

**INTERNATIONAL
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**Mauri Leivo, Timo Asanti, Jari Kontiokorpi, Harri Kontkanen,
Markku Mikkola-Roos, Ari Parviainen and Pekka Rusanen**

Survey on arctic bird migration and congregations in the White Sea, autumn 1999





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Cover pictures: Mauri Leivo

Front cover (larger photo): A total sum of the migrating Barnacle Geese (*Branta leucopsis*) during the White Sea expedition was over 34,000 birds.

Front cover (smaller photo): Famous 'Finnsticks' were used to keep binoculars steady and reduce muscle fatigue.

Back cover: A flock of Long-tailed Ducks (*Clangula hyemalis*) passing the Zizginski Island.

Paino: Edita Oyj, Helsinki 2001

Summary

The White Sea ornithological expedition took place between 21st September and 10th October 1999, and was organised by the Finnish Environment Institute as part of the RECMAB project (Research, Conservation and Monitoring Project of Migratory Arctic Birds in the Baltic Sea and White Sea). The main aim of RECMAB is to identify the most important congregating areas of migratory arctic birds in the Baltic Sea and the White Sea. The expedition covered most of the western part of the White Sea by ship.

The expedition team found many important congregating areas, with up to 10,000 birds present. At least one of these areas was evidently unknown previously. Studies of the daily rhythms of migration suggested that important staging areas for arctic birds also exist in the vicinity of the White Sea Channel and the Kanin Peninsula. Transect line counts revealed that the densities of staging birds on the sea outside congregating areas were generally low.

Heavy migration of arctic birds was recorded on many days. In general, more birds were seen migrating in the morning, although some species continued to migrate actively throughout the day. A new European record for the number of geese counted on one day from a single point during autumn migration, of 112,600 birds, was set on 3rd October 1999.

Some arctic species evidently prefer to follow coastlines, flying around the Tsheshmen Peninsula via the Zizginski Strait, whereas some other species were seen flying across the Peninsula from the coast at Pertominsk, heading straight for the southwestern part of the White Sea. These two areas functioned as migration bottlenecks, where migration could in future be observed as part of the low-budget monitoring of population changes in migratory arctic birds, for instance.

Overwhelmingly the most abundant arctic migrant was long-tailed duck (*Clangula hyemalis*), with 311,000 individuals counted. The largest percentages of the estimated total flyway populations using the White Sea route were recorded for divers (*Gavia*) (25-27 %) and *Branta* geese (16-38 %), however.

The shortcomings of surveying the congregating areas of migratory arctic birds by ship included the slowness of the vessel, and problems reaching the shallow coastal waters which are important for many staging waterbirds. The benefits included long observation times for each recorded individual, good chances to detect more elusive and more sparsely distributed species, and somewhat lower costs. However, intensive aerial surveys are still essential for research into important congregating areas in the White Sea, and for the overall purposes of the RECMAB project.



Contents

Summary	3
1 Introduction	7
2 Arrangements and circumstances on the ship	9
3 Route and itinerary	10
4 Observation	12
5 Methods	13
5.1 Visual observation of migration	13
5.2 Mapping of congregating areas	14
5.3 Transect line counts	14
6 Data gathering	16
7 Findings	17
7.1 Numbers of birds	17
7.2 Identification of birds	17
7.3 Visual observation of migration	18
7.3.1 Daily patterns of migration	18
7.3.2 Migration routes	20
7.4 Congregating areas	20
7.5 Transect line counts	22
8 Discussion	25
8.1 Numbers of birds	25
8.2 Identification of birds	27
8.3 Daily patterns of migration	28
8.4 Migration routes	32
8.5 Congregating areas	33
8.6 Transect line counts	35
9 Marine mammals	36
10 Conclusions	37
11 Acknowledgements	40
Bibliography	41
Appendix: Annotated list of the bird species recorded during the White Sea expedition 1999	43
Documentation pages	53

Introduction

The Finnish Environment Institute (FEI) organised an ornithological expedition to the White Sea from 21st September to 10th October 1999, as part of the international RECMAB project (Research, Conservation and Monitoring Project of Migratory Arctic Birds in the Baltic Sea and White Sea).

The main aim of RECMAB is to identify the most important congregating areas of migratory arctic waterfowl and shorebirds along their migration routes between their wintering areas in the Baltic Sea region and breeding areas in northern Russia (Leivo 1997a). Special attention is paid to marine species, e.g. divers and diving ducks, since they are the least known and most difficult to study of the arctic migratory waterfowl and shorebirds.

Earlier preliminary studies under RECMAB have included a survey by ship of Väänämeri, in western Estonia (Leivo, unpublished), and aerial counts both along the northern (Finnish) coast of the Gulf of Finland (Leivo, unpublished) and in the eastern (Russian) part of the Gulf of Finland (Leivo 1997b).

The White Sea is situated along the main migration route used by most of the arctic waterfowl and shore bird species that breed in northern Russia and winter in the Baltic and Atlantic regions. The numbers of arctic birds using this important migration highway are impressive. Table 2 gives rough estimates of the populations of the the most important waterbird species using the White Sea route. The grand total for these 10 species alone reaches almost 10 million birds (Scott & Rose 1996).

The White Sea is also an important staging area, where most of the arctic waterfowl and shore birds rest before starting their final migration to their wintering areas in the Baltic region and elsewhere (Bianki et. al. 1975, 1993). For some species, e.g. the nominate subspecies of the brent goose *Branta b. bernicla*, the White Sea has been shown to be a very important congregating area where birds stage in autumn for longer periods before a long non-stop flight to the Baltic Sea or even the North Sea region (Leivo 1993, Madsen et.al. 1999).

The importance of the White Sea as a staging area and a migration channel for arctic birds has been known for a long time by Russian ornithologists. Bianki et.al. (1975, 1993) have published plenty of information on the occurrence and migration of northern waterfowl in the area. However, the most detailed part of the data published (Bianki et.al. 1975) was collected during the period of 1956-63 when optical techniques were much less efficient than today, and identification techniques were also poorer. Additionally, considerable population changes have subsequently been recorded, for instance in many arctic goose species (Madsen et.al. 1999).

Finnish ornithologists visited the western parts of the White Sea in 1992 for the first time in recent decades to study the migration of arctic birds. They were surprised to encounter a single feeding flock of 70,000 brent geese (Leivo 1993), which in those days represented a third of the total population of dark-bellied brents (*Branta b. bernicla*). Since then Finnish ornithologists have visited the White Sea every year, particularly in autumn, but due to the bad condition of road network along the western coast of the White Sea, studies have only covered part of

the whole area, mainly the area around the city of Belomorsk. Some of their findings have been published, e.g. Kontiokorpi (1996), Kontkanen (1996), Pöllänen et.al. (1996) and Veijalainen & Kontiokorpi (1998).

In addition to this data, recent studies of the Bewick's swan (*Cygnus columbianus bewickii*) and the brent goose in the White Sea have been published, e.g. by Andreev & Poot (1994) and Nolet & Beekman (1998) (see also Madsen et.al. 1999). However, these works have dealt almost exclusively with the birds of the Dwina Delta, east of the town of Arkhangel, and such studies have been conducted in the spring.

The aims of the White Sea expedition 1999 were:

- (i) to obtain an idea of the general distribution of the major congregating areas, and identify any new areas in the western part of the White Sea;
- (ii) to collect data on the densities of staging birds on the sea;
- (iii) to observe the visible migration of arctic birds, in order to improve the knowledge of the migration patterns of arctic birds, and to use migration data as an indirect indicator of possible staging areas further to the northeast;
- (iv) to evaluate the practicability of using ships in research surveys of congregations of arctic birds during migration;
- (v) to get a closer view of the situation regarding one of the most important research areas of the RECMAB project, in order to improve the planning of more comprehensive research in the future.

The expedition vessel 'Eco-log' is a 32-metre-long ship. The benefits of using a ship in researching congregating areas compared to aeroplane are e.g. lower costs and longer observation time for each detected bird. Disadvantages include slowness and inability to reach shallow waters.

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Arrangements and circumstances on the ship

The expedition was jointly organised by FEI and Northern Water Problems Institute (NWPI) in Petrozavodsk, Karelia, Russia. The ornithologists involved were all from FEI: Timo Asanti (leader of the expedition), Jari Kontiokorpi, Harri Kontkanen, Mauri Leivo (head of research), Markku Mikkola-Roos, Ari Parviainen and Pekka Rusanen. The coordinator from the Russian partner NWPI, Vassili Kovalenko, also joined the expedition. The crew of the research ship numbered seven people.

The research vessel was NWPI's 'Ekolog', a 32-metre-long ship with 12 cabins (for two or four people), a sauna, two bathrooms, two lavatories, a kitchen, and a dining/living room.

All the daylight hours except mealtimes were normally dedicated to observation (normally about 10 hours a day). Sunrise was at 7.24 in the beginning of the expedition and 7.57 by the end, with sunset correspondingly at 19.34 and 18.38. There was also enough light to allow observation about half an hour before sunrise and after sunset.

During the mornings the ship was anchored in the most suitable place available for observation, and the ship was moved only during the afternoon or the hours of darkness, when fewer birds were migrating or migration could not be recorded. The expedition took advantage of the ship's movements by carrying out transect line counts along the route to survey the staging arctic birds, or by observing birds through binoculars and telescopes.

A small boat was also used where shallow waters close to the shore were impossible to reach by ship. The ship's compass fixed on the top deck was used to determine exact compass points.



The expedition team by Finnish Environment Institute together with the crew of the expedition ship.

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3

Route and itinerary

The expedition's itinerary is shown in table 1, and the route followed across the White Sea in map 2.

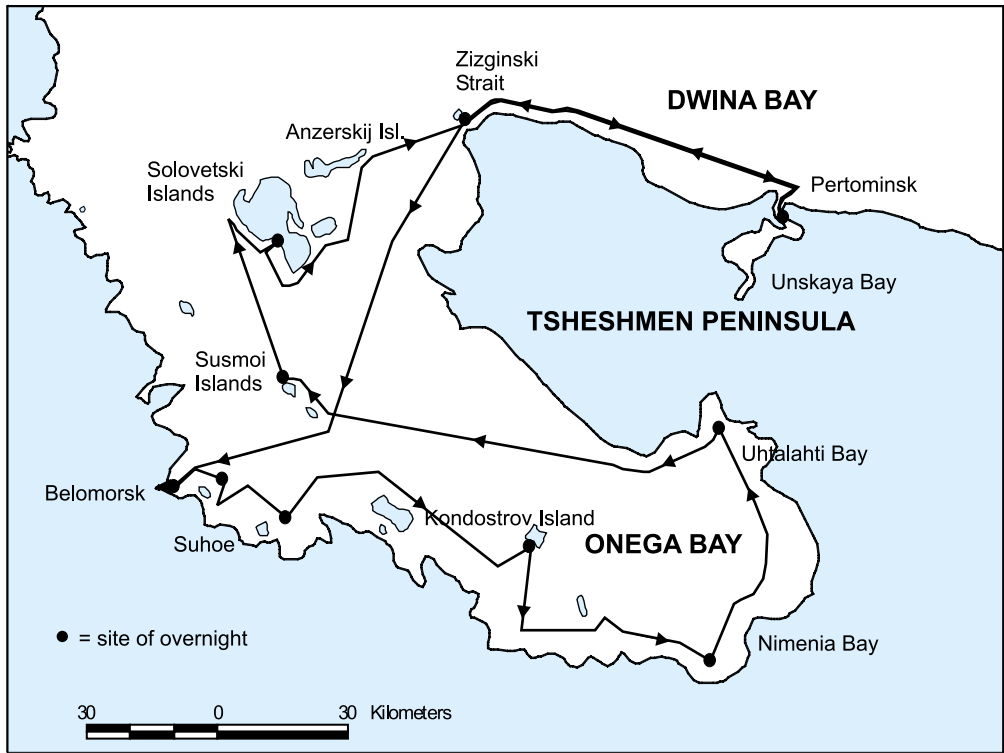
The journey from Petrozavodsk to Belomorsk took three days by ship (see table 1). During the second day the ship passed through 8 locks along the Stalin Canal, with a rise of 70 m from the level of Lake Onega to the level of Lake Vygozero. During the third day the ship sailed through the remaining 11 locks, descending the 103 meters to the city of Belomorsk on the White Sea.

The White Sea expedition can be divided into three sections according to the geographical areas surveyed:

- (i) research in Onega Bay, 24-30th September and 9th October.
- (ii) research in the Pertominsk area and Dwina Bay, 1-5th October.
- (iii) research in the Zizginski Strait, 5-8th October.

Table 1. The timetable and destinations of the expedition.

21/9	Arrival at Petrozavodsk, departure by ship for the Belomorsko-Baltiskij canal (still better known as the Stalin canal), overnight at Lake Onega
22/9	Entry to the Stalin canal, all day passing through the locks of the canal, overnight at Lake Vygozero
23/9	All day passing through the canal, overnight near Belomorsk
24/9	Arrival at Belomorsk in the morning, entering the White Sea in the evening, overnight near Osinka Island
25/9	Departure for the coast off Suhoe in the morning, departure for Razostrov Island in the afternoon, overnight off the island
26/9	Departure at noon for Kondostrov Island, overnight off the island
27/9	Late morning departure, anchoring near the delta of the River Njuhtsa in the afternoon and exploring the delta with a small boat, departure for Nimenia Bay in the evening, overnight on the bay
28/9	Departure for Uhtalahti Bay in the afternoon, overnight on the bay
29/9	Departure for the Susmoi Islands in the late morning, landing and exploration by foot of Greater Susmoi Island in the evening, overnight off the island
30/9	Departure for Solovetski Island in the morning, exploration of the western coast of Solovetski, anchoring at noon, and overnight at the harbour of Solovetski Island, exploring the island by foot in the afternoon
1/10	Departure for Pertominsk in the morning, arrival in the evening and overnight at Pertominsk
2/10	All day in the Pertominsk area, in the morning anchoring off the coast, and landing on the mainland with a small boat for the day, moving to Unskaya Bay in the afternoon and exploring the northern part of the bay by boat and on foot, overnight at the Pertominsk harbour
3/10	All day in Pertominsk, anchored off the coast, returning to the harbour for the night
4/10	All day in the Pertominsk area, the ship moving to an anchorage 10 km off the coast, then back to the harbour for the night
5/10	Morning in the Pertominsk area, the ship moving to an anchorage off the coast, departure for Zizginski in the afternoon, anchoring and overnighing in the middle of the Zizginski Strait
6/10	All day in the Zizginski Strait
7/10	All day in the Zizginski Strait, sailing to the western side of the strait in the evening for the night
8/10	Out into the Zizginski Strait in the early morning, all day in the strait, departure for Belomorsk in the evening
9/10	Arrival on the Belomorsk coast during the night, observation of migration in the morning, entering the Stalin canal through the first lock in the afternoon, overnight in a harbour in Belomorsk
10/10	Observation of migration in the morning, departure for Petrozavodsk at noon by car, arrival at Petrozavodsk in the evening.



Map 2. The route of the White Sea expedition 1999.



A boat of the ship was used to reach beaches and other areas of shallow waters. Here members of the ship crew landing on a beach of the Greater Susmoi Island.
© Markku Mikkola-Roos

4

Observation

Visual observation with binoculars and telescopes was the main method used to detect birds throughout the expedition. Observation was carried out throughout the daylight hours almost every day, although on a few exceptional days with little migration an alternative programme was run.

The magnification of the binoculars used varied between 7 and 10. The famous Finnsticks (sticks approximately 50 cm long, fixed into the binoculars) were used almost all the time by all observers to keep binoculars steady, and to reduce muscle fatigue.

The most powerful telescopes had 20-60x zoom oculars and 80 mm objectives; others had oculars of constant magnification of 22x, 27x or 30x and objectives of 60 mm. Telescopes could be used on the ship deck in conditions of minor or moderate swell, but not in strong swell. To facilitate the use of telescopes, rubber pieces were fixed into the bottom end of tripod legs to dampen the effect of the vibration of the ship when the engine was running.

Observation was mainly carried out from the stern on the middle deck of the ship, about 4 metres above sea level. Thanks to the construction of the ship, the observers were largely sheltered from the wind, and partly also from the rain. The distance that could reliably be observed from the middle deck was 2-4 km for birds on the sea, and 5-10 km in the air, except during occasional bad weather (rain, fog, very strong wind etc.) when observable distances were greatly reduced.

Three ornithologists normally conducted observations on either side of the ship at any time. This varied according to the rate of migration and variations in the rate on the different sides of the ship. During heavy migration, one observer acted as a full-time secretary allowing the others to announce their sightings uninterruptedly. This helped to reduce the numbers of errors and omissions, compared to the usual method of noting sightings at intervals.

Observation of birds by binoculars and telescopes was carried out on ship deck throughout the daylight hours almost every day. During strong migration one member of the team worked as a secretary allowing the others to announce their sightings uninterruptedly.
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Methods

Three basic methods were used to gather data about the migrating birds: (i) visual observation of migration, (ii) mapping of the congregating areas and counts of the numbers of birds present, (iii) transect line counts.

5.1 Visual observation of migration

The basic method used during the expedition was visual observation with binoculars and telescopes. Details of the observation and data gathering are given in sections 4 and 6, respectively.

This method produces the basic data on the migration of arctic birds. This enables researchers to understand the magnitude, patterns, daily rhythm, routes, directions and other details of migration, and also provides indirect information on possible staging areas, the identification of which is one of the ultimate aims of the RECMAB project.

Assuming that birds mainly start their migration at a certain time of the day, by studying daily patterns of migration it is possible to estimate the likely location of their departure area, using existing information on the migration direction and flight speed of the species in question.

By studying the plumages of migrating birds, additional information on the possible moulting areas of arctic birds can also be obtained. Given that most individuals of a species passing an observation point had moulted from their breeding plumage into winter plumage, for instance, the conclusion can be drawn that an important moulting area may lie nearer their breeding area. Furthermore, since drakes of many arctic duck species migrate earlier in autumn than females or juveniles – as is notably the case with scoters (Cramp & Simmons 1977) and long-tailed



The coast of Pertominsk is a very important site for observation of arctic bird migration. On 3rd October, 1999, the expedition team counted here a new European record for the numbers of migrating geese on a single day in one point - 112,600 birds!

