HABITAT PREFERENCES OF THE RED-BREASTED GOOSE *(BRANTA RUFICOLLIS)* IN SOUTH-EAST ROMANIA DURING THE WINTERING PERIOD

EMIL TODOROV[*], DUMITRU MURARIU[**]

In its wintering region on the northern and western shores of the Black Sea (Ukraine, Romania and Bulgaria), the Red-breasted Goose *(Branta ruficollis)* prefers open habitats, especially low-lying agricultural areas in the vicinity of large lakes, wetlands and flooded pastures. The geese are very sensitive to anthropogenic disturbance, especially during the wintering period, when it is in its roosting and feeding areas. If disturbed in the feeding fields, geese make more frequent flights to avoid disturbance or even leave the feeding area in search of quieter places. Conflicts between geese and farmers are well known, especially in Europe, and managing these conflicts can be quite difficult, as it is important to find a balance between conservation and economic interests. In this study, the main habitats and the influence of landscape elements on the distribution of the Red-breasted Goose in south-east Romania during the winter season were investigated. During 2012–2022, Red-breasted Goose preferred three main habitat types in south-east Romania: agricultural lands as feeding areas and water bodies, and wetlands as resting and roosting sites. The main food source for these geese was represented by cereal crops, such as wheat *(Triticum spp.)* or barley *(Hordeum spp.)*, which were encountered in 66% of the records, followed by corn stubble (14%) and pastures (8%). The results show that geese prefer feeding areas in close proximity to roosting areas, and the presence of geese in feeding areas was not influenced by the distances to asphalt roads and settlements. Depending on the season, the distances between roosting areas and feeding areas did not fluctuate significantly. The average distance was around 3,000 m, and the minimum distance around 200 m. The geese flew up to 30 km in search of feeding places. A sensitivity map was created to highlight the wintering areas in south-east Romania where Red-breasted Goose are most sensitive to anthropogenic activities related to the development of large infrastructure projects. It is necessary to expand the special protection areas (SPAs) designated for the conservation of the species, with a minimum distance of 3–5 km, and to establish feeding areas-refugees where the geese can feed peacefully, which could significantly contribute to reducing damage to wheat fields.

Key words: winter wheat, Baragan, Dobrogea, geese, wind turbines, conservation.

ROM. J. BIOL. – ZOOL., VOLUME **70**, N^os. *1–2*, P. 3–22, BUCHAREST, 2025

DOI:

INTRODUCTION

In its wintering grounds along the northern and western shores of the Black Sea (Ukraine, Romania and Bulgaria), the Red-breasted Goose *(Branta ruficollis)* prefers open habitats, especially agricultural regions located at low altitudes, between 0 and 96 meters above sea level (Harrison *et al*., 2017; Todorov *et al*., 2023; Iliev *et al*., 2023). The species prefers large open spaces with grassy vegetation or stubble fields for grazing, as well as wetlands, lakes and freshwater marshes for watering and resting (Madge & Burn, 1988; del Hoyo *et al*., 1992; Snow *et al*., 1998; Cranswick *et al*., 2012). The Red-breasted Goose is a herbivorous species, feeding on a wide variety of common and widespread grasses, as well as sedges and other types of crops. During winter, Red-breasted Goose feed mainly on agricultural lands, in cereal crops and on corn stubble, but also on meadows.

In south-east Romania, during the winter, the main food source for the Red-breasted Goose *(Branta ruficollis)* is wheat and barley crops (Hulea, 2002). At the beginning of the winter season, in November and December, the species feeds on calorie-rich food sources, such as corn grains, which are found in large quantities after harvest. After December, geese prefer wheat crops, but in regions where spilled corn grains are not abundant (such as Coastal Dobrogea), they feed on wheat from the moment they arrive in the area. Less commonly, geese also include rapeseed in their diet, as well as various grasses found in meadows. Since 2022, on the territory of the Great Island of Braila, Red-breasted Goose have been observed feeding on alfalfa crops for the first time (E. Todorov – personal communication). Red-breasted Goose flocks make daily flights from their roosting grounds to their feeding grounds, often in mixed flocks with Great White-fronted Goose. The maximum distance between roosting lakes and feeding grounds varies between a few hundred meters and a few tens of kilometres. Flocks fly in search of suitable fields for feeding, where disturbance is minimal, at a maximum distance of 20–30 km from their resting places. Around noon, flocks return to the lakes to drink water. The watering and resting time in the lakes can last between 30 minutes and 1 hour, after which the geese return to their feeding areas. If they are not intentionally and repeatedly disturbed, the geese will return to the same feeding area, but will settle in areas where they are not yet grazed. Around the sunset, the geese return to the roosting areas, and some continue to arrive even after nightfall. If the conditions are favourable, some flocks may continue to feed at night, coming out to the shores of the lakes.

Observations and data from satellite telemetry studies show that in Romania, geese also feed outside protected natural areas. Agricultural areas in the Great Island of Braila have been identified as the most important in recent years, where the species' numbers can reach over 10,000 individuals, representing almost half of the species' population that winters in Romania (Todorov *et al*., 2023). To a large extent, the availability of feeding habitats depends on both the condition of the

crops and the thickness and maintenance of the snow cover. Research carried out within the LIFE09/NAT/BG000230 project shows that visibility, quietness, low presence of overhead power lines, absence of wind turbines and forest curtains are essential for the choice of feeding habitats (Harrison & Hilton, 2014). Hulea (2002) carried out a much more detailed study on the Red-breasted Goose *(Branta ruficollis)* and the Greater White-fronted Goose *(Anser albifrons)*, contributing significantly to the knowledge of the distribution of these species and habitats in south-east Romania. Geese are extremely sensitive to human disturbance, especially during the wintering period, when they are in their resting and feeding areas. The geese need more time to feed in order to accumulate enough energy from their food sources, which are not always rich in nutrients. If disturbed on their feeding grounds, geese make more frequent flights to avoid disturbance or even leave the feeding area in search of quieter places. These frequent flights lead to significant energy losses, especially during the winter. These losses affect the physical condition of the geese, manifested by weight loss. In response to the disturbance, geese may change their feeding sites and/or diet, if alternatives are available. The time spent feeding also increases, but at the same time, the days are shorter in the winter, which means that feeding can also take place at night. It also increases the time spent foraging, but at the same time, days are shorter in winter, which means that feeding can also take place at night.

