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Non-breeding concentrations of the Tufted Duck (*Aythya fuligula*) in Lithuania

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Non-breeding concentrations of the Tufted Duck were studied in inland waters of Lithuania (7 lakes and 3 fish ponds) and in the Lithuanian part of the Curonian Lagoon (including coastal Lake Krokų Lanka). Data of the investigation period 1983–2007 were analysed. The obtained results extend the knowledge of the Tufted Duck's ecology during the non-nesting period and can be applied for the protection of this species. The largest migratory concentrations in inland waters were observed in Lake Dusia and in the coastal area along the eastern edge of the Curonian Lagoon. Concentrations of moulting tufted ducks were found only along the eastern shore of the Curonian Lagoon and in fish ponds. In spring, migratory concentrations of tufted ducks were most often observed from late March to late April (in some years to early May), and in autumn from early September to late November. During spring migrations, the peaks of concentrations were most often recorded in the first half of April and during autumn migrations in the second half of October. In the Curonian Lagoon, moulting and post-moulting concentrations of tufted ducks reached their peak of abundance in late August. In fish ponds, unlike in other wetlands, the Tufted Duck was already abundant in the first half of summer. In inland waters, migratory concentrations in spring were usually more abundant than in autumn. However, an opposite tendency was observed in the Curonian Lagoon. Water level management in fish ponds affects the timing of waterfowl concentrations, delaying its beginning in spring and hastening its end in autumn.

Key words: Tufted Duck, non-breeding, migratory, staging and moulting concentrations

INTRODUCTION

Breeding and staging the Tufted Duck in Lithuania belong to a large and increasing north-western European population, estimated at about 1,000 000 individuals (Scott, Rosse, 1996). The Tufted Duck had settled in Lithuania by the end of the 19th century. Its rapid spread in Lithuania was part of the overall westward and southward population expansion recorded in north-western Europe since the late 19th century (Cramp, Simmons, 1977). The species was a very rare and sporadic breeder in Lithuania and in former eastern Prussia in the early 20th century (Tischler, 1941; Ivanauskas, 1938). Until the mid-20th century, the Tufted Duck was considered to be a rare breeder (and quite an abundant migrant) in Lithuania (Ivanauskas, 1959). However, already in a subsequent publication the same author attributed the Tufted Duck to the group of species that rapidly increase in breeding abundance in Lithuania (Иванаускас, 1959). It seems that a marked increase in the numbers of breeding birds occurred in the 1940s–1950s, when the Tufted Duck became a common breeding species in Lithuania (Logminas, 1972). A rapid spread of tufted ducks was also recorded during the 1960s–1970s (Logminas, 1990).

The interest of authors in the Tufted Duck in Lithuania before 1968 (Ivanauskas, 1938; 1959) focused on breeding populations rather than on non-nesting concentrations. Ivanauskas (1938) only indicated that the migratory concentrations of this species in Lithuanian lakes were high (up to several thousands in some lakes). Later publications (Вайткявичюс, 1968; Валюс и др., 1968; Valius, 1980) provided more detailed quantitative evaluations of the Tufted Duck seasonal concentrations, but they were not specifically directed to concentration issues, either. Direct investigations into migratory concentrations of this waterfowl species initiated in the last decade of the last century (Nedzinskas et al., 1992; Švažas, 1996; Stanevičius, Švažas, 1998; Stanevičius, 1999; Švažas et al., 1999; Недзинскас, 1990; Станявичюс, 1992) focused mostly on the abundance of these concentrations, while their seasonal dynamics, environmental impacts and distribution received less attention. Investigations into the waterfowl of

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fish ponds (Švažas, Stanevičius, 1998; Stanevičius et al., 2002) also predominantly covered the issues of abundance of tufted duck concentrations.

Analysis of scattered sources dealing with the Tufted Duck concentrations in inland Lithuanian waters over the period 1961–1997 suggests that migratory concentrations of the species increased (Stanevičius, 1999). This coincides with an overall population expansion recorded in Europe, which can be explained as a reaction to zebra mussel (*Dreissena polymorpha*) invasion into Europe (Olney, 1963; De Leeuw, Van Erden, 1992; Suter, van Erden, 1992). An abrupt decrease in the Tufted Duck population recorded in the late 20th century in Lake Žuvintas (Nedzinskas et al. 1992; Stanevičius, 1999) is an exception to the above-mentioned trend. As an outcome of the anthropogenic distrophication of the lake (Nedzinskas, Šarkinienė, 1987; Kavaliauskienė, 1996), the above decline in the Tufted Duck population is local and therefore cannot represent the general trend of the species abundance in Lithuania.

Švažas (2001) presented an overview of the probable climate change impact on the abundance dynamics of waterfowl species (including the Tufted Duck) in Lithuania starting with the 19th century.

As the Tufted Duck constitutes a significant part in the total waterfowl concentration, its abundance at some sites may be one of the reasons for granting the Ramsar site status to separate water bodies. However, so far little is known in Lithuania about the phenology and geography of staging and moulting concentrations of the species, as well as about the impact of local conditions on them. This information is needed for a full clarification of the regional peculiarities of the species' life history, elaboration of its conservation measures, assessment of climate change impact on the fauna and for investigating the transmission of disease pathogens during migrations.

Our study was developed with four major objectives: (1) to evaluate the abundance of migratory and moulting concentrations of the Tufted Duck in the group of the investigated wetlands, (2) to reveal the dates of the principal phenological stages of concentration formation in inland and coastal, as well as in natural and artificially regulated wetlands, (3) to compare the size of spring and autumn migratory concentrations in Lithuania, (4) to use the results of investigation to evaluate whether the present protection of concentrations in the studied wetlands is appropriate.