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duck (Pietiläinen & Leivo 1993) – by studying the plumages of these birds a rough estimate can be made of the proportion of the population that has passed an observation point by that time. Still another benefit of the gathering data on plumages is the information on the proportion of young birds, which reflects breeding success.

5.2 Mapping of congregating areas

Throughout the expedition attempts were made to find important congregating areas, mainly by observing birds along the route of the ship. Some shallow waters, considered likely to be important congregating areas on the basis of map inspection, were more carefully explored with the small boat.

When large gatherings of birds were recorded, the boundaries of the area occupied by the staging birds were mapped, and the abundance of different species were counted. All areas with more than a hundred birds were mapped in this way.

This method produces direct data on congregating areas, and is thus the most valuable method for the purposes of the RECMAB project.

5.3 Transect line counts

Komdeur et.al. (1992) developed a method for surveys of birds by ship (or aeroplane). Briefly described, the method is based on the designation of adjacent 50 or 100 metre wide sectors, at distances of 0-300 meters from the ship, inside which all birds are identified and counted. This method has also been used in the survey of the most important marine areas for wintering birds in the Baltic Sea (Durinck et.al. 1994). However, due to the lack of the necessary tools for estimating the distances, and any previous experience of the method, a simplified version of the basic method was applied during this expedition. Vähätalo (1997) used approximately the same application in counting arctic birds along a route in the Baltic Sea between Helsinki and Riga.

In our application we used a single sector of 500 metres in width. Counting along this sector for sections of two kilometres resulted in figures for survey areas of one square kilometre, which simplified calculations of bird densities (see figure 1). Whenever possible, two groups of surveyors, one group on either side of the ship, counted transect lines at the same time. In the analysis of the results, the data produced by both counting groups was summed to get average values for each line. In many cases, however, counting was only possible on one side of the ship, mostly due to unfavourable conditions on the other side (e.g. reflected glare from sunshine on the sea), and in such cases results from one-sided counts were used as density values for the whole transect line.

Counts lasted 6-10 minutes, depending on the speed of the ship. When the speed was 10 knots (i.e. 18.53 km/h) a distance of 2 km, required by the method, took 6 minutes 29 seconds. Only staging waterbirds (divers, waterfowl and auks) were counted. Gulls were not counted, since they tended to follow the ship.

Counting groups consisted of three people: a counter, a secretary and an assistant. The counter concentrated on detecting, identifying and counting birds inside survey sectors, using binoculars. Determining whether birds were inside the sector was a considerable task. The secretary noted all the data the counter announced, and helped in identifying birds and estimating distances. The assistant used a telescope, and mainly helped with identification, especially of birds taking flight or diving away from the ship. Attempts were generally made to detect birds before they tried to avoid the ship, so particular attention was paid to recording birds ahead of the ship.

Transect line counts could be done in conditions of minor or moderate swell (up to a wind speed of about 9 m/s). During stronger wind, sectors could not be surveyed reliably.

Transect line counts produce data on the densities of birds staging on the sea. They also give a rough idea of the number of birds in a larger area of the sea. This is especially useful when birds are dispersed over the sea, and not concentrated in larger flocks.

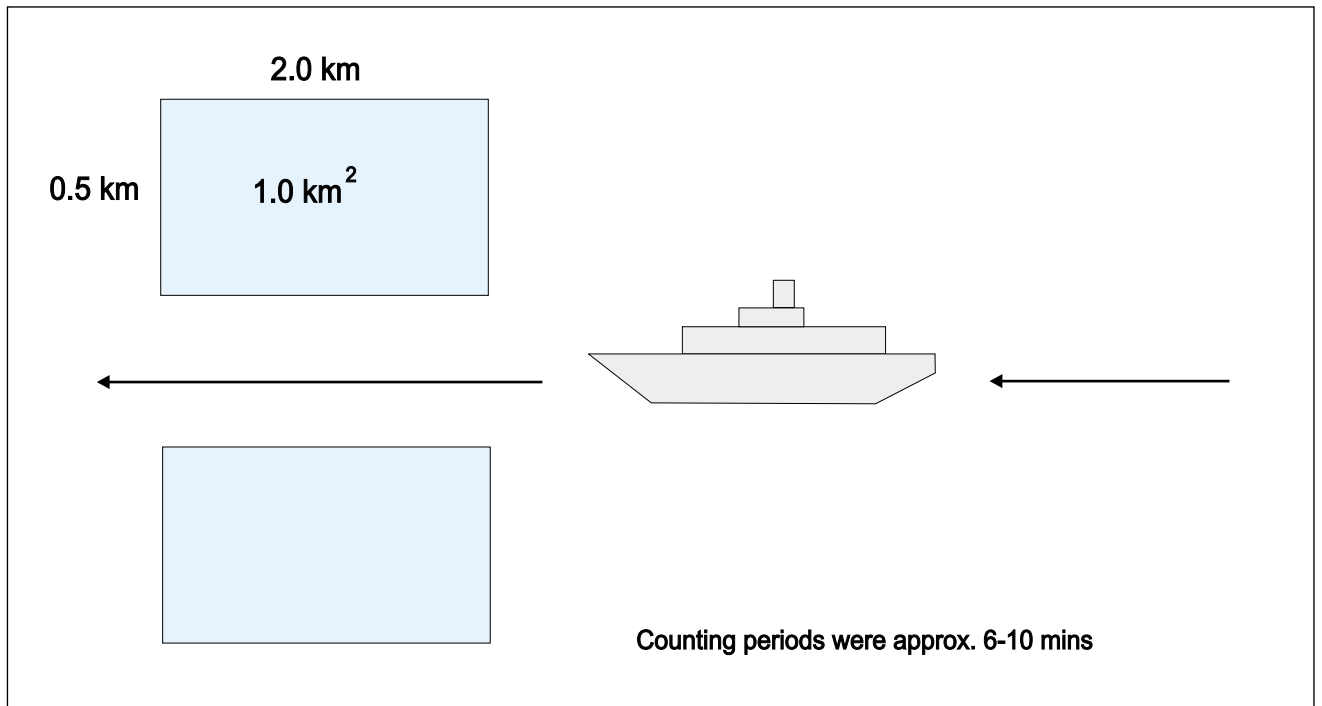


Figure 1. Scheme of the transect line count method used during the White Sea expedition.

6

Data gathering

All sightings were normally entered onto special forms for 30-minute periods. The forms had three sections, to facilitate the noting of sightings:

- (i) the most numerous and important arctic water bird species, e.g. divers, geese and many diving duck species,
- (ii) other water birds and shore birds, e.g. dabbling ducks, waders and skuas
- (iii) other birds, e.g. raptors and passerines.

The basic way to enter a sighting was: species; number of individuals; age; sex; direction of migration; side of the ship; distance (see Uusivuori 1977 a,b). In addition to this basic data, information on the weather, the time of sunrise and sunset etc. was also recorded.

Data on the most important migratory species was collected on the 30-minute-period forms. This facilitated the studying of their daily rhythm of migration and other migration patterns.

Finally, sightings of all species were noted on daily-total forms, with flight directions, plumages, number of flocks, and other details mentioned whenever appropriate.

Another type of form was used for the transect line counts. Data on the sightings and counts of birds inside the counting sector was noted on these forms. General information noted here included the weather, the speed of the ship, the counting period, and a line code.

After the expedition all the data was computerised using various database software.

Findings

7.1 Numbers of birds

The total number of arctic birds recorded during the expedition was over 600,000 individuals. The most abundant species by far was the long-tailed duck (*Clangula hyemalis*), which accounted for half of all the birds recorded. However, the highest percentages of the total White Sea flyway populations were recorded for divers (*Gavia*) (25-27 %) and the *Branta* geese (15-38 %). The percentage of the total long-tailed duck population recorded was relatively low (6 %).

The numbers and the percentages of total White Sea flyway populations for the most important arctic species recorded are given in table 2.

Table 2. The estimate of populations of the most important arctic species using wholly or mainly the White Sea migration route to their wintering areas, and the numbers of birds recorded during the White Sea expedition 1999 and the percentages of these of the whole migration population (see Scott & Rose 1996, Hagemeyer & Blair 1997).

Species	Pop. (ind)	Exp. (ind)	Exp./Pop. (%)
Red-throated Diver (<i>Gavia stellata</i>) ¹⁾	50.000	13.570	27.1
Black-throated Diver (<i>G. arctica</i>) ¹⁾	100.000	24.780	24.8
Bean Goose (<i>Anser fabalis</i>) ³⁾	450.000	5.810	1.3
White-fronted Goose (<i>A. albifrons</i>) ³⁾	600.000	20.260	3.4
Barnacle Goose (<i>Branta leucopsis</i>) ²⁾	250.000	93.820	37.5
Brent Goose (<i>B. b. bernicla</i>) ²⁾	300.000	47.210	15.7
Scaup (<i>Aythya marila</i>)	310.000	1.230	0.4
Long-tailed Duck (<i>Clangula hyemalis</i>) ⁴⁾	5.000.000	311.000	6.2
Common Scoter (<i>Melanitta nigra</i>)	1.600.000	15.000	0.9
Velvet Scoter (<i>M. fusca</i>)	1.000.000	3.830	0.4

¹⁾ Figures for unidentified divers were added to the identified totals of each species according to the respective proportions of each species amongst the divers identified. ²⁾ Figures for unidentified geese were added to the identified totals of each species according to the respective proportions of each species amongst the geese identified. ³⁾ As note 2, except that also the respective proportions of unidentified *Anser* geese were added to the identified totals of each species. ⁴⁾ Figures for unidentified ducks were added to the identified totals of each species according to the respective proportions of each species amongst the ducks identified. **Note:** The estimates for the numbers of unidentified birds allocated to any species totals were calculated on a daily basis.

7.2 Identification of birds

Table 3 lists the percentages of birds of the most abundant species groups that were specifically identified. Identification percentages were highest among ducks and waders, and lowest for divers and geese. Overall, 69.1 % of all the birds observed were specifically identified (420,577 out of 508,478).

Table 3. Numbers of birds and percentages of identified birds out of all recorded birds in some species groups of arctic migrants. ¹⁾ Numbers of *Anser* geese not specifically identified have been added into the total numbers of identified geese.

Species	No. of birds	% specifically identified
Divers	38.374	36.0
Geese ¹⁾	191.003	37.1
Ducks	375.000	88.9
Waders	3.460	63.3
Skuas	630	46.8

7.3 Visual observation of migration

The overwhelming majority of the data was obtained from visual observation of migration. As described in section 5.1., this method provides basic data on the migration of arctic birds, and also gives indirect information on possible staging areas.

7.3.1 Daily patterns of migration

Examples of the daily patterns of migration of arctic birds on three different days are represented in figures 2a-c.

Figure 2a shows the pattern of migration on 3rd October 1999 at Pertominsk. Very early in the morning few birds were migrating. Then for an hour and a half from around 8.30, large flocks of divers (*Gavia*) were seen to appear from north-east, with numbers peaking an hour later (a total of 1,828 birds were recorded for the period 9.30-10.00). A second, even stronger wave of diver migration occurred

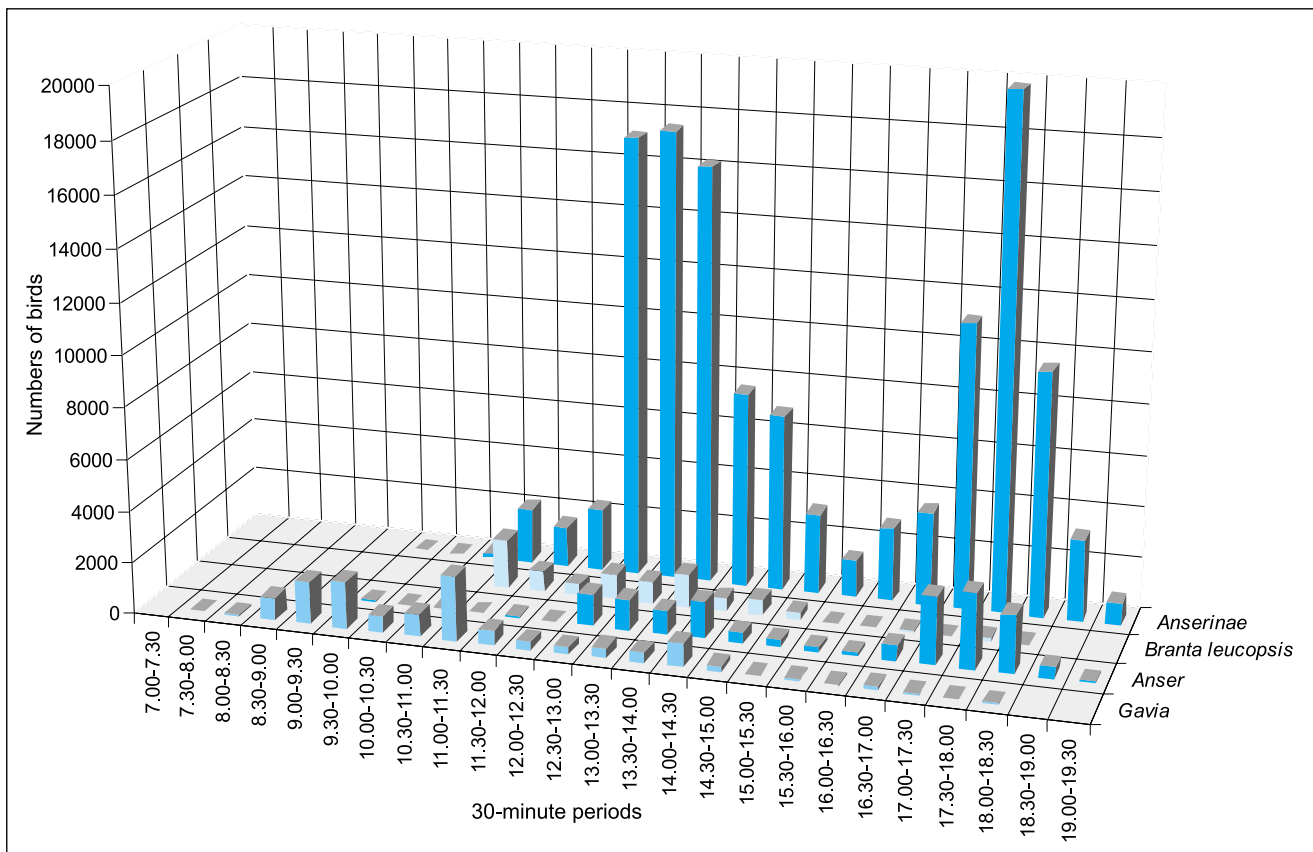


Figure 2a. Waterfowl migration in 1/2-hour-periods in 3rd October at Pertominsk.

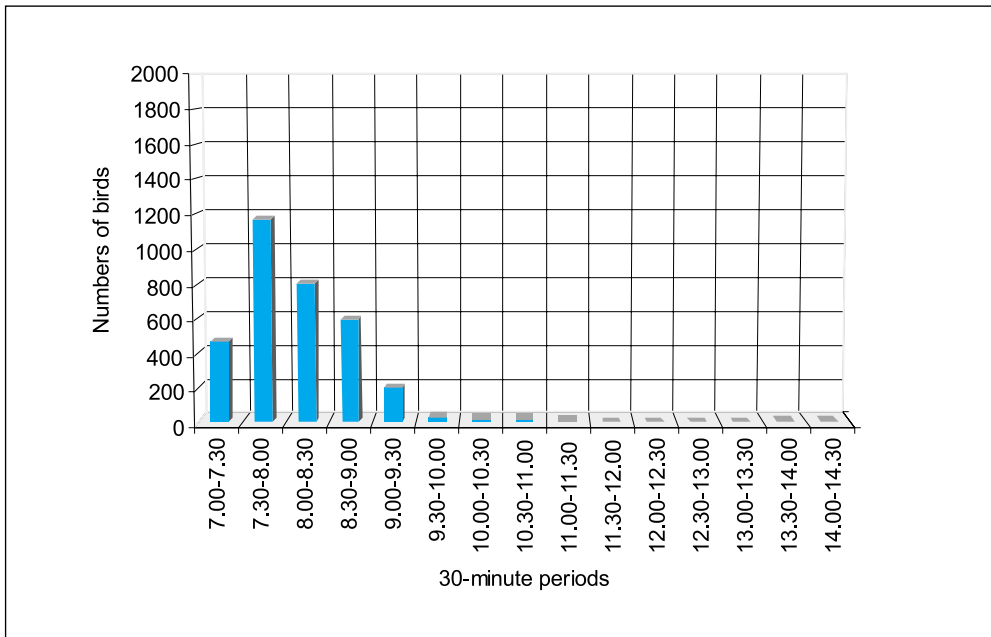


Figure 2b. Diver (*Gavia*) migration in 1/2-hour-periods in 4th October at Pertominsk.

