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Editor-in-chief Annika Forsten
annika.forsten@gmail.com
Editor Antero Lindholm
antero.lindholm@caluta.fi

For more information:
http://www.caluta.fi/

Contents

Migration schedules of Red-breasted Merganser, Velvet and Common Scoter at Põõsaspea, Estonia

ANTERO LINDHOLM

Background and material

Common Scoter *Melanitta nigra*, Velvet Scoter *Melanitta fusca* and Red-breaster Merganser *Mergus serrator* are three species of ducks in the family Anatidae, all of which are common and numerous migrants in the eastern Baltic. Large numbers of these birds pass Põõsaspea, Läänemaa, Estonia during migration. For all three species, the visible migration is stronger in autumn, a typical pattern for waterbirds at this site. Common Scoter is the most numerous waterbird there, with the autumn 2024 migration total exceeding one million birds. The other two species have a very long autumn migration period, stretching from June or July until early December. Both are also abundant – Velvet Scoter numbers in 2024 approached 140 000, while Red-breasted Merganser surpassed 37 000.

In this article, we examine the seasonal and daily migration patterns of these species, as well as the distribution of sex and age (referred to here as plumages). Migration counts were conducted in 2004, 2009, 2014 and 2019-2024. In this article we concentrate on autumn passage, because that material is more complete. There have been five projects when the passage has been counted thoroughly, in the autumns 2004, 2009, 2014, 2019 and 2024. Therefore, analysis of daily and seasonal migration patterns are limited to these years. However, for some of the analysis of the plumage distribution, data from 2020-2023 is also included.

	Sunrise (to nearest 5 min)	Sunset (to nearest 5 min)
1st July	4.15	22.45
1st August	5.10	21.55
1st September	6.20	20.30
1st October	7.30	19.00
1st November	7.45	16.35
1st December	8.50	15.40

Table 1. Sunrise and sunset times at Põõsaspea

Since plumage data from 2004 is incomplete, that year is excluded from certain analyses.

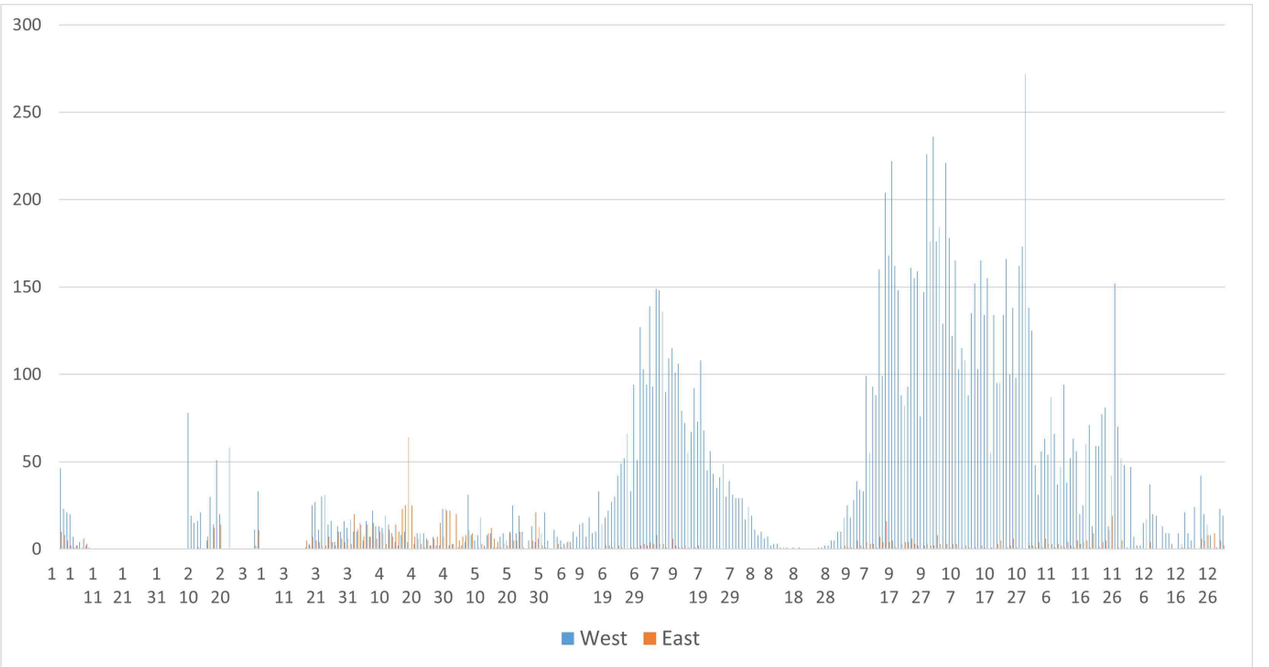
Background information about Põõsaspea and the migration counts can be found in the project reports: Ellermaa & Pettay 2006, Ellermaa *et al* 2010, Ellermaa & Lindén 2015, Ellermaa & Lindén 2020 and Ellermaa *et al* 2025.