STUDY AREA

The study area included inland lakes Dusia (23°42'E, 54°17'N), Metelys (23°47'E, 54°18'N), Obelija (23°50'E, 54°18'N), Simnas (23°38'E, 54°24'N), Žaltytis (23°24'E, 54°25'N), Vištytis (54°24'N, 22°40'E) and Seirijis (23°50'E, 54°12'N), and inland fish pond complexes of Daugai (24°26'E, 54°23'N), Kena (24°40'E, 54°39'N) and Baltoji Vokė (25°08'E, 54°29'N) located in the southern and southeastern parts of Lithuania and the northern part of the Curonian Lagoon (21°10'E, 55°18'N) with adjacent Lake Krokų Lanka (21°19'E, 55°22'N) (Fig. 1).

Lakes Vištytis (total area 1660 ha; area of the surveyed territory belonging to Lithuania is 543.7 ha; average depth 15.5 m) and Seirijis (503 ha, average depth 7.95 m) are mesotrophic with oligotrophic features. Lake Dusia (total area 2317 ha, average depth 14.6 m) is mesotrophic with eutrophic features. Lakes Metelys (1288 ha, average depth 6.8 m), Obelija (575 ha, average depth 4.5 m) and Simnas (246 ha, average depth 2.9 m) are moderately eutrophic, while Lake Žaltytis (235 ha, average depth 1.7 m) is highly eutrophic (Kavaliauskienė, 1995). The Curonian Lagoon (total area 158,400 ha, the area of the territory belonging to Lithuania is 41,500 ha, average depth 3.8 m) is a brackish water body. The study area also included adjacent eutrophic Lake Krokų Lanka (total area 787 ha, average depth 1.89 m). The area of Daugai, Baltoji Vokė and Kena fish ponds was 616 ha, 368 ha and 682 ha, respectively. The depth of all fish ponds varied between 0.70 and 1.5–2 m. All fish ponds can be assigned to eutrophic wetlands.

Lakes Dusia, Metelys, Obelija, Vištytis, Seirijis and Simnas, and the Curonian Lagoon are water bodies with a sand or gravel bottom in their littorals supporting abundant populations of the bivalve molluscs *Dreissena polymorpha* and the communities of *Chara* algae. The bottom of Lake Žaltytis is covered with mud, which is not a suitable substratum for the *Dreissena polymorpha* communities.

METHODS

Bird counts. Surveys of the Tufted Duck at lakes in southern Lithuania were performed during two study periods. The dates of lake surveys conducted in the first period (1983–1986) are as follows: surveys of lakes Dusia, Metelys and Obelija were conducted in 1983 and 1985–1986, of Lake Žaltytis in 1985–1986 and of Lake Simnas in 1985–1986. In this period, birds were censused from July through early November at ten-day intervals, with the exception of Lake Simnas which in 1985 was surveyed only in September and October. From April to mid-June surveys were conducted at half-month intervals. The dates of the Tufted Duck surveys performed during the second study period (1994–1998) were as follows: Lake Dusia was surveyed in April 1995 and 1997–1998, September–October 1994, 1996 and in September 1997; Lake Metelys in April 1997–1998, May 1998, September 1994 and October 1996–1997; Lake Obelija in April and October 1997 and March 1998; Lake Žaltytis in April 1997, March 1998, April–May 1999, September–October 1996 and October 1997; Lake Simnas in April 1997, October 1996, September–October 1997; Lake Vištytis in April 1996–1997, March 1998, October 1996, September–October 1997; Lake Seirijis in April 1997, September–October 1996, October 1997. During this study period, surveys were conducted 1–2 times per month.