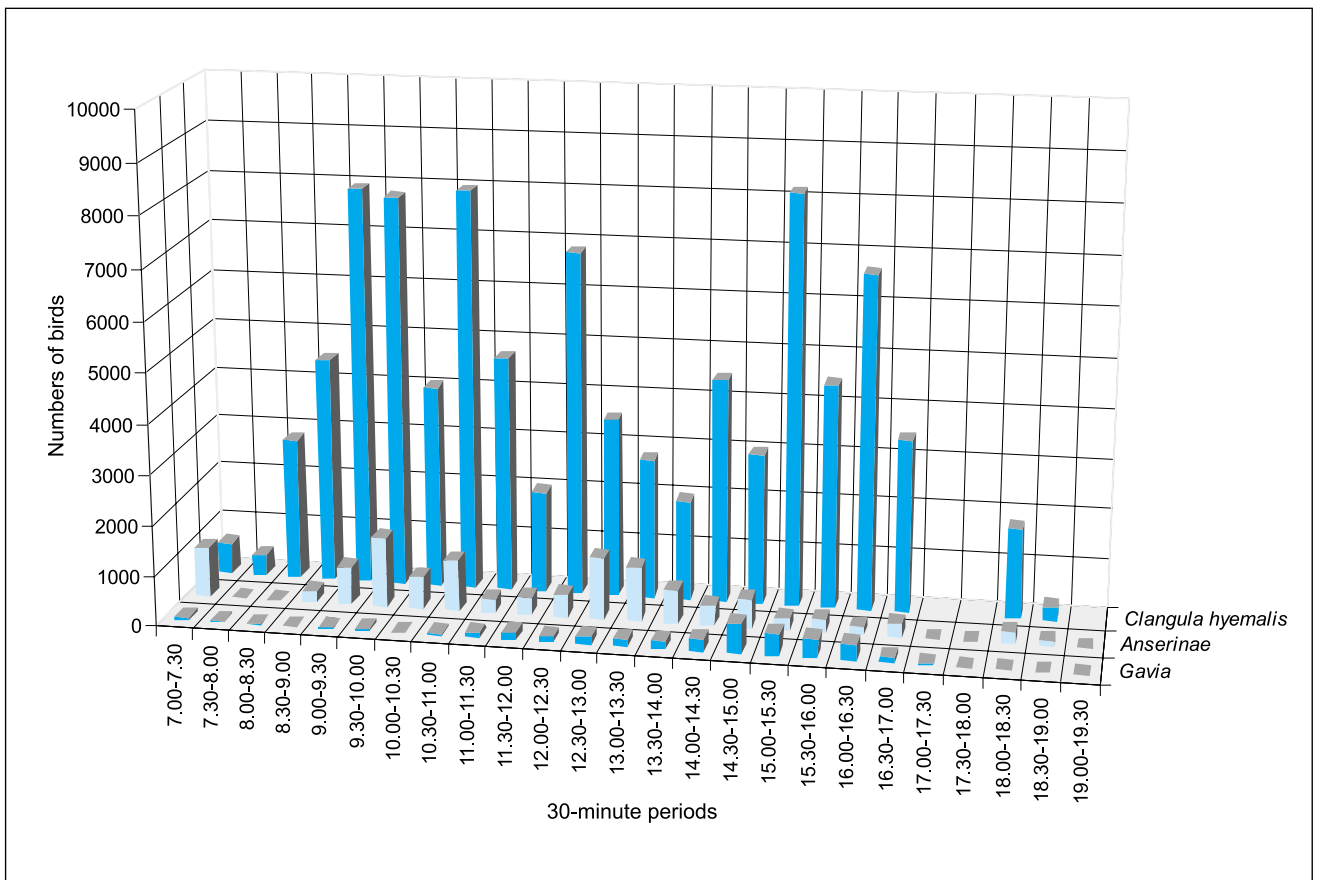


Figure 2c. Waterfowl migration in 1/2-hour-periods in 6th October at Zizginski.

between 11.00 and 11.30 (with a total of 2,531 birds recorded). After midday diver migration weakened noticeably, but a smaller peak was still recorded for 14.00-14.30.

Goose migration on 3rd October began quite suddenly after 11.00. The first very strong peak occurred between 12.30 and 14.00 when a total of 36,500 geese passed the observation point. Barnacle geese (*Branta leucopsis*) were very prominent in the first wave, although *Anser* geese, especially white-fronted geese (*A. albifrons*), were also abundant. A second, still higher peak occurred around 17.00-18.30 just before dusk, and this time *Anser* geese, mainly white-fronted geese, were the species most involved. Very few barnacles were observed during the evening peak.

Figure 2b shows a totally different pattern of migration observed on 4th October. Diver migration began very early in the morning, peaking around sunrise and almost ceasing after 9.30.

A third example of the varying daily patterns of migration is shown in figure 2c. The only diver peak observed on 6th October at the Zizginski Strait did not occur until mid-afternoon (14.30-16.30).

Contrastingly, goose migration featured several peaks throughout the day. The first peak was a sudden rush at dawn. This was caused by birds which had spent the night resting in the strait setting off again on their migration first thing in the morning. This was witnessed by members of the expedition group who observed many flocks first swimming on the sea and then, at dawn, taking off on migration, heading SW. The next larger waves of geese flew over during the periods 9.00-11.00 and 12.30-14.00.

The pattern of long-tailed duck (*Clangula hyemalis*) migration on 6th October was more complicated. Overall, migration was very intense, with a daily total of over 95,000 birds, and there were many peaks.

7.3.2 Migration routes

Data on differences in the selection of migration routes between arctic species was collected during the expedition. Figures 3a-c show the numbers of birds of different species on the Pertominsk coast and at the Zizginski Strait.

The only species found to be much more abundant in the Pertominsk area were white-fronted goose (*Anser albifrons*) and bean goose (*A. fabalis*), whereas red-throated diver (*Gavia stellata*), brent goose (*Branta bernicla*) and long-tailed duck (*Clangula hyemalis*) were much more abundant along the Zizginski route. Black-throated diver (*G. arctica*), barnacle goose (*B. leucopsis*) and *Anas* ducks did not show any clear preference between either of these routes.

7.4 Congregating areas

Important congregating areas for ducks are represented in table 7.4. and on map 3.

The Osinka area seemed to be used merely as a stop-over, with birds continuing their migration after a short rest.

The largest congregations of birds were 10,000 long-tailed ducks (*Clangula hyemalis*) in the Osinka area and 10,000 wigeon (*Anas penelope*) on Uhtalahti Bay. A further 6,100 ducks off Hedostrov Island and 7,000 ducks off the coast at Pertominsk indicate the importance of these areas for arctic waterfowl.

The densities of birds in congregating areas were calculated by dividing the total numbers of birds by the total surface area of the congregation. Although the boundaries of congregations could only be quite roughly defined, indicative density values were nevertheless obtainable by this method. The highest densities of birds counted in any congregating area were 1,350 birds/km² on the Unskaya Bay, 809 birds/km² in the Osinka Island area and 780 birds/km² on Uhtalahti Bay.

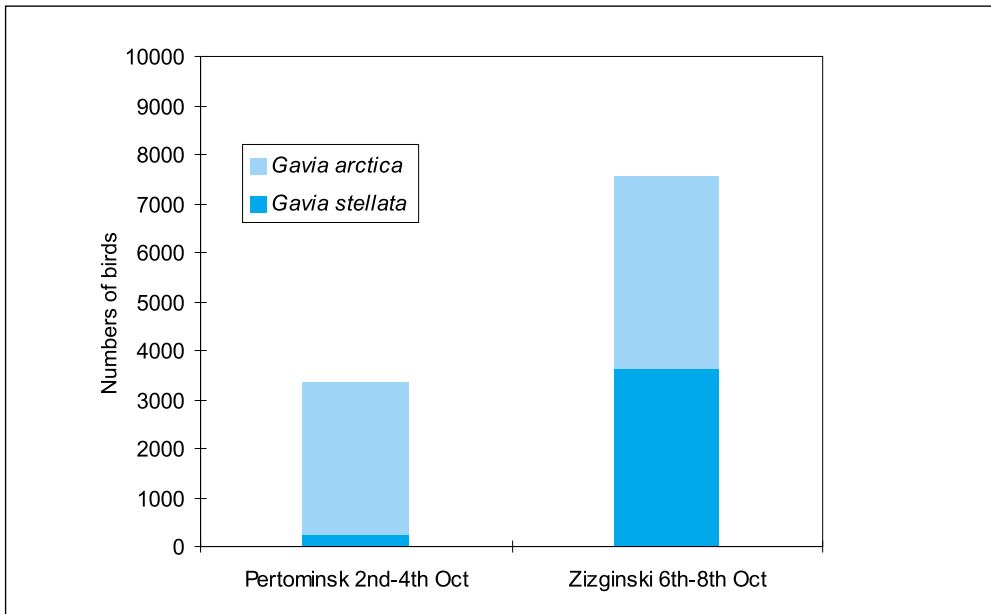


Figure 3a. Numbers of divers in two different areas in the White Sea.

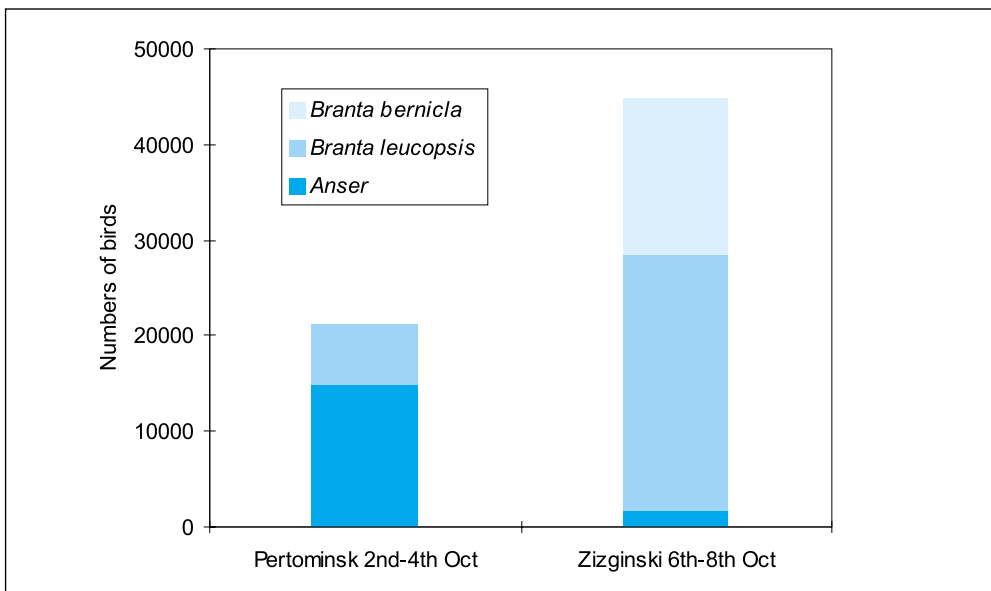


Figure 3b. Numbers of geese in two different areas in the White Sea.

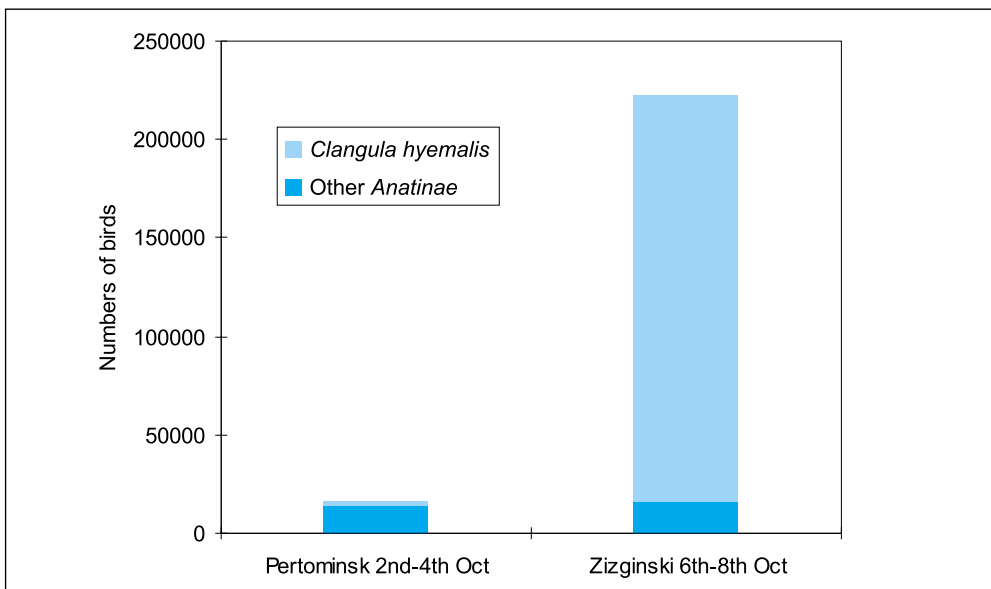
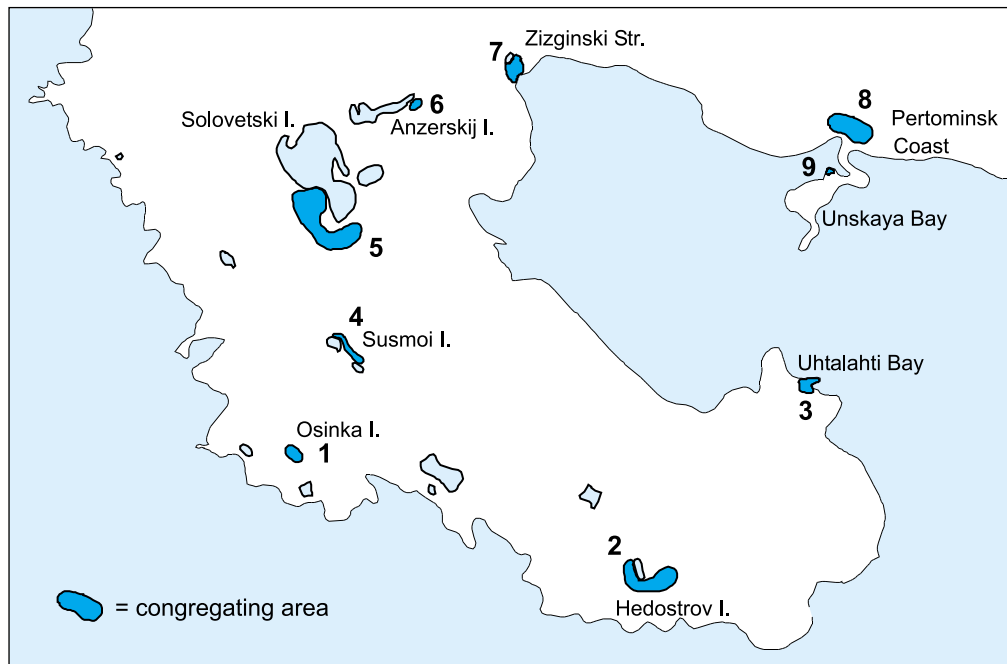


Figure 3c. Numbers of ducks in two different areas in the White Sea.



Map 3. The most important congregating areas found during the White Sea expedition 1999 (numbers of the most abundant species on each area, see table 4).

Table 4. Important congregatory areas of arctic ducks found during the expedition in the White Sea. The sites (with the surface areas) and the species (with the number of staging birds).

Location (area)	Species (number of staging birds)
1. South of Osinka Island (12 km ²)	Long-tailed Duck (10.000)
2. Just off Hedostrov Island (56 km ²)	Eider (3.700), Velvet Scoter (1.700)
3. Uhtalahti Bay (13 km ²)	Wigeon (10.000)
4. East coast of the Susmoi Islands (13 km ²)	Eider (1.500)
5. SW coast of Solovetski Island (117 km ²)	Eider (2.250), Black Guillemot (260)
6. Coast of Anzerskij Island (6 km ²)	Black Guillemot (220)
7. Zizginski Strait (20 km ²)	Eider (1.300)
8. Off Pertominsk (50 km ²)	Eider (3.500), Long-tailed Duck (1.000), Common Scoter (2.500)
9. Unskaya Bay (2 km ²)	Wigeon (3.000).

7.5 Transect line counts

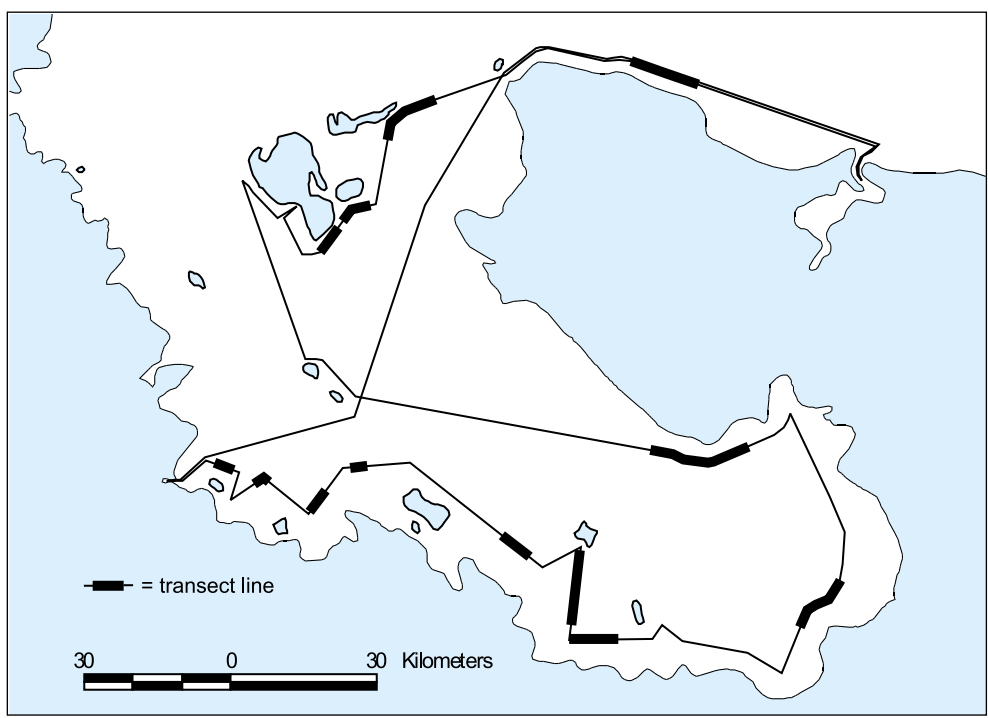
Map 4 shows where transect line counts were made, and table 5 gives the overall results of the transect line counts carried out during the expedition.

A total of 88 counts were made (corresponding to a total survey area of 88 km²) along 57 transect lines (see table 5). The total number of birds recorded in the counts was 695, which indicates an overall average density of 7.9 birds/km².