When collecting and analysing plumage data, a key challenge is that some plumage types are much easier to identify than others. For example, under good conditions, an adult male Common Scoter can be identified from a distance of 3 km or more. However, distinguishing adult females and young birds is only possible to distances up to 500m - 1km. To account for these differences, we aim for plumage type equivalency. The equivalent groups of adult males and female types were counted only when both can be reliably identified within a flock. Similarly, adult female and first-year plumages are equivalent, and were counted only when both are distinguishable.

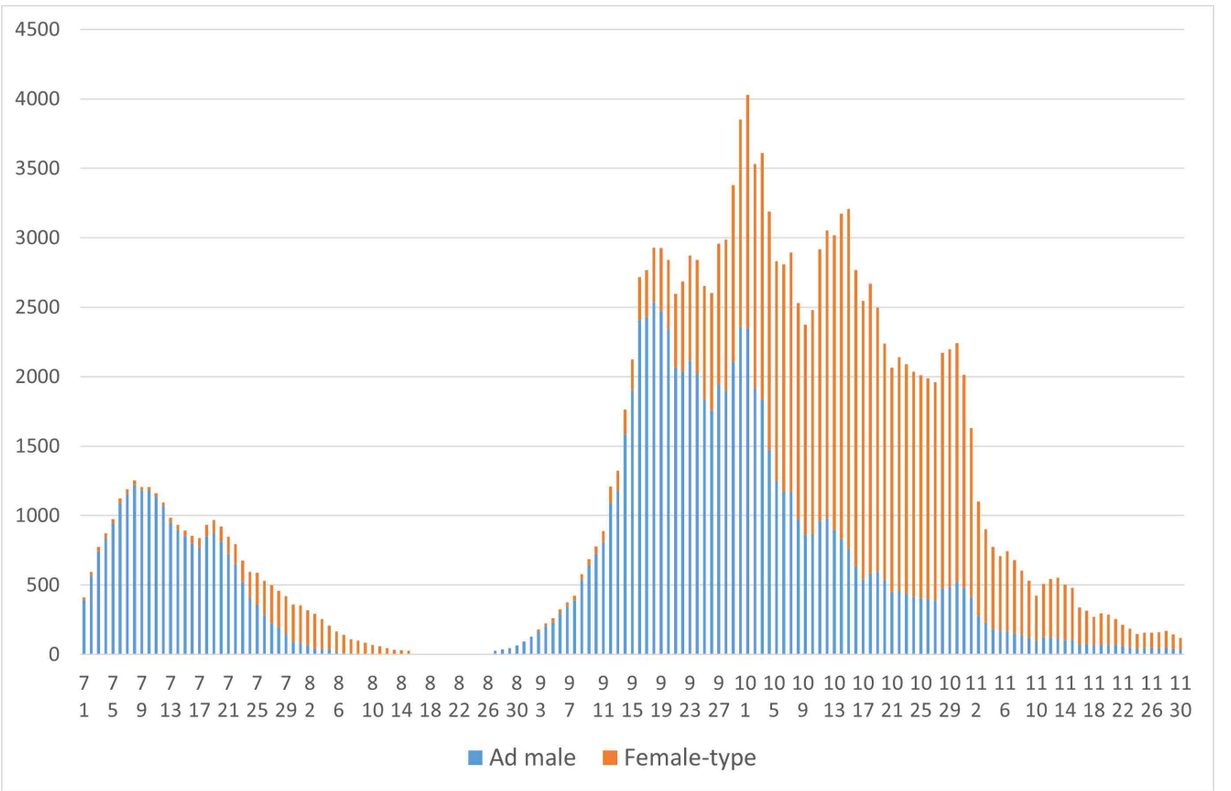
Additionally, to maintain consistency in plumage counts, the standard approach has been to either classify all individuals in a flock or leave the entire flock unclassified– to avoid picking just the easy ones. This methodology results in smaller flocks being overrepresented in the dataset, which could be problematic if plumage ratios differ between large and small flocks. While this issue could be analysed using the existing data, it is not addressed in this study.

Daily distribution

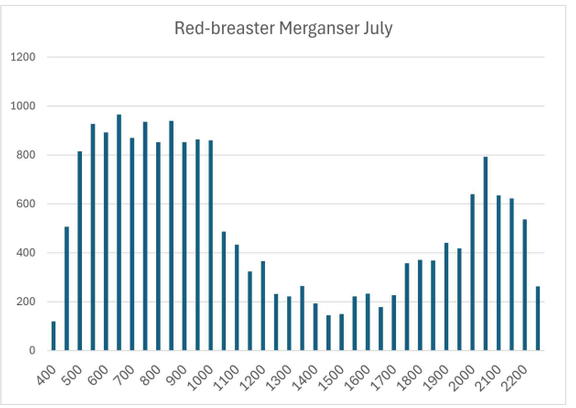
The variation in daylight duration has a significant impact on the observed migration times. Table 1 shows the sunrise and sunset times at Põõsaspea. On the last Sunday of October, clocks are set back by one hour due to daylight saving time. However, in these figures, all times are presented in summer time, as that is used for most of the migration monitoring season. As a result, the solar noon at Põõsaspea occurs around 13:15.