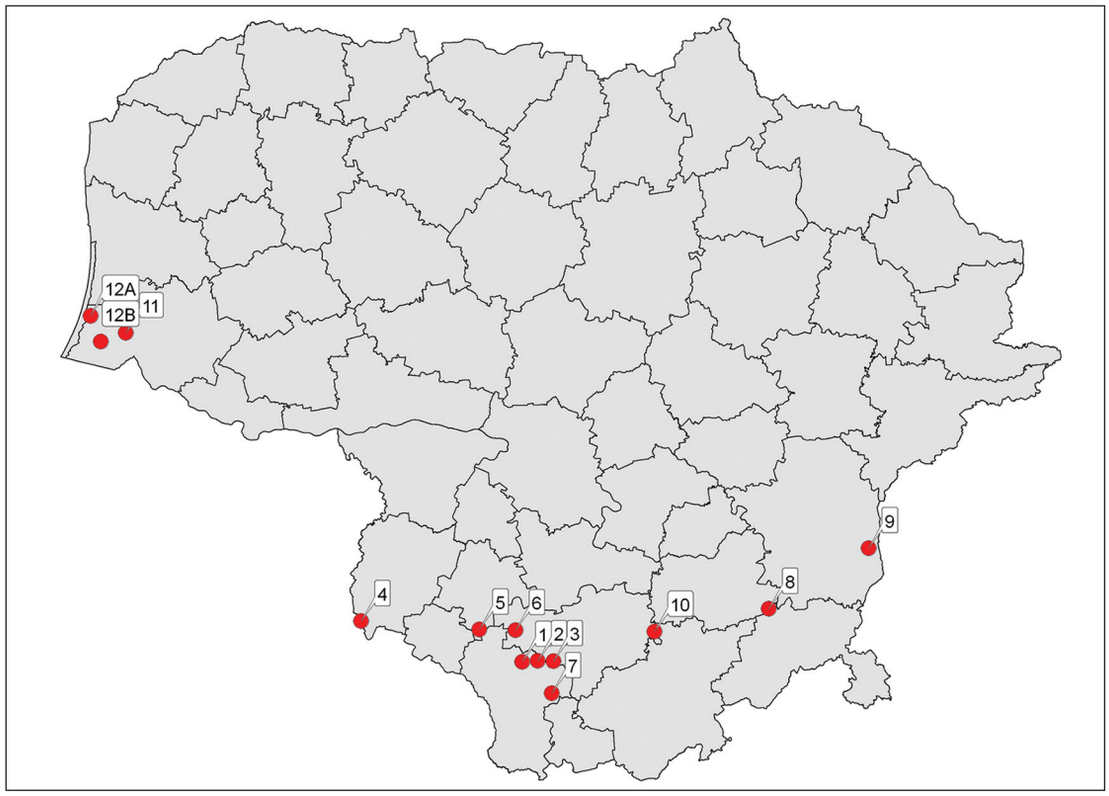

Fig. 1. Count sites of the Tufted Duck: *1* – Lake Dusia, *2* – Lake Metelys, *3* – Lake Obelija, *4* – Lake Vištytis, *5* – Lake Žaltytis, *6* – Lake Simnas, *7* – Lake Seirijis, *8* – Baltoji Vokė and Kena fish ponds, *10* – Daugai fish ponds, *11* – Lake Krokų Lanka, *12A* – western part of the Curonian Lagoon, *12B* – eastern part of the Curonian Lagoon

Lake-surveys were timed to coincide with the periods of peak abundance of migratory concentrations, as well as with the beginning and end of their formation. Published phenological material (Logminas, 1990; Valius, 1980, 1990; Stanevičius, 1983), as well as the data obtained from the first period surveys, was considered when scheduling waterfowl surveys. Depending on observation conditions, lake-surveys were conducted from the shore or by boating along the shoreline.

Counts at Daugai fish ponds were carried out in 1997–1998 and in 2000, at Kena in 1996–1997 and 2000–2002, at Baltoji Vokė in 1996–1997 and 1999. Birds were counted in April–October from the shore.

In the western part of the Curonian Lagoon (along the eastern shoreline of the Curonian Spit), investigations were carried out in 2002–2006. Surveys were conducted at ten-day intervals from the shore in March–November.

In the eastern part of the Curonian Lagoon, waterfowl census was carried out in two periods. During the first period, i. e. in 1989–1991 and 1993–1996 (further '1989–1996 period'), bird surveys were conducted 1–2 times per month in April and from July to early September. Some of these surveys were aerial and were performed from an aircraft "AN 2" or a helicopter "KA-26". Other surveys were conducted from a motorboat or from the shore. The second census of the Common Pochard in this part of the lagoon was taken from mid-September through mid-November 2007. In that year, the Ventės Ragas–Kintai stretch was surveyed by walking the route along the coastline, while Kniaupas Bay, Lake Krokų Lanka and the Nemunas delta edge were surveyed by motorboat-sailing. A total of 18 surveys (4 in September, 5 in October and 9 in November) were completed in 2007. Waterfowl counts in Kniaupas Bay, at Lake Krokų Lanka and along the Nemunas delta edge were made twice (in September and October).

Aerial surveys were conducted following standard methods employed during the implementation of the country-wide monitoring programme (Komdeur et al., 1992). Binoculars or a telescope was used to inspect the area of a water body or its coastal part. Only swimming or flushed birds were included into counts. In this way, a distinction was made between migrating (transiting) and staging birds.

Data processing. We summarised data on the abundance of spring and autumn (including August) migratory concentrations by presenting the lowest and the highest values, as well as the medians, of annual abundance peaks for each lake. We also summarised data on the phenology of spring and autumn concentration formation arranging its particular stages (beginning, peak abundance and end) throughout months and half-months. Additionally, joint phenology and abundance graphs were specially produced for wetlands with extended periods of staging concentrations (for those with summer concentrations as in the eastern Curonian Lagoon and fish ponds) and less regular counts. For this graph, we selected the highest count values in each particular half-month irrespective of the year.

The beginning of concentration formation was identified with the arrival of the first flocks of birds (not just single birds spotted) and its end with the departure of the flocks of birds, when only single birds remained.

Only the years in which surveys were conducted both in spring and autumn were selected for comparison of spring and autumn concentration abundances. To evaluate a possible difference between the abundances of spring and autumn concentrations, we calculated the percent proportion of spring and autumn peaks to the total sum of these two peaks for each water body and for each particular year. The data obtained were used to determine the medians of these proportions for each water body. In addition, we counted how many times during the study years concentration peaks at a particular water body were more abundant in spring and in autumn. We used the Wilcoxon test for matched pairs to verify whether the differences between spring and autumn samples consisting of averaged peak values of birds in lakes were significant.

RESULTS

Abundances of migratory and summer concentrations. The largest concentrations of the Tufted Duck, numbering up to 24,500 individuals in spring, 34,000 in autumn, 12,000 in summer and 54,000 at the end of summer and the beginning of autumn, were registered along the eastern part of the Curonian Lagoon (including Kniaupas Bay and Lake Krokų Lanka) (Table 1, Fig. 2). Among the inland water bodies, Lake Dusia (over 4000 individuals in spring and fewer than 2000 individuals in autumn) had largest concentrations. At the remaining water bodies, peak values of staging concentration varied from several tens to several hundreds of birds. The only exception was Lake Vištytis supporting over 1200 staging birds in spring (Table 1).

In fish ponds, late spring-summer concentrations of the Tufted Duck were more numerous than early spring and autumn migratory concentrations (Fig. 3). They fluctuated between 250–350 birds (Table 1, Fig. 3).