The most abundant species in the transect line counts was, unsurprisingly, the long-tailed duck (*Clangula hyemalis*): a total of 343 birds were recorded in the transect line counts, giving an average density of 3.01 birds/km² (see figure 4). The second most abundant species was the eider (*Somateria mollissima*) (119 birds, 1.04 birds/km²), and the third most abundant, surprisingly, was the black guillemot (*Cephus grylle*) (113 birds, 0.99 birds/km²). The eight other species recorded in the transect line counts were much scarcer (2-45 individuals/species, 0.02-0.39 birds/km²).

Table 5. The overview on the transect line counts during the White Sea expedition 1999.

Total number of transect lines	57
Total area covered by transect line counts (km ²)	88
Total number of birds recorded in transect line counts	695
Number of species recorded in transect line counts	11
Overall average density of birds recorded in transect line counts (birds/ km ²)	7.9
Maximum number of birds recorded along a transect line	169
Minimum number of birds recorded along a transect line	0
Maximum density of birds recorded along a transect line (birds/ km ²)	84.5
Minimum density of birds recorded along a transect line (birds/ km ²)	0
Maximum density of birds of a single species recorded along a transect line (birds/ km ²)	80



Map 4. Situation of transect line counts carried on during the White Sea expedition 1999.

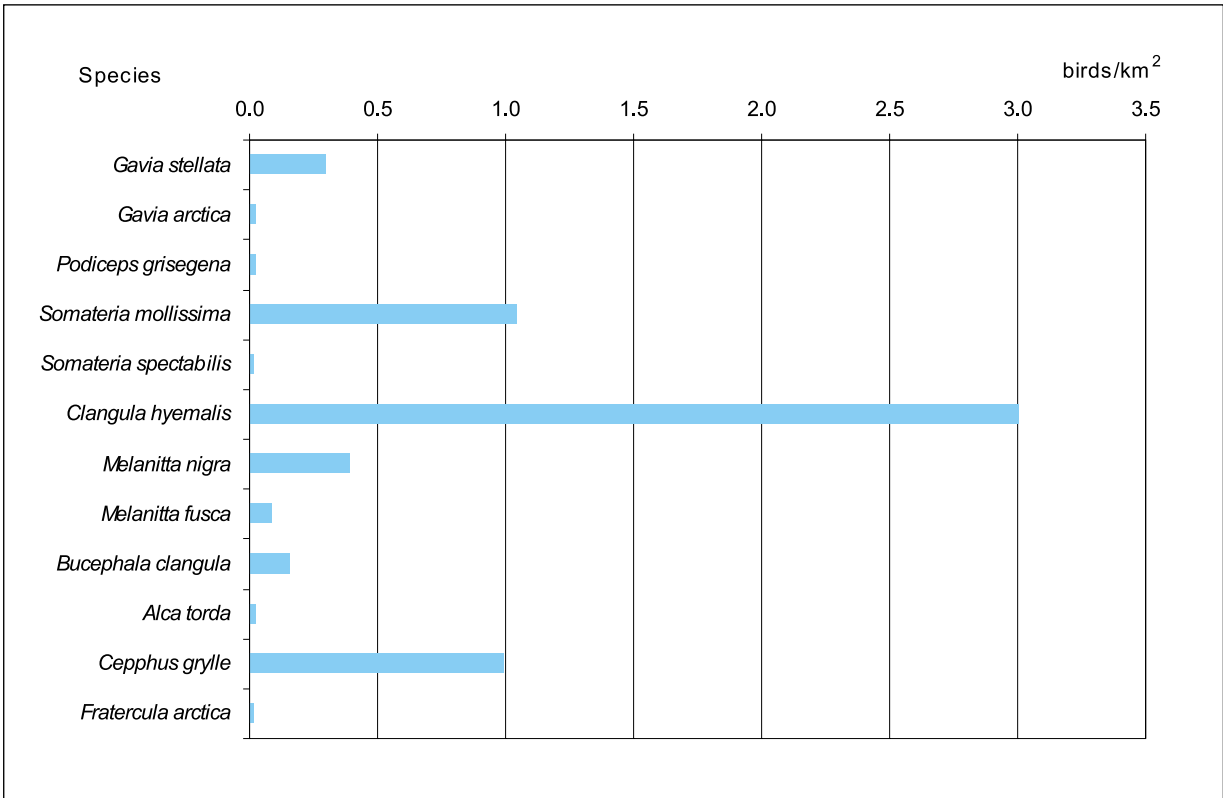


Figure 4. The average density of different bird species on the transect lines.

Discussion

8.1 Numbers of birds

The abundance of different species observed during the expedition depended mainly on the total size of their populations known to migrate via the White Sea, and the stage of their migration at the time.

The long-tailed duck (*Clangula hyemalis*) was overwhelmingly the most frequently observed species during the expedition (see table 2), for obvious reasons: It has by far the largest population of all the arctic species migrating via the White Sea, at least 5,000,000 birds (Scott & Rose 1996), and its main migration period, from the end of September till the first half of October, coincided well with the timing of the expedition. However, the percentage of the total flyway population recorded during the expedition was relatively low (see table 2). This may have been because observation was carried out along its main migration route for just a few days, and no single true mass migration day occurred during this period (see section 7.3.2 and figure 3c).

The low numbers and the percentages of the whole flyway population recorded for common scoter (*Melanitta nigra*) are easier to explain, since adult males already migrate in July-August to the Baltic Sea region to moult (Cramp & Simmons 1977), while the main migration of females and juveniles occurs in September (Leivo et.al., unpublished), so the majority of birds had already left the White Sea before the expedition. Conversely, it is difficult to explain the low numbers of velvet scoter (*M. fusca*). This species is an abundant migrant (the flyway population reaches 1,000,000 birds, Scott & Rose 1996), and a large proportion of adult males stay in the north until late autumn (Pietiläinen & Leivo 1993, Leivo et.al., unpublished), while the main migration period for females and juveniles is thought to be in October (Leivo et.al., unpublished). The low number of velvet scoters remains a



Long-tailed Duck (*Clangula hyemalis*) is overwhelmingly the most abundant arctic migrant in the White Sea with the flyway population of at least 5,000,000 individuals. © Mauri Leivo

Both Red-throated (*Gavia stellata*) and Black-throated Divers (*G. arctica*) (here) breeding in the northern Russia use the White Sea route when migrating to their wintering areas in autumn. Thousands of migrating divers were counted in the best days of the expedition.

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mystery, and their migration patterns is still insufficiently known. The same is true for the scaup (*Aythya marila*): the timing of the expedition should theoretically have coincided well with the scaup's main migration period, but few birds were seen: just 1,229 individuals, corresponding to about 0.4 % of the whole flyway population. Its preference for nocturnal migration (Leivo et.al. 1994), and the possible use of an even more south-easterly migration route could be behind these low numbers.

For divers (*Gavia*) and the *Branta* geese, high percentages (16-38 %) of the flyway populations were recorded during the expedition (see table 2). The main migration period of these species coincided with the timing of the expedition, and it was already known that they congregate in numbers in the White Sea region during migration. In contrast, Anser geese, despite having the same main migration period in the end of September and the first half of October, do not follow the White Sea route as faithfully as the *Branta* geese (Leivo et.al., unpublished). Consequently much lower percentages of the total flyway populations were observed.

The low numbers of swans (*Cygnus*) and waders seen during the expedition (see appendix) can mainly be explained by the timing of their migration period. Swans were just beginning their migration, whereas the migration of waders was mainly over for the autumn; the only species seen in higher numbers being dunlin (*Calidris alpina*) and purple sandpiper (*C. maritima*), both known to be late migrants.

The abundance of eiders during the expedition – with a total of 20,000 staging birds (see appendix) – was surprising. According to Scott & Rose (1996), their total breeding population in the White Sea is estimated at no more than 20,000-30,000 birds. Since about 98 % of the birds observed during the expedition were moulting adult males, either a lot of birds must have come to the White Sea from somewhere else, or the estimate for the breeding population is far too low. The former conclusion is supported by information in Scott & Rose (1996), which suggests that breeding birds from as far as Novaya Zemlya may come to the White Sea to winter. Eiders winter abundantly in the White Sea, mainly in the Onega Bay, in small areas which remain ice-free all winter (Bianki et.al. 1975, 1993).

8.2 Identification of birds

The numbers of birds identified during observation of migration remained relatively high. As can be seen in table 3, identification percentages varied considerably between the species groups. The problems with the identification of flying divers and geese are well known, and result in relatively low numbers of specifically identified birds out of all the recorded birds in these species groups. In these groups only about one in three birds could be specifically identified. On the contrary, the most abundant ducks: long-tailed duck (*Clangula hyemalis*), eider (*Somateria mollissima*), common scoter (*Melanitta nigra*) and wigeon (*Anas penelope*), are quite easy to identify even in flight, resulting in high proportions of identified birds among these species (see table 3).

Identification percentages also varied greatly between different days. During the mass migration day of 3rd October at Pertominsk the percentage of identified arctic birds was 19.2 % out of a total of 126,300 birds, while at Zizginski in 7th October 87.7 % out of 150,065 birds were identifiable. The difference was due to variations in the situation of observation points, weather and the species composition. The most important factor was the variation in species composition. On 3rd October the most abundant migrants were geese and divers, which are difficult to identify specifically, while on 7th October more easily identifiable long-tailed ducks predominated.

Another factor in the differences between identification percentages was variations in migration patterns. Common scoter, wigeon to some extent, and especially long-tailed duck tend to follow coastlines, where most of the observations were carried out. Consequently, these ducks were easily observed and identified with telescopes and binoculars. On the contrary, divers, in particular black-throated divers (*Gavia arctica*), and geese, with the exception of brent geese (*Branta bernicla*) and to some extent barnacle geese (*B. leucopsis*), tended to pass observation points in broad fronts regardless of coastlines, and remained unidentified much more often. This is well illustrated by our findings on two days of mass migration: 3rd October at Pertominsk and 7th October at Zizginski. At Pertominsk, 98.6 % of migrants were divers and geese, the species that migrate in broad fronts, and the overall identification percentage was 19.2 %. At Zizginski 69.7 % of arctic migrants were brent goose and long-tailed duck, both of which tend to follow coastlines, and the identification percentage was as high as 87.7 %.

The shortcomings of existing data due to difficulties with the identification of diver species are often evident, for example in the papers of Bianki et.al. (1975), who could not reliably produce separate data on red-throated (*Gavia stellata*) and black-throated divers; Leibak et.al. (1994), which gives somewhat misleading information on the relative strength of migration of each diver species in autumn on the Estonian coast; and Durinck et.al. (1994), who were forced to combine their ship survey data on the two diver species into a single set of data. However, where the different diver species and their quite distinct migration patterns are concerned, specific identification is essential to understand the various phenomena occurring during migration. Of course, this is also a major factor when identifying the most important congregating areas for different species.

Identification of flying Anser geese is always a challenge, and the most of them remain unidentified by observers. Here Greater White-fronted Geese (*A. albifrons*) which is the most abundant Anser goose species on migration in the White Sea. © Mauri Leivo



8.3 Daily patterns of migration

In general, during the autumn migration, arctic birds, like most other diurnal birds, tend to migrate in greatest numbers in the morning (Kontkanen 1995, Ojanen 1999, Leivo et.al., unpublished). The expedition found this tendency to be clearest for black-throated diver (*Gavia arctica*) (see figure 5b) and long-tailed duck (*Clangula hyemalis*) (see figure 5d). This is supported by data collected by Kontkanen (1995) in Estonia in the autumn of 1994.

However, many species, having left a congregating area, may continue to fly for more than a whole day without stopping. This is the case, for instance, with the geese that traditionally stage in areas quite distant from each other. This means that large flocks of birds may pass any observation point at very different times of the day, or even during the night, depending on the distance from their last point of departure. The expedition data on red-throated divers (*G. stellata*) shows just as strong migration peaks in the afternoon as in the morning (see figure 5a); while the greatest numbers of barnacle geese (*Branta leucopsis*) are evidently on the move around noon (see figure 5c).

By analysing the daily rhythm of migration, some indications of the possible points of departure of arctic birds may be obtained. As was seen in figure 2a, on 3rd October the migrating divers (practically all black-throated) were not very numerous at Pertominsk early in the morning. Assuming that divers start their migration around dawn - as is usually the case according to our experiences - it could be also be assumed that only a few birds ready to migrate had been resting on the sea in the vicinity of the observation point. Later, divers came in two or three strong waves, which could according to this hypothesis be inferred to have departed from various staging or stop-over sites at different distances from the observation point. Keeping in mind that the average flight speed of divers during migration is about 70-80 km/h (unpublished data, Leivo et.al.), and that the birds arrived from a north-easterly direction, it can be inferred that the greatest numbers of divers had set off that morning from waters on either side of the White Sea Channel (see map 1).

Correspondingly, as can also be seen in figure 2a, on 3rd October few migrating geese were seen in the morning. In the afternoon there were two strong peaks in the numbers of migrating geese, with barnacle geese largely involved in the first,

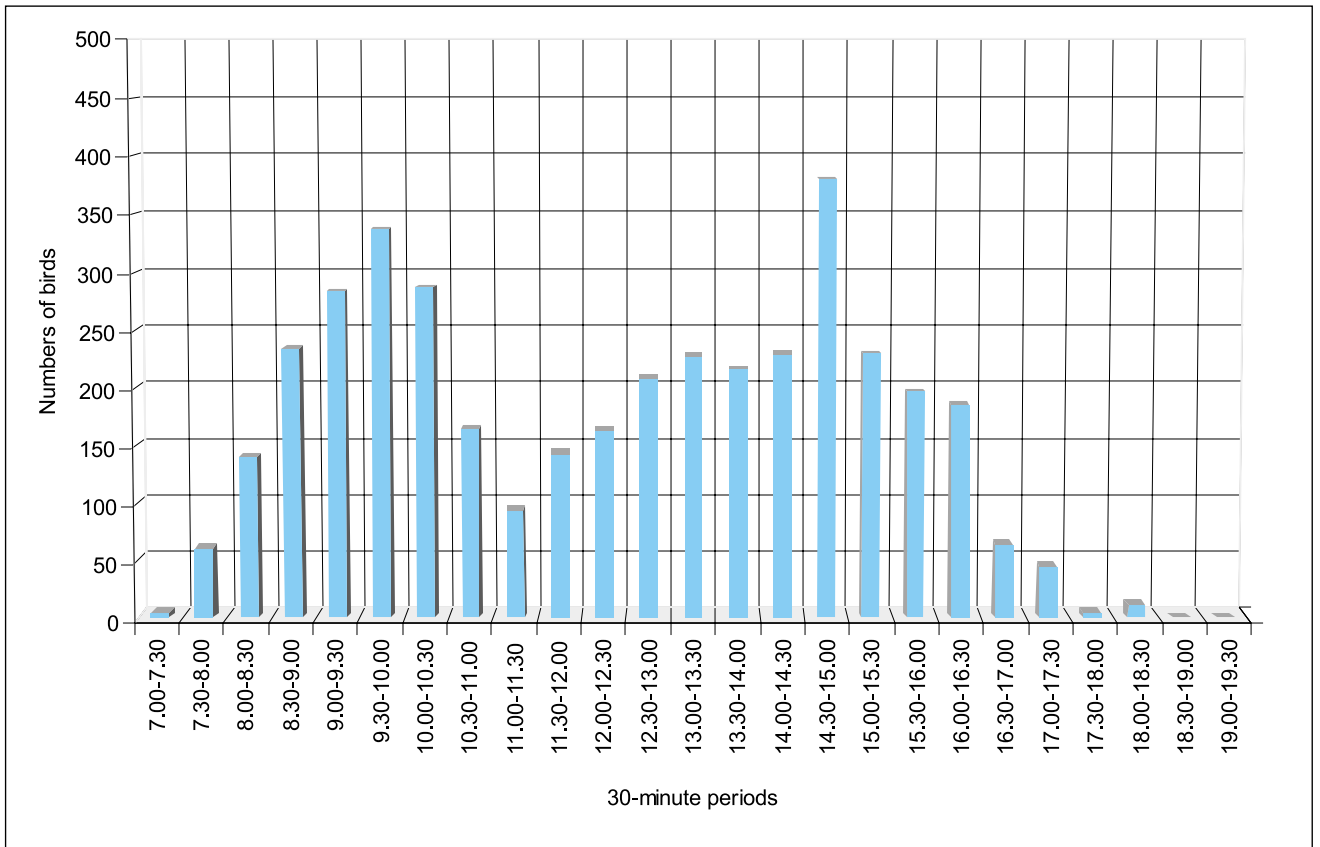


Figure 5a. Migration of Red-throated Diver (*Gavia stellata*) in 1/2-hour-periods during the White Sea expedition 1999.

