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Burgas Wetlands, Bulgaria: a Conservation Area of European Priority for Roosting of the Pygmy Cormorant, *Microcarbo pygmeus* (Pallas, 1773)

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Abstract: The pygmy cormorant (*Microcarbo pygmeus*) has been increasing its population and since the 1980s has extended its wintering range to include the Balkans and Bulgaria. Although the Burgas wetlands on the southern Black Sea coast have been known to be used for wintering by the cormorants, their potential and importance seem to have been underestimated. In the winters of 2011/2012 and 2012/2013, we carried out counts on 15 occasions at two known roosting sites at the Burgas Lake. We recorded two record-high numbers (15,137 in December 2011 and 11,541 in January 2012), combined for the two sites. This represented roughly a quarter of the breeding individuals in Europe. Altogether, we recorded 76,077 observations of roosting birds, with only 11,479 of them at the second location. We counted almost twice the number of birds in 2011/2012, as compared to 2012/2013 (48,367 during eight counts vs 27,710 during seven counts). The birds moved to roost to new locations in 2013/2014. The time of arrival (on a monthly and daily basis) was consistent with previous records. Pygmy cormorants likely forage in the rivers flowing into the Burgas wetlands, suggesting the overall importance of the region beyond the two roosting sites.

Keywords: record count, *Microcarbo*, Burgas Lake, Mandra, Poda, SPA, NATURA 2000

Introduction

The pygmy cormorant *Microcarbo pygmeus* (Pallas, 1773) [after Del Hoyo *et al.* 2014] (=*Phalacrocorax pygmeus*) is a small-sized fish eating bird of the family Phalacrocoracidae. Its distribution has been characterised as sarmatian (Voouse 1962). The global population has been estimated at 85,000-180,000 individuals (Delany, Scott 2006), with the current European population estimated at 28,000-39,000 pairs (75-94% of the global breeding range). The species breeds in South-eastern Europe, Russia, Iran, Kazakhstan, Tajikistan, Turkmenistan and Uzbekistan, with key territories Azerbaijan (estimated 8,000-12,000 pairs) and Romania (11,500-14,000 pairs; Burfield *et al.* 2004). It winters primarily in the Balkan Peninsula states, Turkey, Cyprus, Iraq, Iran, Azerbaijan, Israel, Romania and Syria (BirdLife International 2012).

At the national and European level, the species is included in Annexes 2 and 3 of the Biodiversity law and Annex 1 of Directive 2009/147/EO ("Birds Directive"). Moreover, it is included in Annex 2 of both the Bern and Bonn Conventions, as well as in the African-Eurasian Migratory Waterbird Agreement. The population has generally increased, and its status has improved from Threatened (1988) to Least Concern (2005), with the final assessment made in 2012 (BirdLife International 2012). The status of some populations is still undetermined (Delany, Scott 2006).

The species is Endangered (EN) according to the Bulgarian Red data book (Nikolov *et al.* 2011), although it is frequently found migrating, wintering and nesting (Plachiyski *et al.* 2014). The main nesting sites are along the Danube River, the Black

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Sea coast, and along the Maritsa, Arda and Tundzha Rivers. The breeding pairs have been assessed at 350-500 in 2007 (Kostadinova, Gramatikov 2007) and 100-500 in 2011 (Nikolov *et al.* 2011). Most likely, some nesting birds from Bulgaria migrate to Turkey and Greece to overwinter; some birds from the Danube River delta fly over Bulgaria on their way to Greece (Cramp, Simmons 1977), and possibly some of them stay to winter.

During winter roosting, *M. pygmeus* usually aggregates with densities of hundreds of individuals (Plachiyski *et al.* 2014). It utilises clusters of low trees, reed beds of *Phragmites* and *Typha*, and other vegetation (Plachiyski *et al.* 2014). Birds tend to appear at the roosting location about two hours before sunset, with the numbers peaking around sunset; few if any birds come afterwards (Ivanov, Muraveev 2002). The flocks might be comprised of hundreds of birds. They leave the roosting site at sunrise *en masse*, hindering accurate counting. The roosting sites are relatively stable in time (Plachiyski *et al.* 2014). Birds generally choose roosts with limited disturbance from predators and humans, but might settle close to urbanised areas (e.g. near the cities of Plovdiv and Burgas, the downtown of Simeonovgrad) (Plachiyski *et al.* 2014).

