

The status of an isolated population of Goosander *Mergus merganser* in the Balkans

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Abstract

This paper describes in detail for the first time the small, isolated population of Goosander *Mergus merganser* at the transboundary Prespa Lakes and Lake Ohrid in the Balkans. Co-ordinated censuses made during the breeding season each year from 2011–2015 inclusive estimated that there are 15–25 breeding pairs (15–34 according to the number of drakes counted) involving at least 77 individuals at Prespa Lakes, although numbers vary between years. The maximum number of young reared per pair in May–June 2011–2015 was estimated at 6.4 ± 3.5 (mean \pm s.d., $n = 35$). During the period 1988–2013 the Prespa Lakes have also been the most important wintering site for this population, holding 4.8–100% (mean \pm s.d. = $46.5 \pm 29.5\%$; $n = 21$) of the total numbers of Goosanders wintering in the southwest Balkans (*i.e.* in Albania, the FYR of Macedonia and Greece). Up to 130 birds overwinter in the region, where numbers have increased during the last 30 years, including at Prespa and Ohrid Lakes. The 2014 census provided first evidence of 3–4 pairs of Goosander nesting at Lake Ohrid, the second most important wintering site in the region. Conservation of this isolated population is of utmost importance, at least in a European context.

Key words: Albania, FYR of Macedonia, Goosander census, Greece.

The Goosander *Mergus merganser* is a Holarctic species, breeding throughout Eurasia and North America in the taiga zone, north of 50°N. More southerly populations also occur, however, such as the small, isolated and poorly-known population which breeds at Prespa Lakes in the southern Balkans (Cramp & Simmons 1977; Scott & Rose 1996; Handrinos &

Akriotis 1997). As a breeding species, the Goosander was first recorded on the part of the lakes belonging to the present day FYR of Macedonia in 1939 (A. Ilic, pers. comm. in Makatch 1950), and on the Greek side of the lakes on 4 June 1968 (Bauer & Hodge 1970). In the Greek section, the population was estimated at 3–8 pairs in the early 1990s (G. Catsadorakis, pers. comm. in Handrinos

& Akriotis 1997), and at 50–100 individuals during 1990–1995 (Wetlands International 2012). It is the southernmost breeding population of Goosander in the Western Palearctic, and is presumed to be isolated from populations breeding in central Europe (Scott & Rose 1996; Handrinos & Akriotis 1997). There has been no previous systematic research on, or monitoring of, this population at the Prespa Lakes. This paper is the first to report on a systematic five-year census on the status of this population, resulting from transboundary co-operation between researchers working in the three countries sharing the lakes: Albania, the FYR of Macedonia and Greece.

Study area and methods

Lesser Prespa Lake is situated at *c.* 850 m a.s.l., is eutrophic and *c.* 47.4 km² in area with a mean depth of 4.1 m and a maximum depth of 8.4 m. Most of the lake is located within Greece, while a small section belongs to Albania. Its small size and shallow waters results in Lesser Prespa freezing regularly, especially in the Albanian section. Great Prespa Lake is mesotrophic, varying between 245–270 km² in area depending on water levels, and has a maximum depth of *c.* 55 m and a mean depth of 14–18 m (Hollis & Stevenson 1997). It is shared by Albania, the FYR of Macedonia and Greece. The two lakes should be considered as a functional unit because they are connected hydrologically and waterbirds use both lakes interchangeably for nesting and/or feeding. Both are cyprinid dominated lakes, with the more abundant species being Prespa Bleak *Chalcalburnus belvica*, Prespa

Roach *Rutilus prespensis* and Common Carp *Cyprinus carpio*. Four national parks are wholly or partly situated within the catchment of the two lakes, and both are designated as wetlands of international importance under the Ramsar Convention. The Greek part of the catchment also contains two SCIs (Site of Community Importance) and SPAs (Special Protection Area) in accordance with European Union legislation. More information on the Prespa Lakes can be found in Crivelli & Catsadorakis (1997), Gjijnuri *et al.* (1997) and Veleviski *et al.* (2010).

Lake Ohrid, which is at 693 m a.s.l., is considered to be the oldest lake in Europe (Wagner *et al.* 2014). It has a surface area of 358 km², a maximum depth of 288.7 m, and an average depth of 155 m (Matzinger *et al.* 2007). Its water balance is dominated by inflow from karstic aquifers (*c.* 50% of water coming into the lake) that are recharged by precipitation and from Great Prespa Lake (Matzinger *et al.* 2007). Its effective watershed extends to *c.* 2,489 km². This lake never freezes, and complete deep mixing of the water column occurs roughly once every seven years, during cold winters. Lake Ohrid is a slow-reacting, oligotrophic system with a retention time of 83.6 years (Spirkovski *et al.* 2001). The lake is shared by Albania (*c.* one third of the surface area) and the FYR of Macedonia. With more than 212 endemic species, it is globally significant for its number of species per unit of area (Albrecht & Wilke 2008; Levkov & Williams 2012). It is part of UNESCO's World Natural and Cultural Heritage of the Ohrid Region and also designated a Monument of Nature. Ohrid is a salmonid and cyprinid

dominated lake with the main species being *Salmo* sp.

Goosanders occur on both of the Prespa lakes, principally within a narrow zone c. 200 m from the shore. Adult males are easy to identify in the field, but females are difficult to distinguish from sub-adult males and young birds at a distance (Cramp & Simmons 1977). The census method employed was modified slightly from that described in Gilbert *et al.* (1998) to respond to differences in phenology, breeding habitat (lake shores instead of river), nesting sites (cliffs) and available resources, and is similar to the method used by Keller & Gremaud (2003) to study Goosanders breeding on lakes in Switzerland. Censuses were conducted by one observer in a boat moving slowly (10–15 km/h) along predetermined routes, around 100–150 m from the rocky shore. The observer scanned the shoreline and the zone between the shore and the boat with the naked eye and with binoculars. The position of every individual Goosander, or group of Goosanders, seen was marked using a GPS handset (co-ordinates of the boat overlooking the observation point, perpendicular to the shore), along with notes on sex, age and activity whenever possible.