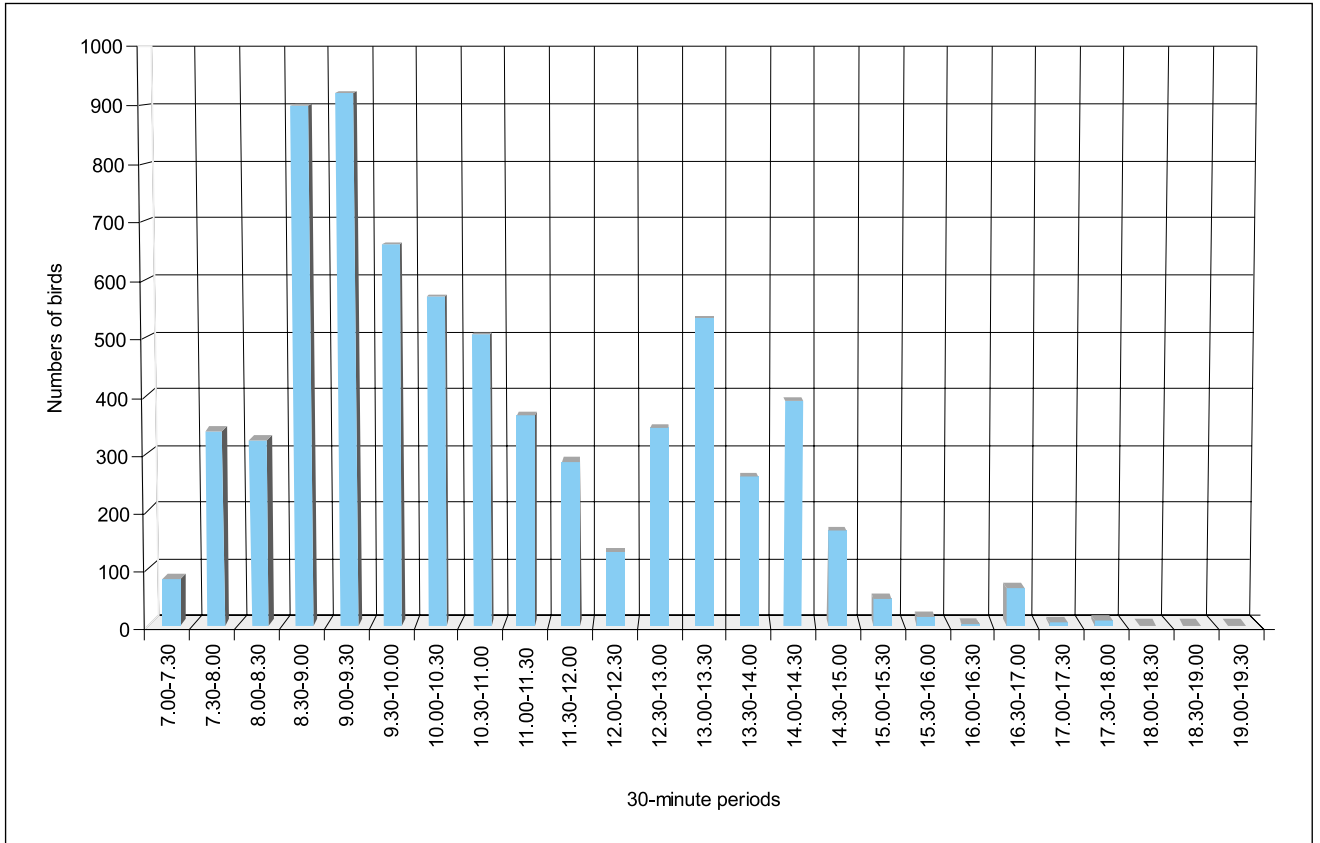


Figure 5b. Migration of Black-throated Diver (*Gavia arctica*) in 1/2-hour-periods during the White Sea expedition 1999.

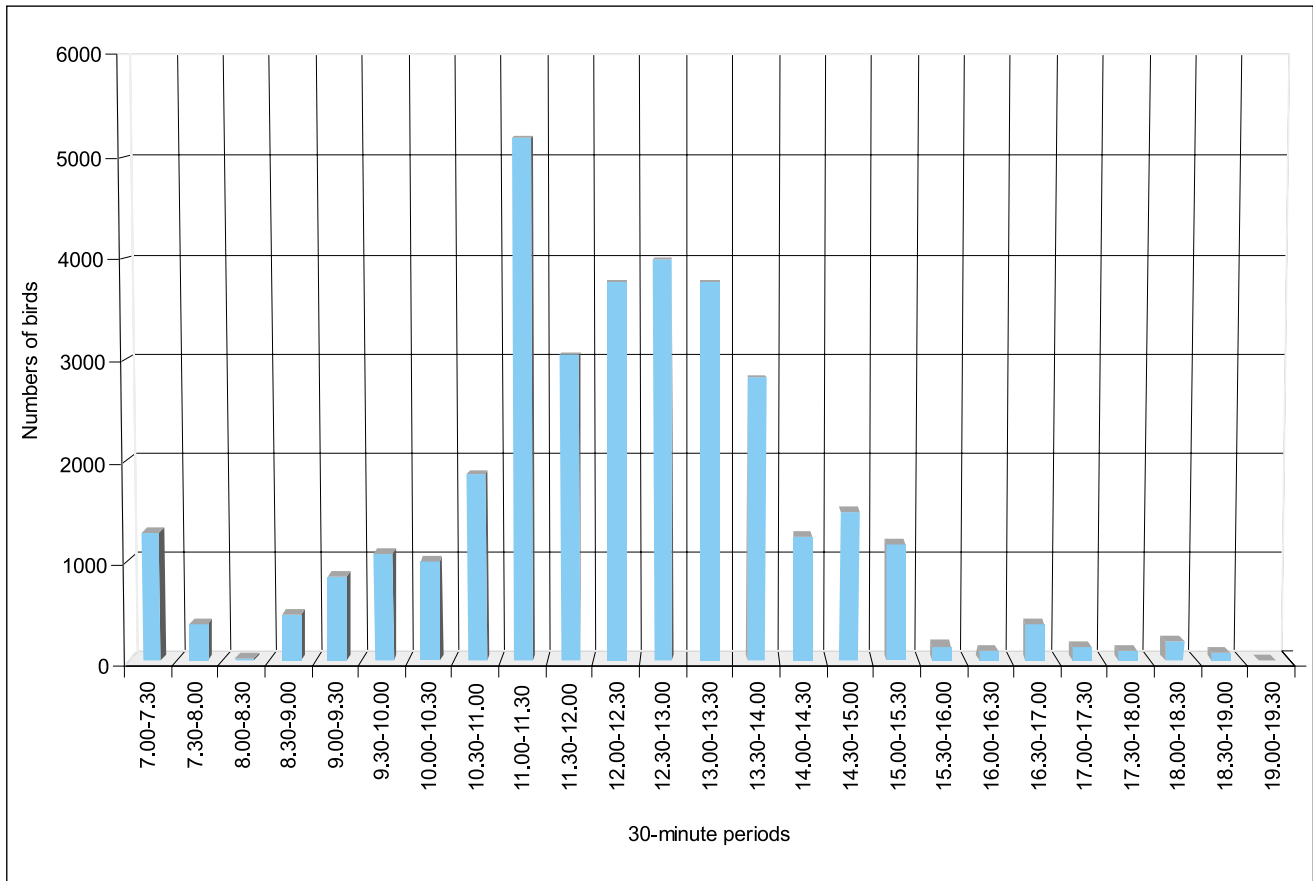


Figure 5c. Migration of Barnacle Goose (*Branta leucopsis*) in 1/2-hour-periods during the White Sea expedition 1999.

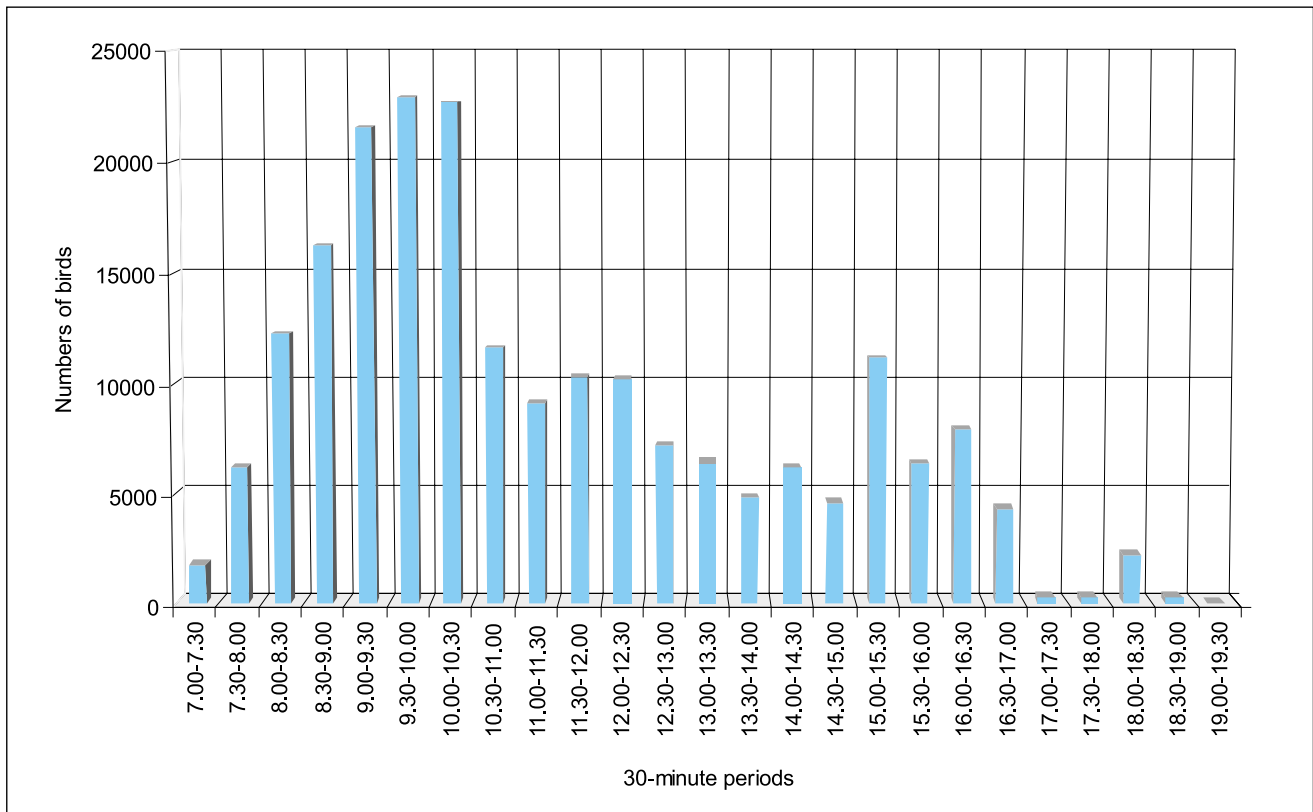


Figure 5d. Migration of Long-tailed Duck (*Clangula hyemalis*) in 1/2-hour-periods during the White Sea expedition 1999.

and *Anser* geese, mainly white-fronted geese (*A. albifrons*) in the second wave. Assuming that the geese had departed early in the morning, the large flocks of barnacles must have come from a staging area a few hundred kilometres away from the observation point, perhaps from around the Kanin Peninsula; whereas the majority of the *Anser* flocks had evidently set off from twice as far away, probably from the shores of the Pechora Sea. This hypothesis is supported by Bianki et.al. (1993) according to whose long-term studies white-fronted geese do not stage on the eastern shores of the White Sea at all, and bean geese (*A. fabalis*) only stage there in small numbers. However, it should be stressed that there is a further possibility that the flocks had departed during the previous evening, which may not be so unusual among geese, even during autumn migration, and this possibility cannot be discounted. If this were the case, they had set off from somewhere much further to the north-east. There is some evidence that at least barnacle geese prefer during their autumn migration to set off in the morning, which is surprising since the mass migration of barnacle geese from Estonia over Finland to northern Russia in spring almost always commences in the evening or early during the night (Estonian Birding Society 1998).

Figure 2b shows quite a different daily migration pattern for black-throated diver. Many birds had been on the move during the previous day (see figure 2a), so large numbers of divers had landed on the sea off the coast at Pertominsk near the observation point to overnight. Migration began very early in the morning and a strong peak was recorded around sunrise. However, the wind turned to the south and strengthened, hindering migration, and probably because of this, migration ceased very soon. The counts from the 3rd and 4th of October at Pertominsk support the previous hypothesis for the overall daily migration pattern for black-throated divers, with intense migration in the morning, weakening considerably towards the afternoon.

The third example of various daily patterns is visible in figure 2c. On 6th October, the peak for divers did not occur until the afternoon, so it can be assumed that the divers, in this case red-throated divers (*Gavia stellata*), had departed from far away, perhaps somewhere around the Kanin Peninsula or the Pechora Sea. In this case, inferring the location of a possible departure area is not so straightforward, since red-throated divers tend to follow the coastline (Leivo et.al. unpublished), so their journeys could have taken more or less time depending on how closely the birds followed the shape of the indented coastline to the east of Zizginski (see map 1). This pattern also reveals the tendency for red-throated divers to continue their migration later in the afternoon than black-throated divers (cf. figures 5a and 5b).

Contrastingly, the numbers of migrating geese exhibited a first peak immediately at dawn on 6th October. This peak involved barnacle geese continuing their migration the morning after resting for the night in the strait, as witnessed by the members of the expedition. The comparatively small numbers of geese observed passing during the day give reason to presume that no large-scale emptying of any important staging area had occurred further along the coast, and there were few signs of any widespread readiness for migration. Subsequent peaks were probably caused by small staging flocks that had departed from various places around the White Sea.

The daily pattern of long-tailed duck (*Clangula hyemalis*) migration on 6th October was more complicated (see figure 2c). The total count for the day (over 95,000 birds) indicates that migration was intense, whereas the many waves and peaks suggest that large numbers of birds had departed from many adjacent staging or stop-over areas in the north-eastern White Sea. The birds in the afternoon waves had possibly set off from the region of the White Sea Channel, assuming that they had departed in the morning.

8.4 Migration routes

Bianki et.al. (1975) studied the volumes, routes and directions of migration in different species during extensive field studies carried out between 1956 and 1963 in various parts of the White Sea. These issues have also been fundamental to earlier Finnish ornithological expeditions to the area (Leivo 1993, Kontiokorpi 1996). These studies, together with the mass of data available from studies of eastern Finland and Estonia by Finnish ornithologists (Pöyhönen 1995), give a relatively good picture of the migration routes and directions used by different arctic species along the White Sea - Baltic Sea route.

The main direction of the autumn migration for most of the species using the White Sea route is SW, since they head to the Baltic Sea region to stop-over or winter. Some of the birds using the White Sea route may exceptionally migrate southwards to the Black Sea region – the black-throated diver (*Gavia arctica*) being the best known example (Cramp & Simmons 1977). However, in different parts of the White Sea the direction of migration varies somewhat on a smaller scale, due to differences in migration strategies between different species, with some species tending to follow coasts, and others migrating in broader fronts regardless of coastlines.

Some species, e.g. swans and Anser geese, migrate more or less directly SW regardless of the coastline or peninsulas. Most of these birds leave the White Sea from Dwina Bay and the southern part of Onega Bay, and many use the Pertominsk route (Bianki et.al. 1975). Contrastingly, some other species, such as red-throated diver (*G. stellata*), brent goose (*Branta bernicla*) and long-tailed duck (*Clangula hyemalis*), normally follow coastlines up to the western coast of the White Sea before heading over the mainland (Leivo 1993, Kontiokorpi et.al., unpublished). These species seem to be quite scarce in the Pertominsk area, but very abundant in the Zizginski and Belomorsk areas, since they fly around the Tsheshmen Peninsula and do not leave the White Sea before the its western coast. Consequently, many of the migration routes of these species converge at the Zizginski Strait, as was observed during the expedition.

Figures 3a-c show the numbers of birds of different species using different migration strategies over the White Sea. The key areas for studying this phenomenon are the Pertominsk coast and the Zizginski Strait which are located along quite separate migration routes (Bianki et.al. 1975). It has to be stressed that a comparison of these routes on the basis of the expedition data is somewhat misleading,

Brent Geese (Branta b. bernicla) tend to follow coast lines on their migration, thus, concentrate strongly on so-called bottle-neck sites like the Zizginski Strait.

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since observation was not simultaneous. The differences in the route selection detected during the expedition may also partly be related to variations in the weather (especially the wind direction and strength), and the migration period of each species. However, our findings are mostly supported by other data both in the White Sea (Bianki et.al. 1975, 1993) and in Finland (Pöyhönen 1995), and by map inspection.

According to the findings of this expedition, red-throated divers clearly favour the northern route, past Zizginski. As can be seen in Figure 3a, red-throated divers were quite scarce migrants at Pertominsk, even though there was at least one mass migration day for divers (11,920 birds in 3rd October), whereas at Zizginski the species was abundant. Black-throated divers were abundant in both areas, showing no apparent preference for either route.

Bianki et.al. (1975) stated that the divers' main migration route was observed as going via Zizginski, and that only a minority of the divers migrated via Pertominsk, passing over the Tsheshmen Peninsula. However, due to identification problems, their data could not distinguish between the two diver species, so no obvious differences in preferred migration routes could be revealed. The events of 3rd October 1999 clearly contradict Bianki et.al. (1975), since very large numbers of black-throated divers were observed crossing the peninsula from the Pertominsk coast.

Another noticeable difference was that Anser geese clearly seemed to prefer the Pertominsk route, whereas brent geese almost exclusively used the northern Zizginski route (see figure 3b). Barnacle geese (*Branta leucopsis*) were abundant along both routes. These findings are supported by many years of observations in Finland (Pöyhönen 1995). Brents and barnacles which leave the White Sea mainly from the Belomorsk area are abundant in most years. Anser geese, on the other hand, are normally much scarcer, since their main migration route passes south-east of Finland.

The differences in preferences between these two separate routes is most clearly evident where long-tailed ducks are concerned (see figure 3c). While other duck species numbers amount to totals of about 15,000 individuals in each area, the difference between the numbers of long-tailed duck is remarkable, with 2,000 birds at Pertominsk, and over 200,000 birds at Zizginski. This is well supported by the data of Bianki et.al. (1975), according to whom only a small proportion of the long-tailed duck population use the Pertominsk route, whereas huge numbers of long-tailed ducks fly around the Tsheshmen Peninsula via Zizginski to the Belomorsk region, from where they start their non-stop flight to the Baltic Sea.

8.5 Congregating areas

Many important congregating areas for arctic waterfowl were found during the expedition (see table 4, and map 3). Although up to 10,000 birds were counted in these areas, these numbers were relatively low compared to the total numbers of birds using the White Sea migration route (see table 2), and to the numbers that have been recorded in many well-known wintering areas in the Baltic Sea region (see Durinck et.al. 1994). This can partly be explained by the fact that the daily numbers of birds in staging areas tend to be much lower than in wintering areas because the turnover of birds in any staging area is high, with only a small fraction of the whole population staying in an area at any time. Unfortunately, no information on this rate of turnover among arctic birds on migration is available to our knowledge.