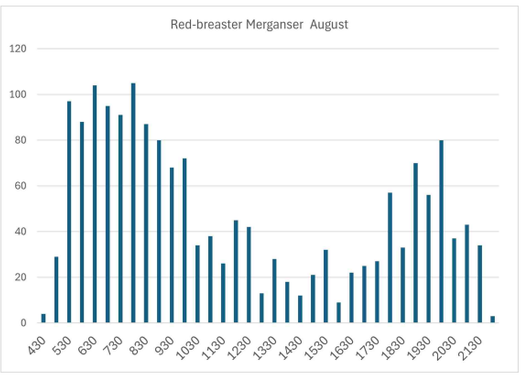


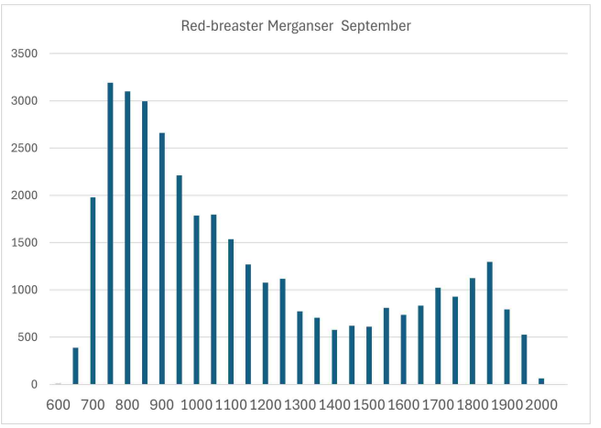
Graph 1: Red-breasted Merganser. Total birds per moult strategy type.

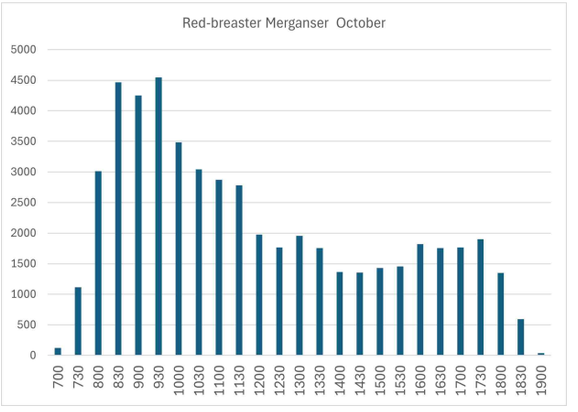


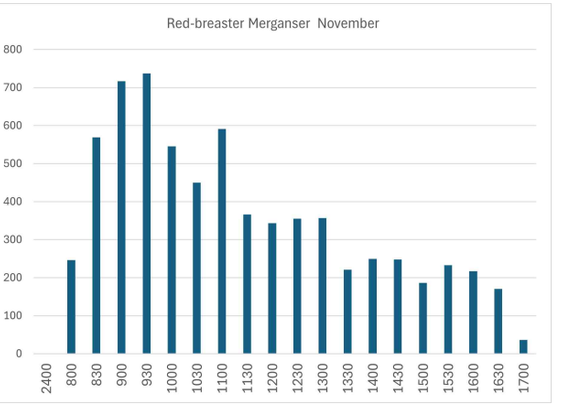
Graph 2: Red-breasted Merganser. The studied birds by plumage type.











Graphs 3-7: Daily distribution of the migration of Red-breasted Merganser.

Red-breaster Merganser

Red-breasted Merganser breeds across Northern Europe, extending eastward to the Pacific coast. It also nests in areas near Põõsaspea, along the Baltic shores of Estonia, and Finland. The Estonian breeding population is estimated at 800–1200 pairs (Mägi 2018b). The migrants observed at Põõsaspea likely include many Russian breeders. However, a significant portion of Russian birds migrate southwest, bypassing the Baltic region and wintering in areas such as the Black Sea (Kharitonov *et al* 2024).

In the case of Red-breasted Merganser, first-year birds can sometimes be identified, and in some cases, their sex can also be determined. Adult males are relatively easy to distinguish from other individuals, including adult females. This remains largely unchanged in spring, meaning that until late July, it is theoretically possible to classify birds into four distinct plumage groups. However, identifying these groups often becomes challenging, especially in larger migrating flocks, so much of the data is categorised into just two classes: adult males and female-type birds. The species undergoes a complete moult in August, after which the birds categorised as adult males are older than born that year, and after 31st December, older than born the previous year. All other birds, young females, young males and adult females are female-type birds. In this analysis, only adult males and female-type birds are distinguished. However, for future studies, it would be beneficial to gather more detailed data to allow further analysis.

Migration directions are classified into just two categories: southwest and northeast. The classification closely reflects the actual flight directions of Red-breasted Mergansers, and most other migrating duck species, as they pass Põõsaspea. Occasionally, birds may fly in other directions, such as north or south, but these are more likely local individuals making only short-distance movements.

Graph 1 illustrates migration directions throughout the year. The y-axis represents the average daily migration totals, calculated by dividing the summed daily counts by the number of observation days. During the early months of the year, there are several days with no observation data available.

The data shows that mergansers migrate almost year-round. However, in August, during the moult, the movement almost ceases for a few weeks, even first year birds are still stationary at this stage. The most intense migration periods occur from early July to the third week of that month and again from mid-September to late October, though the migration remains relatively active during November. Most of the movement is westward, even during mid-winter. However, between March and May, a significant number of birds migrate eastwards or northeastwards. During this period, 47.3% of the birds fly east, whereas during the rest of the year, only 3.9% take this direction.