Consequently, disturbance can have a significant negative impact on population distribution and can negatively affect reproductive processes, especially in goose species (Riddington *et al*., 1996). In south-east Romania, two main anthropogenic factors cause disturbance to geese: farmers who are chasing the geese away from the fields due to fear that the geese will cause damage to their cereal fields, and hunters who hunt game species, especially the white-fronted goose *(Anser albifrons)*, which is a legal quarry species in Romania. These conflicts between geese and farmers are well documented, especially in Europe. Managing these conflicts can be difficult, as we need to find a balance between species conservation and economic interests. To assess the level of conflicts with farmers and to maximize both species conservation and conflict resolution, it is essential to understand how geese select their habitats and use the agricultural areas.

This paper investigates habitats and the influence of landscape elements on the distribution of the Red-breasted Goose in south-east Romania during the winter season. Our aim is to analyse the available information on the preferred habitats of geese in this region and to analyse the relationships between the distribution of geese during the wintering period and various independent variables. We will also examine the effect of the presence of wind farms on important areas for the geese. Based on our findings, we will identify the most sensitive areas in south-east Romania where Red-breasted Goose should be protected, not only within the special protection areas, part of the Natura 2000 network, but also outside, in the vicinity of the protected areas.

MATERIAL AND METHODS

Study area and data collection

The study area is located in south-east Romania, predominantly in the Baragan and Coastal Dobrogea regions, covering the most important areas where the Red-breasted Goose population is concentrated (Todorov *et al*., 2023). More complex details about the geographical locations in the study area are presented in the work of Todorov *et al*. (2023), where the methodology for collecting data on geese in the winter seasons between 2012/2013 and 2021/2022 is also described. The Red-breasted goose populations were monitored both at roosting and feeding sites, according to the studies of Bibby *et al.* (2000) and Todorov *et al.* (2023), during 72 field trips carried out in favourable weather conditions (no rain or snow fall). Geese were counted from a distance to avoid disturbing their feeding behaviour. Data on the types of crops that the geese used for feeding were also collected.

Habitat selection

Information on habitats overlapping with Red-breasted Goose observations during the survey was selected from data available in Corine Land Cover (CLC) 2018 (ETC/LC, 1995). CLC is a system that collects and monitors information on land in Europe, data that is divided into 44 different land use classes. The coordinates where geese were observed in the 2,501 records were overlaid with vector data from CLC 2018 in south-east Romania, in order to provide a general overview of the habitats preferred by Red-breasted Goose. To determine more precisely the habitats used by this species in the southeast of the country, only data from the national monitoring scheme for wintering geese in Romania were selected. Data where the species was recorded in flight were excluded, resulting in 1,480 records in the period 2012–2022. Vector spatial data on the places where geese spend the night were extracted from the CLC 2018, classes: 411 – Inland marshes, 512 – Water bodies and 521 – Coastal lagoons. Using a simple regression, we investigated the distance between feeding areas and roosting sites, as well as the distance to the nearest edges of settlements and asphalt roads. We also took into account lakes, which are preferred as roosting areas. We only used data from the national scheme collected between November 2020 and February 2023, as additional data were collected, including locations where geese were found foraging, totalling 266 observations.

We collected data on the types of crops where geese were observed during the day in the feeding fields, also during the aforementioned period. To investigate the relationships between geese and preferred crops, we applied a simple regression. All maps were made in ArcMap 10 (ESRI Redlands, CA, USA, 2014).

The independent variables mentioned above were calculated in R (R Core Team, 2018). We also performed a one-way ANOVA to observe whether there were differences between the mean results obtained for each of the four months of the winter period (November–February). The p-value is reported as 0.05.

Development of the map on the sensitivity of the landscape in south-east Romania for Red-breasted Goose

The map was developed as a combination of different layers showing the sensitivity of geese, in relation to the risk of (1) habitat loss, (2) collision mortality and (3) proximity to roosting areas, which were considered the most important components of a goose-specific planning tool in this region.

The layers used to build this map are:

- Data of the gees distribution collected during field studies undertaken between 2012 and 2023;
- Corine Land Cover 2018 used to establish the preferred habitats of geese;
- Unsuitable areas: artificial surfaces (CLC1) and forests (CLC3); buffer zones of 100 m near roads and railways;
- Areas of low and medium importance, CLC: 211 – non-irrigated arable land, 213 – rice fields, 231 – pastures, 241 – annual crops associated with permanent crops, 242 – areas of complex crops, 243 – predominantly agricultural land mixed with natural vegetation;
- SPAs important for the conservation of the Red-breasted Goose, designated as areas of special importance and the delimitation of 5 km buffer zones around them to establish areas of high importance.

RESULTS

Flock size on feeding grounds

During the study period, the size of goose flocks (n=1,401) found on feeding grounds in the Baragan and Coastal Dobrogea regions was very diverse, but most were grouped in the range of 1–1,000 individuals, on 1,254 occasions (Table 1). The largest compact flock recorded in the last 10 years on Romanian territory was found in 2013 on feeding grounds near Vama Veche, estimated at approximately 20,000 individuals. This was a compact flock of Red-breasted Geese that were moving away due to the disturbance caused by hunting activities in Bulgaria, near Lake Durankulak, where the roosting area is also located. Flocks of over 4,000 individuals were rarely observed, predominantly in the areas of Pardina (Danube Delta) and Great Island of Braila. The average flocks observed in Romania are 433 individuals during the winter period.

