CONSIDERATIONS ON THE DENSITY, PREFERENCE OF HABITAT AND ETHOLOGY OF THE PYGMY OWL (*Glaucidium passerinum* Linnaeus, 1758) FROM THE FĂGĂRAŞ, IEZER-PĂPUŞA AND LEAOTA MOUNTAINS (SOUTHERN CARPATHIANS, ROMANIA)

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Abstract. The paper is a continuation of previously published results and brings new data regarding the density, preferences of habitat and ethology of the Pygmy Owl (*Glaucidium passerinum* Linnaeus, 1758) from the Făgăraş - Iezer-Păpuşa - Leaota Mountains (România). It was found that the species is mainly present in the forests from the slopes oriented to NNW, SW and S with a 12-20° terrain gradient, as well as the fact that it prefers the vicinity to the small and open spaces, located in mature and relatively mature forests. For the researched area, the density can be assessed to 0.73 pairs/km^2, in the spruce forests, and to 0.61 pairs/km^2, in the spruce forests with logging, so that the population from the Făgăraş, Iezer-Păpuşa and Leaota Mountains can be evaluated at maximum 450-650 pairs, of which maximum 350-500, in the Făgăraş Mountains. The birds showed a certain degree of tolerance to the forest exploitations on low level and, therefore, we think that the protection of the species can be achieved not only in the protected areas, but also in other categories of forests that are suitable for the species.

Keywords: Pigmy Owl, density, habitat, behaviour, protection.

Rezumat. Consideraţii despre densitatea, preferinţa de habitat şi etologia ciuvicii (*Glaucidium passerinum* Linnaeus, 1758) din Munţii Făgăraş, Iezer-Păpuşa şi Leaota (Carpaţii Meridionali, România). Lucrarea reprezintă o continuare a rezultatelor publicate anterior şi aduce noi date privitoare la densitatea, preferinţele de habitat şi etologia ciuvicii (*Glaucidium passerinum* Linnaeus, 1758) din munţii Făgăraş, Iezer-Păpuşa şi Leaota (România). S-a constatat prezenţa speciei cu predilecţie în pădurile situate pe pantele orientate către NNV, SV şi S şi care au o inclinaţie de 15-20° şi, de asemenea, preferinţa pentru vecinătatea spaţiilor mici, deschise, situate în pădurile mature şi relativ mature. Pentru zona cercetată, densitatea poate fi estimată la 0,73 perechi/km^2, în pădurile de molid, şi la 0,61 perechi/km^2 perechi, în pădurile de molid cu exploatări forestiere, astfel că, populaţia din Munţii Făgăraş, Iezer-Păpuşa şi Leaota poate fi estimată la maximum 450-650 perechi, din care maximum 350-500, în Munţii Făgăraş. Păsările au dovedit un numit grad de toleranţă faţă de exploatările forestiere de mică amploare şi, de aceea, considerăm că protecţia acestei specii poate fi realizată nu numai în zonele protejate, ci şi în alte categorii de păduri adecvate speciei.

Cuvinte cheie: ciuvică, densitate, habitat, comportament, protecţie.

INTRODUCTION

Until now, the Eurasian Pigmy Owl (*Glaucidium passerinum* Linnaeus, 1758) was less studied in Romania (PAŞCOVSCHI, 1959; RADU, 1967; VASILIU & ŞOVA, 1968; MĂTIEŞ, 1977-1979; KLEMM & KOHL, 1988; POP et al., 2008; MUNTEANU, 2009, 2012). From the area of Făgăraş - Iezer-Păpuşa - Leaota Mountains, there are some references about its presence (LINŢIA, 1954; BĂCESCU, 1961; CIOCHIA, 1992; GEORGESCU & GEORGESCU, 1996; MUNTEANU et al., 2002) and a single work focused on it (MESTECĂNEANU & MESTECĂNEANU, 2019). The present paper comes with some considerations about the density, preference of habitat and behaviour of the species.

MATERIAL AND METHODS

The smallest species of owl from Europe, the Pigmy Owl is primarily a resident species that prefers to breed in coniferous or mixed forests, where it places its nest in a hole of a tree (SVENSSON et al., 2009). In Romania, it inhabits the large woods of spruce with cold and wet environment and, more seldom, mixed forests (MUNTEANU, 2009), mountain forests of Norway spruce and fir (DARÓCZI, 2014) and heterogeneous and tall spruce forests, with fellings being favoured (MUNTEANU, 2012).

The area of study covers the southern slopes of the Făgăraş, Iezer-Păpuşa and Leaota Mountains (Fig. 1) from the Southern Carpathians.