Table 1. **Annual peak abundances of the Tufted Duck spring and autumn staging concentrations (N is number of counts)**

Water body	Spring			Autumn		
	N	Median or one-year value	Range	N	Median or one-year value	Range
Dusia	4	1,674	790–4,180	3	680	400–1,728
Metelys	5	109	45–279	3	300	100–321
Obelija	3	99	23–180	3	185	35–220
Vištytis	2	1,081	891–1,270	2	390	200–580
Žaltytis	2	195	71–320	2	13	10–15
Simnas	2	56	35–76	2	64	33–92
Seirijis	1	423	–	2	174	80–267
Baltoji Vokė fish ponds	1	170	–	1	65	–
Kena fish ponds	1	122	–	1	6	–
Daugai fish ponds	1	24	–	1	0	–
Western part of the Curonian Lagoon	4	180	24–405	3	206	140–402
Eastern part of the Curonian Lagoon (from spring to early autumn 1989-1996)	3	5,970	5,760–24,500	3	34,150	32,650–34,200
Eastern part of the Curonian Lagoon (late autumn 2006-2007)	1	1,730	–	2	4,277	947–7,607

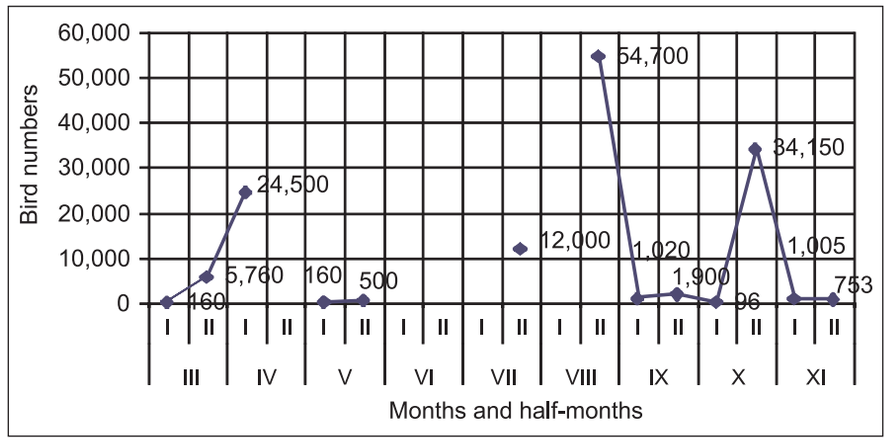

Fig. 2. The Tufted Duck staging concentrations in the eastern part of the Curonian Lagoon (including the coastal lake Krokų Lanka) based on peak-values selected from the count data of surveys conducted in 1989–1996 and 2006–2007. III–XI – months from March through November; I and II – first and second halves of each month

Timing of formation of the Tufted Duck concentrations. In spring, concentration formation can already start in early March, but most frequently it begins in the second half of this month (Fig. 2, Fig. 4). In fish ponds, first spring concentrations were always observed only in the first half of April (Fig. 3). Peaks most frequently occur in the first half of April (nearly 2 / 3 of all peaks in lakes) (Fig. 4). It seems also to be true for fish ponds, whilst summer peaks may occur in May or even in June there (Fig. 3). By late April or early May, spring concentrations in natural water bodies disappear (Fig. 2, Fig. 4). The situation in fish ponds is more complicated because the end of spring concentrations partly overlaps with the beginning of summer concentrations (Fig. 3).

In autumn, the first migratory concentrations in lakes were observed in September, most frequently in the first half of the month (Fig. 5). Some exceptions were lakes Žaltytis and Simnas, where concentrations always started half a month later. It is difficult to identify the beginning of autumn migratory concentrations at the Nemunas delta

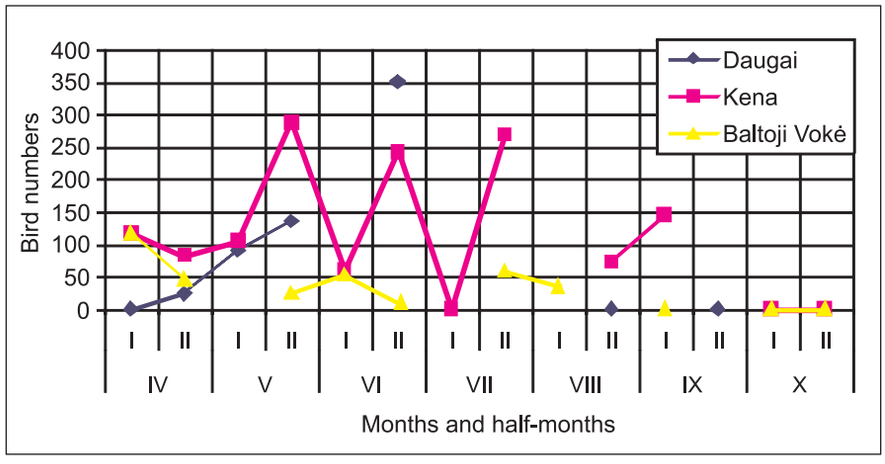

Fig. 3. The Tufted Duck staging concentrations in fish ponds based on peak values selected from the count data of surveys conducted in 1997–1998 and 2000 (Daugai), in 1996–1997 and 2000–2002 (Kena), and in 1996–1997 and 1999 (Baltoji Vokė). IV–X – months from April through October; I and II – the first and second halves of each month