At least two censuses were carried out each year, one during 24 April–7 May to count courting pairs and prenuptial concentrations, and one during 5–20 June to count females with young. After some mild winters, an additional exploratory census was carried out as early as late March, because it was unclear when the first pairs would start nesting in these years. Additional records from casual observations, around the set census dates, were also used to complement

the census data. Censuses were carried out simultaneously in the three countries, with a small part of the Albanian shoreline being checked from suitable vantage points along a road close to it. All data were entered on GoogleEarth® maps using the co-ordinates obtained and the best visual recognition of specific sites. The number of pairs was estimated in two different ways: 1) Male-female duos were registered as pairs and their exact locations were entered on 1:10,000 scale maps. A courting group was also considered to represent at least one pair. All cases of birds coming out of, or entering, crevices suitable for nesting, as well as observations of families, were also counted as one pair. 2) By counting adult males, the best indirect approximation of the number of pairs (Haapanen & Nilsson 1979; Gregory *et al.* 2010).

Winter counts were obtained from the mid-January International Waterbird Census data (IWC; collated by Wetlands International) for the FYR of Macedonia and Greece, provided by the Macedonian Ecological Society and Hellenic Ornithological Society respectively. Since 2010 the IWC counts at the Ohrid and Prespa Lakes have been coordinated across the three countries that share them, so that the counts can be summed to provide the total number wintering on the lakes and keep the risk of double counting to a minimum.

Results

Breeding numbers/population census

All of the Goosanders recorded at Great Prespa Lake were distributed along three distinct stretches of shoreline habitat

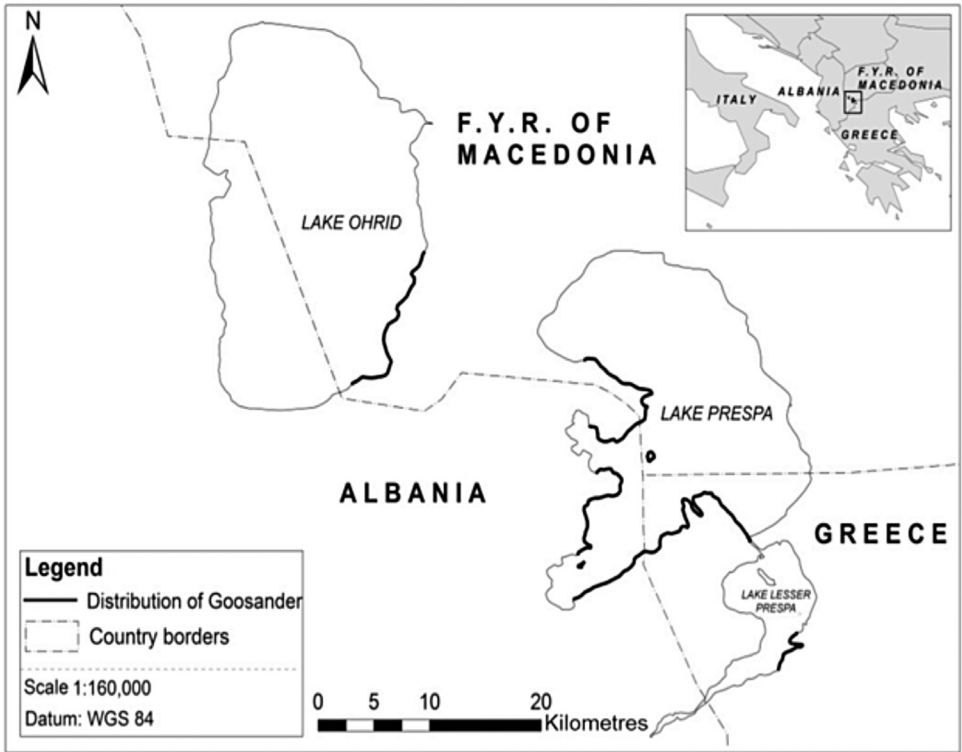


Figure 1. Coastlines with Goosander *Mergus merganser* occurrence during the breeding season and nesting sites at the Prespa Lakes and Lake Ohrid.

apparently suitable for nesting, comprising a total length of *c.* 48.7 km: 12.2 km in Albania, 15.9 km in the FYR of Macedonia and 20.6 km in Greece (Fig. 1). At Lesser Prespa Lake they occupied *c.* 3.0 km of shoreline.

Estimates of the numbers of pairs counted in each of the three littoral countries sharing the Prespa Lakes are given in Table 1. Total pairs varied from 15–25 over the period 2011–2015, with estimates of pairs based upon the number of drakes counted being slightly higher at 15–34. There was no significant difference between the two methods used in the median

number of pairs recorded (Mann-Whitney U test: $U = 11.5$, $n_1 = 5$, $n_2 = 5$, $P = 0.92$, n.s.). The overall number of adults counted as present at both lakes in Prespa varied from 32 (considered to be an underestimate) to 77 individuals.

On 14 June 2014, an exploratory census in the southern part of Lake Ohrid recorded at least 65 Goosanders along a 6.4 km length of coastline, all but one being adult females or immature birds (at least 12 were definitely identified as immature). There was also one female with eight small, flightless ducklings (size-class 2 *sensu*

Table 1. Estimated numbers of breeding pairs of Goosanders for the period 2011–2015 according to Method 1 (see Methods). The numbers of pairs estimated from the number of males counted are given in parentheses.

Year	2011	2012	2013	2014	2015
Great Prespa (GR)	18	12	10	10	11–15
Great Prespa (AL)	3	3	3	Not counted	1–2
Great Prespa (MK)	1	1	2	3	4
Lesser Prespa GR	1	2	4	2	4
TOTAL PAIRS	24 (24)	18 (15)	19(34)	Min. 15 (15)	20–25(19)

Gilbert *et al.* 1998) and three other concentrations of birds comprised of adult females and immature birds. The census was repeated on 25 May 2015 when > 40 individuals were counted (5 males, possibly 5 pairs) but no families.

The proportion of drakes in the Goosanders counted at the Prespa Lakes is shown in Figure 2. No drakes were ever observed after 9 June (day 160); however, the latest back-calculated incubation initiation date recorded was on *c.* 20 June (day 171).

Breeding performance

There was some uncertainty about the actual number of families counted each year (Table 2), due to the mixing of families later in the season. Generally, in all years at the Prespa Lakes, families with young were rarely observed before early May (125–130 days from the beginning of the year). In fact, the majority of chicks hatched in the second half of May, *i.e.* incubation had

started around mid-April.