Table 1

Flock size of the Red-breasted Geese registered in the south-east Romania during the winter period of 2012–2022

Flock size	Observations
1–1000	1254
1001–2000	72
2001–3000	30
3001–4000	21
4001–5000	9
5001–6000	3
6001–7000	1
7001–8000	5
8001–9000	1
9001–10000	2
10001–11000	2
19001–20000	1

Habitats preferences and food sources during the winter period

During the period 2012–2022 Red-breasted Goose preferred three main habitats in southeastern Romania, agricultural lands as feeding areas, water bodies and wetlands as resting and roosting places (Fig. 1). The habitats of artificial surfaces and forests and semi-natural areas come from observations where geese were detected in flight or on semi-natural surfaces.

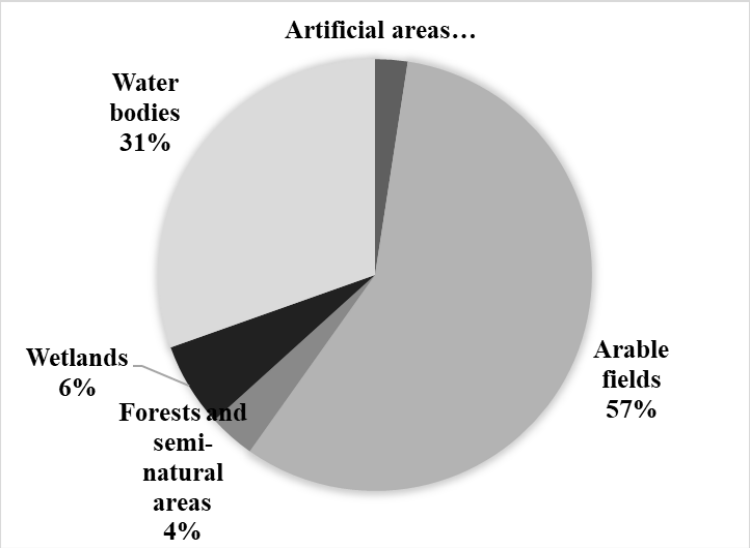

Figure 1. Habitats at Class I of Corine Land Cover 2018 used by the Red-breasted Goose in the south-east Romania during the period 2012–2023.

Taking into account class II of the 2018 CLC, the most preferred habitats were non-irrigated arable land, followed by water bodies, pastures and inland marshes (Table 2).

Table 2

Habitats use by the Red-breasted Goose in the south-east Romania during the period 2012–2023

Class I	**Code**	**Class II**	**Observations**
Artificial surface	112	Discontinuous urban fabric	39
	121	Industrial or commercial units	8
	123	Port areas	5
	131	Mineral extraction sites	2
	132	Dump sites	3
	142	Sport and leisure facilities	3
Agriculture areas	211	Non-irrigated arable land	1175
	213	Rice fields	22
	221	Vineyards	3
	231	Pastures	214
	242	Complex cultivation patterns	7
	243	Land principally occupied by agriculture with significant areas of natural vegetation	2
Forests and semi-natural areas	321	Natural grasslands	68
	324	Transitional woodland-shrub	17
	331	Beaches, dunes, sands	1
Wetlands	411	Inland marshes	101
421	Salt marshes	55	
Water bodies	511	Water courses	21
	512	Water bodies	662
	521	Coastal lagoons	68
523	Sea and ocean	4	

The roosting areas where the geese were detected are belonging to three main habitats: Inland marshes, water courses and coastal lagoons, while during foraging, Red-breasted Goose preferred non-irrigated arable land and pastures.

In terms of Natura 2000 habitats distributed in southeastern Romania (Gafta *et al*., 2008), Red-breasted Goose were recorded in the following habitats during the period 2012–2022:

Habitat Code	Habitat name
1150	Coastal lagoons
1210	Annual vegetation of drift lines
1310	Salicornia and other annuals colonizing mud and sand
1530	Pannonic salt steppes and salt marshes
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoeto-Nanojuncetea
3160	Natural dystrophic lakes and ponds
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
3270	Rivers with muddy banks with Chenopodion rubri pp and Bidention pp vegetation
6510	Lowland hay meadows
62C0	Ponto-Sarmatic steppes

As a food source, the Red-breasted Goose preferred mostly fields planted with cereal crops, wheat *(Triticum ssp.)* or barley *(Hordeum ssp.)* in 66% of records, corn stubble in 14% and pastures in 8% of records. Rapeseed was the least preferred, only 5% (Fig. 2). In corn stubble fields geese were observed only in November and December, before the fields were ploughed. Winter wheat dominated as a food source in each of the months of the wintering period. Rapeseed *(Brassica napus oleifera* and *Brassica rapa oleifera)* was preferred only on 14 occasions. Other crops include a few observations of geese in alfalfa *(Medicago sativa)* fields, rice stubble *(Oryza nivara)* and ploughed fields. The largest flocks of geese, over 4,000 individuals, were found on arable land with wheat crops.

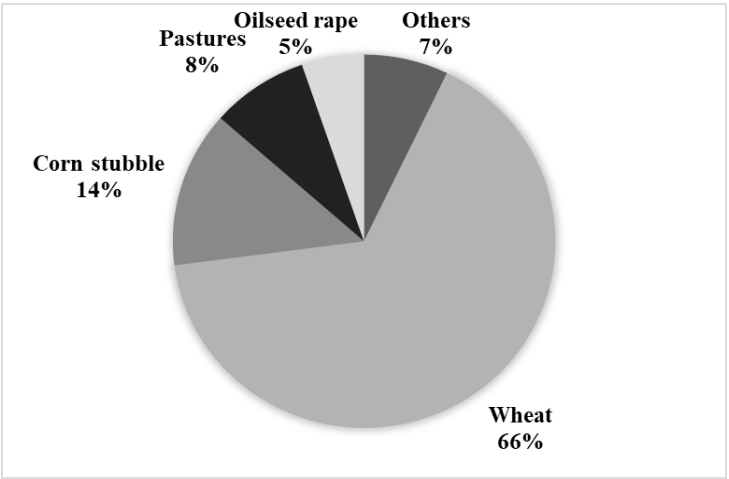

Figure 2. Preferred crop types of the Red-breasted Goose during wintering in south-east Romania, 2020–2023.