It has been long suggested that Bulgaria is of key importance for the wintering of the global population, as well as for the migration of significant numbers between wintering and breeding sites (Ivanov, Muraveev 2002). Until the 1980s, Bulgaria was at the periphery of the wintering grounds, with less than 500 birds observed. In 1982-1984, wintering birds started to visit more frequently the Balkan Peninsula, centred in the valley of Maritza River (5,030-6,950 ind.) (Nikolov *et al.* 2000). Between 1995-2000, the midwinter count was 7,000-13,000 ind. according to Nikolov *et al.* (2011) and 13,095 according to Michev, Profirov (2003).

The most recent information on *M. pygmeus* from Bulgaria has been compiled and analysed in the *Action Plan for the Conservation of the Pygmy Cormorant in Bulgaria (2014-2023)* (see Plachiyski *et al.* 2014).

The Black Sea coastline is of high ornithological importance as part of the major migration route Via Pontica. The Burgas coastal wetlands are one of the three most important areas of concentration of waterfowl on the Bulgarian Black Sea coast (Kostadinova, Gramatikov 2007). Seven Important Bird Areas have been included specifically for *M. pygmeus* (Kostadinova, Gramatikov 2007). Only Chengene Skele (Natura 2000 site, BG0000242) is on the Black Sea coast, and it is of world importance for breeding (five-ten pairs), with some birds wintering (one-thirteen ind.) (Kostadinova, Gramatikov 2007).

The rest of the Burgas wetlands are also of recognised importance. A six-year monthly water bird monitoring (1996-2002) provided valuable information on the species and the Burgas wetlands and estimated that up to 10,592 ind. utilise the wetlands complex (Dimitrov *et al.* 2005). In the Mandra-Poda complex records exist of 0-30 breeding pairs, 246-3,235 migrant ind., and 17-4,520 wintering ind. (Kostadinova, Gramatikov 2007), with wintering numbers being of international significance. For Atanasovsko Lake 0-1 breeding pairs, 14-565 migrating ind., and 1-32 wintering ind. have been recorded (Kostadinova, Gramatikov 2007).

The Burgas Lake has been identified as an important roosting site as well (Vassilev *et al.* 2013), with 9-16 breeding pairs, 7-266 migrating ind., and 142-7,323 wintering ind. (Dimitrov *et al.* 2005; Kostadinova, Gramatikov 2007). The Burgas Lake roost was formed around 1997, with 6,850 birds in 2000 (Michev, Profirov 2003).

Although the literature data contain clear indication of the importance of the Burgas wetlands, our prior observations from the field and historic data suggest that the area might be of even higher importance for roosting than previously recorded. The aim of our study was to obtain current information on the numbers and temporal dynamics of *M. pygmeus* roosting around the Burgas wetlands.

Material and Methods

Study site

The mosaic of the Burgas wetlands includes three large coastal lakes (from north to south: Atanasovsko, Burgasko, and the Mandra-Poda complex), their tributaries, and several smaller wetlands such as the Chengene Skele Bay (Fig. 1). The three lakes and Chengene Skele have been included in the European network of protected sites Natura 2000 (Special protected areas [SPAs], respective codes: BG0000270, BG0000273, BG0000271, BG0000242). Parts of them have received additional designations on national and international level (IBAs, Protected areas, Ramsar sites).

These water bodies consist of diverse water habitats: hypersaline and shallow (0.1-1 m) in the traditional saltwork at Atanasovsko Lake; the freshwater and deep (1-15 m) Mandra Lake; and various intermediate freshwater to brackish habitats in the Burgasko Lake (depth ca. 1.3 m), along a relatively fresh sea water (ca. 17‰) [for additional descriptions

see Vassilev *et al.* 2013]. The wetlands are in the vicinity of the city of Burgas (ca. 250,000 inhabitants).

Prompted by preliminary observations, in the fall of 2011 we identified two major roosting sites (*A* and *B*) of *M. pygmeus* on the edge of the Burgas Lake. They were located on the border of the Natura 2000 site and practically within the city limits of Burgas (Fig. 1). Birds at both roosting locations concentrated at old reed beds of relatively small size (ca. 1 ha each) on the border of the water line. Location *A* is in a reed bed on both sides of the road, around a canal (~5 m wide) that connects the Burgas Lake to the Black Sea. Location *B* is across from the parking lot of a major convenience store. Both locations are next to the main road along the Black Sea coast (the European route E87) that provides access to some populous Burgas neighbourhoods.