After exceptionally mild winters, such as those of 2012/13 and 2013/14, females with young were observed five times in April, or very early May: on 24 April, 30 April and 1 May 2013 (12, 1 and 1 chicks respectively) and on 21 April and 30 April 2014 (12 and 1 chicks respectively), which indicates that incubation had started during the last ten days of March. At the other end of the breeding season some young had still not fledged by early July. The earliest estimated incubation initiation date recorded during the study was *c.* 11 March and the latest was *c.* 21 June.

On pooling brood size data for all years, the average brood size (number of young reared) per pair was 6.4 ± 3.5 (mean \pm s.d., $n = 35$). This estimate should be treated with care, however, because the data were derived from families with young of different ages, and broods may suffer some mortality as the young grow, so the brood size at fledging may be lower (Table 2).

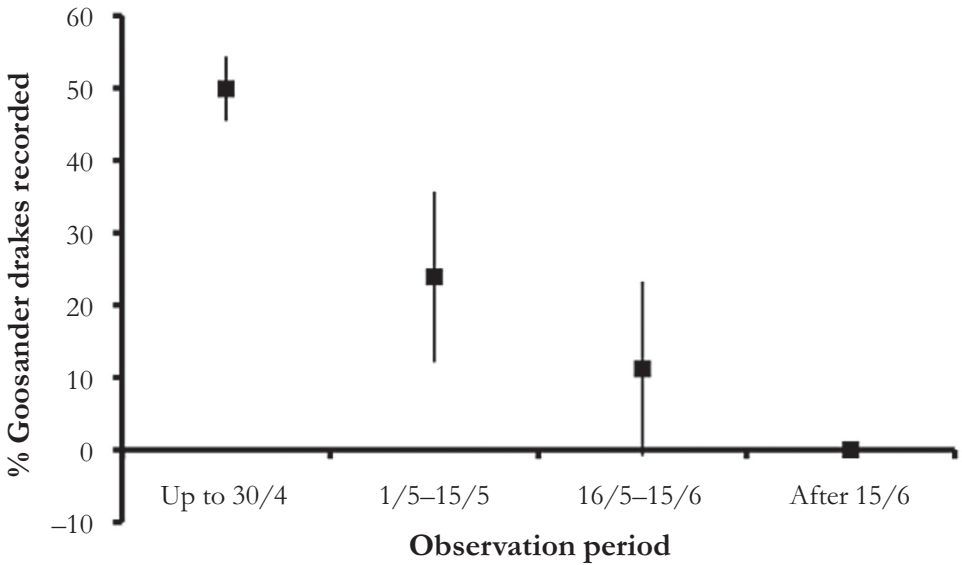


Figure 2. Mean (\pm s.d. bars) percentage of drakes among Goosanders counted at the Prespa Lakes during various stages of the breeding period in 2011–2015.

Table 2. Number of families encountered, minimum total numbers of adults counted at both Prespa Lakes and estimated brood size from pooled data from all families observed 2011–2015.

Year	2011	2012	2013	2014	2015
Total adults	77	43	72	Min. 32	58
Total families	4	8	7	9–10	9
Number of chicks	8,7,4,3	11,10,10,8,5,3	12,11,9,5,4, 1,1	10,9,8,7,6,5, 4,3,2	13,11,10,10, 4,4,3,2,2
Brood size (mean \pm s.d.)	5.5 \pm 2.4 (<i>n</i> = 4)	7.8 \pm 3.2 (<i>n</i> = 6)	6.1 \pm 4.6 (<i>n</i> = 7)	6.0 \pm 2.7 (<i>n</i> = 9)	6.5 \pm 4.4 (<i>n</i> = 9)

Nesting habitat

The shores of the Prespa Lakes are, to a large extent, rocky with precipitous calcareous cliffs, with pronounced karst. Only five Goosander nest holes have so far

been discovered. They were situated in cavities from 2–15 m above the water level and up to 10 m from the shore. One was just over a metre deep and situated *c.* 6 m above the ground (Fig. 3). A second was found in a

