Extension of Goosander *Mergus merganser* distribution into the Carpathian Mountain range

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Abstract

The Goosander *Mergus merganser* occurs mainly in the Holoarctic boreal zone but isolated populations also exist in the Alps, the Balkans and in central Asia. In the late 20th century, the breeding distribution extended to the Carpathian Basin in central Europe, and the species is now widespread in the west of the Carpathian Mountain range, whilst remaining scarce in the east Carpathians and breeding only occasionally in the southern Carpathians. It was estimated that at least 240–360 pairs bred in the Carpathian Mountains in 2010–2013 (of which *c.* 80% were in Poland), where they are restricted to river valley systems which are generally in a natural or semi-natural state. This remains a rare species in central Europe, meriting conservation measures in the Carpathians and monitoring of its continued expansion in the region.

Key words: conservation status, distribution, expansion, mountains, *Mergus merganser*.

The three Common Goosander *Mergus merganser* sub-species occur mainly in the boreal zones of Eurasia (*M. m. merganser*), central Asia (*M. m. orientalis*) and North America (*M. m. americanus*) (del Hoyo *et al.* 1992). In Europe, their range stretches from the British Isles, across Scandinavia and the southern coast of the Baltic Sea to Belarus and northern Russia. Isolated populations also exist in Iceland, the Alps and the Balkans (Scott & Rose 1996; Marti & Lammi 1997; Marinkovi *et al.* 2008; Keller 2009). The European population was estimated at < 74,000 pairs at the end of the 20th century, with the majority of the birds breeding in Fennoscandia and Russia (BirdLife International 2004). In the Alps, numbers are estimated at 1,000–1,400 pairs (Keller 2009), whereas in the Balkans it is a rare species (40–80 pairs) (BirdLife International 2004; Marinkovi *et al.* 2008). At the end of the 20th century, Goosanders also started to breed in the Carpathian Basin (Poluda 1991; Kondêlka 2000; István & Tamás 2003; Kajtoch & Piestrzyńska-Kajtoch 2005; Lešo & Kropil 2005). This study reviews the history of Goosander expansion in the Carpathians and assesses its present distribution and abundance in the region.

Methods

Data on breeding Goosanders in the Carpathians were collected from several sources. Firstly, their distribution in the Polish Carpathian Mountains was recorded and verified via field surveys. Data from a survey of the key bird species of the Polish Carpathians carried out by the Polish Society for the Protection of Birds (OTOP) were included in this review. In 2012–2013, the OTOP surveyed a total of 485 km (97 5-km sections) of river valley systems which were randomly selected and surveyed three times (once per month) during the breeding season (April–June). During these surveys experienced observers counted all riparian breeding birds including Goosanders. Records entered by volunteer observers onto an online database of bird observations developed for the OTOP's project were also used. From 2000 onwards, the most abundant Goosander populations in the Polish Carpathians, those of the Raba River (50 km of river surveyed) and Dunajec River catchments (30 km) were monitored for Goosander abundance 1–3 times per year. Secondly, data on Goosander numbers and distribution in the literature were collected and analysed (specifically: Tomiałojć & Stawarczyk 2003; Mohr *et al.* 2007; Kajtoch & Piestrzyńska-Kajtoch 2005 and Kajtoch *et al.* 2010 from Poland; Kondêlka 2000; Šuhaj *et al.* 2003 and Šťastný *et al.* 2006 from Czech Republic; Lešo & Kropil 2005, 2007 and Šrank 2011 from Slovakia; Poluda 1991; Potish 2009 and Grishchenko & Yablonovska-Grishchenko 2010 from Ukraine; and István & Tamás 2003 from Romania). Finally, unpublished data were gathered via personal communication with individual researchers and amateur ornithologists (see Acknowledgements). Birding mailing lists, forums and web pages (mainly the Polish "PTAKI yahoo group", the Slovakian "Aves vtaky" and the "Hungarian birdwatchers' site") were also consulted.