Roosting counts

We performed counts during the mass roosting in winter, between the middle of November and the middle of March (Nikolov *et al.* 2000) in 2011/2012 and 2012/2013, with incidental observations in 2013/2014. When possible, observations were carried out at an interval of 15 days.

Usually, we carried simultaneous counts at both locations (see Fig. 1). There were at least two researchers with binoculars at each location. The primary observer was an experienced birder who was responsible for performing the identification and counting. The second researcher aided in spotting incoming flocks, counting, and recording the data in field protocols. Observers were standing approximately 50-100 m away from the roosting sites. This way, we were able to spot all the birds without disturbing them and we did not note any behaviour indicating anxiety caused by our presence. Observations started around 2 hours before sunset (15:00-16:00h) and continued until sunset (17:00-18:00h local time). Each flock was counted on landing with the highest possible accuracy. Caution was taken not to double-count birds that took off shortly after landing and relocated slightly.

For each individual we collected information on the direction and time of arrival; data were tallied in 15-minute intervals. To assess the time of arrival compared to astronomical sunset, the tallied data were assigned to 10-min intervals and subtracted from the astronomical sunset time.

Regular monitoring of the Burgas wetlands

Additionally, a long-term avian monitoring was carried at the Burgas wetlands twice a month. We included data from 12 June 2011 to 12 December 2013.

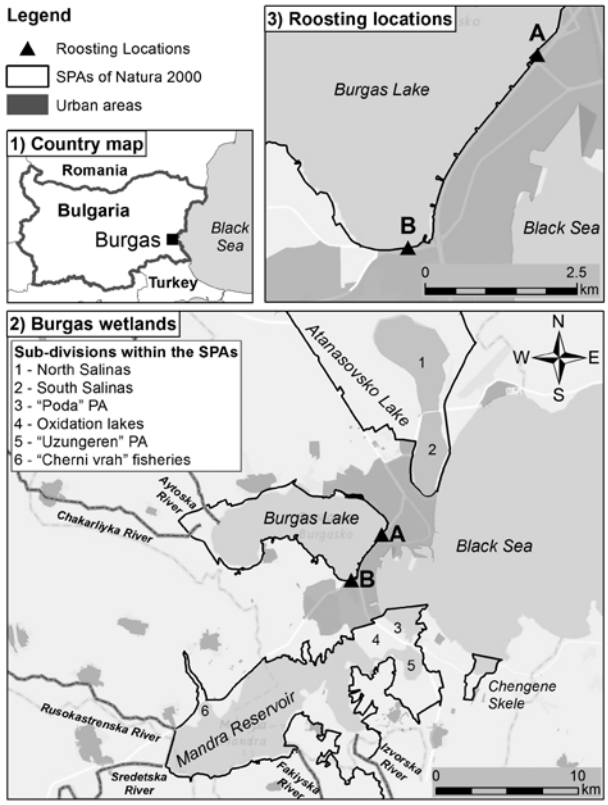

Fig. 1. The Burgas wetlands and the major roosting locations (*A* and *B*) of *Microcarbo pygmeus* in 2011-2013 at the Burgas Lake, South-eastern Bulgaria

The birds from the wetlands were counted and identified from predetermined locations or while moving from one location to the next, using high-magnification spotting scopes. The wetlands were divided into smaller polygons in advance, based on the perceived differences in habitat characteristics (e.g. separate water bodies, water depths, water salinity). Parts of the main water bodies of Mandra and Burgas Lakes were separated based on landmarks which allowed the observers to identify in the field the polygons into which birds were observed. In this way, spatial distribution of the birds within the wetlands could be assessed. The wetlands were usually covered within three days with observations starting around sunrise and continuing until 14:00-15:00. Therefore, the *M. pygmeus* observed during the regular monitoring were likely individuals that were feeding or resting between feedings. between feeding.