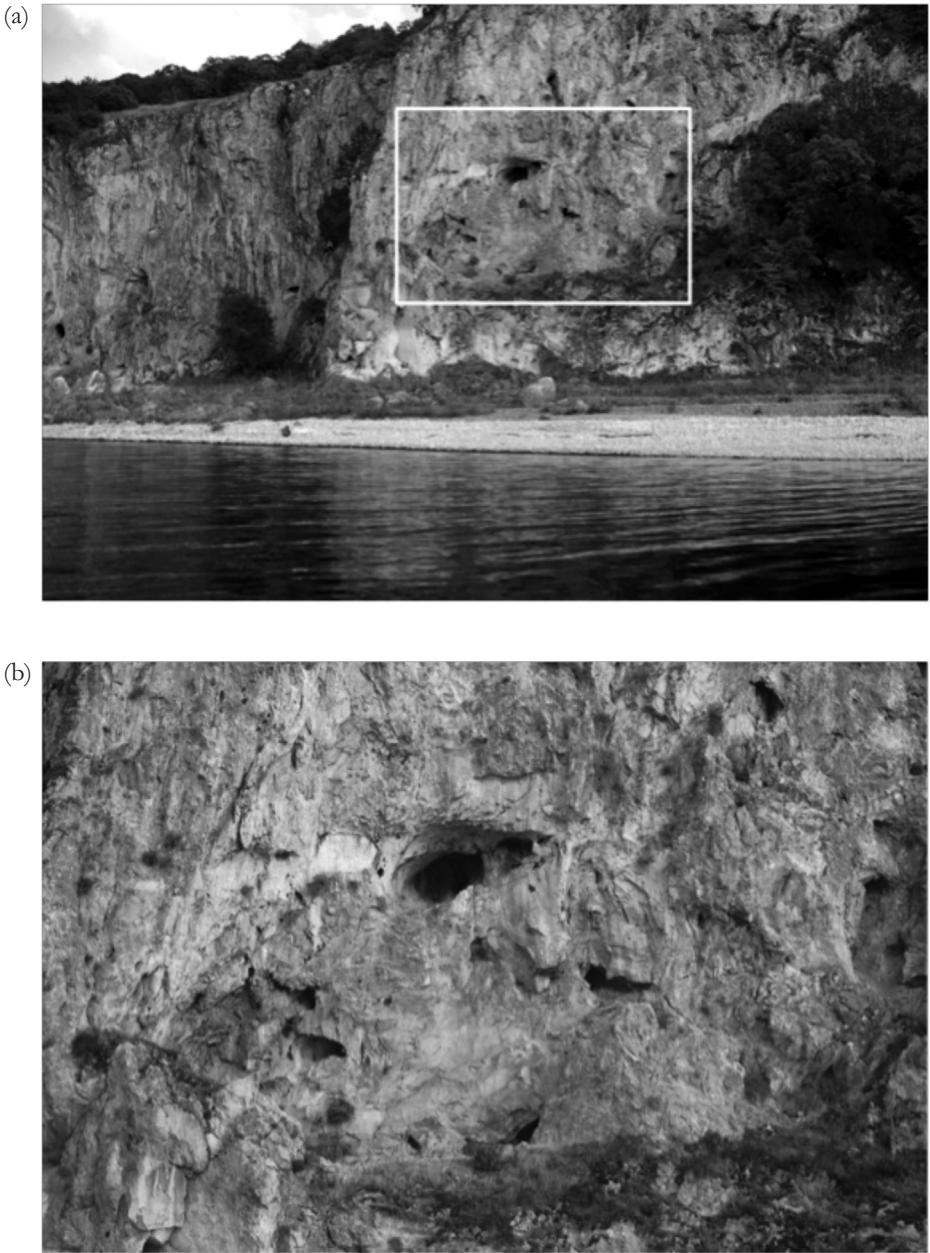


Figure 3. (a) Typical nesting habitat of Goosanders at Great Prespa Lake. The birds nest mainly in crevices and cavities in the coastal limestone cliffs. (b) Detail of a nesting hole on a cliff surface (Photograph, by L. Nikolaou, courtesy of the Society for the Protection of Prespa).

small cave on the island of Golem Grad, c. 10 m from the shore and < 2 m above the ground. Judging from the many observations of Goosanders entering or leaving cavities and crevices and from the fact that there are almost no large trees with holes available to the birds, there is little doubt that the majority of nests at Prespa are in rock crevices, cavities and holes. The same also appears to hold true for Ohrid Lake.

Wintering status

The wintering sites of birds from the Balkan population remain as yet undiscovered due to the lack of an individual marking programme. Moreover, the only data on numbers of Goosander wintering in the region are those collected during the annual,

mid-January IWC. In the Greek part of the Prespa Lakes the IWC has been carried out without interruption since 1988, and there has been a statistically significant increase of the number of Goosanders observed in the Greek sections of both Prespa lakes over the period 1988–2015 (Linear regression: $F_{1,26} = 6.82$, $R^2 = 0.21$, $P < 0.02$, range: 0–33).

In most years the majority of Goosanders have been counted in the Greek part of the lakes (mean \pm s.d. = $55.4 \pm 26.5\%$, $n = 10$). Since the birds are not only observed in Greece, however, all available IWC data were compiled for the entire surface of both lakes. Simultaneous counts in the three littoral states were available only for the years 1997–2000 and 2010–2015 (Fig. 4) and, although there were many more

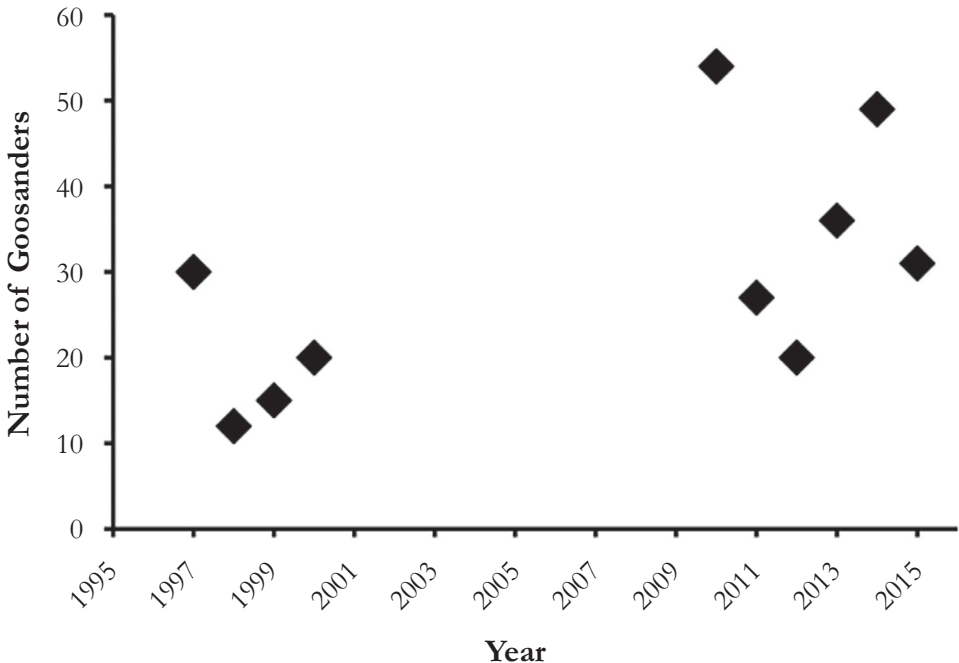


Figure 4. Numbers of Goosanders counted during the annual International Waterbird Censuses (IWC) across the Prespa Lakes (Albania, the FYR of Macedonia, Greece) in years 1997–2000 and 2010–2014.

Goosanders counted in the latter period, the increase just failed to attain significance (Mann-Whitney U test: $U = 2.5$, $n1 = 4$, $n2 = 6$, $P = 0.054$, n.s.). There were practically no Goosanders observed in the Albanian parts of the lakes.

During the period 1988–2013, Prespa Lakes have been the most important wintering site for this species in the region, holding 4.8–100% (mean \pm s.d.= 46.5% \pm 29.5% ; $n = 21$) of the total numbers of Goosanders wintering in the southwest Balkans (*i.e.* in Albania, the FYR of Macedonia and Greece).

In winter Goosanders are also encountered at nearby Lake Ohrid (Table 3). Despite there being gaps in the data, it is apparent that Ohrid is becoming a very important wintering site for the species; in 2013, 2014 and 2015 the proportion of birds present at Lake Ohrid was much higher than at all other places combined. The highest ever number of Goosanders present at a single wetland in the region was of 114 birds recorded at Lake Ohrid in 2014.