Graph 2 illustrates the plumage distribution during autumn. The values represent the total from the daily counts divided by the number of observation days, but they are further smoothed using a five-day moving average, where the current day is centered. Additionally, the daily proportion of each plumage type is calculated by incorporating data from the current day, the two preceding days, and the two following days. This proportion is then applied to the total number of counted birds, including those not identified to a specific plumage type.

In autumn, approximately 25% of adult males migrate before the moulting period in August, while the remainder pass through during September and October. Their numbers decline sharply in the last week of July, then begin to increase again in the first week of September. Based on this pattern, the moult period for an individual is estimated to last around five weeks.

	Adult male%
March-May	53
June-July	85
September	79
October	32
November	26
All year	55

Table 2. Percent of adult males in Red-breasted Merganser

Female-type birds start migrating in larger numbers just before the August migration pause, but after that, they continue several weeks later than the adult males in September.

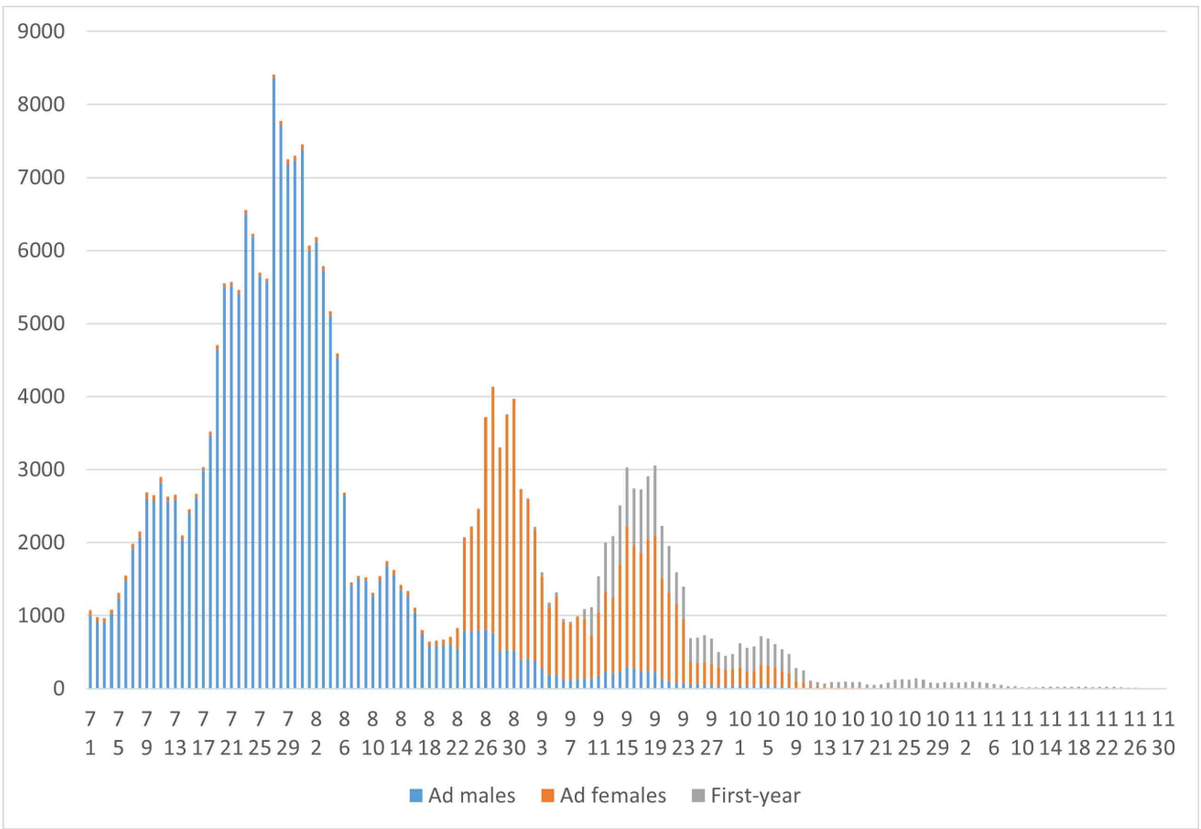
The median migration date for the autumn season (from early June to late December), for adult males is 21 September, while for female-type birds it is 14 October.

Table 2 presents the proportions of different plumage types. Between March and May, adult males make up nearly half of the identified birds, suggesting that most individuals are paired and migrating together. However, from June to July, the proportion of adult males rises to 85.1%, indicating that pairs have separated, with females staying to breed while males move toward their moulting areas.

Among birds with female-type plumage in summer, a significant proportion is likely second-calendar-year males. Even in September, adult males remain dominant, but their numbers decline rapidly as autumn progresses. Across the entire dataset, adult males make up 55.4% of the identified individuals.

Graphs 3–7 illustrate the diurnal migration patterns of Red-breasted Mergansers, categorized by calendar month. The species primarily migrates in the mornings, although in July-August there is also a notable evening movement.