Results

Roosting counts

Two record-high numbers of roosting cormorants were counted. On 9 December 2011 we counted a record number of roosting *M. pygmeus* for a single roost in Bulgaria – 15,137; almost 99% of them

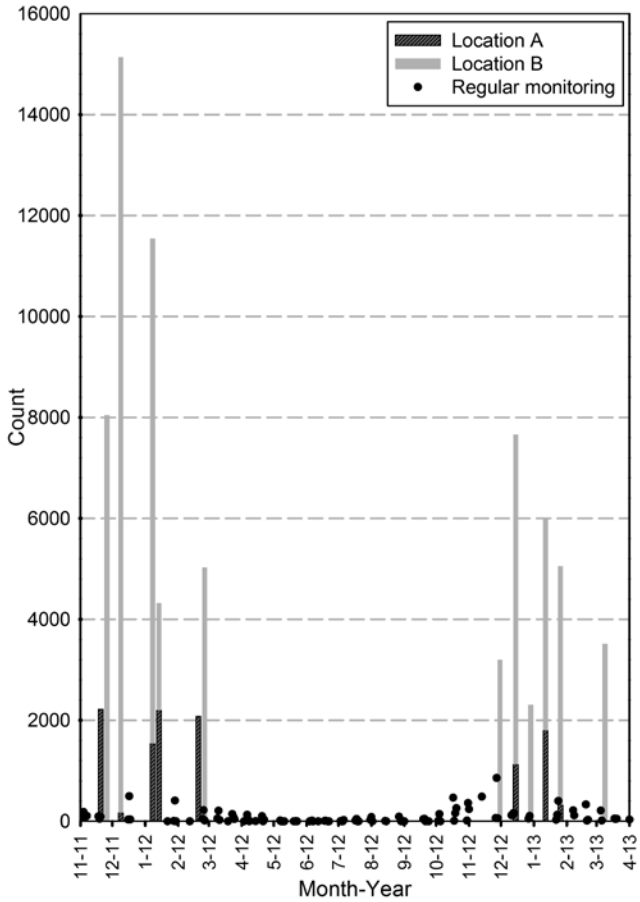

Fig. 2. Counts of pygmy cormorants from the two roosting sites (bars) at the Burgas Lake during the winters of 2011/2012 and 2012/2013, compared to the daily counts (circles) from the bi-weekly diurnal monitoring of the Burgas wetlands

roosted at location *B* (Fig. 2). On 8 January 2012 another high number was counted (11,541, with > 86% again at location *B*), suggesting that the majority of the birds were staying in this area. The peak of congregating during roosting in the Burgas wetlands was November-February.

Overall, we conducted 15 counts in the winters of 2011/2012 and 2012/2013, eight and seven, respectively. Both locations were visited simultaneously on ten occasions; only location *A* was visited on two occasions and location *B* – on three. During two March counts no birds were observed roosting, and this terminated the counting.

Combining all roosting counts in 2011-2013, a total of 76,077 observations of roosting birds were recorded. Location *B* was clearly favoured by the birds over location *A* (a total of 64,598 vs 11,479 observations). We recorded almost twice the number of observations in 2011/2012 as compared to 2012/2013 (48,367 during eight counts vs 27,710 during seven counts).

Regular monitoring data

During the simultaneous regular monitoring of the waterfowl from the Burgas wetlands, between 12 June 2011 and 17 December 2013, we conducted a total of 181 daily counts. We observed a total of 12,361 records for *M. pygmeus* on 132 occasions, with a mean of 68.29 (1 St. Dev. = 116.20; range: 0-857; n = 181; Table 1).

The data collected support differential usage of the wetlands, both spatially and temporally (Table 1). During the peak of roosting (November-March) we collected 58.5% (7,230) of the records. Although comparable numbers could be found during the non-winter months, the SPAs were visited by the birds unevenly during the year. The Burgas and Atanasovsko Lakes were favoured during the winter (respectively, 91% and 79% of records were between November and March), while Chengene Skele was mostly visited during the non-winter months (35% of records were during winter; Table 1). Even within the wetlands themselves, there was temporal and spatial variation in the observed birds: within the Mandra-Poda complex (43% obs. in winter), Poda PA and Cherni vrah fisheries were mostly visited during the non-winter months (23% and 31% obs. in winter, respectively), while in the North Salinas of Atanasovko Lake 90% of the observations were during the winter. At an even smaller scale, pooling all the data showed that different habitats in the lakes were used unevenly (Fig. 3).

Direction of arrival

We identified the direction of arrival of 72,849 observations of birds. On several occasions, on arrival we noted and counted relatively few birds that have already landed (a total of 3,228), with unknown origin. The results were similar for both roosts. The majority of the birds arrived from the south (53.96%) and the west (33.00%; Table 2; for reference, see also Fig. 1).