Finally, if all Goosanders overwintering in all Greek wetlands and at the Prespa and Ohrid Lakes are considered to be associated only with the nesting populations at the Prespa and Ohrid Lakes, then there has been an increasing but not significant trend over the last 26 years (1988–2013) (Linear regression: $F_{1,24}=1.98$, $R^2 = 0.076$, $P = 0.17$, n.s.) (Fig. 5).

Discussion

Population census

In general, the issue of how to obtain accurate estimates of the numbers of nesting

Goosanders (and of nesting sawbills in general) has not been resolved satisfactorily. The difficulties relate mainly to the fact that their nests are hidden in cavities, so they

Table 3. Number of Goosanders counted in the parts of the Ohrid and Prespa Lakes belonging to the FYR of Macedonia during the IWC (source: Wetlands International). *Empty cells indicate that no census was carried out, so a total value is not given.

Year	Ohrid	Prespa	Total*
1987	1	0	1
1988	0	0	0
1989	0	3	3
1990	0	2	2
1991	0		–
1997	4	12	16
1998	0	10	10
1999	6	10	16
2000	0	0	0
2001		1	–
2002	0	0	0
2004		0	–
2005		2	–
2006		22	–
2009		20	–
2010	0	21	21
2011	12	10	22
2012	2	3	5
2013	78	6	84
2014	114	16	130
2015	58	15	73

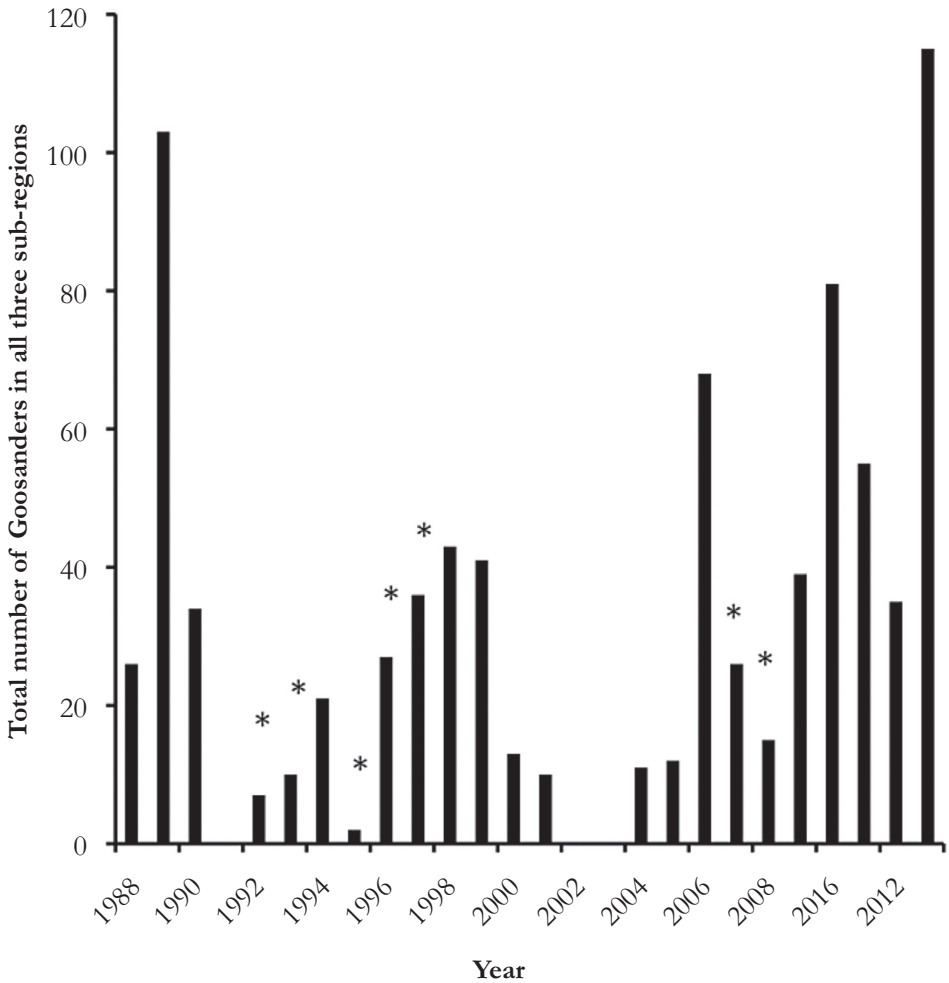


Figure 5. Goosander numbers counted during the annual International Waterbird Censuses (IWC) from 1988–2013 in all Greek wetlands and the parts of the Prespa and Ohrid Lakes in the FYR of Macedonia. Asterisks denote minimum numbers, as during the years indicated the IWC counts did not cover the whole of Lake Ohrid or the Prespa Lakes.

cannot be counted directly, and that the nesting cavities themselves cannot be located or checked easily. Furthermore, the birds nest on linear habitats such as river banks and lake shores, which they tend to move along, so counting them accurately is problematic. They also exhibit communal

courtship, as well as probable polygyny (Cramp & Simmons 1977) and laying dates within the populations vary widely between years. Gilbert *et al.* (1998), indirectly acknowledging these difficulties, suggest more intensive use of available resources, in the form of manpower, effort invested and

frequency of sampling. In addition, the exact method used to estimate the number of nesting birds is not described in satisfactory detail in any paper on Goosander populations except for those nesting in nest boxes (Aspinall & Dennis 1988; Marinkovic *et al.* 2008; Gregory *et al.* 2010). The methods used here were similar to those used in Switzerland for censuses carried out around lakes (Keller & Gremaud 2003), but in the case of the Balkan population there were a number of additional problems relating to both the available resources and the particular habitats, which made the work even more difficult: a) it is almost impossible to use a large number of observers from land or from boats because the coastline that must be covered is too long, resources and the necessary infrastructure are limited, and practical and visual limitations are insurmountable; b) when approached, the birds tend to fly away from the boat and the likelihood of double counting is increased; c) many nesting sites suffer from disturbance by fishing and tourist boats, so a few days after hatching the majority of females move their broods away from the vicinity of the nesting area (see also Cramp & Simmons 1977), and the locations of courting pairs therefore cannot be matched subsequently with the locations of families; d) recent mild winters have permitted some breeders to start laying extremely early, but when the laying period is highly unpredictable the timing of the census can be really poor and this may lead to errors; and e) the lakes are shared by three countries and when bird families move from one country to another it is not possible to

follow them to document such movements. All these factors lead to increased variation in the estimates of nesting pairs; similar difficulties were also discussed by Keller & Gremaud (2003).