Relationships between landscape elements and their influence on the presence of geese

The Table 3 presents the results regarding the relationships between geese and independent variables located in south-east Romania during the wintering period between 2020 and 2023.

Table 3

Relationships between geese presence and independent variables in south-east Romania during the wintering period between 2020 and 2023

	November		**December**		**January**		**February**	
Independent variables	**Coefficient**	***p***	**Coefficient**	***p***	**Coefficient**	***p***	**Coefficient**	***p***
Distance to the margins of the settlements	384.00	0.13	237.00	0.08	562.00	0.19	484.00	0.27
Average (meters)	*3,750.52*		*3,196.19*		*2,838.68*		*3,103.31*	
(± s. e.)	*379.68*		*430.09*		*291.07*		*359.48*	
Distance to the roads (meters)	326.58	0.11	152.72	0.17	136.79	0.62	78.96	0.83
Average (km)	*3,036.93*		*3,140.49*		*2,577.59*		*3,836.43*	
(± s. e.)	*455.71*		*384.65*		*379.64*		*431.38*	
Distance to the roosting areas	169.20	**0.01***	363.07	**0.00***	368.19	**0.02***	493.20	**0.00***
Average (km)	*3,308.34*		*2,457.53*		*2,478.46*		*3,206.22*	
(± s. e.)	*242.46*		*130.73*		*163.25*		*178.07*	

***** Significant correlation $P < 0.05$

Localities

The greatest distance to the edge of the settlements was in November 3,750.52 meters + 379.68 meters (se), and the smallest in January 2,838.68 m, + 291.07 m (se). In December and February the distance to the edge of the settlements was almost equal, around 3,000 m (Table 3).

A one-way ANOVA showed that there was no statistically significant difference in the average distance between the edge of the settlements and the area where the geese were feeding between all four months (F (3, 262) = [1.622], p = 0.18). Regarding the average distance to the edge of the settlements, the ANOVA showed that there was no significant difference, (F (3, 262) = [1.658], p = 0.17).

Roads

Regarding the distance to asphalt roads, geese kept an average distance of around 3,100 meters. The highest was in February, 3,836.43 m, + 431.38 m (se), and the lowest in January, 2,577.59 m, + 379.64 m (se). Regarding the average distance to the roadside, ANOVA showed that there was no significant difference (F (3, 262) = [1,621], p = 0.18).

Roosting areas

The distance between roosting areas and feeding areas was on average around 3,300 m in November and February, and around 2,400 m in December and January. In all months, a statistically significant relationship was found in the results obtained. Regarding the distance between the areas where geese rest during the nights and the feeding areas, the analysis showed that there is a statistically significant relationship (F (3, 262) = [6.918], p = 0.00). Geese preferred feeding areas closer to the roosting areas.

The shortest distance between roosting areas and feeding areas in south-east Romania during the period 2012–2022 for Red-breasted Goose was recorded in January. Regarding the maximum distance, Red-breasted Goose flew up to 27 km from their roosting areas in February (Table 4).

Table 4

Minimum and maximum distance between roosting areas and feeding areas in south-east Romania during 2012–2022, depending on the months of the winter season

Month	November	December	January	February
Average	3,670	2,523	2,614	3,478
Std. error	281	133	188	220
Minimum	52	35	212	135
Maximum	17,971	11,892	20,188	27,824

Depending on the season, the distances between roosting and feeding areas did not fluctuate significantly during the period 2012–2022. The average distance was around 3,000 m, and the minimum distance was around 200 m. Large fluctuations are recorded in the maximum distances that Red-breasted Goose fly to feeding sites (Table 5).

Table 5

Minimum and maximum distances between roosting areas and feeding areas in south-east Romania during 2012–2022, depending of the season

Season	Average (m)	Min (m)	Max (m)
2012/2013	3,714	232	17,971
2013/2014	2,343	362	5,946
2014/2015	3,616	358	11,892
2015/2016	3,634	423	18,802
2016/2017	2,573	129	27,824
2017/2018	2,548	187	9,564
2018/2019	2,078	35	6,829
2019/2020	3,624	255	20,188
2020/2021	3,046	89	11,474
2021/2022	2,944	52	11,830
Average per season	**3,012**	**212**	**14,232**

Geese established relatively the same feeding sites during the study period. Distances between roosting areas and feeding sites according to the main regions in south-east Romania where geese winter are presented in Table 6.

Table 6

Minimum and maximum distances between roosting areas and feeding areas in south-east Romania during 2012–2022, depending of the primary wintering areas

Foraging areas	Balta Alba	Tataru-Strachina	Great Island of Braila	Danube Delta – Pardina-Razim	Danube Delta - Sinoe	Calarasi – Oltina
Average (m)	2,855	1,876	6,488	3,009	1,344	9,231
Std. Error	324	184	255	111	63	895
Minimum	178	35	222	129	37	410
Maximum	11,544	8,321	11,837	7,444	6,950	27,824

The minimum distances, from tens to several hundred of meters are mostly in cases when geese feed in the immediate vicinity of the roosting areas, predominantly on the shores of lakes and wetlands with marsh vegetation or meadows. Examples of such a feeding areas where geese feed up to 100 m away are the sites – Balta Tataru and Balta Alba-Amara-Jirlau. There are also recorded cases where geese feed just as close to the shore but on cereal crops, for example in the sites – Lacul Strachina, Balta Alba, Saratura, Sarinasuf, Beibugeac, Salcioara, Sabangia, Istria and Nuntasi. The furthest distances from roosting areas are recorded in Iezerul Calarasi, Lake Oltina, the Pardina area within the Danube Delta and Great Island of Braila due to the fact that these roosting areas are located at greater distances from the feeding fields (Figs. 3–8).