Time of roosting

Considering the counts in comparison to the time of sunset, birds started to arrive at the roosting site around 2:30 h before sunset (Fig. 4), and over 65% of the observed birds landed between 16:00 h and 17:00 h. Following a slight increase in arrivals, the peak occurred between 1:10 h-0:20 h before sunset; a major drop in numbers was noted in the last 20 min before sunset. 814 records were after the astronomical sunset because it did not coincide with the complete darkness.

Results from roosting 2013/2014

During the winter of 2013/2014 the two locations were visited again on several occasions; how-

Table 1. Counts of pygmy cormorants, obtained during regular monitoring of the Burgas wetlands, June 2011-December 2013, broken down by location. Descriptive statistics are for the complete data for the respective period. "SPA" = Special Protected Area from Natura 2000; "PA" = Protected area according to national legislation. "Winters" includes the data between 1 November – 31 March, 2011-2013

	Counts				
Location	**Overall (0)**	**Winters (W)**	**Nov-Mar 2011/2012**	**Nov-Mar 2012/2013**	**W vs O**
Atanasovsko Lake SPA	3311	2631	311	2101	79%
North Salinas	1815	1635	156	1274	90%
South Salinas	1496	996	155	827	67%
Burgas Lake SPA	1471	1343	303	939	91%
Mandra-Poda SPA	7377	3185	1765	856	43%
Poda PA	4204	973	435	300	23%
Oxidation lakes	208	160	97	1	77%
Uzungeren PA	482	246	94	62	51%
Cherni Vrah fisheries	36	11		11	31%
Mandra reservoir	2447	1795	1139	482	73%
Chengene Skele PA / SPA	202	71	28	13	35%
Sum	12361	7230	2407	3909	58%
Mean	68.29	124.66	100.29	169.96	
1 St. Dev.	116.20	153.93	127.00	196.06	
Min	0	0	0	13	
Max	857	857	496	857	
Count	181	58	24	23	

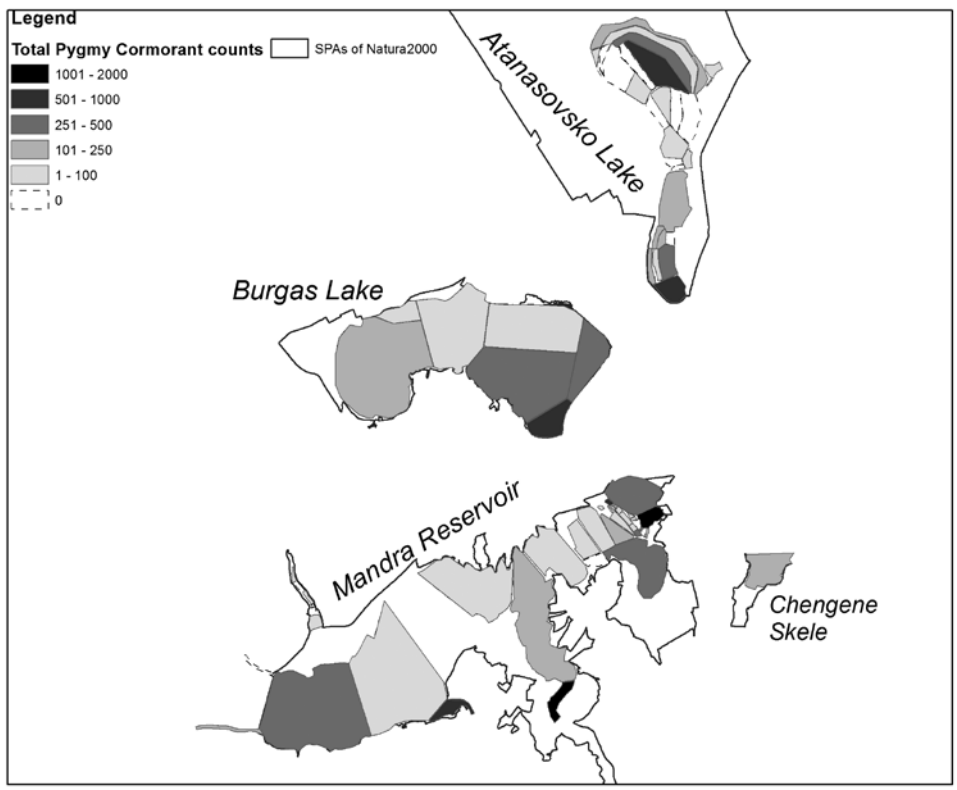

Fig. 3. Total counts of pygmy cormorants within parts of the Burgas wetlands, June 2011 – December 2013. Refer to Fig. 1 for additional geographic information