During the busiest migration months, the July morning flight lasts approximately five hours. In the afternoon, the migration activity is about one-fifth of the morning total, but increases to two-thirds during the two-hour evening period. In October, the morning peak appears



Graph 8: Migration of age-sex classes of Common Scoter

shorter, with afternoon activity reaching one-third of the morning total and evening movement peaking at half of the morning level. By November, no evening migration peak was observed.

In July, the peak half-hour passage period begins at 6:30, shifting later as the season progresses: 8:00 in August, 8:30 in September, 9:30 in October, and 10:00 in November.

The median passage time—when half of the birds have passed, also follows a similar pattern. It falls within the 9:30–10:00 window in July, August, and September, shifting to 10:30 in October and 11:00 in November.

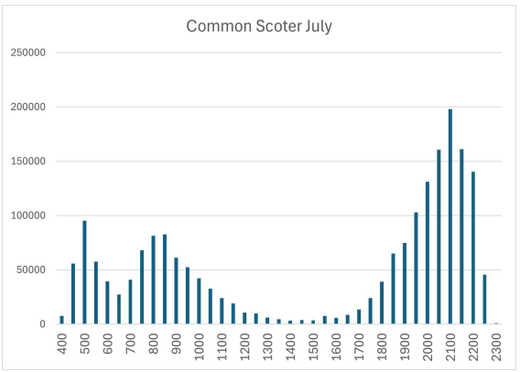
Common Scoter

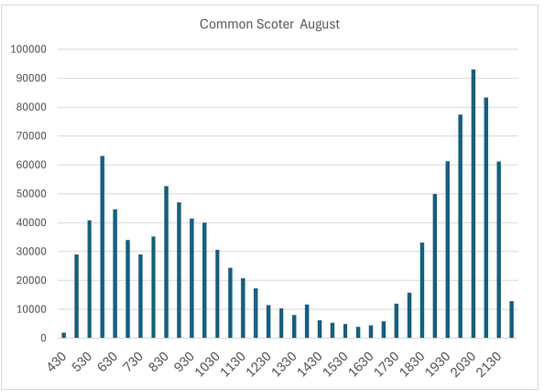
Common Scoter does not breed in the Baltic but instead nests in northern Scandinavia and extends eastward across the northern regions of Eurasia to the Olenyok River in Siberia, northwestern Yakutia (Carboneras & Kirwan 2020). Its primary migration route passes through the White Sea and Baltic, with wintering areas mainly in the southern Baltic and the North Sea (Kharitonov *et al*. 2024).

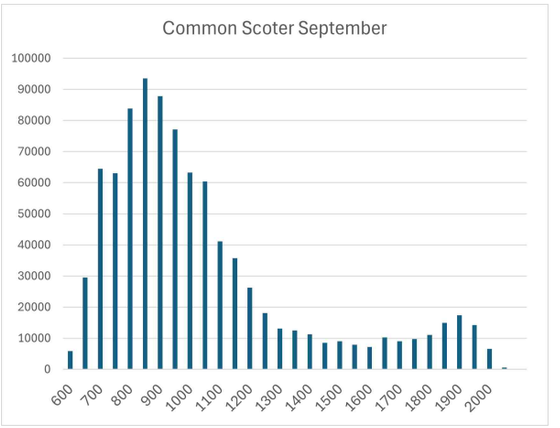
For Common Scoter, we classified individuals into three groups: adult males (older than oneyear in autumn), adult females (also older than one year in autumn), and first-year birds (born that same year). However, in many cases, adult females and first-year birds were not distinguished in the field. When combined, they are referred to as female-type birds. In this analysis, however, we divide them into adult female and first-year categories based on the proportions of identified individuals.

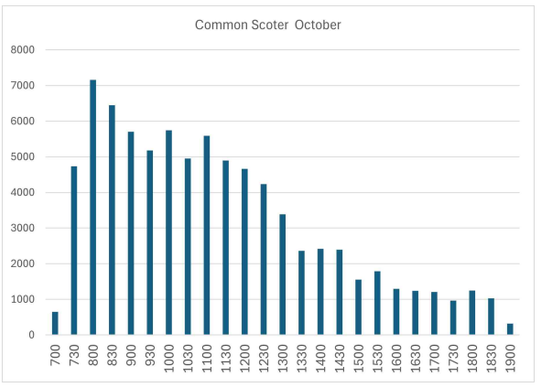
For Common Scoter and Velvet Scoter, the seasonal migration graph is constructed using the following method:

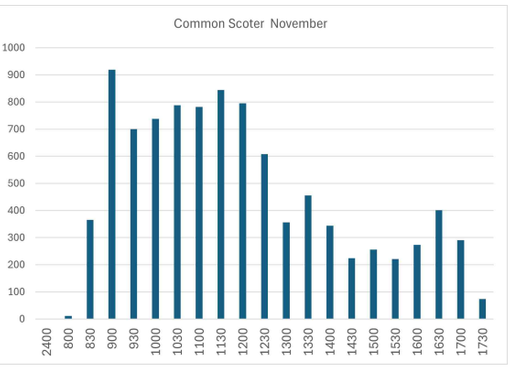
Only the five project years are taken into consideration.
Daily migration counts (in both directions) are extracted from the database for each plumage class:











Graphs 9-13. Daily distribution of Common Scoter migration by month

first-year birds, female-type birds, adult females, adult males and unclassified individuals

The analysis is restricted to the period from early July to late November, excluding some migration occurring in June and December.