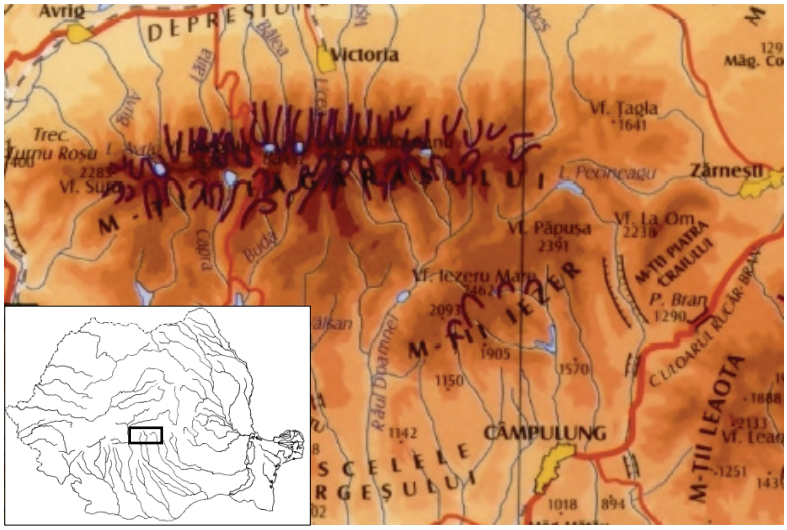

Figure 1. The map of the area (modified, by http://elearning.masterprof.ro/).

The relief is formed by ridges interrupted by deep valleys on the north-south direction, from the main crest, in Făgăraş, on south-east direction, in Iezer-Păpuşa, and radial, from the high peaks, in Leaota. Their maximum sea level altitude is 2,544 m (the Moldoveanu Peak, from Făgăraş).

There are a few major rivers that collect their waters from the area: the Olt River, in West, the Argeş with Dâmboviţa River, in South, and the Ialomiţa River, in East.

The temperate continental climate has mountain features, with -2°C average air temperature, and over 1,400 mm of precipitations a year on the highest peaks of the Făgăraş Mountains (BARCO & NEDELCU, 1974).

The lower elevations (up to ca. 1,200 m) are occupied by forests of beech (*Fagus sylvatica* L.), the middle level (up to 1,450 m) belongs to the mixed forests of beech and Norway spruce (*Picea abies* (L.) Karst.), more seldom Silver fir (*Abies alba* Mill.), and the upper level (up to 1,850 m) is covered by the Norway spruce forests. The Dwarf mountain pine (*Pinus mugo* Turra) and the Common juniper (*Juniperus communis*) compose the sub-alpine level (up to 2,200 m), while *Festuca supina* Schur., *Carex curvula* All., *Agrostis rupestris* All., *Oreochloa disticha* (Wulfen) Link, *Nardus stricta* L. are met typically in the alpine level (over 2,200 m) (DONIŢĂ et al., 2005; ALEXIU, 2008).

As field method, the point count with a play-back device was used (by DARÓCZI, 2014, modified). In general, 5 minutes (1 minute calling, 1 minute listening) were taken on every point and, usually, the calling ceased when the individuals were heard. Information about the species, habitat, geographical coordinates, cote, date, hour, weather conditions was noted in every point of observation. The distance between the points of playback, randomly chosen in all types of forests and weather conditions, exceeded 700 m. October-April (2015-2019) represented the survey period, 8:00-17:00 (GMT+2) was the diurnal time of monitoring and the points were visited once. The first place of observation of every individual was located on a map.

The density was calculated using a circle with 0.85 km radius, centred in every point of counting, the radius being the medium of the maximum distance from which a calling individual can be heard, which is between 0.7 and 1 km (DARÓCZI, 2014). The area covered by the sounds emitted by the play-back, without the sectors hidden by ridges, the terrain gradient and the distance from the individual initial place of detection to the nearest open space were obtained using Google Earth.

RESULTS AND DISCUSSIONS

The density provides a good expression of the habitat quality. It varies according to the habitat and, also, to the method of work. So, taking into account all observations from the points of counting, performed during October-April, between 8:00 and 18:00 (by the Romanian standard time) and in any kind of weather, except snowy, rainy or windy one (> 3 on Beaufort Scale), it is smaller than the density obtained in the same circumstances, apart from the points from young forests, which is smaller, in its turn, than the one resulted from optimal conditions. In the first case, we also excluded the observations affected by the stream noise or situated inside the forests, with poor detectability. Through optimal conditions, we meant all observations from the points of counting, as we explained above, excepting the ones made in the intervals of time and on weather with the lowest rate of success of observations, as well as the ones devoid of statistical coverage – the observations performed in October and March, between 8:00-9:59 and 16:00-17:59, in the intervals -15-11°C, 5-9°C and 10-14°C, on 7-8 nebulosity, in conditions of predominantly middle-level clouds, wind of 3 on Beaufort Scale and snow-free ground (MESTECĂNEANU & MESTECĂNEANU, 2019).