The densities of up to 780 – 1,350 birds/km² of arctic waterfowl in the congregating areas found during the expedition were generally higher than those reported by Durinck et.al. (1994) in the wintering areas of arctic birds in the Baltic Sea.

Tidal beaches of the Uhtalahti Bay attract large numbers of Wigeon (Anas penelope) as well as their hunters - White-tailed Eagles (Haliaeetus albicilla) and a man.
© Mauri Leivo



Almost the whole Unskaja Bay is shallow while its beaches are flat, sandy and muddy being suitable as a congregating area of dabbling ducks and waders.
© Mauri Leivo



However, the methods used and the sizes of the areas in question differ so enormously that any comparison of density values is not very meaningful. In any case, it can be suggested that densities in congregating areas in the White Sea, at least when inspected on a smaller scale during the mass migration period, may well be even higher than those in the most important, admittedly much larger, wintering areas in the Baltic Sea. This spotlights the importance of the protection of congregating areas during migration periods.

Bianki et.al. (1993) reported surprisingly large maximum densities of over 10,000 birds/km² for long-tailed duck and more than 1,000 birds/km² for eider (*Somateria mollissima*), common scoter (*Melanitta nigra*) and, on Onega Bay, goldeneye (*Bucephala clangula*). On the basis of our experiences, these must be figures calculated for the heaviest recorded concentrations, rather than averages for any larger areas in the White Sea. In either case, the older figures reinforce the evidence of the status of the White Sea as a very important congregating area for migratory arctic birds.

The importance of the waters around Hedostrov Island as a congregating area is apparently a new discovery, as it is not mentioned in any previous literature, such as Bianki et.al. (1975). More importantly, this was the only location visited during the expedition where the velvet scoter (*M. fusca*), the least known species of all the migratory arctic waterfowl species occurring in the White Sea region, was recorded in larger numbers.

The relatively high numbers of black guillemot (*Cepphus grylle*) in the coastal waters of the Solovetski and Anzerskij Islands (see appendix) were also noteworthy. The observed density, 3.9 birds/km², was as high as the densities in its most important wintering areas in the Baltic Sea (Durinck et.al. 1994).

Still another significant finding was that among 20,000 eiders recorded during the expedition, only a few hundred females and juveniles were seen. Eiders of different sexes and ages evidently congregate in completely different areas (see also section 8.1., and appendix).

The coastal waters between the villages of Suhoe and Sumskij Posad (see map 1) are known to be a very important staging area, especially for brent goose (*Branta b. bernicla*) and wigeon (*Anas penelope*) (Bianki et.al. 1975, Leivo 1993). Unfortunately, due to strong winds and swell conditions the expedition was not able to explore this area.

8.6 Transect line counts

The data from transect line counts carried out during the expedition (see table 5) revealed that the densities of staging birds in off-shore areas outside the important congregating areas were low. The density values obtained along transect lines were much lower than the densities observed in congregating areas during the expedition (see section 7.4), or those reported by Durinck et.al. (1994) in the Baltic Sea in winter.

However, during this expedition transect lines were counted only while the research vessel was sailing directly from one research area to another (see map 4), and not along the previously planned zig-zagging route which should have given better coverage of the most promising coastal areas – a procedure which would be followed during a more thorough survey. Since the identification of the most important congregations of birds and the related counts of the numbers and densities of birds were carried out using another method (see sections 5.2, 5.3 and 7.4), transect line counts were mainly used merely to provide comparative density values for assessing the importance of congregating areas.

Marine mammals

Although marine mammals are outside the scope of the RECMAB project, they were observed during the expedition almost as assiduously as birds. Every sighting of a marine mammal was also noted on the bird sighting forms. Detecting marine mammals at sea is more challenging than observing birds since even a moderate swell can easily conceal the shape of a seal or a whale between the waves. Seals on the shore are of course much easier to detect and identify.

Three species of marine mammals were recorded: **ringed seal** (*Phoca hispida*), **bearded seal** (*Erignathus barbatus*) and **beluga** (*Delphinapterus leucas*). These species are the only widely distributed marine mammals in the White Sea (Jensen 1993). The more sporadic Greenland (or harp) seal (*Pagophoca groenlandica*) is very abundant in the area in some years, but its occurrence is normally restricted to waters near the White Sea Channel (Jensen 1993).

The ringed seal was the most frequently observed marine mammal during the expedition, with a total of about 300 animals recorded. The highest daily total of 233 individuals was counted on 1st October on the way from the Solovetski Islands to Pertominsk, with the largest numbers seen in the vicinity of the Solovetski, Muksalma and Anzerskij Islands. The weather that day was cloudy and totally calm – in fact the best conditions of the whole expedition – and this facilitated the seal count.

The bearded seals seen during the expedition were clearly concentrated in the waters between Kondostrov Island and Nimenia Bay in Onega Bay. Fifty of the expedition's total of 70 animals were recorded in this area. This archipelago differs from the others along our route, as the landscape is dominated by relatively high, rounded, treeless islands with quite open and steep cliffs sloping into the sea.

A total of about 70 belugas were observed during the expedition, 37 of which were also counted on 1st October, perhaps mainly due to the excellent weather conditions for whale observations. The largest numbers of belugas were recorded off the western and southern shores of the Solovetski Islands (7 whales) and along the coast at Pertominsk (over 10 whales). The biggest school of Belugas consisted of 5 individuals. In addition to adults, one sub-adult and three young, brown-coloured whales were recorded.

Conclusions

The White Sea expedition was successful in spite of the relatively short time available. The numbers of arctic birds recorded, totalling over 600,000 individuals, were high. Large numbers of migrating birds were recorded on many days. A new European record for the numbers of geese counted on a single day at one observation point during the autumn migration was established: 112,600 birds on 3rd October, at Pertominsk. The highest daily totals for divers (11,900), ducks (103,800), and skuas (377), were also noteworthy. In general, the numbers of migrating birds recorded were much higher than those reported by Bianki et.al. (1975), probably mainly due to the participation of highly experienced observers, the chance to choose ideal anchorages for the ship with regard to the observation of migration, the use of high-quality equipment (telescopes, binoculars etc.) and relatively suitable weather.

The findings of the expedition reinforce the ideas of Bianki et.al. (1975) regarding the most promising observation points in the White Sea. The locations where the heaviest migration could be observed, known as migration bottle-necks, are the Zizginski Strait, the Pertominsk area and, to a lesser extent, the coast around and to the south-east of Belomorsk. The importance of these areas for the observation of migration was predicted from the preliminary map inspection, which is why these areas were preselected for the most intensive observation during the expedition. Such bottle-necks could play an important role in setting up a low-budget monitoring system to study population changes, breeding success and other respects of the ecology of arctic species, as well as to produce basic data on daily rhythms, differences in the timing of migration between different sexes or age-classes, or other details of migration dynamics. The monitoring of the populations of arctic bird species should ideally be conducted at both of these sites at the same time, since their species compositions are quite distinct (see figures 3a-c and section 8.4).



Barnacle Goose (Branta leucopsis) - one of the most significant features of arctic bird migration in the White Sea.
© Mauri Leivo

The Zizginski Strait turned out to be a particularly promising observation point, as here migration routes funnel through the 7-km-wide strait. The whole strait can be well covered from an observation point in the middle of the strait, or possibly even from the shores of both the peninsula and the island, at least during good visibility. The ideal location and geography of the Zizginski Strait resulted in high identification percentages for arctic birds during this expedition, varying daily between 79.1 and 97.9 % for the observation period 5th-8th October. At this kind of optimal observation point the plumages of the birds can even be studied, which helps with the assessment of the progression of migration for certain species, by observing the percentages of different age and sex classes; the evaluation of breeding success, by counting the numbers of juveniles; and the mapping of potential moulting areas, by studying the stage of moulting of passing birds.

Our results in the most important congregating areas are well supported by Bianki et.al.(1975). The most interesting area was perhaps the waters around Hedostrov Island, which seemed to be an important congregating area for many species of sea duck, although the numbers of staging birds were not particularly high. Also the importance of the coasts of the Solovetski, Muksalma and Anzerskij Islands for black guillemot (*Cephus grylle*) was noteworthy.

Findings related to the studies of the daily patterns of migration observed during the expedition support the previously held idea about the importance of the White Sea Channel and the Pechora Sea region as research areas for the RECMAB project, since they evidently contain important staging areas for many arctic species. Furthermore, from map inspection, it can be surmised that the White Sea Channel is also a significant migration bottle-neck for arctic birds.

The findings from this kind of expedition do not necessarily give completely reliable information on the congregating areas of arctic birds in the area discussed. The situation can change rapidly as migration progresses, and sites occupied only by few birds one day may be crowded with large numbers of birds on another day. The data can clearly reveal that certain areas are important, but cannot be relied upon to infer that other areas are not important, or to indicate the maximum numbers of birds that can be seen in any area during a migration period. Although many important staging areas may be revealed even during such brief surveys, other known and presumed congregating areas should be surveyed using extensive counts during the whole migration period for at least one season, or preferably over two or three successive years, to get a more comprehensive idea of bird numbers and the dynamics of congregations in different areas.

Another possible shortcoming of the expedition was that potential congregating areas could only be surveyed along 5-10 km wide sectors along either side of the ship's route. As a result, large sea areas remained uncovered. However, most congregating areas should have been evident, since arctic water birds normally stay in waters less than 20 metres deep to feed (Durinck et.al. 1994), and the ship sailed in such waters for most of the voyage. Areas that remained undiscovered most probably include some stop-over areas in the open sea, and others in waters right along the coast which could not be reached by the ship.

The expedition revealed that ship surveys are not the most suitable way to study congregating areas in expansive areas of sea. By ship it is difficult to react to rapid changes in the numbers of staging birds during a migration period. A survey of the whole of the White Sea by ship would take at least three weeks, during which time many migrating species would pass through the area and many large congregations would remain undiscovered. If transect line counts were also widely conducted at the same time, the survey would last at least another two weeks.

Another significant disadvantage of ship surveys is the inability to reach shallow coastal areas. Congregating areas used by brent goose (*Branta b. bernicla*), wigeon (*Anas penelope*) and scaup (*Aythya marila*), for instance, largely remained out of reach of our ship. The chances to use small boats from a ship are often limited by swell conditions, as was often the case during this expedition.

In conclusion, a survey of congregating areas in an area the size of the White Sea cannot be comprehensively conducted by using a ship alone. A similar conclusion was previously drawn in Väinämeri, Estonia, where a survey of staging arctic birds, especially scaup, was carried out as part of the RECMAB project in spring 1996 (Leivo, unpublished). However, using a ship survey to map congregating areas has some benefits compared to aerial surveys, the other much used method for counting birds on the sea. These benefits included the long observation times for each recorded individual (resulting in better identification percentages, better chances to discern the plumages of birds, and more accurate counts of the numbers of birds), better chances to detect elusive and more sparsely distributed species like divers and auks, which can easily remain undetected during aerial counts (Komdeur et.al. 1994), and lower costs.

Experiences and results from an aerial survey of the Russian waters of the Gulf of Finland conducted in spring 1996 were very promising (Leivo 1997b). In just four hours the whole of the eastern (Russian) end of the Gulf was surveyed by aeroplane.

Organising intensive aerial counts over the White Sea would be essential for research into important congregating areas. In addition, to get a clear overall idea of the dynamics of congregations of migratory arctic species, aeroplane surveys should be simultaneously carried out in adjacent parts of the migration route, i.e. over the White Sea, Lake Ladoga, the Gulf of Finland and perhaps also Estonian waters. How such a survey could be realised is explained and discussed in detail in the RECMAB plan (Leivo 1997a). In addition to aerial counts, ship surveys should also be organised in certain limited areas.

Research projects like RECMAB are necessary to give keys for the adequate protection of arctic migrants. The impact of conservation measures taken in these birds' relatively well-known and protected breeding and wintering areas in western Europe is somewhat diminished if their congregating areas along their migration routes remain unknown and unprotected. In general, congregating areas are very sensitive to environmental risks during migration periods, since very large numbers of birds simultaneously congregate in very limited areas. A serious oil-spill in a congregating area, for instance, could be catastrophic for a population of an arctic species. International conventions and agreements on the protection of birds that cover arctic migrants include the Ramsar and Bonn Conventions on the global scale; the Bern Convention and the EU Wild Birds Directive on the European level; and CAFF (Conservation of Arctic Flora and Fauna), a programme which covers arctic countries.



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Appendix. The annotated list of the bird species recorded during the White Sea expedition 1999.

The first figure after the name of each species indicates the total number of individual birds of the species identified during the expedition. For some species these figures are lower than the corresponding figures in Table 2, which also include some unidentified birds allocated to each species according to their respective proportions amongst the birds of their species group identified. For many species the largest numbers seen on any single occasion or day are also noted.

Abbreviations: ind. = individual, m. = migrating, ad. = adult, imm. = immature, cy = calendar-year (e.g. 3cy is a bird of the third calendar-year).

The following 114 species were observed during the expedition:

Red-throated Diver (*Gavia stellata*) 4,901

No important congregating areas were found. In transect line counts the average density was 0.3 birds/km² and the highest density 2.5 birds/km². Heavy migration recorded on 7th and 8th October, with 1,583 and 1,537 ind. respectively. More than 200 identified birds were seen on four days out of the 16 days of the expedition. Abundant only on the Zizginski route (see figure 3a, and section 7.3.2.). Heavy migration recorded both in the morning and in the afternoon (see figure 5a). A hypothesis was formed that the birds passing during the afternoon peaks had come from far away, probably from the White Sea Channel region.

Black-throated Diver (*Gavia arctica*) 8,962

No important congregating areas were found and few staging birds were observed at all. In transect line counts the average density was only 0.03 birds/km². However, heavy migration was recorded on many days. On 3rd October and 7th October migrating numbers were very high, with 2,317 and 2,831 birds identified respectively. On the best day, 3rd October, a total of 11,920 divers were recorded, with 93.4 % of the 2,480 birds identified being *G. arctica*. More than 200 birds were identified on seven days out of the total of 16 days of the expedition. No significant difference was observable in their abundance along the Pertominsk and Zizginski routes (cf. red-throated diver) (see figure 3a, and section 7.3.2.). Migration was largely concentrated in the morning, although a clear afternoon peak also occurred (see figure 5b). The departure area for the birds recorded in the afternoon is probably situated east of the White Sea Channel.

Great Northern Diver (*Gavia immer*) 9

All sightings: 2nd October 3 ind. m., and 3rd October 1 ind. m. Pertominsk, 6th October 4 ind. m., and 7th October 1 ind. m. Zizginski. All in immature plumages: one 2cy, others 1-2cy.

White-billed Diver (*Gavia adamsii*) 5

All sightings: 3rd October 1 ind. m. Pertominsk, 7th October 3 ind. m., and 8th October 1 ind. Zizginski. Plumages: 4 ad. summer, 1 1cy.

Great Crested Grebe (*Podiceps cristatus*) 20

All 22nd September, Lake Onega.

Red-necked Grebe (*Podiceps grisegena*) 36

Max. 7th October 11 ind. m. Zizginski.

Great Shearwater (*Puffinus gravis*) 1

1 m. 24th September near Osinka Island. Probably not previously recorded in Russia. A detailed note on this observation is published in the Russian Journal of Ornithology (Leivo et.al. 2000).

Cormorant (*Phalacrocorax carbo*) 46

Max 9th October 15 ind. Belomorsk.

Bewick's Swan (*Cygnus columbianus bewickii*) 10

Surprisingly few sightings. Much heavier migration was expected in the Pertominsk area since it was known that the species uses the south-eastern route on the way to wintering areas in north-western Europe. According to Bianki et.al. (1993) the Bewick's swan is more abundant on Dwina Bay than the whooper swan.

Whooper Swan (*Cygnus cygnus*) 31

The notes for the previous species are mostly relevant also for this species. Unlike Bewick's swans, whooper swans are known to congregate to some extent in the White Sea (Bianki et.al. 1975), but probably due to the late migration of the species no staging migratory birds were seen during this expedition. In the southern Kola peninsula thousands of moulting subadult whooper swans are known to congregate (Bianki et.al. 1975, Scott & Rose 1996).

The migration route of Bewick's Swans (*Cygnus columbianus bewickii*) goes through the south-eastern parts of the White Sea between their breeding areas in the arctic Russia and NW Europe. The size of the flyway population of this species is 17,000 birds. © Mauri Leivo



Bean Goose (*Anser fabalis*) 1,685

Although recorded in fairly large numbers, this species was the least abundant goose recorded during the expedition. No staging birds were recorded. The only day of heavy migration was 3rd October when 1,292 birds were identified (with the relevant proportion of unidentified birds added to this sum, the number of birds on that day was actually much higher). Bean geese occurred in the same flocks as white-fronted geese which indicates that they use similar congregating areas, and that they are strongly associated with the Pertominsk route (see figure 3b). The majority of birds of the populations in northern Russia (more than 600,000 ind., Madsen et.al. 1999) probably use a more south-eastern route to their wintering areas in Central and NW Europe. In theory, most of the bean geese occurring in the White Sea region should belong to the eastern subspecies *A.f.rossicus*, but this expedition did not compile data on subspecies (due to difficulties in studying the details of the plumage of birds in flight).

White-fronted Goose (*Anser albifrons*) 5,885

The more abundant of the two *Anser* goose species. The only day of heavy migration was 3rd October when 4,401 birds were identified (with the relevant proportion of unidentified birds added to this sum, the number of birds on that day was actually much higher). White-fronted geese seem to use the same staging areas as both bean geese and barnacle geese since during the expedition they were almost always seen in mixed flocks with either or both of these species. The population that migrates through NW Russia (700,000 ind., Scott & Rose 1996), and partly also the White Sea region, is the largest of any goose species occurring in Europe. The majority of birds are thought to use more south-eastern routes over the mainland of NW Russia to their wintering areas in Europe.