Daily counts are divided by the number of observation days, which is typically five, except for after November 5, when fewer observations were made in some years, reducing the sample size.

Each day's value is smoothed using a five-day moving average, incorporating data from the current day, the two preceding days, and the two following days.

The total number of birds per day is then calculated, and the total of female-type birds is calculated by adding identified adult females and first-year birds.

Finally, the proportions of each plumage class are calculated.

[Proportion of female-type birds] = [Female-type calculated] / ([Female-type calculated] + [Adult males calculated])

[Proportion of adult males] = [Adult males calculated] / ([Female-type calculated] + [Adult males calculated])

[Proportion of adult females in female-type birds] = [Adult females calculated] / ([Adult females calculated] + [First-years calculated])

[Proportion of first-year birds in female-type birds] = [First-years] / ([Adult females calculated] + [First-years calculated])

Then the final y-axis numbers in the graph are calculated:

[First-years]= [Proportion of first-year birds in female-type birds] * [Proportion of female-type birds] * [All birds calculated]

[Adult females] = [Proportion of adult females in female-type birds] * [Proportion of female-type birds] * [All birds calculated]

[Adult males] = [Proportion of adult males] * [All birds calculated]

Graph 8 illustrates the autumn migration of Common Scoter, categorised by plumage class. The migration is already underway at the beginning of July. There is some movement already during the last week of June, and indeed even earlier, but then in both directions. It seems that many of the unpaired adult males do not leave Baltic at all but just at some point turn back towards the moulting areas. Adult male migration increases steadily throughout July, reaching its peak in late July and early August, before declining sharply. Adult females are scarce in July, with their migration increasing in late August and continuing until late September. The adult female passage follows a two-peaked pattern: the first peak occurs in late August, the second in mid-to-late September, aligning with the main migration of first-year birds. The first-year bird passage begins rapidly after mid-September, declining after early October. Even at the peak of first-year passage, only 37% of the female-type birds are first-years.

Graphs 9-13 illustrate the diurnal migration patterns of Common Scoter by calendar month. In July, the passage follows a distinct bimodal pattern with a morning peak between 5.00 and 9.00 and an evening peak between 20.00 and 22.30. Between 6.00 and 7.30 there is a noticeable dip in activity, humorously referred to by observers as the “coffee break”. After the morning peak, migration numbers gradually decline until 14:00–15:30, before rising again toward the evening peak in a similarly smooth pattern.

In August, the morning and evening peaks remain visible but occur closer together. The morning migration continues until about 10:30, and the evening migration begins around 19:00, while the "coffee break" lull and the gradual afternoon decline are still present.

In September, the evening peak disappears, along with the "coffee break." The passage becomes more concentrated to late morning, peaking between 8:30 and 9:30.

After September, Common Scoter numbers decline, and migration is mostly limited to a forenoon peak between 8:00 and 12:00.

The median migration time shifts throughout the season: July – 18:30, August – 12:00 (as a greater proportion of the birds migrate in the morning), September – 9:00, October – 10:30 and November – 11:00.

Velvet Scoter

Velvet Scoter breeds in relatively small numbers along the northern and eastern Baltic shores, as well as in northern Scandinavia and northern Russia, extending eastward to the Yenisey River (Carboneras *et al* 2020). Estonia’s breeding population is only a few hundred pairs (Mägi 2018a). While the species nests in the northernmost regions of Eurasia, it also occupies a vast breeding range in western Siberia, reaching as far south as Kazakhstan—much farther south than Common Scoter. Most birds from this extensive breeding area appear to migrate through the White Sea and Baltic, wintering in the southern Baltic and North Sea (Kharitonov *et al* 2024).

The methodology follows that of Common Scoter, except that the seasonal graph is based on the years 2019–2024. This adjustment accounts for uncertainties in the classification of first-year birds in earlier years, and for the migration becoming later in recent years.