Following the observations carried out in optimal conditions (inside the circles with r = 0.85 km), we see that the highest density (0.67 pairs/km^2) was calculated for mature Norway spruce forests, while it was of only 0.34 pairs/km^2 in the mature mixed forests. In the relatively mature forests of spruce, it was 0.51 pairs/km^2. For all investigated mixed forests, regardless of age, it was 0.28 pairs/km^2 and for all spruce forests it was 0.57 pairs/km^2, so, in general, for all forests from the area, it was 0.53 pairs/km^2. If the areas of logging are included here, the density decreased to 0.26 pairs/km^2 (i.e. by 23.52%) in mature mixed forests, to 0.53 pairs/km^2 (i.e. by 20.89%) in mature spruce forests, to 0.22 pairs/km^2 (i.e. by 21.42%) in mixed forests, to 0.47 pairs/km^2 (i.e. by 17.54%) in spruce forests and to 0.44 pairs/km^2 (i.e. by 16.98%) in all forests, regardless of their composition and age. If the radius of the circle around each point of counting (r) is considered equal to 0.7 km, the density is higher – for instance: 0.32 pairs/km^2 in mixed forests with logging, 0.61 pairs/km^2 in spruce forests with logging, 0.69 pairs/km^2 in forests and 0.57 pairs/km^2 in forests with logging (Table 1). For comparison, in some regions of the Oriental Carpathians, there are densities of 1 pair/1.5-3 km^2 or 0.33-0.66 pairs/km^2, that represent values considered optimum for all Carpathians (DARÓCZI, 2014). In other parts of Central and Eastern Europe, in optimal habitats, 0.22 occupied territories/km^2 (SHURULINKOV et al. 2007) were calculated for W Rhodopes (Bulgaria), and 0.39 territories/km^2 for the Rila Mountains (W Bulgaria), while 0.95-1.04 territories/km^2, maximum 1.1-1.4 territories/km^2, were recorded in West Slovakian Carpathians (PACENOVSKY & SHURULINKOV, 2008). In Poland, the density can reach 0.2 pairs/km^2 (CIACH & CZYŻOWICZ, 2014) and even over 0.5 pairs/km^2, in the Stolowe Mountains (MIKUSEK, 2001). In the eastern Alps (Austria), 0.14 pairs per km^2 (n = 8), while the territory size in the Alps and Böhmer Wald (West Germany) is 0.45–1.9 km^2, average ca. 1.25 km^2 (SNOW et al., 1998). In Central European Mountains, the density is between 0.07-0.42 pairs/km^2 (MIKKOLA & SAKL, 1997). According to GOLODUSHKO & SAMUSENKO (1961), the territories occupied in winter are larger than the one from the breeding season.

In the Făgăraş Mountains, the area covered by forests is 1,420 km^2, of which ca. 554 km^2 are coniferous forests, 525 km^2 are mixed forests and 341 ha are broadleaf forests (CIUTEA, 2017) and, as consequence (considering r = 0.85 km), the number of pairs from here can be evaluated to 116 pairs in all mixed forests, 261 pairs in all coniferous forests and, summing, 376 pairs, overall. For the entire area Făgăraş - Iezer-Păpuşa - Leaota, the population have to be ca. 496 pairs. For r = 0.7 km, it should be ca. 506 pairs, in the Făgăraş Mountains, and ca. 668 pairs, in the whole studied area.

Table 1. The density of Eurasian Pygmy Owl (*Glaucidium passerinum*) from Făgăraş - Iezer-Păpuşa - Leaota Mountains.

Type of observations	Parameter	Mature mixed forests	Mature spruce forests	Relatively mature forests of spruce	Mature mixed forests with logging	Mature spruce forests with logging	Mixed forests	Spruce forests	Mixed forests with logging	Spruce forests with logging	Forests	Forests with logging
All observations*	**pairs/km^2**	0.09	0.61	0.31	0.08	0.46	0.08	0.47	0.06	0.38	0.41	0.33
(n = 67 points of counting)	**km^2/pair**	12.72	1.74	3.56	15.31	2.34	15.33	2.27	17.93	2.81	2.68	3.28
All observations except young forests*	**pairs/km^2**	0.10	0.65	0.34	0.08	0.50	0.09	0.53	0.07	0.44	0.46	0.38
(n = 59 points of counting)	**km^2/pair**	11.24	1.62	3.28	13.83	2.14	13.15	2.00	15.74	2.47	2.35	2.88
All observations in optimal conditions*	**pairs/km^2**	0.34	0.67	0.51	0.26	0.53	0.28	0.57	0.22	0.47	0.53	0.44
(n = 24 points of counting)	**km^2/pair**	3.63	1.59	2.00	4.88	2.04	4.41	1.93	5.66	2.31	2.10	2.54
All observations in optimal conditions**	**pairs/km^2**	0.48	0.85	0.59	0.37	0.66	0.39	0.73	0.32	0.61	0.69	0.57
(n = 24 points of counting)	**km^2/pair**	2.08	1.18	1.69	2.69	1.51	2.54	1.37	3.16	1.65	1.45	1.75

* r = 0.85 km, ** r = 0.7 km.