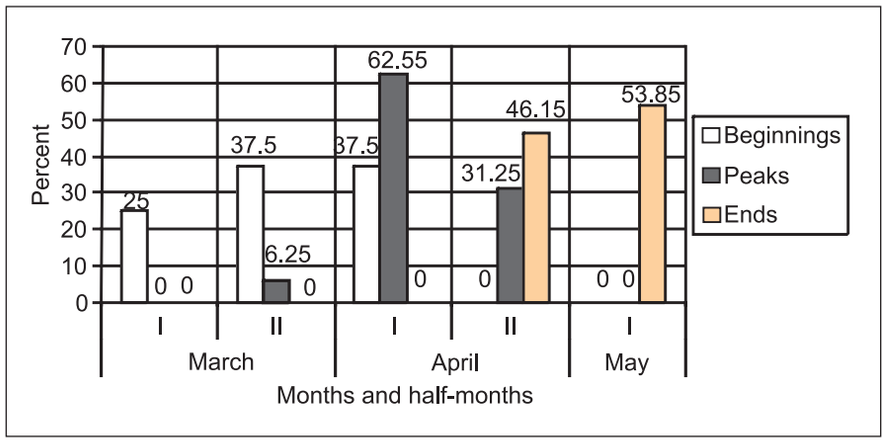

Fig. 4. Timing of the Tufted Duck spring concentrations in study lakes: percentage distribution of the number of dates of the beginning, peak and end of concentrations over a staging season. Sample sizes are (the number of dates is known): 8 dates of concentrations' formation beginning, 16 dates of their peak and 13 of their end

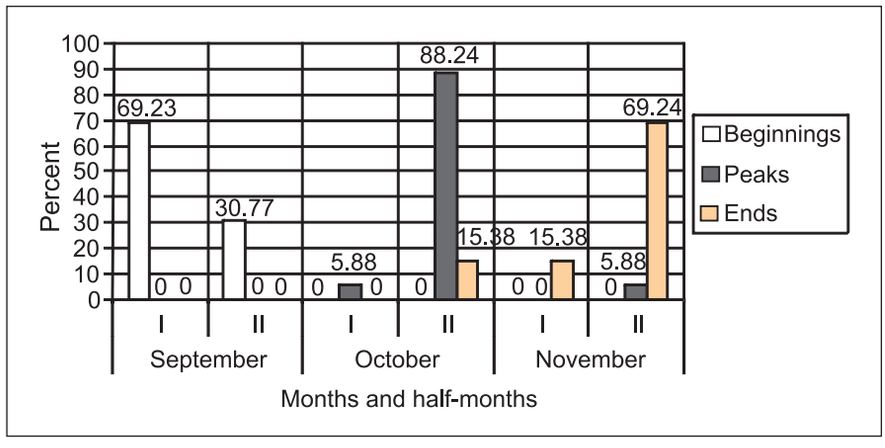

Fig. 5. Timing of the Tufted Duck autumn concentrations in study lakes: percentage distribution of the number of dates of the beginning, peak and end of concentrations over a staging season. Sample sizes are (the number of dates is known): 13 dates of concentrations' formation beginning, 17 dates of their peak and 13 of their end

sector of the Curonian Lagoon (Kniaupas Bay, Lake Krokų Lanka; 1989–1996 count seasons) due to prolonged moulting concentrations there (see Fig. 2). Nevertheless, the beginning of autumn migratory concentrations was recorded in early September in the stretch between Ventės Ragas and Kintai settlements (2006–2007 count seasons in the eastern part of the Curonian Lagoon), where no summer concentrations were observed. Nearly a round-season presence of staging the Tufted Duck in fish ponds also makes the identification of the beginning of autumn (migratory) concentration complicated. Based on the data available, we conclude that it occurs between late August and early September (Fig. 3). The autumn peak abundance of the Tufted Duck concentrations in natural wetlands usually occurs in the second half of October (almost 90% of all cases in continental lakes) (Fig. 5). In lakes Simnas, Obelija and Žaltytis, this period was more prolonged than in the remaining natural wetlands. Large concentrations in the eastern part of the Curonian Lagoon (including those at Lake Krokų Lanka and Kniaupas Bay) were already recorded in the second half of July. The peak number was observed in the second half of August. The autumnal peak of concentrations occurred in the second half of October (Fig. 2). In fish ponds, peaks of the Tufted Duck concentrations were more frequent in mid- or late summer than in autumn (Fig. 3). In lakes, concentrations disappeared by the second half of November. A rather similar situation was observed in the eastern part of the Curonian Lagoon (Figs. 2, 5). In fish ponds, staging concentrations disappeared by October (Fig. 3).

Distribution of staging ducks between spring and autumn concentrations. Comparison of peak abundance values of the Tufted Duck concentrations in lakes showed that concentrations in spring were usually larger than in autumn (Table 2). In 14 cases versus 6, the Tufted Duck abundances were higher in spring than in autumn. Besides, the average median of spring peaks for lakes was 66% (the range was 43–90%), and only 34% (10–57%) for autumn peaks. The prevalence of spring concentration values over autumn values was also recorded in fish ponds. However, the difference between spring and autumn medians in the lake group was not statistically significant (Wilcoxon test for matched pairs: $Z = 1{,}521$; $n = 7$; $p = 0{,}128$). On the other hand, an increase in sample size (pooled lake and fish pond data) revealed significant differences between spring and autumn abundances of staging concentrations ($Z = 2{,}073$; $n = 9$; $p = 0{,}038$) in inland wetlands.

At the western edge of the Curonian Lagoon, which hosts small numbers of the Tufted Duck, the domination ratio between peak values of spring and autumn concentrations was rather balanced. However, at the eastern edge of the lagoon, which contains large the Tufted Duck concentrations, the ratio between autumn and spring concentrations was in favour of autumn concentrations (Table 2). This is particularly demonstrated by the percentage ratio of spring and autumn abundances: 80% in autumn versus 20% in spring.