Breeding range

Up to the mid-1980s this population of Goosanders was > 1,000 km from its nearest neighbours in the Alps (Cramp & Simmons 1977). In 1986 the species started to breed in the Sjeničko, Zlatarsko and Radojina Lakes in Serbia, and in the following years also dispersed gradually to the Zvorničko, Perućac and Višegradsko Lakes in the Republic of Srpska (Marinkovic *et al.* 2008). These populations are *c.* 300 km north of the one in Prespa and they might be associated in one way or another with an expansion of the isolated population of Prespa to other wetlands, or they might have originated from other birds of more northern populations.

On 10–11 May 2006 Skorpikova *et al.* (2007) observed three males and five females at Lake Ohrid. The females were flying along the rocky shore “as if looking for suitable breeding cavities”. Three females gradually appeared from a large cavity opening around 2 m above water level. This was regarded as the first record of probable breeding at this lake. However, M. Veleviski (*in litt.*) has mentioned certain breeding there since the 1980s, at least occasionally. Dimovski & Matvejev (1955) and Micevski (1998) registered breeding only at Great Prespa Lake. Micevski (2003) presented no data for this species at Lake Ohrid during the breeding period. In May 2006 Skorpikova *et al.* (2007) also noted “a

pair at the Doiran Lake”, but there is no other evidence for breeding there. Thus, more evidence is needed for nesting at Lake Doiran. At least occasional nesting at Lake Ohrid has been reported in this study. It is worth mentioning that Mendel (1988) reported an observation on 11 and 12 June 1988 of a female Red-breasted Merganser *Mergus serrator* with 8 young in the Greek part of Great Prespa Lake, and H. Källander (*in litt.*) made a similar observation in 1990. These sightings remain unconfirmed, however, as there have been no other records of non-breeding individuals of this species in the area or the wider region.

Breeding data

Marinkovic *et al.* (2008) counted “number of juveniles per female” of Goosanders in certain areas in Serbia and Bosnia-Herzegovina, but without defining the age of the young birds. They reported 6.5 young per nest for Zlatarsko and Radojina Lakes based upon 112 families. This is comparable to this study’s overall estimate of 6.4 ± 3.5 (mean \pm s.d.) young per nest for 35 broods combined over the five study years at the Prespa Lakes. Linkola (1962) in Cramp and Simmons (1977) stated that, for Finland, 10.8 is an average clutch size and 6.8 young were reared per nest, also comparable to the results reported in this study.

Marinkovic *et al.* (2008) mentioned that “juveniles on their mother’s backs” were observed at the beginning of June at Radojina Lake, Serbia. In the Prespa area incubation starts on average 4 weeks earlier than that at Radojina Lake, which is 150 km to the north of the Prespa-Ohrid Lakes but

at a similar altitude (810 m a.s.l.). It is also noted that the early laying by some pairs which is occasionally observed after mild winters might lead to high duckling mortality if ducklings experience adverse weather, and perhaps may also lead to re-nesting.

Wintering data

Toskos *et al.* (2006) claimed that Lake Kastoria was the most important wintering area for Goosanders breeding at Prespa (with 17 individuals counted there in January 2005 and 13 individuals in January 2006). However, during the period 1997–2000 there were 12–30 individuals at the Prespa Lakes (all three countries) every winter, and from 2010–2014 there were 20–54 individuals. This suggests that in many winters a large part of the population remains in Prespa, although some may disperse to other wetlands such as Kastoria, and perhaps other lower-lying wetlands with milder climatic conditions.

Goosanders have also been counted at other wetlands in Greece during winter, at sites 40–400 km away from Prespa. Since 1988 they have been recorded at 1–6 of these wetland sites each winter, with total numbers counted ranging from 2–100 birds and with no particular trend over time. Goosanders have been consistently present at only three wetlands, however: Prespa (23 out of 24 years), Kastoria (17 out of 24) and Kerkini (11 out of 24). Although Toskos *et al.* (2006) suggest that these are all birds from the Prespa-breeding population so far there is no evidence to support this view. There is no information about the origins of Goosanders wintering in the wider region around the Balkan nesting areas,

because there have been no ring recoveries for Goosanders in Greece (Akriotis & Handrinos 2004), and there are similarly no ring recovery data for the FYR of Macedonia or Albania.

In neighbouring Bulgaria the numbers of wintering Goosanders counted are at levels similar to those for Greece: the average for 1977–2001 was *c.* 25 birds, with maxima of around 66 in 1977 and 72 in 1999, with no clear trends noted (Michev & Profirov 2003). The species has been observed in all regions of the country, but is more widely spread along the Danube. There are no indications as to where these birds originate from, as the closest breeding sites are on the Carpathians in Romania (Kajtoch & Bobrek 2014). For Greece, while it is a reasonable hypothesis that birds recorded in winter in Prespa and Kastoria are connected to the birds nesting in Prespa, those wintering in Kerkini and the other wetlands of northeast Greece might alternatively be associated with the pool of birds overwintering in Bulgaria.

The low numbers of wintering Goosanders recorded by the IWC indicate that there is no major influx to the southern Balkans of wintering individuals from more northerly populations, as has been recorded for the Alpine populations (*e.g.* Keller 2009). At a local scale, because the Prespa Lakes are at high altitude and winter conditions are normally harsh, it is thought that the birds generally leave the area to overwinter at lower-lying and more southerly wetlands, mainly in Greece. The increase in the number of birds wintering at the Prespa Lakes (particularly in the Greek part) in the last 10–15 years may be attributable to the

milder weather conditions in recent winters (see also Catsadorakis *et al.* 2013), resulting in fewer birds leaving the area. That the increase in the local breeding population is contributing to an increase in wintering numbers also cannot be excluded.

Little & Furness (1985) have shown that British male Goosanders migrate to Finnmark in northeast Norway to moult. Breeding and non-breeding females from the Alpine populations moult either at the nesting sites or within short distances of them, whereas the moulting sites of the males are still unknown (Keller 2009). In a similar way to the situation in Switzerland, where coordinated counts were carried out four times per season (Keller & Gremaud 2003), in the Prespa-Ohrid area practically all of the males disappear before the first week of June. This is a strong indication that the males of this population may also move long distances to as yet unknown moulting sites. Indeed, the Prespa males, like the males from Serbian (Marinkovic *et al.* 2008) and Alpine nesting sites (Keller 2009), may migrate to northern areas several hundred kilometres north of the region to moult.