Regarding the expositions of the slopes, most owls were recorded on flanks oriented to north-north-west (NNW), south-west (SW) and south (S), in equivalent proportions (14.7%). A relative symmetry can be noted, with a lack of individuals from the west-south-western (WSW) to the north-western (NW) slopes and with a few specimens from the south-south-eastern (SSE) to the eastern (E) slopes. Also, toward south-south-west (SSW), north (N) and north-north-east (NNE) a small number of birds was registered, so the resultant is 3.45 individuals, at 61.58° below OE direction on the chart (Fig. 2). Although some works (RAJKOVIĆ et al., 2013) link the sunny aspect to the presence of Tawny Owl (*Strix aluco* Linnaeus, 1758) which preys on Pygmy Owl, we do not find this, and maybe it is valuable to the lower altitudes. In the Alps, it was observed to occupy habitats from highest breeding territories of Tawny Owl upwards, where it has to tolerate lower temperatures and higher precipitations (SNOW et al., 1998), namely from 700-1,000 m a.s.l. to the treeline, at 1,800-2,100 m. The interspecific competition with the Ural Owls (*Strix uralensis* Pallas, 1771) is also mentioned (MIKKOLA & SAKL, 1997). In our case, the individuals were missing on west-north-west (WNW) and almost absent on east-south-east (ESE) and adjacent directions, that partially infirm the westness assumption, that says the Pygmy Owls prefer western slopes because they are cooler and assure favourable temperatures for them (EZATTI, 2015). Also, others predators, like Tengmalm's Owl (*Aegolius funereus* Linnaeus, 1758) and, possibly, Honey Buzzard (*Pernis apivorus* Linnaeus, 1758) and Sparrowhawk (*Accipiter nisus* Linnaeus, 1758) (PAČENOVSKÝ & ŠOTNÁR, 2010) can be considered as preying the Pygmy Owl, but its occurrence depends on old woodpecker nests, too (MUNTEANU, 2012), primarily on the Great Spotted Woodpecker (*Dendrocopos major* Linnaeus, 1758) and Three-toed Woodpecker (*Picoides tridactylus* Linnaeus, 1758) (SVENSSON et al., 2009; PAČENOVSKÝ & ŠOTNÁR, 2010). However, at least when rodent supply is good, it may breed alongside Tengmalm's Owl (SNOW et al., 1998). Some authors (PAČENOVSKÝ & ŠOTNÁR, 2010) found that most slopes were oriented to south-west (SW) and south-east (SE) in equal amounts, 23.7%, then to north-west (NW), 13.2%, and south (S), 10.5%, and conclude that the orientation of nest slope has no determining value for the selection of territory, in accordance with KLOUBEC (1987). In our area, although most of the major rivers flow, generally, on the north-south direction, there are numerous tributaries which have different courses and therefore, practically, the slopes are exposed on all cardinal points, but we do not know to what extent.

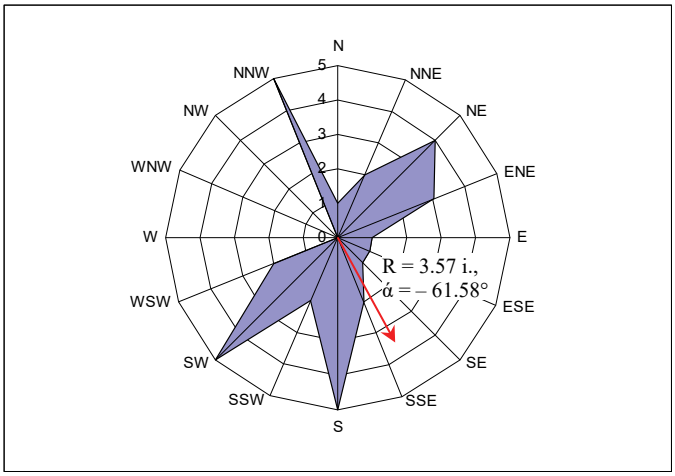

Figure 2. The expositions of the slopes with Pygmy Owls (n = 34 individuals).