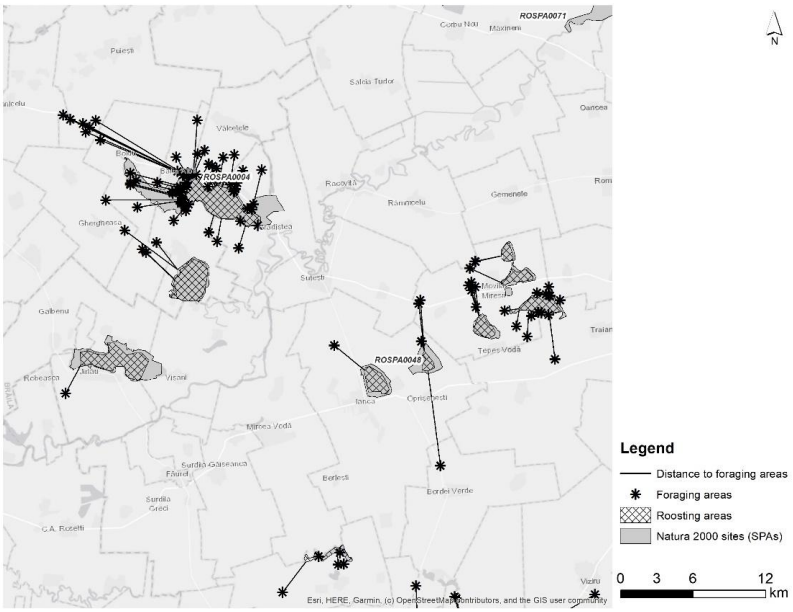

Figure 3. Distances between roosting areas and feeding areas around the Natura 2000 sites ROSPA0004 Balta Albă-Amara-Jirlau and ROSPA0048 Ianca – Plopu – Sărat.

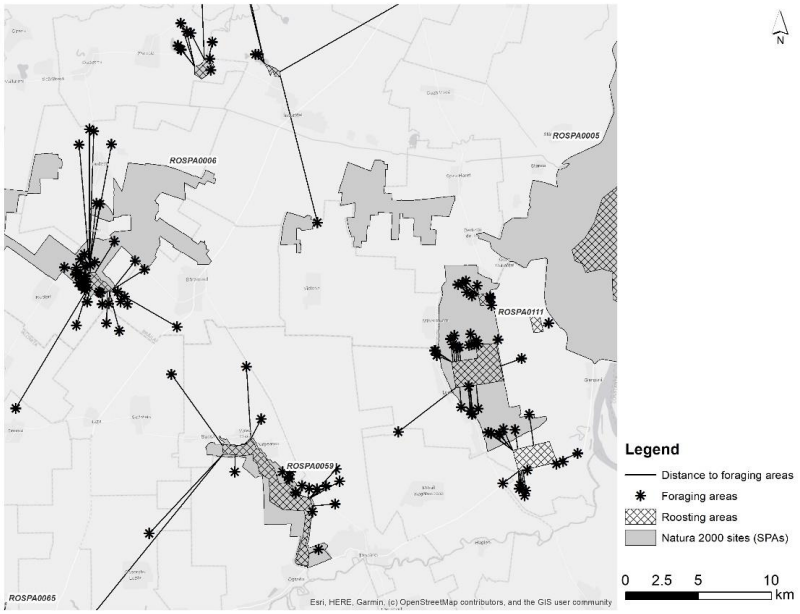

Figure 4. Distances between roosting areas and feeding areas around the Natura 2000 sites ROSPA0006 Balta Tătaru, ROSPA00059 Lake Strachina and ROSPA0111 Berteştii de Sus - Gura Ialomiţei.

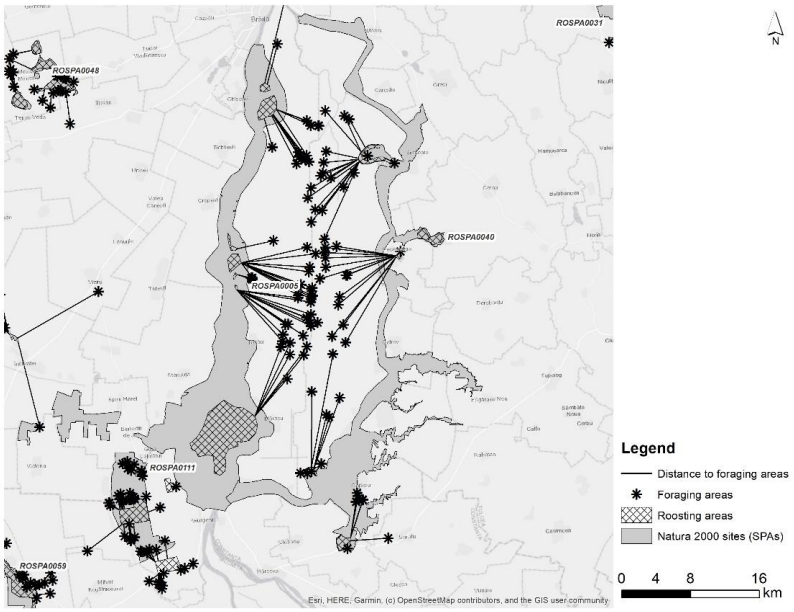

Figure 5. Distances between roosting areas and feeding areas around the Natura 2000 sites ROSPA0005 Great Island of Brăila and ROSPA0040 Old Danube - Braţul Măcin.