Breeding localities were defined as those sites where females were seen with broods (pulli or juveniles) by 20th July. All females with broods, regardless of the age of the young, were counted on the 5 km sections, and used to estimate of total number of breeding females, on the assumption that movement of birds to another part of the river valley (and thus the likelihood of double-counting) was limited during an single count. During counts of long river sections, only females with the youngest broods (approximately up to one week old) were recorded. Counts were confined to young broods to avoid overestimating the total numbers of breeding females, as females with older broods are not sedentary, often moving (swimming) along river channels to be potentially counted again, especially as human (observer) presence might encourage the birds to move (see Kajtoch *et al.* 2014). The movement of families was especially considered a problem when counting long river sections; on shorter stretches the birds can usually be tracked to avoid counting them twice. Breeding was considered to have taken place in valleys where the birds were frequently seen between the 20th April and 20th July and showed territorial, mating and/or breeding behaviour. Single sightings of birds, mainly males, during the breeding season

were not included as potential breeding localities because males do not stay with breeding females and non-breeders are known to move between river valley systems. Moreover, Carpathian Goosanders remain within the river valleys and do not appear to undertake the moult migration described for those in the British and Alpine populations (see Marquiss & Duncan 1994; Keller & Gremaud 2003; Hatton & Marquiss 2004). Sightings of family groups with young birds capable of flight after 20th July were also omitted, as the precise breeding locality of such birds could not be determined.

Results

First breeding records for the Carpathian Mountains

Prior to Goosanders breeding in the Carpathian Mountains, the closest breeding sites were thought to be in the catchment of the San and Upper Vistula Rivers, in the Sandomierz Valley of southern Poland, where birds have bred since the 1980s (Czyż 1992; Fig. 1). The expansion of Goosanders into the Carpathians started almost simultaneously in several areas and in different countries. The first broods in the Polish and Czech Carpathians had been preceded by irregular breeding attempts, which started approximately 10 years earlier (in 1986 and 1987) in the Ukrainian Transcarpathia and near Ivano-Frankivsk, also in the Ukraine. Birds first bred regularly in the upper Oder River and the Olza River in the Czech Republic in 1999. In the Raba and Dunajec Rivers in Poland, the first broods were also found in 1999, but the birds must have settled there much earlier, as about 16 pairs were found in the Raba River valley in 2000 (Fig. 2). Thus, Goosanders are likely to have started breeding there several years earlier, most likely after the severe flood of 1997, which had restored riparian habitats (*i.e.* restored the braided riverbed with gravel alluvia and isles, scarps on riverbanks and an accumulation of large amounts of wood), as was also observed following the flood in 2010 (Kajtoch & Figarski 2013; Fig. 2). The first case of breeding in Slovakia was tentatively reported from the Hron River in 2004 and confirmed in 2007. The first nesting Goosanders in Romania were sighted in 2003 in the gorge of the Mures River. In Hungary, a possible case of breeding was observed on the Danube River in 2004. These records suggest that the expansion of the Goosander's breeding ranges was quite rapid. It commenced in the northern part of the west Carpathian range in 1999, and over the next five years breeding birds were detected across most parts of this mountain range (Fig. 1); however, the most numerous populations are still restricted to the western Carpathians.

Current estimates for Goosander breeding in the Polish Carpathians

Goosanders are now present in almost all river systems in the Polish part of the Carpathian range, with the two central catchments of the Raba and Dunajec Rivers being the most densely populated. By 2010, 30–35 pairs bred within the surveyed sections of the Raba River catchment and 15–20 pairs in the Dunajec River catchment. Extrapolation of these numbers in relation to the total length of suitable river valleys within these catchments gave an estimated total of