Regarding the terrain gradient, the average was 26.09° (Table 2). Most individuals were observed between 15 and 19.99°, but relatively high percentages were within intervals 30-34.99° and 20-24.99° (Fig. 3). The areas with low incline were the least occupied, but we do not have exactly the proportion of gradient terrain for whole relief to clearly

extract a connection between it and the presence of the owls. Obviously, the abrupt slopes are predominant in the mountains and some papers found here a consistent correlation and other not (EZATTI, 2015). It is worth to reveal here that the average slope of the rivers is 463 m/km at the hydrometrical point Buda on the Buda River (22.4 km from the source), 327 m/km at the hydrometrical point Brădet on the Vâlsan River (39.9 km from the source), and 569 m/km at the hydrometrical point Bahna Rusului on the Doamnei River (42.9 km from the source) (UJVÁRI, 1972).

Table 2. The main parameters of the terrain gradient at the initial place of observation of the Eurasian Pygmy Owls.

Parameter	Value (°)
Mean	26.09
Standard Deviation	10.61
Range	39.83
Minimum	4.58
Maximum	44.42
Count	34
Confidence Level (95.0%)	3.70

The distance between the initial place of observation of every individual and the nearest open space is, on average, 85.85 m (Table 3). However, most individuals were recorded between 0 and 50 m, and, generally, this weight decreased with the increase of the interval of distance (Fig. 4). Depending on the type of nearest open space, it is obvious that the birds preferred to stay close to clearings (in 55.88% of cases), and, here, the clearings with isolated remaining trees were preponderantly chosen (in 23.52% of cases) and clearings in small patches (in 11.76% of cases), while the total clearings were the least selected (in 2.94% of cases). The owls had a high preference for windbreaks or similar spaces, too (20.58%), while the alpine forest outskirts and the corridors of snow avalanche, normally found at big elevations, appeared each in 11.76% of the cases (Fig. 5). The vicinity of avalanche pathways was also remarked by others (MIKKOLA & SAKL, 1997; SNOW et al., 1998). As a result, it is obvious that the Pygmy Owls associate the clearings (artificial environments) with the natural forest breaks and avoid the vicinities of the large spaces, as well as the alpine outskirts, as we saw in the precedent paper, too (MESTECĂNEANU & MESTECĂNEANU, 2019). Usually, it does not hunt in open spaces (FELIX & HISEK, 1992) and the radio-tagged owls were never observed outside forest habitats (STRØM & SONERUD, 2001).

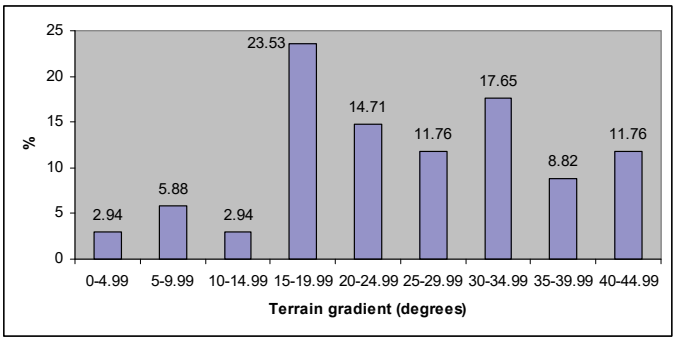

Figure 3. The distribution on intervals of terrain gradient at the initial place of observation (n = 34 individuals).

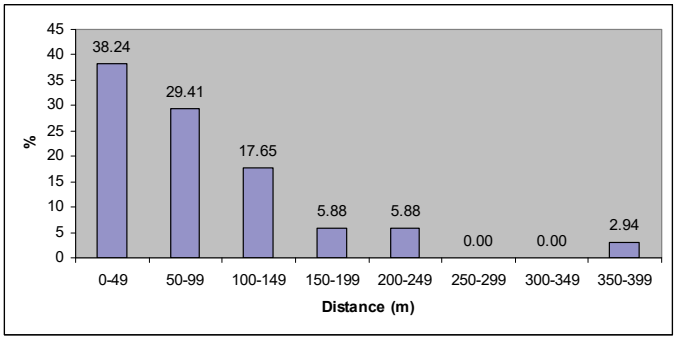

Figure 4. The distribution on intervals of distance between the initial place of observation and the nearest open space (n = 34 individuals).

Table 3. The main parameters of the distance between the initial places of observation of the individuals of Eurasian Pygmy Owl (*Glaucidium passerinum*) and the nearest open spaces.