Table 2. Percentages of all roosting pygmy cormorants observed, based on cardinal directions of arrival during combined winter roost counts in 2011/2012 and 2012/2013

	Arrival direction					
	East (%)	**West (%)**	**North (%)**	**South (%)**	**Total ind.**	**Total (%)**
Total	2.38	33.00	10.65	53.96	72 849	
Location *A*	15.15	18.88	7.90	58.06	10 921	14.99
Location *B*	0.13	35.49	11.14	53.24	61 928	85.01

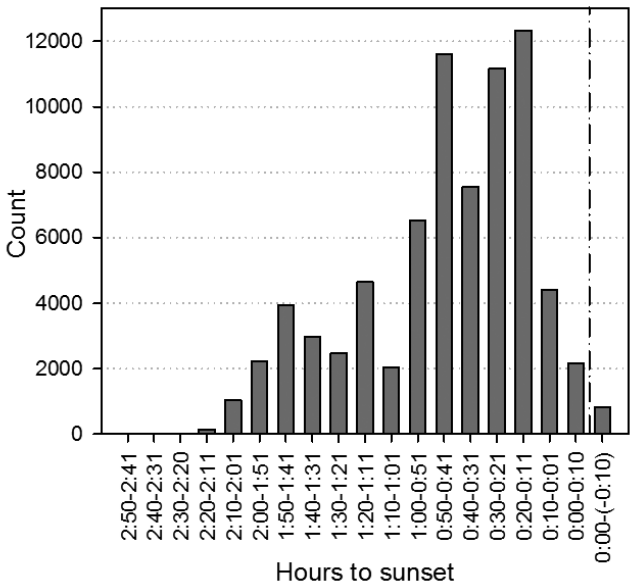

Fig. 4. Arrival time (before sunset) to roosting location of pygmy cormorants at the two roosts at the Burgas Lake, 2011-2013. Dashed line denotes sunset

ever, the birds relocated to roost elsewhere. We succeeded in locating a new roosting site in the western part of the Burgas Lake in the middle of a large reed bed. However, the distance from which it could be observed made it impossible to accurately count the landing birds, and thus, no precise data were collected. This roost also moved in the middle of the winter and birds seemed to roost in smaller numbers at multiple locations, including around Mandra Lake and Poda Protected area.

Discussion

Our data demonstrates that the national and international importance of the Burgas wetlands as a roosting location is greater than previously recognised. The number of *M. pygmeus* that roosted at Burgas Lake only compares to previous national roosting estimates (Nikolov *et al.* 2011), and does not include the Danube and Maritsa Rivers counts. Furthermore, compared to the estimates of the European population (28,000-39,000 pairs) from which 11,500-14,000 nest in Romania (Burfield *et al.* 2004), it is evident that even the lower counts during the 2012/2013 winter represent a substantial proportion of the world population. As part of the Ramsar Convention, in 2006 the 1% criterion for populations of international importance where the species is frequently observed was 700 individuals for South-eastern Europe and Turkey (including Bulgaria) (Delany, Scott 2006).

Although the data from 2013/2014 suggest that other roosting sites exist in the area, the two reed beds monitored must be preserved to allow safe future roosting. Roosts in the western part of the Burgas Lake were well known in the past (Dimitrov *et al.* 2005), with the roosts we report on as appearing afterwards. Historically, the Pygmy cormorants roosted in other locations across the wetlands, such as Komlushka lowland (K. Bedev, pers. comm.). In 2013/2014, we did not find new roosting locations with such significant numbers; this suggests that they are either further away from the lakes or several smaller roosts were established. Roosts with fewer birds are likely to be more susceptible to depredation.

Climatic conditions

We hypothesise that global climatic conditions are the major driver of long-distance migrations of *M. pygmeus*. We stipulate that unfavourable climatic conditions in the northern European range of the species caused the record-high number of roosting cormorants in the Burgas area in 2011/2012. November-March of 2011/2012 was colder throughout parts of Europe than in 2012/2013 (for Burgas, the mean air temperatures were 4.3°C vs 6.6°C). Compared to key wintering locations for *M. pygmeus*, in 2011/2012 the mean air temperature in Burgas was slightly lower than in Serres (Greece) and Tirana (Albania), but was generally higher than in Belgrade (Serbia), Constanta (Romania), and Odessa (Ukraine), thus likely causing a massive migration of birds further south.