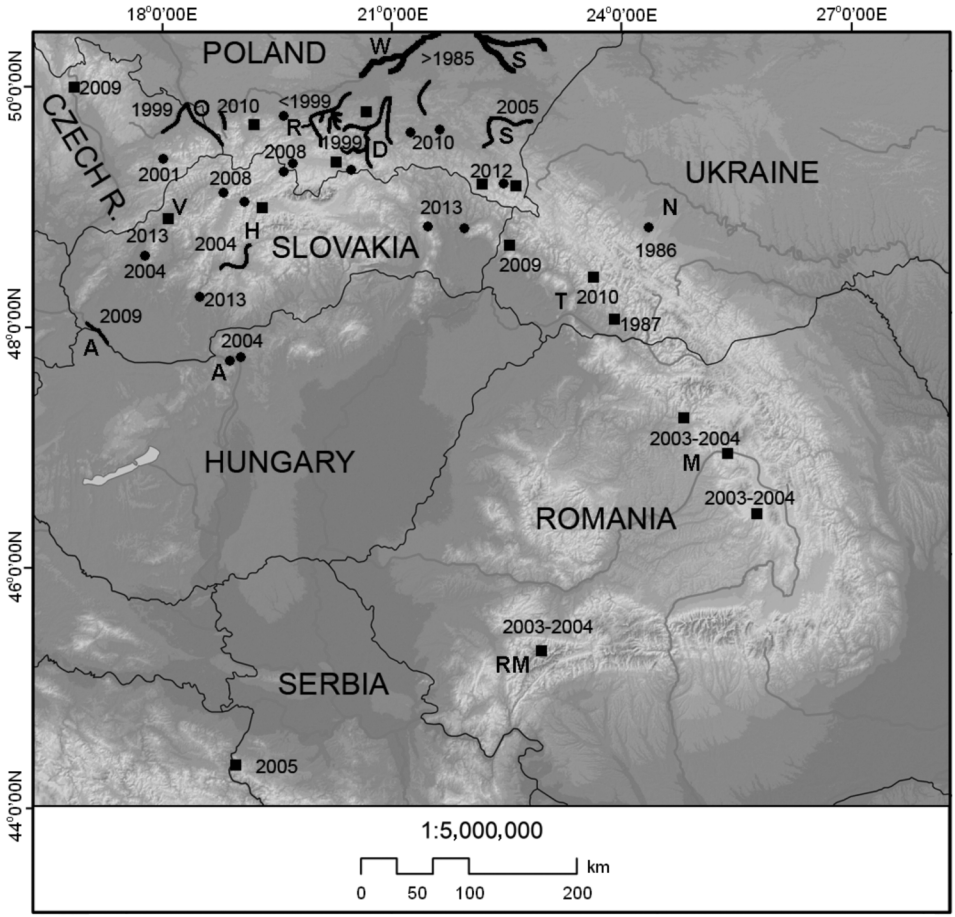

Figure 1. Distribution of breeding sites recorded for Goosanders in the Carpathian Mountains and surrounding areas (thick black lines = rivers where breeding is established, black squares = additional known breeding localities, black dots = possible breeding localities). The Carpathian range (white elevation) extends in an arc from the Czech Republic in the northwest through southern Poland, Slovakia, northern Hungary and southwest Ukraine to Romania in the east and Serbia in the south. Dates indicate the first year in which Goosanders were detected in particular areas. Major river catchments mentioned in the text: O = Oder and Olza, W = Vistula, R = Raba, D = Dunajec, S = San, V = Vah, H = Hron, A = Danube, T = Tisza, N = Dniester, M = Mures and RM = Retezat Mountains. Map of the Carpathian after Jarvis *et al.* 2008 and OpenStreetMap, www.openstreetmap.org.

50–70 and 40–60 pairs of Goosanders breeding there, respectively. Since 2010, Goosanders have also been found in the western part of the Polish Carpathians, in the upper Vistula River (several pairs), the Soła River, the Skawa River and the Czarna Orawa River (single pairs in each). In the central part of the Polish western Carpathians, except for