Parameter	Value (m)
Mean	85.85
Standard Deviation	83.62
Range	395
Minimum	0
Maximum	395
Count	34
Confidence Level (95.0%)	29.17

Also, the predilection of the Pygmy Owls for the areas of forests interposed with openings emerges from the evaluation of the areas occupied by deforestations and natural openings from the forests in relation to the areas covered with forests (Table 4, Fig. 6). Thus, the weight of the clearings and natural openings from the area of mature and relatively mature forest was 25.97%, with most of the cases situated in the interval 10-19.99% open spaces, and the weight of the clearings and natural openings from the area of all forests, including clearings, was 16.04%, with most of the cases situated in the interval 0.01-9.99% open spaces. The compact forests were populated to the same extent that

the areas with 20-29.99% open spaces (each with 12.5%), while the spaces predominantly without trees were avoided. As a result, strong habitat fragmentation is not beneficial for the species.

While some sources affirm that it has became more seldom in the last decades due to the vigorous human presence in the breeding area (CIOCHIA, 1992), the tolerance of the species to a certain level of forestry activity was also observed by other authors (SHURULINKOV et al., 2012). Also, MUNTEANU (2012) mentions that it lives mainly in tall forest of spruce, interrupted by windbreaks, clearings or openings, but, on the other hand, its density was bigger in some closed forests without human activities than in others where the logging was high and illegally practiced (SHURULINKOV et al. 2007).

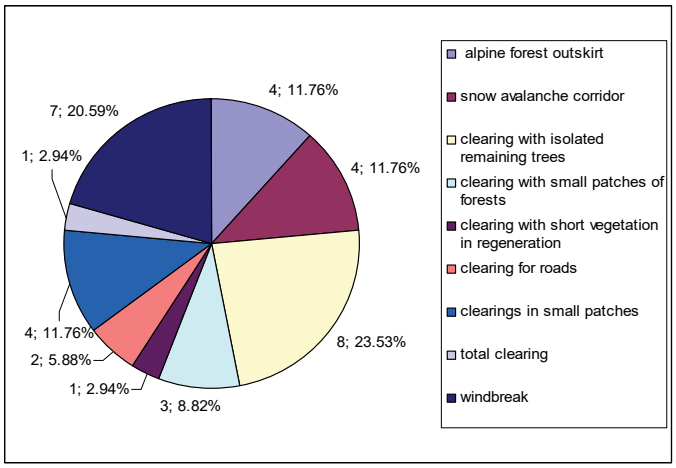

Figure 5. The diagram of distribution depending on the type of the nearest open space (n = 34 individuals).

A reason for why the Pygmy Owl prefers the limits between the mature boreal forests and the open spaces is that it has crepuscular habits (SVENSSON et al., 2009) and even day light activity (EZATTI, 2015) and some researches shows that it uses UV light to detect the prey, similar to diurnal raptors (STRØM & SONERUD, 2001). Its strategy is to stay in the forest and wait for food (HÄRMÄ et al., 2012): birds, even thrushes (*Turdus* sp. Linnaeus, 1758) (SVENSSON et al., 2009) and Great Spotted Woodpeckers (SNOW et al., 1998), and small rodents and shrews, the mammals being more than 50% of the diet. The proportion of birds increases when the mammals are scarce and, rarely, it consumes lizard, fish and large insects (SNOW et al., 1998; MIKKOLA, 2012). The owls use high perches for prey surveillance (STRØM & SONERUD, 2001). According to DEUTSCHMANN (2013), the combination of close forests and open spaces supplies the food year-round (EZATTI, 2015). The outskirt effect on biodiversity can be essential in this regard, too. Also, it is known that the species prefers the areas with moist or swampy terrains, or rivulets with open water, near groups of younger spruces, to place its nest, and, equally, the quarters with dead trees which attract insectivorous birds, as food, and woodpeckers, as builders of nest holes (KÖNIG & WEICK, 2008). In our area, the density of the hydrographical web is up to 1.3 km/km^2 (UJVÁRI, 1972).

Table 4. The main parameters regarding the weight (%) of the clearings and natural openings from the area of mature and relatively mature forest (1) and from the area of all forests, including clearings (2).

Parameter	**1**	**2**
Mean	25.97	16.04
Standard Deviation	25.08	12.98
Range	90	45
Minimum	0	0
Maximum	90	45
Count	24	24
Confidence Level (95.0%)	10.59	5.48

As regards the behaviour, the birds generally responded to the play-back signals, came to investigate us (while a few stayed away) and uttered calls of territory. Some individuals used for this purpose perches with good visibility: top of spruces in forests – 76.0% (19 cases) or dead trees in the deforested area – 4.0% (1 case), and others stayed inside the crowns – 20.0% (5 cases). About the height where the birds stood, 16.66% (4 cases) were seen under 5 m, 29.16% (7 cases) were seen between 5 and 9.9 m, 25.0% (6 cases) were seen between 10 and 14.9 m, 8.33% (2 cases) were seen between 15 and 19.9 m, 16.66% (4 cases) were seen between 20 and 24.9 m, and 4.16% (1 case) were seen above 25 m, the mean being 10.70 m (n = 24).