Barnacle Goose (*Branta leucopsis*) 34,810

The most abundant goose species during the expedition. The White Sea is well situated along the migration route of barnacles from their breeding areas in northern Russia (Novaja Zemlya and adjacent areas) to their wintering areas in NW Europe. Staging and feeding birds were seen only on Zizginski Island (c. 1,000 ind). Heavy migration was recorded on many days, e.g. 3rd October (6,148 identified birds), 6th October (6,871), and 7th October (17,666) (see also table 2). In figure 5c it can be seen that a very strong peak of migration occurred around noon. Assuming that the majority of the birds had started their migration early in the morning, as seems to be the case with barnacle geese, the large majority of birds had probably departed from areas near the White Sea Channel. The majority of barnacles were recorded in monospecific flocks, with only a minority of birds in mixed flocks, mainly with white-fronts and brents. Barnacles used both the Pertominsk and the Zizginski routes in large numbers (see figure 3b). This is probably exceptional among geese, since *Anser* geese seem to clearly prefer the southern (Pertominsk) route, and brents the northern (Zizginski) route. A frequently debated detail of barnacle migration is its tendency to follow coastlines. Contrary to earlier statements, according to our data in recent years, barnacles do follow coastlines whenever this does not result in too much of a detour away from their main migration direction. This was well proved at the Zizginski Strait where thousands of Barnacles came from different eastern directions (some straight from the NE, some even from the ESE) and were clearly following the coast westwards.

(Dark-bellied) Brent Goose (*Branta b. bernicla*) 17,532

An abundant species. The number identified was the second highest of all the goose species, but if the numbers of unidentified

birds are added to the species sums, the actual number of white-fronted geese possibly exceeds the number of brents. In the southern parts of the White Sea only a few brents were seen during the expedition, as expected, while heavy migration was recorded in the northern White Sea, at Zizginski, e.g. 3,328 migrating birds on 6th October, 9,551 on 7th October and 3,459 birds on 8th October. However, even higher numbers had been expected, since the total population of the dark-bellied brent goose in northern Russia is estimated at 300,000 (Scott & Rose 1996, Madsen et.al. 1999), of which at least the large majority should migrate through the Zizginski Strait in autumn. The brent goose congregates in large numbers in the White Sea (Bianki et.al. 1975, 1993). Probably the most important congregating area is off the villages of Suhoe and Virma, where a flock of 70,000 Brents was recorded in autumn 1992 (Leivo 1993). Unfortunately, due to heavy swell these areas could not be explored during this expedition. In other areas only very low numbers of staging brents have been recorded during autumn. However, it is also possible that brents gradually gather through the autumn on the western coast of the White Sea, and thus no huge mass migrations pass over the Zizginski Strait. A relatively large percentage of the brents recorded during the expedition were juveniles, which indicates that breeding had been quite successful that year.

Wigeon (*Anas penelope*) 18,200

Although not a focus species of the REC-MAB project, the wigeon is an abundant subarctic migrant in the White Sea, where it congregates in large numbers on many sea bays (Bianki et.al. 1975). During the expedition two large congregations were recorded: at least 10,000 ind. in the southern part of Uhtalahti Bay, and 3,000 ind. in the northern part of Unskaya Bay (see map 3). In both areas wigeon (and other wildfowl) were disturbed by preying white-tailed eagles (*Haliaeetus albicilla*) and hunters (*Homo sapiens*). The coastal waters off Suhoe, Virma and Sumskiy Posad are also known as important congregating areas for wigeon, where Finnish ornithologists have recorded up to 10,000 birds in autumn (Leivo 1993, Kontiokorpi 1996). Due to heavy swell, this area could not be explored this time. Large numbers of migrating wigeon were recorded at Zizginski: 1,037 identified birds on 7th October and 2,782 on 8th October. Typically for wigeon, migration was heavy almost all day, perhaps indicating that there are plenty of suitable staging areas (sea bays) for the species in the White Sea region.

Teal (*Anas crecca*) 177

Max. 7th October 36 ind. m. and 8th October 77 ind. m. Zizginski.

Mallard (*Anas platyrhynchos*) 833

Largest staging flocks 22nd September 205 ind. Poventsya, and 9th October 295 ind. in Belomorsk Harbour. Highest numbers on migration 8th October 42 ind. Zizginski.

Pintail (*Anas acuta*) 443

Very few staging birds were seen during the expedition. Moderate migration was recorded at Zizginski 7th & 8th October (114 and 281 birds, respectively). Pintail congregating areas and migration patterns greatly resemble those of wigeon (Bianki et.al. 1993).

Sholever (*Anas clypeata*) 14

Tufted Duck (*Aythya fuligula*) 52

Max. 8th October 19 ind. m. Zizginski.

Scaup (*Aythya marila*) 1,229

Much less abundant than expected. No larger congregations were found, and no birds were seen during transect line counts (total of 88 km² covered). This may partly be due to a strict preference to stage and feed in shallow waters (Leivo, unpublished, see also Durinck et.al. 1994) that remained insufficiently explored during this expedition. Normally scaups concentrate clearly on the Pertominsk route, i.e. in the south-eastern parts of the White Sea, where they also congregate in large numbers, up to 100 - 1,000 birds/km² (Bianki et.al. 1975, 1993). Regardless of very active observation on all four days in the Pertominsk area during the assumed main migration period of the species, only a few migrating birds were recorded. The largest numbers were recorded at Zizginski on 7th October (278 ind.) and 8th October (345 ind.). The scaup still remains one of the most mysterious arctic waterfowl species, whose migration pattern is quite unclear. This may be partly due to its preference for nocturnal migration (Leivo et.al. 1994).

Eider (*Somateria mollissima*) 20,000

Practically all the birds recorded were staging, and no real migration was proved. Large congregations were counted in many areas, e.g. 3,700 ind. off Hedostrov Island, 1,500 ind. on the E coast of the Susmoi Islands, 2,250 ind. on the SW and S coasts of Solovetski Island, 1,300 ind. at the Zizginski Strait, and 3,500 ind. along the Pertominsk coast (see map 3). Bianki et.al. (1993) classified the eider as a scarce staging species in Dwina Bay, especially in autumn. Perhaps a congregating area along the Pertominsk coast is unknown to Russian ornithologists? Remarkably, c. 98 % of eiders were moulting adult males (see sections 8.1 and 8.5). Eiders winter in large numbers in the White Sea (Bianki et.al. 1975, 1993). No migration occurs from the White Sea to the Gulf of Finland via eastern Finland (various bulletins of local ornithological societies in Finland).

Few autumn records of eider are known in recent decades despite intensive observation. Furthermore, out of the thousands of birds ringed in the White Sea, none have been found in the Baltic Sea (M.Hario, verbal account). This contrasts with king eider (several sightings each autumn in eastern Finland), and especially Steller's eider, which migrates partly through eastern Finland to wintering sites in the Baltic Sea (Pöyhönen 1996 and Estonian Birding Society 1998).

King Eider (*Somateria spectabilis*) 100

The largest numbers were seen on the Pertominsk coast (50 ind.) and at the Zizginski Strait (18 ind.). The species is highly arctic and is known to move westwards from breeding areas in northernmost Russia in late autumn (Scott & Rose 1996). Bianki et.al. (1993) classify it as a regular visitor both during migration periods and in winter in the White Sea. Unlike eider, almost all the birds seen during the expedition were juveniles (over half) or females, only a few moulting adult males were seen.

Steller's Eider (*Polysticta stelleri*) 2

Two individuals was much less than expected, since the size of winter population of the Baltic Sea is c. 7,000 ind. (Scott & Rose 1996), and the species migrates there via the White Sea route (see Estonian Birding Society 1998). According to Bianki et.al. (1975), Steller's eiders moult regularly in the White Sea Channel each autumn, but only a minority of these birds winter irregularly in the White Sea (Bianki et.al. 1993). The low numbers seen during this expedition could be explained by the very late migration period of the species, since the majority of the population do not migrate before the beginning of December (see Estonian Birding Society 1998).

Long-tailed Duck (*Clangula hyemalis*) 270,000

Overwhelmingly the most abundant arctic migrant in the White Sea (Bianki et.al. 1993). The size of the Northern Russian population is about 5 million birds (Scott & Rose 1996) most of which migrate via the White Sea to the Baltic Sea to winter (Cramp & Simmons 1977). Although it was clearly the most abundant species recorded during the expedition, the number of birds and magnitude of migration were lower than expected. The number of birds recorded was only 6.2 % of the whole flyway population, while this percentage was much higher for divers (25-27 %) and *Branta* geese (16-38 %) for example (see table 2 and section 7.1.). Only two congregations of moderate numbers of birds were found: 10,000 ind. near Osinka Island, and 1,000 ind. on the Pertominsk coast (see map 3). The Osinka area seemed to be a stop-over area where birds merely had a short pause between legs of their migration, while the Pertominsk area obviously was a staging area where birds feed actively and stay longer. In addition to these areas, the waters between Pertominsk and Zizginski seemed to be an important stop-over area. Many dense, non-feeding flocks were seen on the sea between Pertominsk and Zizginski. Bianki et.al. (1975) have also regularly recorded large numbers of long-tailed duck on this part of the White Sea. In transect line counts long-tailed duck was by far the most abundant species. The average density of long-tailed duck in transect line counts was 3.01 birds/km², and the maximum density along a single line was 80 birds/km². These values are much lower than those counted in the congregating areas during the expedition (see section 7.4) or in transect line counts in the most important wintering areas in the Baltic Sea (Durinck et.al. 1994). Heavy migration was recorded

A mixed flock of male and female Eiders (*Somateria mollissima*) seems to be a rare occasion in the White Sea in the late autumn. Eiders recorded during the expedition were almost exclusively males.
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on two days: 6th October (92,000 ind.) and 7th October (103,860 ind.) at Zizginski. These migrations were dominated by adult males (more than 50 % of the birds), masses of which, according to our long-term studies in Russia, Estonia and Finland (Kontio Korpi, Kontkanen and Leivo, unpublished), migrate a week or so before females and juveniles. This indicated that the majority of long-tailed ducks had not yet migrated through the White Sea. On 9th October moderate migration was recorded in the morning and around noon at Belomorsk, with birds surprisingly flying from the White Sea straight over the mainland (heading S-SW). According to Kontio Korpi (unpublished), this is unusual since the mass departures of long-tailed duck from the western White Sea coast in autumn normally occur in the evening. As can be seen in figure 5d, the migration of long-tailed duck was heaviest in the morning. However, the graph also indicates that many migration waves can occur during a single day (see e.g. 6th October in figure 5d), and that migration may continue almost throughout the day. This can be explained by the fact, also observed during the expedition, that the stop-over flocks of long-tailed duck are widely dispersed over the White Sea, i.e. they seem not to concentrate as much in certain staging areas as many other species. Long-tailed ducks winter regularly in moderate numbers in the White Sea (Cramp & Simmons 1977, Bianki et al. 1993).

Common Scoter (*Melanitta nigra*) 15,000

Abundant arctic migrant in the White Sea (Bianki et al. 1993). The whole flyway population is 1,600,000 birds (Scott & Rose 1996). Only one congregating area was found during the expedition: 2,500 ind. on the Pertominsk coast. Common scoters evidently use the Pertominsk area as a staging area for a longer period, since a similar number of actively feeding birds was observable there on several days. The scarcity of common scoters elsewhere in the White Sea is shown by the results of transect line counts: the average density was only 0.39 birds/km² and the maximum 15 birds/km² (these values are respectively a tenth and a fifth of the figures for long-tailed duck). Common scoters in Northern Europe migrate during two separate periods: in July-August adult males migrate to the Danish Straits to moult, and in September-October females and juveniles migrate to the Baltic region (Cramp & Simmons 1977). Fairly heavy migration was recorded at Zizginski 6th & 8th October (2,692 ind., 2,452 ind. and 3,660 ind., respectively). As expected, only a few adult males were seen in flocks.

Velvet Scoter (*Melanitta fusca*) 3,834

Only low numbers were recorded during the expedition, and many questions about the migration patterns of this insufficiently documented species remained open. However, a probably previously unknown congregating area was found in shallow waters off the Hedostrov Island in Onega Bay (27th September 1,700 ind.) (see map 3). In addition to this, staging birds were seen only on the Pertominsk coast (100 ind.). The overall scarcity of velvet scoter in the White Sea is also well illustrated by the results of transect line counts. No more than 10 birds were counted in the whole survey area of 88 km² giving an average density of 0.09 birds/km². The number of birds on migration was low (maximum only 441 ind. on the best day). At least half of the migrants were adult males, indicating that migration was just beginning. It has been noticed that adult males dominate velvet scoter flocks until the late autumn (Pietiläinen & Leivo 1993, Kontkanen & Leivo, unpublished). According to Bianki et al. (1975, 1993), the highest numbers of velvet scoter can be seen in Dwina Bay, and fairly strong migration should occur there in the very beginning of October. Regardless of this, only low numbers were seen in the Pertominsk area during the expedition (1st & 5th October). The velvet scoter's migration pattern remains still largely unknown, and to our knowledge large numbers of birds on autumn migration have not been reported anywhere in NE Europe. Contrastingly, migrations of huge numbers (up to 0.5 million birds a day!) have been counted during spring migration in Estonia (Leivo et al. 1995).

Goldeneye (*Bucephala clangula*) 2,076

Although goldeneyes migrate in large numbers via the White Sea to the Baltic Sea to winter, relatively low numbers of birds were recorded during this expedition. The only areas where larger flocks of staging birds were seen were Uhtalahti Bay (100 ind.) and the Pertominsk coast (200 ind.). The maximum density recorded by Bianki et al. (1993), 1,000 birds/km², is much higher than our figures. Moderate migration was recorded at Zizginski 7th-8th October, with 430 ind. and 750 ind., respectively. About ¾ of the birds in the goldeneye flocks observed were adults.

Smew (*Mergus albellus*) 14

Surprisingly low numbers were recorded during the expedition, considering that the size of the flyway population migrating from North Russia to wintering areas in the Baltic Sea is over 20,000 birds (estimate from Scott & Rose 1996).

Red-breasted Merganser (*Mergus serrator*) 500

Recorded widely during the expedition but in low numbers. The largest numbers of staging birds were 80 ind. on the SW coast of the Solovetski Island and 70 ind. on the Pertominsk coast. Only a few flocks were seen on migration.

Goosander (*Mergus merganser*) 369

Occurrence during the expedition similar to the previous species. The largest numbers of staging birds were 89 ind. on the SW coast of Solovetski Island and 50 ind. on the Pertominsk coast. According to Bianki et.al. (1993), the goosander is not very abundant in the White Sea.

Honey Buzzard (*Pernis apivorus*) 3

All on migration 21st September, Petrozavodsk.

White-tailed Eagle (*Haliaeetus albicilla*) 35

Only a few birds were seen on migration, but others were lurking around areas where large flocks of ducks were staging, e.g. 29th September 4 ind. Uhtalahti Bay, 2nd October 4 ind. Unskaja Bay. Plumages: 22 ad, 1 5cy, 1 3cy, 1 1cy, 6 imm.

Hen Harrier (*Circus cyaneus*) 3

Goshawk (*Accipiter gentilis*) 6

Sparrowhawk (*Accipiter nisus*) 14

Rough-legged Buzzard (*Buteo lagopus*) 58

The best migrations: 23 ind. heading S-SE 23rd September, and 18 ind. heading SE 24th September, Stalin Canal. No juveniles seen.

Golden Eagle (*Aquila chrysaetos*) 1

1 imm. heading S 3rd October, Pertominsk.

Osprey (*Pandion haliaetus*) 4

Merlin (*Falco columbarius*) 12

Peregrine (*Falco peregrinus*) 8

All except one on migration. Identified by plumages: 2 ad. 2 1cy. In addition to these birds, 2 unidentified large falcons seen were also probably peregrines, as the gyrfalcon (*Falco rusticolus*) is very rare in the White Sea (Bianki et.al. 1993).

Hazelhen (*Bonasa bonasia*) 1

1 ind. 2nd October, Pertominsk

Black Grouse (*Tetrao terix*) 13

Common Crane (*Grus grus*) 71

All 22nd September migrating S in 5 flocks, Stalin Canal.

Oystercatcher (*Haematopus ostralegus*) 20

Max. 2nd October 12 ind. Pertominsk.

Ringed Plover (*Charadrius hiaticula*) 27

All 2nd October, Pertominsk.

Golden Plover (*Pluvialis apricaria*) 54

Max. 3rd October 28 ind. m. Pertominsk.

Grey Plover (*Pluvialis squatarola*) 72

Max. daily total 14 ind.

Sanderling (*Calidris alba*) 2

Surprisingly many Purple Sandpipers (*Calidris maritima*) were recorded during the expedition.
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Dunlin (*Calidris alpina*) 1,891

The only wader species recorded in large numbers during the expedition. Two congregations recorded: 700 ind. on the coast at Belomorsk and 270 ind. (including 100 unidentified small waders) at Unskaya Bay. Fairly good migration was recorded on several days (unidentified small waders included in the sums): 563 ind. 24th September, 390 ind. 25th September, 440 ind. 28th September, 792 ind. 3rd October. About 99 % of the dunlins were juveniles. The main migration period for adults is July-August. According to Bianki et.al. (1993), the dunlin is by far the most abundant wader in the White Sea.

Purple Sandpiper (*Calidris maritima*) 67

All except two recorded at Dwina Bay (Pertominsk - Zizginski). On the best day (3rd October at Pertominsk) 39 ind. in 15 flocks were recorded on migration. Normally, purple sandpipers are observed feeding on stony seashores, and little data has been published about their migration in northern Europe. The purple sandpiper is a regular autumn visitor to the White Sea, and winters in large numbers on the northern coast of the Kola Peninsula (Bianki et.al. 1993).

Common Snipe (*Gallinago gallinago*) 1

1 ind. 24th October, Belomorsk.