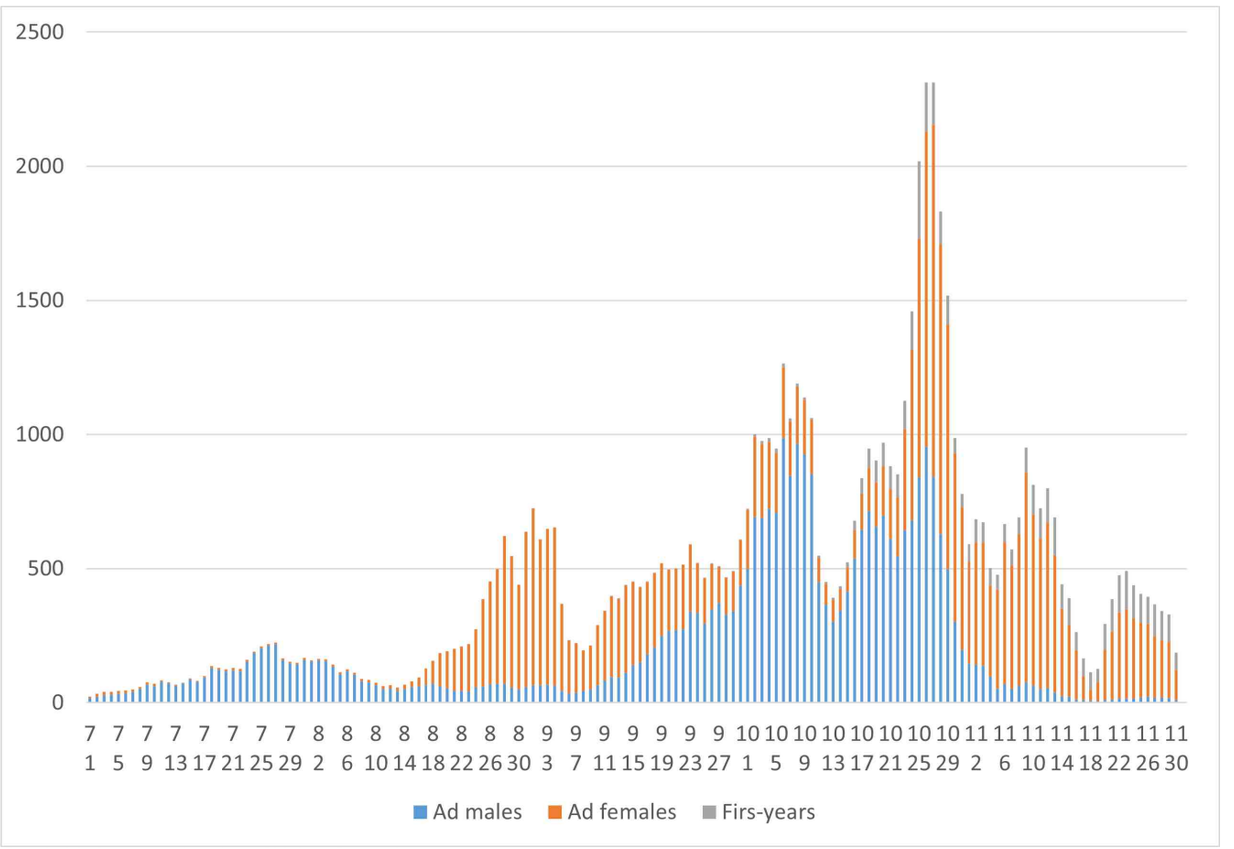
Graph 14 illustrates the autumn migration of Velvet Scoter, categorized by plumage type.

Adult males first peak in July, followed by a period of reduced movement from early August to mid-September. The strongest peak occurs in early October, rapidly declining by early November.

Adult females are scarce in July, but their migration is distinct from late August to late September, after which males once again outnumber them. After late September, numbers remain low until the last week of October, when migration becomes intense until mid-November.

This indicates that both males and females show two migration peaks, but female peaks occur about a month later than male peaks, and the two do not overlap. Together, their movements cover most of the migration season.

First-year birds migrate late in the season, with consistently low observed numbers. The median first-year bird passed on 10 November.



Graph 14. Autumn migration of Velvet Scoter by sex-age groups.

Year	Median bird
2004	23.09.
2009	01.10.
2014	04.10
2019	03.10.
2024	08.10.

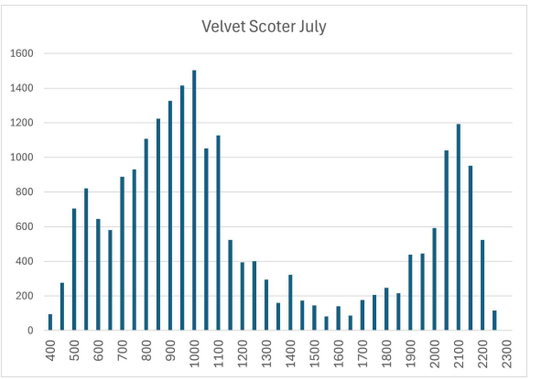
Table 3. Passage of the median Velvet Scoter between 1 July and 5 November in different years.

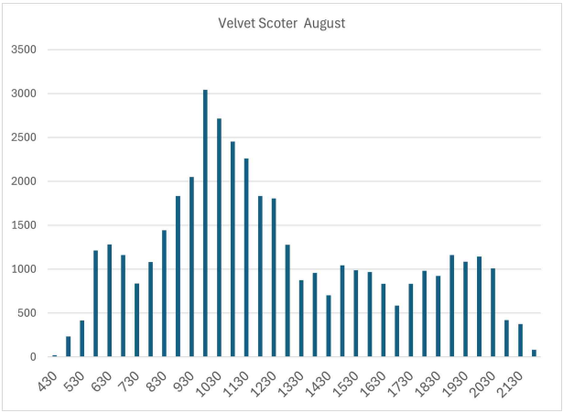
Graph 15 compares Velvet Scoter numbers across different project years, using standard pentads. As expected for species like this, migration intensity fluctuates significantly—from day to day, between consecutive pentads, and across the years. When the years are combined, the variation smooths out, revealing overall patterns. However, this approach can obscure yearly trends. From Table 3, we see that migration timing has shifted noticeably—the median passage date for Velvet Scoter in 2024 was two weeks later than in 2004 and one week later than in 2009.