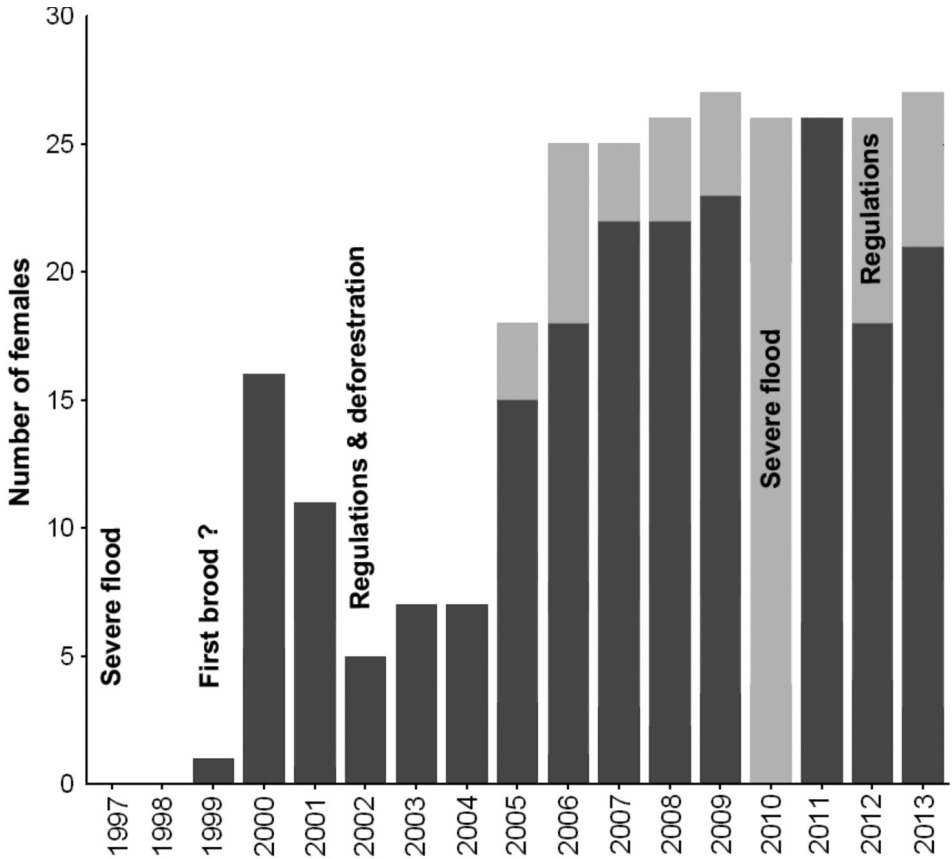

Figure 2. Number of Goosander pairs breeding in the middle part of the Raba River valley (from Dobczyce to Bochnia, *c.* 30 km), with the first brood recorded in 1999. Dark grey = maximum number of breeding females (recorded as females with broods); light grey = approximate additional number of non-breeding females and females which lost their broods (in 2010 these mainly comprised females which lost their broods during a severe flood).

the valleys of the Raba and Dunajec Rivers, Goosanders have been detected only since 2010 on the Wisłoka (several pairs), Ropa, Jasiołka and Wisłok Rivers (single pairs in each). In 2005, the birds started to breed in the eastern part of the Polish Carpathians, on the San River and its tributaries in the Bieszczady and the Beskid Niski Mountains as well as in the Przemyśl foothills, where probably > 30 pairs are now breeding. Most of the river systems in the Polish Carpathians in which Goosanders breed are tributaries of the Vistula River.

The number of Goosanders breeding in the middle part of the Raba River valley increased significantly between 1999 and 2013 (Linear regression: $F_{1,14} = 11.9$, $P = 0.005$), but that period also saw some

fluctuations caused by natural factors (*e.g.* floods) and anthropogenic factors (*e.g.* regulation of the river channels and deforestation of river banks) (Fig. 2). The total number of breeding Goosanders in the Polish Carpathians is currently estimated at 200–270 pairs (Table 1).

Goosanders breeding elsewhere in the Carpathians

In 2001, Goosanders breeding in the Czech Republic Carpathians and their foothills were found to occur mainly on the Olza River (probably several pairs) (Oder catchment) and in ponds in the upper Bečva River valley (Morava catchment) (Kondêlka 2000; Šuhaj *et al.* 2003; and Šťastný *et al.* 2006). Some 10–20 pairs are now thought now to breed in the Czech Carpathians (Table 1).

In Slovakia, Goosanders have been regular breeders in the Hron river valley (since 2007–2008, several pairs), the catchment of the Vah River (since 2004, several pairs) and on the Danube near Bratislava (since 2009, several pairs) (Lešo & Kropil 2005, 2007; Šrank 2011). Individual possibly breeding pairs were also observed on the Orava River in 2010 (Ł. Kajtoch unpubl. data). In the eastern part of the Slovakian Carpathians, Goosanders were observed on small rivers in the Torysa and Laborec catchments in 2013 ("Aves vtaky" site). Goosander sightings

Table 1. Estimated number of breeding pairs for Goosanders in Carpathian countries. * = estimates highly uncertain due to insufficient data.

Country	River catchment	Estimated numbers of breeding pairs
Poland	Raba	50–70
	Dunajec	40–60
	Elsewhere in west Carpathians	80–100
	San	30–40
Czech Republic	Oder	10–20
	Morava	1–2
Slovakia	Danube	15–25
	Tisza	2–5
Hungary	Danube	2–3
Ukraine	Dniester*	0–5
	Tisza*	5–20
Romania	Tisza*	5–10
Total		240–360

during the breeding season peaked in 2013 and, although the total number of pairs has not been determined, there are estimated to be 15–25 pairs breeding in the country (Table 1).