Table 2. **Peak differences between spring and autumn migration seasons. Numbers in spring and autumn columns indicate how many times birds were more numerous in spring than in autumn and in autumn than in spring**

Water body	Number of study years	Spring peak >Autumn peak	Autumn peak >Spring peak
Dusia	5	4	1
Metelys	4	2	2
Obelija	4	2	2
Vištytis	2	2	0
Žaltytis	2	2	0
Simnas	2	1	1
Seirijis	1	1	0
Total in lakes	20	14	6
West Curonian Lagoon	5	2	3
Eastern part of the Curonian Lagoon (in 1991)	1	0	1
Eastern part of the Curonian Lagoon (in 2007)	1	0	1
Total in the Curonian Lagoon	2	0	2
Baltoji Vokė fish ponds	1	1	0
Kena fish ponds	1	1	0
Total in fish ponds	2	2	0

DISCUSSION

Abundance. Two key migratory and moulting grounds of the Tufted Duck concentrations can be distinguished in the group of wetlands under study. The majority of them are situated along the eastern shore of the Lithuanian part of the Curonian Lagoon, mainly at Kniaupas Bay and Lake Krokų Lanka, in the sections of the lagoon along the Nemunas Delta and in the north of the Ventė peninsula, while Lake Dusia represents a smaller site (only for migratory concentrations) (Table 1, Fig. 2). Analysis of both recent and older sources (Ivanauskas, 1939, 1959; Вайткявичюс, 1968; Valius et al., 1968; Valius, 1980, 1990; Logminas, 1990, 1992; Stanevičius, Švažas, 1998; Stanevičius, 1999; Švažas, 2001) leads to the conclusion that the aforementioned sites traditionally were most important staging sites for the Tufted Duck amongst Lithuanian wetlands. These water bodies are larger than the other ones in this study. Both the Curonian Lagoon and Lake Dusia have large areas of shallow water and are rich in species-specific food supply – zebra mussel (*Dreisena polymorpha*). The colonisation of European waters by this mollusc is thought to be the major factor that contributed to the growth and spread of the Tufted Duck population across the continent (e. g. Olney, 1963).

Investigations carried out in the seventh decade of the 20th century revealed numerous spring migratory concentrations of the Tufted Duck in the Curonian Lagoon and Lake Krokų Lanka (Вайткявичюс, 1968; Valius, 1980). Our investigations show that large migratory concentrations are still

characteristic of the eastern part of the Curonian Lagoon. However, according to new findings, huge concentrations of the Tufted Duck occur in July, late August and early September (Fig. 2). Some of these findings have already been published (Švažas, 1996; Švažas et al., 1999).

Dates of the presence of the Tufted Duck in the Curonian Lagoon overlap with the moulting period of the species in western Europe (Reinder and Zomerdijk, 1979). An increase in size of the Tufted Duck concentrations by late August to early September in the Curonian Lagoon (see Fig. 2) may be caused by the influx of moulting females (the second wave of arriving birds). The moult of the Tufted Duck females reaches its peak precisely during this period (Reinder, Zomerdijk, 1979).

In fish ponds, like in the Curonian Lagoon, the Tufted Duck is more abundant during the summer than autumn migration. Birds which remain in fish ponds through the second half of summer form moulting concentrations. The Tufted Duck moulting in fish ponds is also observed in Latvia (Бауманис, 1987).

Several reasons may account for the relatively abundant and permanent occurrence of the Tufted Duck concentrations in fish ponds. Fish ponds are shallow water bodies with water depth ranging from 1.2 to 2 meters, while the Tufted Duck in search of food is able to dive much greater depths – up to 8 m (Schifferly, 1990). Fish ponds do not provide a habitable environment for zebra mussel. However, this shortcoming is compensated for by the ability of the Tufted Duck to switch to a new diet (fish fodder) of a very high energetic value, which was also reported from elsewhere in eastern Europe (Бауманис, 1987; FAO, 1989). Low rates of disturbance is another characteristic of fish ponds throughout ice-free seasons. Both quality of foraging conditions and levels of disturbance are commonly recognised factors of critical importance for flightless moulting waterfowl with high energetic demands. Therefore, the fish pond network established in Lithuania in the early 20th century creates new habitats for staging Tufted Duck and has an important impact on the species status in the country. The expansion of the fish pond network in neighbouring Belarus is considered to be the main reason for the recorded increase in the abundance of the Tufted Duck in the second half of the 20th century (Kozulin et al., 2002). Consequently, the established fish pond network has a positive effect on the status of the species in the south-eastern Baltic region.

Timing. According to the results of our investigations, the formation of the Tufted Duck spring migration concentrations in Lithuania starts in March, or half a month earlier than in Lake Žuvintas in 1966–1972 (Valius, 1980) and in 1976–1981 (Станявичюс, 1983). Such a shift in phenophases coincides with a rise in winter and spring temperatures in Lithuania due to global climate change (Bukantis, 1998; Žalakevičius et al., 2006). A half-month delay in concentration formation in fish ponds is related to the late artificial filling of the largest ponds (three year-old fish ponds) with water (in April).

In spring, the numbers of the Tufted Duck are highest in early April. Little is known about the peak-dates of this species in the past because previous authors (Ivanauskas, 1938; 1959; Valius, 1980; 1990) were not much interested in the phenology of the formation of the Tufted Duck concentrations.

Spring concentrations of the Tufted Duck disappear in late April to early May. However, in fish ponds the end of migratory concentrations overlap with the beginning of summer concentrations, which makes it difficult to distinguish between these two dates. No data exist on the dates of the end of spring concentrations in the past.