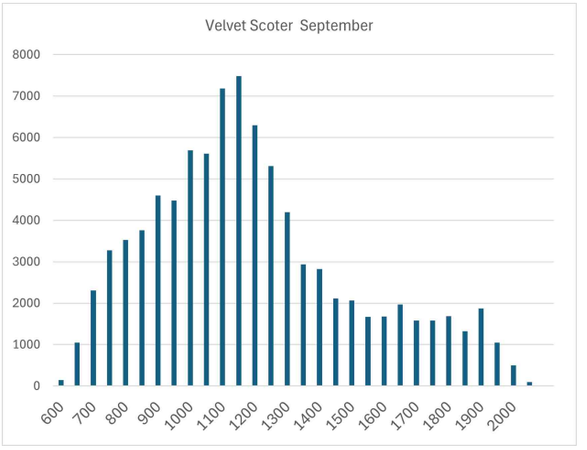
Graphs 16–20 illustrate the diurnal migration pattern of Velvet Scoter. In July, numbers increase for over five hours after sunrise, then decline until noon, remaining low (about 10% of the morning peak) until 19:00. An evening peak occurs around 21:00, reaching approximately two-thirds of the morning maximum, before declining toward sunset. The first hour after sunrise and the last hour before sunset are relatively quiet, suggesting limited nocturnal migration. However, if any nocturnal movement occurs, it may follow a different route or altitude. Therefore its absence cannot be conclusively determined from this data set.

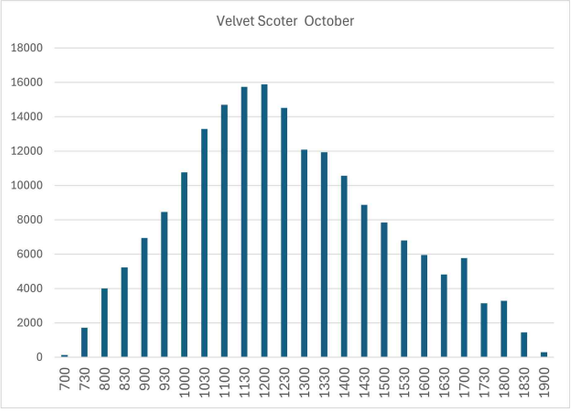
In August, the evening peak largely disappears. The busiest migration hours shift to later, occurring between 9:00 and 12:30, slightly later than in July.

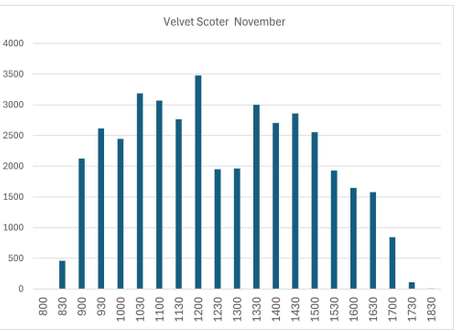
In September, the pattern remains similar to that in August, with the peak migration period from 10:00 to 12:30.











Graphs 15-19. Daily migration of Velvet Scoter by month.

In October, the pattern becomes more distinct and somewhat unusual for a diurnal migrant. Unlike earlier months, there are no clear morning or evening peaks. Instead, migration numbers steadily increase throughout the morning, peak between 11:00 and 12:30, and then gradually decline.

In November, the pattern mirrors that of October, though there is a slight drop in migration during one midday hour—possibly due to the smaller sample size from fewer observation days.

The median migration time for the median bird occurred at 9:30 in July, 11:00 in August and September, 12:00 in October and November.

During the first half of the migration season, Velvet Scoter tends to migrate in earlier hours than Common Scoter, while in the second half, it migrates later than that species.

Discussion

The most common migration strategy among ducks is to depart after breeding and moulting, as seen in dabbling ducks *Anas*, *Mareca*, *Spatula*, Greater Scaup *Aythya marila*, and Long-tailed Duck *Clangula hyemalis*. However, the three species analysed here follow a different pattern.

In Red-breasted Merganser and Velvet Scoter, a significant minority of males migrate before undergoing their annual complete moult. In Common Scoter nearly all males migrate prior to moulting, which takes place far from the breeding grounds. In

these species, moulting occurs in distinct locations separate from breeding sites, but these moulting grounds are situated along the regular migration route to wintering areas or within the wintering areas themselves.

In both *Melanitta* species, the female migration is double-peaked. The later peak coincides with the main migration of the first-year birds. This suggests that females in the later peak are likely successful breeders, while those in the earlier peak either may have failed or even not tried to reproduce. For example younger females may follow this strategy.

For Red-breasted Merganser, too few young birds have been identified for a detailed analysis, but the available data suggest that first-years migrate late in the season. Since both sexes moult almost at the same time and the breeding areas are relatively close, the passage comes to a noticeable halt in August.

The number of young birds in the *Melanitta* species appears low for a viable population, yet neither species has declined in long-term counts. In fact, especially Common Scoter has increased in numbers (e.g., Ellermaa & Lindén 2020 & Ellermaa *et al* submitted).

Ducks exhibit strong morning migration in July and August, often accompanied by a notable evening peak depending on the species. As the autumn progresses, the evening peak disappears. Velvet Scoter develops a strong midday peak—an unusual pattern for any duck species.

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