In the Hungarian Carpathians, single pairs of Goosanders were present only on the Danube River near Veröce in 2004 and 2009 ("Hungarian birdwatchers' site").

In the Ukraine these birds breed near Ivano-Frankivsk on the Lukva River (Dniester catchment) (1986) and in Transcarpathia on the Tereblya River (1987), the Rika River (2010), and the Uzh River (2009 or earlier) (on the last three rivers in the Tisza catchment) (Poluda 1991; Potish 2009; Grishchenko & Yablonovska-Grishchenko 2010). There are insufficient data to determine the total number of Goosanders breeding in the Ukrainian Carpathians, but taking into account numbers in the Polish east Carpathians (in the San River catchment) on the border with Ukraine, and the expansion of Goosanders into Slovakia, the species bird is possibly also more widespread in Ukraine (Table 1).

In Romania, Goosanders were found in the eastern Carpathians in 2003–2004 on the Bistrita River, on the Mures River and on the Tarnava Mare River, all within the Tisza catchment. A single breeding site was also detected in the southern Carpathians on a lake near the Retezat Mountains in 2003 or 2004 (István & Tamás 2003). The total number of Goosanders breeding in the Romanian Carpathians is not known but they amount to at least 5–10 pairs (Table 1).

Goosanders in the Carpathians are found mostly in the foothill zones and in the lower and middle parts of larger mountain rivers at altitudes of 250–500 m a.s.l. They mainly occur on rivers, and rarely on artificial dam lakes and ponds. Only a few breeding sites have been found higher in the mountains, on typical mountain rivers or, occasionally, on natural mountain lakes.

Discussion

From their initial colonisation in the 1990s, the Goosander is now widespread as a breeding species in the western Carpathians, especially in the northern part of these mountains in Poland and the Czech Republic, as well as locally on their southern slopes in central-western Slovakia (Fig. 1). There are also breeding birds along the Danube valley in Slovakia and Hungary (Fig. 1). On the other hand, Goosanders are still scarce breeders in the eastern Carpathian Mountain range, except in the San River valley in Poland, as only several isolated breeding sites have been detected in eastern Slovakia, Ukraine and Romania. This species is thought to breed only occasionally in the southern Carpathians, where it was reported breeding just once, in Romania. It is probable that some breeding localities in the eastern and southern Carpathians either still remain unknown or that Goosanders will also breed in these areas in the near future. It is worth noting that maximum numbers of Goosanders breeding in the western Carpathians in Poland were recorded in *c.* 2007–2009 and in 2011 (after a major flood, Kajtoch & Figarski 2013). In some river systems numbers declined thereafter, mainly because of habitat changes due to river channel regulation (which includes strengthening of river banks and riverbeds, often in conjunction with the construction of

small dams), such as when the Raba River system was subject to severe regulation and the catchment deforested in 2001–2002 (Fig. 2). In some river valleys the number of breeding pairs may have peaked in recent years, especially the Raba and Dunajec in Poland, where the increase in the number of breeding birds stabilised in 2007 at a density of *c.* 0.8 breeding female/1 km of river length. During the 2013 breeding season, the highest numbers of Goosanders were observed in Slovakia and the east Polish Carpathians. This suggests that there may in future be an increase in the intensity of expansion to the south and east.

The relatively short and rapid expansion of the Goosanders into the Carpathians is analogous to the range change recorded for this species in the Dynaric Alps, where birds also started breeding in 1986 and increased in number and distribution over the next 20 years (Marinković *et al.* 2008). These rapid expansions are in contrast to the long-term expansion of Goosander populations in the Alps (Keller & Gremaud 2003; Keller 2009) and in Britain (Holloway 1996; Rehfisch *et al.* 1999), where Goosanders started breeding in the 19th century and increased slowly. The different patterns of Goosander expansion could perhaps reflect different levels of persecution (the species has come into conflict with fishing interests in some regions, but not in the Carpathians), or be a result of the breeding birds having different origins. For instance, it's possible that only relatively small numbers of birds settled in Britain and the Alps in the 19th century, resulting in local populations which increased in number independently of the north European population, whereas newly-established populations in the Carpathians and possibly in the Dynaric Alps may be more regularly reinforced by immigration of birds from the north.