Changes of roosting sites

Amongst the reasons for the establishment of the Burgas wetlands as a choice of roosting location for the European population might be the relatively mild winters, suitable and ample food supply, and numerous trees and reed beds for roosting. Climatic

conditions likely forced fewer birds to roost in the area during the winter of 2012/2013, but other reasons might have acted in conjunction and caused the eventual change of the two roosting locations.

We have recorded the cases of disturbances, but have not been able to ascertain what prompted the birds to change their roosting sites and move out of locations *A* and *B*, and then out of the western part of Burgas Lake. We did not note human disturbance or attempts at depredation, nor changes in the habitat. The two locations chosen for roosting of the cormorants are with very high level of anthropogenic activity in their immediate vicinity, due to the busy roads and the proximity to the centre of the city. Our observations on birds at Poda Protected Site, situated about 7 km south along the same road, suggest that birds get accustomed to heavy vehicular traffic, but get easily scared by infrequent pedestrians. However, behavioural responses in birds are not the best predictors of stress levels (Gill *et al.* 2001; Beale, Monaghan 2004) and suggest that their use may be misleading when determining conservation priorities.

Seasonality and daily arrival times

The recorded monthly peaks during roosting (November-February) and times of arrival to the roosting sites were consistent with previously reported data (Ivanov, Muraveev 2002; Plachiyski *et al.* 2014). Mass arrival is a behaviour that fits the hypothesis that it increases the safety of the roost and the individuals. It is also likely linked to optimising the birds' time-budget, especially during the winter when the hours with sufficient light for fishing and drying up are limited.

Direction of arrival

We presume the direction from which the birds came is directly linked to the locations at which they feed during the day. Pygmy cormorants fly up to 70 km from the roosting sites during their feeding (Ivanov, Muraveev 2002). We hypothesise that they feed primarily around the smaller water bodies in the region. Roughly 87% of the birds came from such directions: two small rivers (Aytoska and Chakarliyka) and their tributaries flow into the west of the Burgas Lake; south, four rivers (Rusokastrenska, Sredetska, Fakiyska, and Izvorska) flow into Mandra Reservoir.

The feeding biology of *M. pygmeus* in Bulgaria has not been studied. At the Danube delta 15 fish species have been recorded from 130 birds, including perch (*Perca fluviatilis*, in 18.8% of the sampled birds), roach (*Rutilus rutilus*, 14.8%), carp (*Cyprinus carpio*, 10.8%), loach (*Cobitis taenia,* 9.7%) and pike (*Esox lucius*, 5.6%); the average weight of the fish was 15 g (7-71 g) (Andone *et al.* 1970). There are limited data on the fish abundance and sizes from the Burgas wetlands, but based on the birds distribution that we observed during the day and the arrival directions during the roosting counts, we suppose that these rivers are also of great importance for *M. pygmeus* as feeding grounds. The fish species found in these rivers would generally fit the feeding requirements of *M. pygmeus*. In addition, during early morning winter counts of geese resting in the lakes, we observed hundreds of *M. pygmeus* that fly upstream of the rivers flowing into the Burgas Lake and Mandra Reservoir.

In the other two directions of arrival (east and north) are situated the Black sea and the hypersaline Atanasovsko and Pomoriysko Lakes (outside of the scope of Fig. 1). Only 13% of the birds came from these directions, suggesting that these habitats lack enough suitable characteristics (shallow depths, fish stock).

In addition, the data obtained during the regular monitoring strongly indicate that various parts of the three Burgas lakes attract different numbers of birds and that the main bodies of the Burgas Lake and the Mandra Reservoir do not provide sufficient feeding grounds everywhere. This necessitates future conservation measures to consider the greater network of the Burgas wetlands including the smaller water bodies.

Conclusions

The significance of the Burgas Lake and the wetlands complex for the conservation of this recently threatened species has been documented and unambiguously demonstrated. Measures must be taken to further protect both the presently known and the potential future roosts around the wetlands. Otherwise, threats such as increased disturbance, changes or loss in habitat, unfavourable meteorological conditions, and food availability might put a significant portion of the world population at risk.

Further ecological and biological studies on *M. pygmeus* specific for Bulgaria would improve our capability to protect the species and its habitats at a local and national level.

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