Conservation

This population may be either an ice-age relict from the last Pleistocene interglacial that was left behind in a refugium area, or a population that was instigated by individuals which migrated south to winter. Relict populations, particularly isolated ones, present very interesting cases for scientific research in terms of their phylogenetic evolution. The degree of genetic isolation of the Balkan population is unclear, since it has not been studied genetically. To address this,

10 wooden nest boxes were installed in the Greek part of Prespa during winter 2014, in an effort to collect genetic material from likely users. Nest boxes were built according to dimensions and guidelines given by Lumsden (1982) and Du Plessix (*in litt.*), but no birds used them in two consecutive breeding seasons.

There is currently no reason to believe that the Prespa population might be limited by the availability of holes and crevices in disturbance-free zones. Nevertheless it is certain that the birds do suffer from disturbance, especially from people walking on the strip of land between the coastal cliffs and the waterline, which has become dry after a substantial fall in the water-level since the 1990s. An additional problem is that the birds, particularly females with small young, are also probably disturbed by speedboats moving very close to the coastline (< 50m). The fact that the majority of families in the Greek part of Prespa were not observed near their breeding sites a few days after hatching is an indication that females move their broods, either to other disturbance-free places, or to other habitats with better conditions for concealment and/or food availability. This move is also corroborated by the fact that families were frequently encountered in areas where there were no proper nesting sites.

Overall, the Goosander is not endangered in Europe, but the conservation status of birds in restricted breeding areas, such as in the Balkans, is unclear or controversial (Hefti-Gautschi *et al.* 2009). Using genetic analyses, Hefti-Gautschi *et al.* (2009) have shown that small breeding populations in Europe are endangered, despite a large, male-mediated

gene-flow, because when these populations decline, only males – but not females due to strong philopatry – can be efficiently supplemented by migration from the large northern European populations. They therefore propose that the small breeding areas be managed independently, and conservation efforts for this species in Central Europe be strengthened. The Balkan population fits this profile exactly.

On the other hand, twenty years ago all that was known about the populations south of the Alps was that the species nested at the Prespa Lakes (Scott & Rose 1996), and that the population consisted of about 100 individuals. Recently, it has been demonstrated that the species has expanded its range in Italy, Serbia, Bosnia and Herzegovina and the Carpathians (Keller 2009; Marinkovic *et al.* 2008; Kajtoch & Bobrek 2014), and this paper clearly shows that the species has also expanded to the large, deep and ancient Lake Ohrid (the FYR of Macedonia-Albania). Thus, it seems that there has been a recent expansion of the species at least in the Alps and southern and eastern Europe, outside of its stronghold in northern Europe.

The study indicates that future research and monitoring efforts should focus on: 1) a genetic analysis of this and neighbouring populations (Serbia, Bosnia & Herzegovina), to determine their origins and genetic similarities with other populations; and 2) an intensive ringing and transmitter-fitting programme aimed at identifying the moulting sites of drakes. Meanwhile, human disturbance of the species in this sensitive area should be minimised by establishing a buffer zone free of

speedboats c. 100 m along the shore, and by also establishing no-access zones on land at some important nesting areas.

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References

- Akriotis, T. & Handrinos, G. 2004. *Bird Ringing Report, 1985–2004*. Hellenic Bird Ringing Centre, Athens, Greece.
- Albrecht, C. & Wilke, T. 2008. Ancient Lake Ohrid: biodiversity and evolution. *Hydrobiologia* 615: 103–140.
- Aspinall, S.J. & Dennis, R.H. 1988. Goosanders and Red-breasted Mergansers in the Moray Firth. *Scottish Birds* 15: 65–70.
- Athanasiou, H. 1987. *Past and Present Importance of the Greek Wetlands for Wintering Waterfowl*. International Waterfowl and Wetlands Research Bureau (IWRB), Slimbridge, UK.
- Bauer, W. & Hodge, M. 1970. I. Nachtrag zum “Catalogus Faunae Graeciae; Pars Aves. *Die Vogelwelt* 91: 96–105.
- Bauer, W., Böhr, H.J., Mattern, U. & Müller, G. 1973. II. Nachtrag zum “Catalogus Faunae Graeciae; Pars Aves. *Die Vogelwelt* 94: 1–21.
- Berlic, G. 1983. Contribution a l’étude de l’avifaune du lac de Micra Prespa. *Biologia Gallo-hellenica* 10: 345–355.
- Bibby, C.J., Burgess, N.D. & Hill, D.A. 1992. *Bird Census Techniques*. Academic Press, Cambridge, Massachusetts, USA.
- Biber, O. & Crivelli, A. J. 1978. Mission en Grèce, du 2 au 23 Juin 1978. Unpublished report to Tour du Valat Biological Station, Le Sambuc, France.
- Brosselin, M. & Molinier, A. 1968. Visite au lac de Mikra Prespa. Unpublished report to Bureau MAR, Paris, France.
- Catsadorakis, G., Aleksi, P., Avramoski, O., Bino, T., Bojadzi, A., Brajanoski, Z., Fremuth, W., Kazoglou, Y., Koutseri, I., Logotheti, A., Malakou, M., Nikolaou, H., Nikolaou, L., Putilin, X., Shumka, S., Uzunova, D. & Velevski, M. 2013. Waterbirds wintering at the Prespa lakes as revealed by simultaneous counts in the three adjoining littoral states. *Macedonian Journal of Ecology and Environment* 15: 23–32.
- Cramp, S. & Simmons, K.E.L. (eds). 1977. *The Birds of the Western Palearctic. Volume I*. Oxford University Press, London, UK.
- Crivelli, A.J. & Catsadorakis, G. (eds). 1997. Lake Prespa, northwestern Greece, a unique Balkan wetland. *Hydrobiologia* 351: 1–196.
- Dimovski, A. & Matvejev, S. 1955. Ornithologische Forschungen in der VR Macedonien. *Archives des Sciences Biologiques* 7: 121–138.
- Geroudet, P. 1973. Mikra Prespa, le lac des Pelicans. *Nos Oiseaux* 351: 147–167.
- Gilbert, G., Gibbons, D. W. & Evans, J. 1998. *Bird Monitoring Methods*. Royal Society for the Protection of Birds, Sandy, UK.
- Gjinknuri, L., Miho, A. & Shumka, S. (eds). 1997. *Proceedings of the International Symposium*