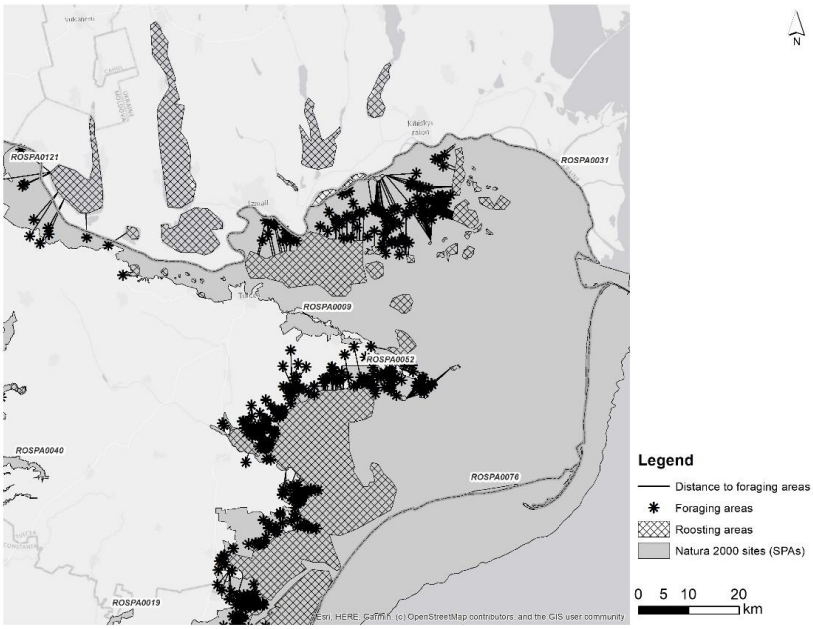

Figure 6. Distances between roosting areas and feeding areas around the Natura 2000 sites ROSPA0031 Danube Delta and the Razim-Sinoe complex (northern part).

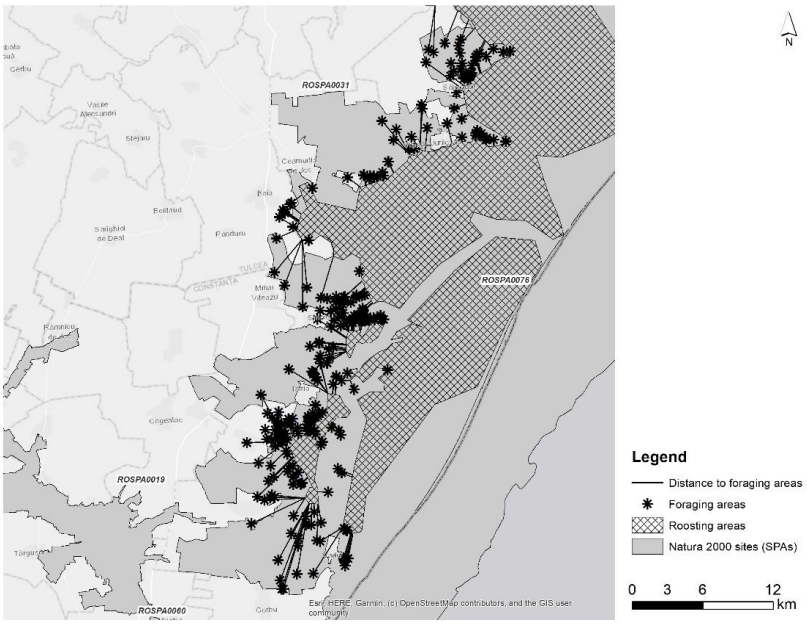

Figure 7. Distances between roosting areas and feeding areas around Natura 2000 sites ROSPA0031 Danube Delta and Razim-Sinoe complex (southern part).

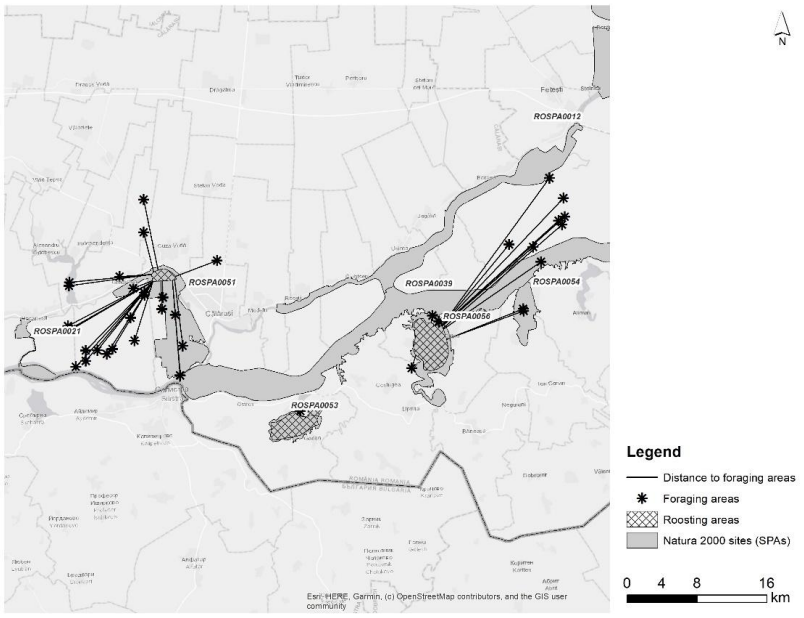

Figure 8. Distances between roosting areas and feeding areas around the Natura 2000 sites ROSPA0051 Iezerul Călăraşi and ROSPA0056 Lake Oltina.

Windfarm parks

The correlation results indicated that there is a very small, significant positive relationship between the distance to the nearest wind farm and the abundance of Red-breasted Geese in the feeding areas, (r (905) = .0899, p = .007). These results means that the abundance of the species in the feeding areas is not influenced by the distance to the nearest wind farm.