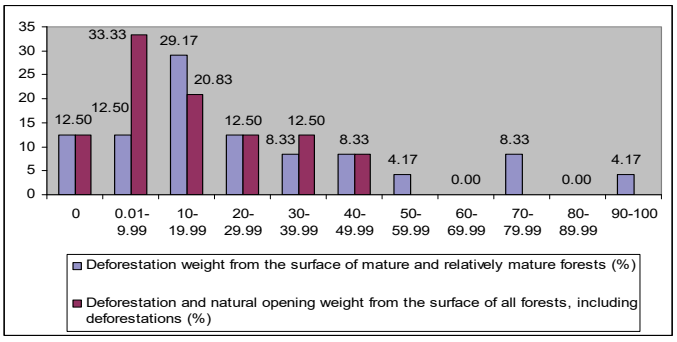

Figure 6. The distribution on intervals of percents of the weights of deforestation from the surface of mature and relatively mature forests and of the weights of deforestation and natural opening from the surface of all forests, including deforestations (n = 24 points of counting).

Just one individual was found by chance, without the help of play-back device, on November 8, 2014. It was spotted on the top of the young spruce (at 7 m height) from the bottom of the valley, in an old cut area with young rare trees, at 1,350 m a.s.l. The bird accepted us up to ca. 10 meters away and it continued to hunt ignoring us, from a dead branch, at 3 m height, from where it searched the prey from the ground, moving quickly its head.

There were 3 situations when males were registered singing isochronously, on January 28, 2018, March 25, 2018 and December 9, 2018. They were always on different slopes and the minimum distance between them at the initial place of observation was 0.69 km and the maximum, 0.92 km.

Some remarks about the attitude of the owls from the time or after the time of play-back emissions:
- February 28, 2015, 12:55, 14:20, 14:50 – 3 individuals, apparently singing louder in the distance and slower nearby, maybe because of the wind direction change;
- April 11, 2015, 15:00 – 1 individual that came from ca. 1 km and that uttered light calls;
- November 21, 2015, 12:10 – 1 individual responding (initially having a stutter) on light rain;
- November 30, 2015, 11:10 – 1 individual singing agitatedly, with a stutter at the beginning, and actively seeking the alleged rival through flights (inclusively gliding) from a tree to another, a behaviour performed when the bird became aggressive (KÖNIG & WEICK, 2008);
- January 1, 2016: 12:20 – 1 individual coming to us incognito, then singing agitated, fanning the tail, and performing short flights after play-back resumed, after that singing unprovoked (initially having a stutter) from a small distance, by 10 minutes from the switching of the play-back device, the cause being the human voice;
- January 24, 2016, 10:55 – 1 individual responding from distance to the play-back, coming unspotted near us and singing unprovoked;
- January 30, 2016, 10:45, 11:40 – 2 individuals responding from distance to the play-back, coming unspotted near us, one of them uttering calls (5 times, in series of ca. 1 minute, in a 30 minutes interval) in response to our voice; the other sang on both slopes of the major ridge, probably from the margin of its territory that it did not passed;
- February 14, 2016, 12:10 – 1 individual singing (initially having a stutter) and hiding in the crown of the spruce when the wind became stronger (stopping the calls);
- April 9, 2017, 11:40 – 1 individual coming to 4 m away from the device, from over 1 km away;
- January 28, 2018, 11:20 – 2 individuals responding simultaneously to the play-back sounds (on fair weather with wind of 3 on Beaufort scale), both coming to the outskirt from different valleys; one individual occupied the top of a spruce, uttering strong calls, while the other remained at 50 m away, hidden in the crown of the trees and uttering lighter sounds, concomitantly with the first or in the moments of silence; for two times, it emitted a short song, more elaborated than usually;
- February 17, 2018, 10:10 – 1 individual calling and searching insistently for the source of signals, flying between the tops of spruces; it stopped and uttered, for a few minutes, a series of rapid sounds; finally, it retreated inside the forest, on top of a spruce, where stayed until 11:35, when a Golden Eagle (*Aquila chrysaetos* Linnaeus, 1758), which overflew it (at 200 m height), eloigned;
- December 2, 2018, 11:00 – 1 individual responded to the play-back 40 minutes after the calls stopped; it called ca. 10 minutes; at 12:10, 12:20 and 12:40, it uttered spontaneous normal calls for 1-2 minutes, while at 12:05 and 12:50 it uttered series of accelerated sounds; it ended the calls when an individual of Hooded Crow (*Corvus corone cornix* Linnaeus, 1758) arrived 100 m away;
- December 9, 2018, 11:10 – 2 individuals responded to the play-back, from the nearby valleys – the first responded immediately, the second one after ca. 30 seconds; by 45 minutes, the birds appeared at the outskirts, on opposite slopes, 245 m apart from one another, the first one called spontaneously, uttering accelerated sounds, followed by normal calls, for 1 minute, at the same time, the second one calling, too, but slower; after 10 minutes, the situation repeated; the first individual always occupied the top of the spruces, while the second one remained constantly inside the crown of trees, appearing to be dominated by the other.