- “Towards Integrated Conservation and Sustainable Development of Trans-boundary Macro and Micro Prespa Lakes”, 24–26 October 1997, Korcha, Albania.
- Gregory, R.D., Carter, S.P. & Baillie, S.R. 1997. Abundance, distribution and habitat use of breeding Goosanders *Mergus merganser* and Red-breasted Mergansers *Mergus serrator* on British river. *Bird Study* 44: 1–12.
- Haapanen, A. & Nilsson, L. 1979. Breeding waterfowl populations in northern Fennoscandia. *Ornis Scandinavica* 10: 145–219.
- Handrinos, G. & Akriotis, T. 1997. *The Birds of Greece*. Christopher Helm, London, UK.
- Hefti-Gautschi, B., Pfunder, M., Jenni, L., Keller, V. & Ellegren, H. 2009. Identification of conservation units in the European *Mergus merganser* based on nuclear and mitochondrial DNA markers. *Conservation Genetics* 10: 87–99.
- Hollis, G.E. & Stevenson, A.C. 1997. The physical basis of the Lake Mikri Prespa systems: geology, climate, hydrology and water quality. *Hydrobiologia* 351: 1–19.
- Kajtoch L. & Bobrek, R. 2014. Extension of Goosander *Mergus merganser* distribution into the Carpathian Mountain range. *Wildfowl* 64: 91–101.
- Keller, V. 2009. The Goosander *Mergus merganser* population breeding in the Alps and its connections to the rest of Europe. *Wildfowl* (Special Issue No. 2): 60–73.
- Keller, V. & Gremaud, J. 2003. Der Brutbestand des Gänsesägers *Mergus merganser* in der Schweiz 1998. *Der Ornithologische Beobachter* 100: 227–246.
- Levkov, Z. & Williams, D.M. 2012. Checklist of diatoms (Bacillariophyta) from Lake Ohrid and Lake Prespa (Macedonia) and their watersheds. *Phytotaxa* 45: 1–76.
- Little, B. & Furness, R.W. 1985. Long distance moult migration by British Goosanders *Mergus merganser*. *Ringing & Migration* 6: 77–82.
- Lumsden, H.G. 1982. Artificial nesting structures for waterbirds. In D.A. Scott (ed.), *Managing Wetlands and their Birds. Manual of Wetlands and Waterfowl Management*, pp. 179–199. International Waterfowl and Wetlands Research Bureau (IWRB), Slimbridge, UK.
- Makatch, W. 1950. *Die Vogelwelt Mazedoniens*. Akademische Verlagsgesellschaft, Geest & Portig K.–G., Leipzig, Germany.
- Marinković, S.P., Skorić, S.B., Zorica, S., Popović, S. & Nikčević, M.V. 2008. Research on long-term colonization of Goosander (*Mergus merganser* Linnaeus, 1758) with reference to habitat availability. *Archives of Biological Science Belgrade* 60: 501–506.
- Matzinger, A., Schmid, M., Veljanoska-Sarafiloska, E., Patceva, S., Guseska, D., Wagner, B., Müller, B., Sturm, M. & Wüest, A. 2007. Eutrophication of ancient Lake Ohrid: Global warming amplifies detrimental effects of increased nutrient inputs. *Limnology and Oceanography* 52: 338–353.
- Mendel, H. 1988. Mittelsäger-Brut (*Mergus serrator*) am Prespa-See. *Ornithologische Mitteilungen* 40: 236.
- Micevski, B. 1998. *Ornithofauna na Prespansko Ezero. [Avifauna of Prespa Lake]*. Vest, Skopje, Former Yugoslav Republic of Macedonia.
- Micevski, B. 2003. *Avifauna of Ohrid Lake*. Bird Study and Protection Society of Macedonia, Special edition No. 5, Skopje, Former Yugoslav Republic of Macedonia.
- Michev, T. & Profirov, L. 2003. *Mid-winter Numbers of Waterbirds in Bulgaria (1977–2001)*. Pensoft, Sofia, Bulgaria.
- Sage, B.L. 1966. Recentes observations ornithologiques au lac Prespa, Macedoine (Yugoslavia). *Alauda* XXXIV 34: 45–54, 120–132.
- Scott, D.A. & Rose, P.M. 1996. *Atlas of Anatidae Populations in Africa and Western Eurasia*. Wetlands International Publication No. 41.

- Wetlands International, Wageningen, The Netherlands.
- Škorpíková V., Prášek, V. & Valášek, M. 2007. Ornithological notes from Macedonia in 2006. *Ciconia* 15: 30–45.
- Spirkovski, Z., Avramoski, O. & Kodzoman, A. 2001. Watershed management in the Lake Ohrid region of Albania and Macedonia, lakes and reservoirs. *Research and Management* 6: 237–242.
- Terrasse, J.F., Terrasse, M. & Brosselin, M. 1969. *L'avifaune du Lac du Micra Prespa*. Bureau MAR. Musée d' Histoire Naturelle, Paris, France.
- Toskos, Ch., Panagiotopoulos, N. & Kazantzidis, S. 2006. The Goosander *Mergus merganser* (Aves, Anseriformes) in Lake Kastoria. In S. Coles, P. Dimopoulos & G. Kehagias (eds.), *Proceedings of the 3rd Conference of the Hellenic Ecological Society and the Hellenic Botanic Society, Ioannina, 2006*, pp. 383–387. [In Greek.]
- Velevski, M., Hallmann, B., Grubač, B., Lisičanec, T., Stoynov, E., Lisičanec, E., Avukatov, V., Božič, L. & Stumberger, B. 2010. Important Bird Areas in Macedonia: Sites of Global and European Importance. *Acrocephalus* 31: 181–282.
- Wagner, B., Wilke, T., Krastel, S., Zanchetta, G., Sulpizio, R., Reicherter, K., Leng, M., Grazhdani, A., Trajanovski, S., Levkov, Z., Reed, J. & Wonik, T. 2014. More than one million years of history in Lake Ohrid cores. *EOS, Transactions, American Geophysical Union* 95: 25–26.
- Wetlands International 2012. *Waterbird Population Estimates – Fifth Edition*. Wetlands International, Wageningen, The Netherlands.



Photograph: A pair of Goosanders at Lake Great Prespa, by Thanos Kostritis.