Landscape sensitivity in south-east Romania for the conservation of Red-breasted Geese

The colours of the map represent different sensitivity scores (Fig. 9). The score acts as a guide to the potential sensitivity of an area for geese in relation to the risks associated with different infrastructure projects, such as wind farms, large buildings, roads, hunting.

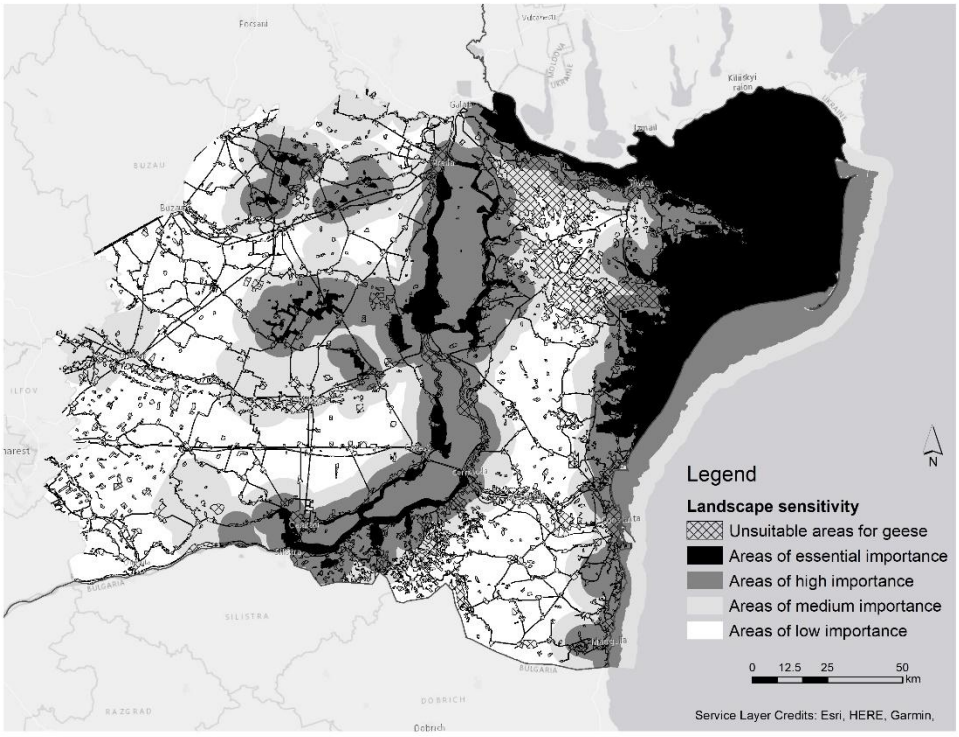

Figure 9. Sensitive areas in south-east Romania for the conservation of Red-breasted Geese *(Branta ruficollis)* in relation to strategic territorial planning and individual investment projects.

Unsuitable areas for geese. Artificial constructions, forests and habitats that are not important for the conservation of the species.
Areas of low importance. Predominantly arable land of low importance for geese.
Areas of medium importance. Predominantly feeding areas where agricultural activities must be carried out with great care during the period November–March. Any activity related to large infrastructure projects must be subject to SEA/EIA.
Areas of high importance. Predominantly feeding areas where agricultural activities must be carried out with great care during the period November–March. Any activity leading to a change in the category of use, change in agricultural crops, and construction of wind turbines or photovoltaic parks must be prohibited.
Areas of essential importance. SPAs essential as roosting and feeding areas for geese. Any activity related to hunting, construction of wind turbines, photovoltaic parks, change in the category of land use, change in agricultural crops and modification of natural habitats must be prohibited.

DISCUSSION

Arable lands and water bodies are the most preferred habitats for Red-breasted Goose in south-east Romania during the wintering season. This result confirms the findings of Hulea (2002), which showed that geese were present exclusively on agricultural lands in Coastal Dobrogea during 1999–2001. Historical data from the beginning of the 20th century indicate a similar situation, in which Red-breasted Goose and Great White-fronted Goose were distributed on agricultural lands in Coastal Dobrogea, Romania (Lintia, 1955; Papadopol, 1965; Tălpeanu, 1971). The results show that geese prefer feeding areas in the immediate vicinity of roosting sites, and the presence of geese in feeding areas was not influenced by the distances to asphalt roads and settlements. If geese are not disturbed while feeding, they will choose sites with preferred crops in the immediate vicinity of their roosting sites. Regardless of the month in winter, the average distance between roosting and feeding sites was around 3,000 meters. Same value of 3,000 meters was observed as an average also during the months in the season. The findings indicate that this distance is extremely important for ensuring sufficient feeding areas, where anthropogenic disturbance should be avoided as much as possible in order to allow geese foraging relaxed and gaining sufficient fat.

Much more precise data provided by the LIFE16/NAT/BG/000847 project, where Red-breasted Goose were tracked by GPS with transmitters, show that feeding sites are located between 15 and 26,000 meters from roosting sites, with an average of 4,000 meters (Iliev & Petkov – personal communication). The fact that geese were also observed at greater distances, over 10 km, indicates either a lack of feeding areas with their preferred crops, or high levels of anthropogenic disturbance from various agricultural or hunting activities. A major problem is that many of the

most important places in south-east Romania, where this species winters, are not included within the boundaries of special protection areas. It is very important that, in order to ensure adequate conservation for this species, the boundaries of certain sites, such as ROSPA0004 Balta Albă – Amara – Jirlau, ROSPA0006 Balta Tătaru, ROSPA0031 Danube Delta and Razim – Sinoe Complex, ROSPA0048 Ianca – Plopu – Sărat, ROSPA0051 Iezerul Călăraşi and ROSPA0059 Strachina Lake, be extended in radius by a minimum of 3 to 5 km, and that this area act as feeding and refuge areas for geese. In this way, and if they are not disturbed, geese will remain attracted to these areas and will not spread to other fields where they could cause damage to much more crops. In addition, to reduce crop damage to wheat, farmers should increase the area of fields left as corn stubble, as well as the time they are left without ploughing.