Autumn migratory concentrations of the Tufted Duck most often emerge in the first half of September. The only exceptions are lakes Žaltytis and Simnas, where concentration formation starts half a month later than in the remaining wetlands. The most plausible reason for this difference is small autumn numbers of the Tufted Duck staging in these lakes that are smallest of all the investigated lakes. And vice versa, the earliest dates of the beginning of concentration formation are characteristic of large lakes such as Dusia, Metelys, Obelija holding large autumn concentrations of the Tufted Duck (see Table 1). The reason for differences in size of concentrations is a different food base of small and large lakes. Lakes Dusia, Metelys and Obelija have wide and shallow sand or gravel bottom littorals supporting the abundant populations of zebra mussels, the communities of the pondweed *Potamogeton,* and *Chara* algae, whereas the bottom of Lake Žaltytis is covered with mud that is not a suitable substratum for zebra mussels. In fish ponds and in the eastern part of the Curonian Lagoon, where the end of moulting-postmoulting concentrations and the beginning of migratory concentrations overlap, a precise date of the onset of autumn concentrations is difficult to establish.

The peaks of the Tufted Duck autumn migratory concentrations were recorded in late October. However, July–August peaks along the eastern part of the Curonian Lagoon (see Fig. 2) most presumably are related not only to migratory, but also to moulting and postmoulting periods. In fish farms, autumn concentrations of the Tufted Duck have but little time to reach their abundance peaks due to the early drainage of ponds. Hence, this date is not natural, but is strictly predetermined by man.

Autumn concentrations of the Tufted Duck disappear in late November, however in some lakes this can occur earlier. The latter is characteristic of smaller lakes. This may be attributed to a certain scarcity and irregularity of occurrence of staging the Tufted Duck concentrations in small lakes that possess lower food resources than large lakes. The dates of the end of the Tufted Duck autumn migratory concentrations in the Curonian Lagoon are similar to those in lakes, though more variable. The earliest dates of disappearance of the Tufted Duck autumn concentrations were recorded in fish ponds. Birds are forced to leave fish ponds due to early dates of artificial drainage.

Very little data are available on the main dates of the Tufted Duck concentration formation for the years preceding the present study. This complicates the assessment of the

possible impact of climate change on the phenology of waterfowl concentrations. The shortage of the relevant information makes the results of our study a baseline for future investigations into the impacts of climate warming on the course of waterfowl concentration formation in Lithuania and the south-eastern Baltic region.

Distribution between spring and autumn seasons. To shed more light on the spatial distribution of tufted duck migratory flows in the south-eastern Baltic region, it is meaningful to establish the ratio between spring and autumn abundances of the species' concentrations in Lithuanian wetlands. In general, in inland waters (lakes, fish ponds) the Tufted Duck is more numerous in spring than in autumn, meanwhile the situation in the Curonian Lagoon is quite opposite: autumn concentrations are much more numerous than spring concentrations. We do not know the reason behind these patterns yet.

Meeting conservation requirements. As stop-over places for waterbird species holding the most productive Tufted Duck concentrations, the Curonian Lagoon and Lake Krokų Lanka, as well as lakes Metelys, Dusia and Obelija (the latter three lakes as a complex) are designated as Important Bird Areas (IBAs). These sites cover two main staging areas of the species in the country – Lake Dusia and the eastern part of the Curonian Lagoon. However, only some areas of the Curonian Lagoon (including the Nemunas delta) are important for staging the Tufted Duck. They are Kniaupas Bay, coastal Lake Krokų Lanka and the shore stretch along the Ventės Ragas peninsula (Fig. 6).