It is difficult to determine the total number of breeding pairs in the Carpathians, due to a lack of precise counts in most countries and most of the river catchments. Simple summary of breeding Goosanders estimates from the Carpathian countries suggests a total of at least 240–360 pairs (2010–2013), of which at least 80% are located in Poland (Table 1). It is possible that actual number of breeding Goosanders in the Carpathians is even larger and that total population fluctuates due to dynamic changes in river and riparian habitat quality and suitability (which may result from anthropogenic and natural causes) and demographic reasons (it is uncertain to what extent Carpathian Goosanders depend on inflow of birds from northern areas to sustain numbers). The estimated number of breeding Goosanders makes those in the Carpathians the third most numerous concentration of Goosanders in Europe, exceeding those in the Balkans (40–60 pairs) and Iceland (100–300 pairs) (Bird Life International 2004).

In the Carpathians, Goosanders breed almost exclusively on rivers which are generally in natural or semi-natural state (unregulated channels and banks covered by riparian forests) (Kajtoch *et al.* 2014). Breeding birds have only rarely been found on ponds and artificial reservoirs, mostly in Poland, Slovakia and Romania. There has probably been only a single breeding attempt on a natural lake in the southern Carpathians (near the Retezat Mountains) in Romania. This preference for river valleys with fast-

running water as breeding sites probably results from the availability of suitable habitats as artificial reservoirs often have treeless banks, while mountain lakes in the Carpathians are extremely rare and located in highest parts of the mountains, above the tree line. Breeding in river valleys makes the Carpathian population similar to populations from the Balkans and also the British Isles and Iceland, but distinct from populations in the Alps (where Goosanders breed mostly on sub-montane lakes, Keller & Gremaud 2003) and northern Europe (where they mostly breed on lakes and large lowland rivers). In several localities, semi-colonial Goosanders have been found (up to 8 pairs on the Raba River, Kajtoch *et al.* 2009). This phenomenon was earlier known for this species amongst its island (Madge & Burn 1988) and mountain populations (Keller & Gremaud 2003).

It is not certain if birds breeding in the Carpathians are sedentary or migrate to the south, as during the winter large numbers of birds (probably mainly of northern origin, but possibly also local individuals) flock on some river stretches and reservoirs. The source of Goosanders movement into the Carpathians is most likely from northern European (particularly from northern Poland, Latvia and/or Scandinavia), but other expansion routes (*e.g.* from the mountain areas of the Alps or the Balkans) cannot be excluded. Ringing and/or genetic studies are needed to confirm the source of colonising birds. It has recently been shown that Goosander populations are structured genetically (Hefti-Gautschi *et al.* 2009) and each geographically isolated population of these birds should be considered as an evolutionarily significant unit in conservation biology. It would be interesting to verify how Carpathian Goosanders are related genetically to other European populations.

At the same time as Goosanders were expanding their range into the Carpathians, the species also settled on the Morava River in the Sudetes (in 2009), on the Otava River in southwest Bohemia, Czech Republic (in 2006; Šuhaj *et al.*2003; Št'astný *et al.* 2006; Adamík & Beran 2010; Hudec *et al.* 2011), and in Dunaj River in Lower Austria (2007; P. Lešo, pers. comm.). These two range extension routes will probably connect the northern populations with the populations inhabiting the Alps in the near future. However, it seems unlikely that Goosander expansion to the south connected the Carpathian and Balkan populations as no population of these birds in the Southern Carpathians has been established yet.

In addition to the zoogeographic implications of this work, some conservation recommendations can be offered to provide better protection for Goosanders in the Carpathians in the future. To maintain populations of these birds, and to enable their further expansion, it is necessary to maintain river valleys in natural or semi-natural state, for instance by leaving river channels unregulated (retaining numerous alluvia, scarps and woody debris) and their banks afforested. It is also important to work on improving the water quality and fish populations in the rivers. Goosanders are not threatened in Europe as their northern populations are very numerous; however, in central Europe it remains a rare species, and in several countries it is a newly colonised breeder. Moreover, due to their habitat and food preferences, Goosanders could be good

indicators of naturalness and biodiversity of sub-montane river valleys (Kajtoch *et al.* 2014). For these reasons, we consider it is necessary to plan the effective conservation of this species in the Carpathians and to monitor further its expansion in the region.

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