The results of the preferred food sources of geese show that corn stubble where geese find scattered grains is one of the main food sources in November and December. If they have enough corn stubble fields and time available, geese will be attracted to corn fields (Gill, 1996), which will provide enough time for wheat crops to grow, and damage to the wheat could be significantly minimized. At the beginning of the winter season, geese are in larger numbers in the Baragan region compared to Coastal Dobrogea which could be explained by the fact that in Baragan, where there are also much better irrigation systems, corn is cultivated on larger areas compared to the Coastal Dobrogea. However, the results of this study show that the main food source of geese in south-east Romania remains wheat crops. Historical data reported from Romania show that geese were seen on wheat and corn stubble (Scott, 1970; Johnson & Biber, 1971). Later Hulea (2002) confirms that during 1999–2001 geese were found on wheat fields and corn stubble up to 40 km from the lakes where geese roost in the Coastal Dobrogea region.

Regarding the correlation between wind turbines and important feeding sites for geese, I would like to point out that at the moment we still do not have wind farms near the most preferred feeding sites for geese. This might be the reason why the correlation between these two variables is very low. It is proven that the location of wind farms near roosting and feeding areas has a negative impact on goose populations. The main effect recorded is the abandonment of feeding areas leading to the effective habitat displacement (Larsen & Madsen, 2000; Larsen & Clausen, 2002; Madsen & Boertmann, 2008). A study carried out in Bulgaria in 2012–2013, through the LIFE09/NAT/BG000230 project, to assess the repulsive effect of turbines, shows a reduction of habitats favourable to the species by 24%, if all the proposed investments in the Bulgarian part of Dobrogea are implemented (Harrison *et al*., 2014). By flying longer distances between the roosting and feeding areas, geese consume more energy, causing a significant decrease in their physical condition (through increased energy consumption and reduced feeding time). Last but not least, geese are identified as one of the species potentially vulnerable to collision with wind turbines (Langston & Pullan, 2003).

The landscape sensitivity map was created to assist in the strategic planning of wind farm developments or other activities that may have a negative impact on Red-breasted Geese in south-east Romania. According to studies, geese are particularly sensitive to the presence of wind farms (Larsen & Madsen, 2000; Larsen & Clausen, 2002; Madsen & Boertmann, 2008), being affected in particular by the reduction of suitable foraging habitats, disturbance, but also by collision mortality (Langston & Pullan, 2003) and potential effects on energy resources consumed for movement (Harrison & Hilton, 2014), due to the barrier effects created by wind farms. This map highlights the wintering areas in south-east Romania where Red-breasted Geese are most sensitive to anthropogenic activities related to the development of large, medium and small infrastructure projects. On a smaller scale, it provides guidance on whether a particular area that is important for geese could be used for early identification of development projects or to target areas for which an Environmental Impact Assessment or Appropriate Assessment should be undertaken.

The two recommendations, with the extension of certain Special Protection Areas designated for the conservation of the species by a minimum of 3–5 km and the establishment of feeding areas as refuges where geese feed peacefully, could significantly contribute to reducing damage to wheat fields. If the sensitivity map and these two measures are respected, they will certainly make a positive and significant contribution to the conservation of the species in the most important wintering grounds of the species where almost half of the global population is concentrated.

Acknowledgements. The authors would like to express their gratitude to all participants in the national goose monitoring program: Anania Iulia, Ajder Vitalie, Amarghioalei Vlad, Arghius, Baltag Emanuel-Ștefan, Bandacu Dan, Benescu Gabriel, Benkő Zoltán, Bugariu Sebastian, Birău Alexandru Cătălin, Brad George, Cernisov Liviu, Chirilă Florin, Ciortan Bogdan, Claudia Câmpeanu, Constantin Ion, Cotoara Andrei, Cunadi Iancu Cuzic Viorel, Ilarion, Danuţ Florinel Drăgan, Dima Marius Cornel, Damoc Dorin, Dinu Andrei, Duluta Ştefan, Domșa Cristian, Ciprian Fântână, Fasola-Matasaru Lucian, Federeac Bogdan, Ferenc Kósa, Filote Beti, Fuciu Cătălin, Gavril Dumitru Viorel, Grosu Lucian, Groza Camelia, Gyongyosi Livia, Helerea Codruţ, Hulea Gheorghe Dănuţ, Hutuleac Mihai, Ifrim Alexandru, Imre Simó, Jercai Simó, Cristian, Jurjescu Ana, László Ambrus, László Gál, Mestecăneanu Adrian, Nándor Veres-Szászka, Neag Tudor, Pal Lajos, Pantîru Lidia, Pantîru Silviu, Petrencu Laurenţiu, Petrescu Eugen, Petrescu Daniel, Pintilioaie Alexandru-Mihai, Popovici Floarea, Pui Anca, Sandu Cristian, Simion Mihaela, Spac Doru, Stavarache Florin, Stefanescu Mihai Bogdan, Suba Catalin, Szabó József, Szabó Zoltan, Tibu Paul, Todorova Lavinia, Toncean Florin-Costin, Török Ana Maria, Tudor Diana Alexandra, Vanesa Duceac Ioana, Veres-Szászka Judit, Vernescu Marius and Viorel - Ilie. Without their valuable help, the monitoring the Red-breasted Goose in south-east Romania would not have been possible. Financial support for the implementation of the national monitoring scheme for the species in the country was obtained mainly through the project Conservation of the Red-breasted Goose along the Global Flyway (LIFE16/NAT/BG/000847) co-financed by the LIFE Programme of the European Union, but also from the Romanian Ornithological Society's own funds.

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Received May 22, 2025

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