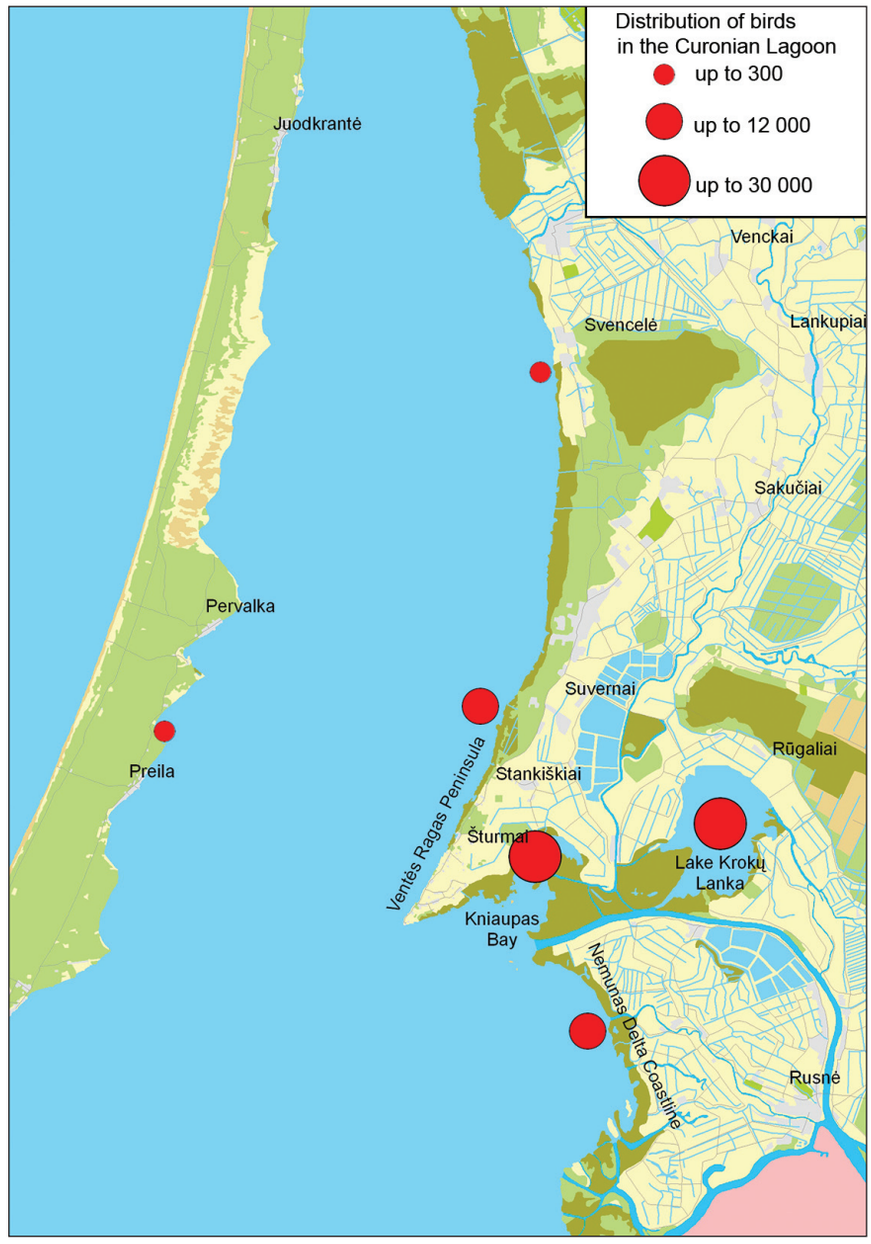

Fig. 6. Internationally important staging sites of the Tufted Duck in the Curonian Lagoon during the moulting and autumn migration seasons. Circles indicate major locations and peak limits of staging concentrations

Kniaupas Bay and Lake Krokų Lanka have the status of zoological reserves, while the coastal area around Ventė is designated as a landscape reserve. These reserves belong to Nemunas delta Regional Park. Lake Dusia has a status of a hydrographical reserve, which belongs to Meteliai Regional Park. Besides, all the above-mentioned areas are also designated as Natura 2000 sites.

The established periods of abundance peaks (early April for spring migratory concentrations, late October for autumn migratory concentrations, and late summer through early autumn for moulting and post-moulting concentrations in eastern part of the Curonian Lagoon with Kniaupas Bay and Lake Krokų Lanka) prove that the imposed restrictions in the Nemunas River Regional Park and in the adjacent coastal zone of the lagoon are well-grounded. In Lake Krokų Lanka and Kniaupas Bay, commercial fishing is forbidden, but recreational-boat sailing is still permitted. However, during the above-indicated periods restrictions should also be applied to recreational-boat sailing. Motor-boat sailing should be banned along the shoreline of the lagoon between Ventė and Kintai, with an exception being made only for motor-boats heading for Ventė, Šturmai and Kintai harbours.

As the Tufted Duck and the Common Pochard (another abundant species of diving ducks in Lithuania) often form mixed non-breeding concentrations, the protection of the first species largely presupposes the protection of the second species, too.

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KUODUOTOSIOS ANTIES (*AYTHYA FULIGULA*) PAVASARINIŲ IR RUDENINIŲ MIGRACINIŲ IR ŠĖRIMOSI SANKAUPŲ FORMAVIMOSI YPATYBĖS LIETUVOJE

S a n t r a u k a

Kuoduotosios anties nelizdinių sankaupų formavimasis tirtas Lietuvos vidaus vandenyse (7 ežeruose, 3 žuvininkystės ūkių tvenkiniuose) ir Lietuvai priklausančioje Kuršių marių dalyje. Aprašytos sankaupų formavimosi ypatybės, kurios papildo žinias apie rūšies ekologiją nelizdiniu laikotarpiu ir gali būti panaudotos jos apsaugai. Analizuoti 1983–2007 m. vykdytų įvairių tyrimų duomenys. Vidaus vandenyse didžiausios kuoduotųjų ančių migracinės sankaupos pastebėtos Dusios ežere, o pajūryje – išilgai rytinio Kuršių marių pakraščio. Kuoduotosios anties šėrimosi sankaupos aptiktos tik rytinėje Kuršių marių dalyje (komplekse su Krokų Lankos ežeru) ir žuvininkystės ūkių tvenkiniuose. Žuvininkystės ūkių tvenkiniai taip pat yra tarp pagrindinių vietų, kuriose formuojasi kuoduotosios anties sankaupos. Kuoduotosios anties pavasarinių migracinių sankaupų pagrindinis laikotarpis yra nuo kovo antros pusės iki balandžio antros pusės (kartais jos užsitęsia iki gegužės pirmos pusės), o rudeninių – nuo rugsėjo pirmos pusės iki lapkričio antros pusės (sankaupų pikai užfiksuoti atitinkamai 04.01–15 ir 10.16–30). Didžiausios sankaupos šėrimosi laikotarpiu ir po šėrimosi Kuršių mariose nustatytos rugpjūčio antroje pusėje. Žuvų tvenkiniuose, kitaip nei kituose vandenyse, kuoduotoji antis santykinai gausi jau pirmoje vasaros pusėje. Vidaus vandenyse rūšies migracinės sankaupos pavasarį dažniau gausesnės nei rudenį, tačiau Kuršių mariose stebima priešinga situacija. Vandens reguliavimas žuvų tvenkiniuose vėlina pavasarinių sankaupų pradžią pavasarį ir ankstina pabaigą rudenį.

Raktažodžiai: kuoduotoji antis, nelizdinės, šėrimasis, migracinės ir šėrimosi sankaupos