Bar-tailed Godwit (*Limosa lapponica*) 2

Pomarine Skua (*Stercorarius pomarinus*) 111

The large numbers of pomarine skuas observed was one of the most notable findings of the expedition. The species' autumn migration along the White Sea - Baltic Sea route is not well documented, and autumn observations in Finland are scarce (Pöyhönen 1998b). Also Bianki et.al. (1993) know of very few sightings of pomarine skua in the White Sea, whereas they classify it as a very abundant species on the northern coast of the Kola Peninsula. During the expedition pomarines were seen almost every day. Juveniles were seen even at Lake Onega and Lake Vygozero, and large numbers were recorded at Onega Bay in the White Sea. However, juveniles did not seem to be ready to migrate, rather they were flying in various directions, with no apparent attempt to migrate over the mainland. In contrast, adults were recorded only at Dwina Bay, migrating purposefully southwards. A total of 38 adults (37 pale phase, 1 dark phase), 5 adults/subadults, 1 subadult and 67 juveniles (mostly normal, i.e. intermediate, phase) were identified. The largest daily sums were 21 ind. 28th September, 29 ind. 3rd October, and 15 ind. 4th October.

Arctic Skua (*Stercorarius parasiticus*) 181

Fairly large numbers were recorded during the expedition. In contrast to the pomarine skua, no birds were seen at Lake Onega or Lake Vygozero, and only a few at Onega Bay in the White Sea. Occurrences were concentrated at Dwina Bay. Remarkable heavy migration (with 99 arctic skuas and 249 unidentified skuas) was recorded on 3rd October along the Pertominsk coast. The birds were mainly heading SE towards the end of Dwina Bay, instead of the expected direction of SW along the route over Unskaya Bay. A question arose whether these birds were heading for the Black Sea region or the Baltic Sea. The former alternative seems more likely. This hypothesis is supported by data reported by Cramp & Simmons (1983), according to whom there are many migration records of arctic skuas in the Black and Caspian Sea and at Lake Aral, from where they are supposed to continue to Arabian waters to winter. A total of 138 adults (134 pale phase, 4 dark phase), 1 subadult and only 39 juveniles were identified. The ratio of adults to juveniles (3:1) contrasted with that of the pomarine skuas observed (1:2). Bianki et.al. (1993) mention that the arctic skua is a regular but fairly scarce autumn migrant in the White Sea. However, according to extensive Finnish data (e.g. Kontkanen 1994, Pöyhönen 1998a) the arctic skua is a regular and abundant migrant over eastern Finland in autumn (c. 1,200 - 1,500 ind./year), and these birds must have departed from the White Sea.

Great Skua (*Catharacta skua*) 3

All sightings: 1 1cy 3rd October and 1 ind. 5th October, Pertominsk, 1 ind. 7th October, Zizginski.

Little Gull (*Larus minutus*) 12

Max. 28th September 11 ind. m. Nimenia Bay. All 1cy.

Black-headed Gull (*Larus ridibundus*) 24

Common Gull (*Larus canus*) c. 1,000

Common all around the White Sea. No clear migration recorded.

Lesser Black-backed Gull (*Larus fuscus*) c. 200

Two distinctive subspecies were seen: the nominate subspecies *L.f.fuscus* (108 ind) and the eastern subspecies (known as the eastern black-backed gull) *L.f.heuglini* (58 ind.). In addition, some tens of birds could not be identified as to their subspecies. Among these were a few intermediate (adult) birds in which the colour of the back was between the almost black of *L.f.fuscus* and the slaty-grey of *L.f.heuglini*. *L.f.fuscus* was clearly dominant along the Stalin Canal and at Onega Bay in the White Sea (98 ind. against 13 ind. of *L.f.heuglini*) while *L.f.heuglini* was the much more abun-

Kittiwake (*Rissa tridactyla*) is a regular but uncommon migrator in the White Sea. Here a first-calendar-year bird.

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dant subspecies at Dwina Bay (45 against 10 ind. of *L.f.fuscus*). The majority of the lesser black-backed gulls recorded were adults. A significant difference in moulting dynamics between the subspecies was noticed: Almost all the adult *L.f.heuglini* were moulting their outer primaries. None of the *L.f.fuscus* showed signs of primary moulting. In the identification of the subspecies, Rauste (1999) was followed.

Herring Gull (*Larus argentatus*) c. 700

Common all around the White Sea. No clear migration recorded.

Great Black-backed Gull (*Larus marinus*) 60

Uncommon everywhere in the White Sea. Max. 24th September 20 ind. Belomorsk.

Kittiwake (*Rissa tridactyla*) 8

All sightings: 25th September 1 ind. Osinka Island, 28th September 2 ind. Nimenia Bay, 4th October 1 ind. Pertominsk, 7th October 4 ind. heading W, Zizginski. All birds 1cy.

Arctic Tern (*Sterna paradisaea*) 1

1 ind. 28th September, Nimenia Bay.

Common/Arctic Tern (*Sterna hirundo/paradisaea*) 7

All 1cy.

White-winged Tern (*Chlidonias leucopterus*) 1

1 1cy. 9th October, Belomorsk.

A surprising sighting of this fairly southerly species, which winters in the tropics. The closest breeding areas are situated to the south of St. Petersburg. According to Bianki et.al. (1993) there are no previous records of the species in the White Sea.

Razorbill (*Alca torda*) 71

Recorded in low numbers during the expedition all over the White Sea without any concentrations (cf. black guillemot). The largest daily total was 11 birds. However, both Bianki et.al. (1993) and Snow & Perrins (1998) found the razorbill to be as abundant as the black guillemot.

Black Guillemot (*Cepphus grylle*) 1,117

Recorded in surprisingly large numbers during the expedition (cf. razorbill). The overwhelming majority of the birds were recorded on a single day (1st October) on the sea around the Solovetski and Anzerskij Islands. The largest concentrations were on the SW-S coast of Solovetski Island (260 ind.) and off the SE coast of the Anzerskij Island (220 ind.) (see map 2). In other parts of the White Sea the species was much scarcer (max. 35 ind./day). The black guillemot was, surprisingly, the third most abundant species in the transect line counts. The average density was 0.99 birds/km² and the maximum density on a line was as high as 16.0 birds/km², only long-tailed duck having a higher value. In wintering areas in the Baltic Sea the densities in the most important areas are no more than 7.0-11.2 birds/km² and in most of the other important areas are less than 1.0 birds/km² (Durinck et.al. 1994). In comparison to these figures, the densities observed during this expedition were high.

Puffin (*Fratercula arctica*) 14

1st October 5 ind. Solovetski Island, 6th October 2 ind. and 7th October 7 ind. Zizginski.

Feral Pigeon (*Columba livia*)

Common in urban areas between Petrozavodsk and Belomorsk.

Hawk Owl (*Surnia ulula*) 1
1 ind. 10th October between Belomorsk and Petrozavodsk.

Short-eared Owl (*Asio flammeus*) 1
1 ind. m. 6th October Zizginski. Another unidentified *Asio* was seen the same day.

Black Woodpecker (*Dryoscopus martius*) 2

Great Spotted Woodpecker (*Dendroscopus major*) 26
Max. 22nd September 6 ind. (plus a further 8 unidentified middle-sized woodpeckers) heading NW on the northern shore of Lake Onega.

Lesser Spotted Woodpecker (*Dendroscopus minor*) 1
1 ind. 21st September, Petrozavodsk.

Three-toed Woodpecker (*Picoides tridactylus*) 3

Shorelark (*Eremophila alpestris*) 11

Barn Swallow (*Hirundo rustica*) 3
All 23rd September, Stalin Canal

Meadow Pipit (*Anthus pratensis*) >100 ind.

White Wagtail (*Motacilla alba*)
Fairly common.

Waxwing (*Bombycilla garrulus*) >100 ind.

Northern Wheatear (*Oenanthe onanthe*) 1
1 ind. 22nd September, Poventsä.

Fieldfare (*Turdus pilaris*)
Abundant. Max. 24th September c. 500 ind. mainly heading SW in the Belomorsk region, 29th September 200 ind. Great Susmoi Island, 1st October 500 ind. Anzerskij Island.

Song Thrush (*Turdus philomelos*)
Uncommon.

Red-winged Thrush (*Turdus iliacus*)
Fairly common.

Mistle Thrush (*Turdus viscivorus*)
Uncommon.

Chiffchaff (*Phylloscopus collybita*)
Uncommon. Interestingly, 4 ind. seen on 22nd and 24th September along the Stalin Canal were identified by their "tsi-vy" call as a southern race. Other identified birds had "normal" calls.

Goldcrest (*Regulus regulus*)
Fairly common. Max. 29th September 15 ind. Great Susmoi Island.

Long-tailed Tit (*Aegithalos caudatus*)
Uncommon.

Willow Tit (*Parus montanus*)
Uncommon. Interestingly, birds seen on 29th September on Great Susmoi Island had calls which very much resembled the calls of Siberian tits.

Siberian Tit (*Parus cinctus*) 2
2 ind. 2nd October, Pertominsk

Coal Tit (*Parus ater*)
1 ind.

Great Tit (*Parus major*)
Fairly common.

Great Grey Shrike (*Lanius excubitor*) 3

Jay (*Garrulus glandarius*)
Fairly common.

Maggpie (*Pica pica*)
Fairly common.

Jackdaw (*Corvus monedula*)
Tens at Petrozavodsk.

Rook (*Corvus frugilegus*)
Tens at Petrozavodsk.

Hooded Crow (*Corvus corone cornix*)
Common everywhere around the White Sea, e.g. 50 ind. 1st October, Solovetski Island.

Raven (*Corvus corax*)
Fairly common.

Starling (*Sturnus vulgaris*) >50
Max. 24th September 10 ind. and 9th October 40 ind. Belomorsk

House Sparrow (*Passer domesticus*)
Fairly common in urban areas.

Tree Sparrow (*Passer montanus*)
Uncommon, e.g. 2nd October 2 ind. Pertominsk

Chaffinch (*Fringilla coelebs*)
Common.

Brambling (*Fringilla montifringilla*)
Fairly common.

Greenfinch (*Carduelis chloris*)
Uncommon.

Siskin (*Carduelis spinus*)
Fairly common.

Redpoll (*Carduelis flammea*)
Abundant.

Two-barred Crossbill (*Loxia leucoptera*) 2
2 ind. 2nd October, Pertominsk

Crossbill (*Loxia curvirostra*)
Fairly common.

Bullfinch (*Pyrrhula pyrrhula*)
Fairly common.

Snow Bunting (*Plectrophenax nivalis*) 9

Yellowhammer (*Emberiza citrinella*)
Uncommon.

Rustic/Little Bunting (*Emberiza rustica/pusilla*)
3

All sightings: 22nd September 1 ind. and 24th
September 2 ind. Stalin Canal.

Reed Bunting (*Emberiza schoeniclus*)
Fairly common.

Documentation page

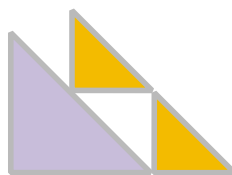
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Abstract	<p>The White Sea ornithological expedition took place between 21st September and 10th October, and was organized by Finnish Environment Institute as a part of RECMAB project (Research, Conservation and Monitoring Project of Migratory Arctic Birds on the Baltic Sea and White Sea). The aim of RECMAB is to identify the most important congregating areas of migratory arctic waterbirds in the Baltic Sea and White Sea.</p> <p>The expedition team found many important congregating areas of which at least one was evidently unknown previously. Studies during the expedition suggested that remarkable congregating areas also exist in the vicinity of the White Sea Channel and the Kanin Peninsula. Transect line counts revealed that the densities of staging birds on the sea outside congregating areas were generally low.</p> <p>During the expedition a lot of data on patterns of arctic bird migration was gathered; e.g. on daily rhythm, directions, routes, magnitude, and timing of migration. There were obvious differences between species in the dynamics and magnitude of migration. Some species fly in broad fronts, while others tend to follow coast lines. In general, more birds were seen migrating in the morning, although some species continued to migrate actively throughout the day.</p> <p>The expedition was carried out by ship. Compared to aeroplane, that has also been used for research on congregating areas of arctic birds, ship has some benefits: lower costs, long observation times for each recorded individual, and good changes to detect more elusive and more sparsely distributed species. On the other hand, ship is slow, and areas of shallow waters, which are important for many arctic waterbirds as staging areas, can not be reached by ship. Intensive aerial surveys are essential for research into important congregating areas in large sea areas.</p>	
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Tiivistelmä	<p>Suomen ympäristökeskus järjesti ornitologisen tutkimusmatkan Vianmerelle 21.9.-10.10.1999. Tutkimusmatka oli osa laajempaa RECMAB-hanketta (Research, Conservation and Monitoring Project of Migratory Arctic Birds on the Baltic Sea and White Sea), jonka tarkoituksena on kartoittaa Itämeren ja Vianmeren alueiden tärkeimmät muuttavien arktisten vesilintujen kerääntymisalueet.</p> <p>Tutkimusryhmä löysi Vianmereltä useita tärkeitä vesilintujen kerääntymisalueita, joista ainakin yksi oli ilmeisesti aiemmin tuntematon. Lisäksi tutkimustulosten perusteella voitiin epäsuorasti päätellä Viankurkun ja Kaninin niemimaan alueilla olevan merkittäviä kerääntymisalueita. Linjalaskennat merellä osoittivat, että lintuilehdet näiden kerääntymisalueiden ulkopuolella ovat pieniä.</p> <p>Matkan aikana saatiin runsaasti tutkimusaineistoa lintujen muutosta; päivärytmiikasta, muutos suunnista ja -reiteistä, voimakkuudesta, ajoittumisesta jne. Yleisesti muuton dynamiikassa ja voimakkuudessa havaittiin lajien välillä suuria eroja. Osa lajeista muuttaa laajalla rintamalla, toiset seuraavat rannikkolinjoja. Yleisesti muutto oli voimakkainta aamulla, mutta jatkui monilla lajeilla voimakkaana läpi valoisan ajan.</p> <p>Tutkimusmatka tehtiin laivalla. Verrattuna lentokoneeseen, jota myös käytetään vesilintujen kerääntymisalueiden kartoituksissa, laiva on kustannuksiltaan halvempi, se sallii lintujen pitemmän tarkkailuajan ja siitä on helpompi havaita arkoja lajeja. Toisaalta laiva on hidas eikä sillä päästä matalikoille, jotka ovat monille vesilinnuille tärkeitä levähdysalueita. Kattavat lentokone-laskennat olisivatkin välttämättömyys arktisten vesilintujen kerääntymisalueiden kartoituksissa laajoilla merialueilla.</p>	
Asiasanat	linnut, muuttolinnut, vesilinnut, kahlaajat, hanhet, kuikat, kihut, lokit, tutkimus, havainnointi, seuranta, kartoitus, lintulaskenta, kansainvälinen yhteistyö, arktika, arktinen muutto, arktinen luonto, tundra, Vianmeri, Venäjä	
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Presentationsblad

Utgivare	Finlands miljöcentral	Datum Augusti 2001
Författare	Mauri Leivo, Timo Asanti, Jari Kontiokorpi, Harri Kontkanen, Markku Mikkola-Roos, Ari Parviainen och Pekka Rusanen	
Publikationens titel	Undersökning av arktisk fågelsträckning och samlingar vid Vita havet hösten 1999	
Publikationens delar/ andra publikationer inom samma project	Publikationen finns tillgänglig på internet: http://www.vyh.fi/eng/orginfo/publica/electro/fe465/fe465.htm	
Sammandrag	<p>Finlands miljöcentral arrangerade en ornitologisk expedition till Vita havet 21.9.-10.10.1999. Expeditionen var en del av ett större projekt, RECMAB (Research, Conservation and Monitoring Project of Migratory Arctic Birds on the Baltic Sea and White Sea), vars syfte är att kartlägga Östersjö- och Vita havs-områdets viktigaste samlingslokaler för sträckande arktiska vattenfåglar. Forskningsgruppen fann vid Vita havet många viktiga samlingslokaler för vattenfåglar, av vilka åtminstone ett uppenbarligen var tidigare okänt. Därtill kunde man utgående från forskningsresultaten indirekt utläsa, att det vid Vitahavskanalen och på Kanin-halvön finns viktiga samlingslokaler. Linjetaxeringar på havet visade att fågeltätheterna är små utanför dessa samlingslokaler.</p> <p>Under resan inhämtades rikligt med undersökningsmaterial om fåglarnas sträckning; dagsrytmik, sträckningsriktningar och -rutter, styrka, tider osv. Generellt observerades i sträckningens dynamik och styrka stora skillnader mellan arterna. En del av arterna sträcker med en bred front, andra följer kustlinjerna. I allmänhet var sträckningen livligast på morgonen, men fortsatt hos många arter kraftig hela den ljusa tiden.</p> <p>Expeditionen gjordes med båt. Jämfört med flygplan, som också används för kartläggning av samlingslokaler, är en båt billigare, den tillåter en längre observationstid av fåglarna och det är lättare att observera rädda fåglar. Å andra sidan är båten långsam och man når inte grunt vatten med den, som är viktiga viloområden för många fåglar. Täckande taxeringar från flyg skulle vara nödvändiga för att kartlägga arktiska fåglars samlingslokaler på vidsträckt havsområden</p>	
Nyckelord	fåglar, flyttfåglar, vattenfåglar, gäss, lommar, vadare, labbar, måsar, forskning, observation, uppföljning, kartläggning, internationellt samarbete, arktisk flyttning, arktiskt natur, tundra, Vita havet, Ryssland.	
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INTERNATIONAL COOPERATION

Survey on arctic bird migration and congregations in the the White Sea, autumn 1999

The White Sea is situated along the main migration route of millions of arctic waterbirds that breed in northern Russia and winter in the Baltic and Atlantic regions. In this report results of an ornithological expedition to the White Sea are represented and discussed. During the three expedition weeks many important congregating areas of migratory arctic waterfowl were found, and a lot of data on routes, directions, daily rhythms and other details of arctic bird migration was collected. In



many species remarkable percentages of the whole highway population were recorded, and the total number of migrating arctic waterfowl and shorebirds was over 600,000 individuals. The report also reviews results of little-known Russian studies on the area, discusses surveys and monitoring of arctic bird populations, and emphasizes the significance of conservation of important congregating areas of arctic birds along their migratory routes.

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