that waders prefer to follow the coastlines of marine bays. The intense post-breeding migration of waders observed in 1988 mostly in a northern direction along the coasts of the Ob Gulf was rather unexpected, although some observations of slightly pronounced northwards movements have been already described for both breeding and post-breeding periods (Gromadzka 1985; Kistchinski 1988; Kretchmar *et al.* 1991). In 1988 it was mostly Ruffs that were migrating northwards; the appearence of birds to the north of their breeding grounds is characteristic of this species (Dementiev *et al.* 1951). Almost all the Red-necked Phalaropes (which were observed in flight), most Curlew Sandpipers, half the Little Stint and Dunlin, and a third of the Pacific Golden Plovers also migrated northwards. Further migration of these birds towards their wintering grounds probably runs through the northern parts of the Yamal Peninsula and then westwards along the arctic coast.

On the basis of all the data for 1971-1991, the total density of waders in the breeding period in southern shrub and low-shrub subarctic tundras is about 33 to 37 ind./km^2, while in the northern moss subarctic tundra it is approximately three times higher (Table 2). In the arctic tundras the total density of waders again decreases by 15%. During the post-breeding period the numbers of waders in southern tundras remain rather stable, while in low-shrub and northern moss tundras it is at least twice as low. On average for the whole subactic tundra subzone, densities of waders in the post-breeding period decline by half, while in the arctic tundra subzone they increase by a factor of three to four. During the breeding period the total number of waders in tundras of the west Siberian plain is about 19-20 million individuals, 27% of these birds inhabiting the arctic tundra subzone, 43%, 14%, and 16% occurring respectively in the northern, middle, and southern parts of the subarctic tundra subzone. In the post-breeding period the total number of waders in the region increases approximately to 27 million individuals (by 40-41%): 67% of this number occur in the arctic tundra subzone, 15%, 5%, and 13% - occurring respectively in the northern, middle, and southern parts of subarctic tundras. Therefore, the number of waders in the post-breeding period increases in the arctic tundras, and decreases in the subarctic tundras. In the subarctic tundras rapid emigration of birds to both the northern and southern areas occurs even in years with high breeding success.

Besides the 26 wader species listed in Table 2, six more species are known for the Yamal Peninsula: Lapwing *Vanellus vanellus*, Oystercatcher *Haematopus ostralegus*, Green Sandpiper *Tringa ochropus*, Purple Sandpiper *Calidris maritima*, Knot *Calidris canutus* and Woodcock *Scolopax rusticola* (Danilov *et. al.* 1984). We do not yet have any data on their numbers in the study region.

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