Several Passeriformes species became alerted when they heard the play-back sounds: Wren (*Troglodytes troglodytes* Linnaeus, 1758), Nutcracker (*Nucifraga caryocatactes* Linnaeus, 1758), Goldcrest (*Regulus regulus* Linnaeus, 1758), Great Tit (*Parus major* Linnaeus, 1758), Coal Tit (*P. ater* Linnaeus, 1758), Crested Tit (*P. cristatus* Linnaeus, 1758), Willow Tit (*P. montanus* Conrad von Baldenstein, 1827), Long-tailed Tit (*Aegythalos caudatus* Linnaeus, 1758), a few gathering in high numbers, mainly because of their social life in winter: Siskin (*Carduelis spinus* Linnaeus, 1758) – maximum ca. 20 individuals in a flock, Red crossbill (*Loxia curvirostra* Linnaeus, 1758) – maximum ca. 50 individuals in a flock. They uttered an alarm sound concomitantly with the Pygmy Owl calls or in its absence, proving that the owl was in the area or that the birds knew it from other occasions. Other authors have reported similar situations, too (KÖNIG & WEICK, 2008). These birds reacted because they are on the menu of the Pygmy Owl (KELLOMÄKI, 1977), but in the case of the Nutcracker, a much heavier bird, most likely it is about food competition (MIKUSEK, 2019).

Some individuals seem to know that the human is the intruder, others do not. These birds looked at us, and, as we mentioned above, responded to our voice. In other situations, they even attacked the humans who used the play-back (KÖNIG & WEICK, 2008).

CONCLUSIONS

Considering the best conditions for monitoring, the density of the Pygmy Owls from the investigated areas from the Făgăraș - Iezer-Păpușa - Leaota Mountains can be estimated at 0.73 pairs/km^2 in the forests of spruce and at 0.61 pairs/km^2 in the forests of spruce with logging. It is lower in other types of habitats, so the whole population from the area can be assessed at 450-650 pairs (of which, 350-500 in Făgăraș Mountains). However, we think the figures are overrated because the forests are not uniformly distributed and the younger ones predominate in the lowlands.

The majority of the owls were recorded on flanks oriented to north-north-west, south-west and south, each with 14.7%, and this can be linked to a multitude of factors like the local conditions of habitat, occurrence of the predators or woodpeckers, food etc.; the westness assumption was confirmed to a small extent.

Most individuals were observed between 15 and 19.99° terrain gradient (the average, 26.09°) and this can reflect both the preference of the birds for a slope and the predominance of typical relief for the mountain region.

The shortest distance between the initial place of observation of every individual and the nearest open space is, on average, 85.85 m, while most individuals were recorded lower than 50 m.

The owls preferred to stay in mature forests, near open spaces, whether they were natural or man made, and avoided the vicinities of the terrains devoid of trees, like the alpine pastures and completely deforested areas; they seemed to assimilate the artificial open spaces with the natural ones.

On average, within the studied area, the weight of open spaces from the forests in relation to the areas covered by mature and relatively mature forests was 25.27% and the weight of open spaces from the studied forests in relation to the areas covered by all forests, inclusively the exploited ones, was 16.04%. The Pygmy Owls were recorded mainly in the forests where the open spaces represented less than 10% of the areas covered by the forest fund and where the proportion of open spaces was between 10 and 10.99% of the mature and relatively mature forests.

Regarding the behaviour, we observed that some birds were braver than others, recognising the man as an intruder. Some of them responded to the human voice, while others actively sought the alleged rival through flights from tree to tree. Generally, the males used the top of trees as place of call broadcasting and the stutters, registered from November to February, showed their raised state of excitation. At the limits between the territories, some males seemed to dominate others that manifested shyness and, in case of danger, the males stopped the calling.

Many species of Passeriformes, who are afraid of the Pygmy Owl, can be used as indicators of its presence.

Because some males responded even after 40 minutes from the play-back calling, for good results, the time of expectance after sound emissions should be increased up to at least 30 minutes, where the birds do not betray their presence.

We trust our data will be helpful for the forestry administrators of the area to protect this species, presently listed in the Annex I of the Birds Directive (DIRECTIVE 2009/147/EC), and therefore subject of special conservation measures concerning its habitat in order to ensure its survival and reproduction in its area of distribution. While it is considered a good indicator of biodiversity and ecosystem health (ROMULO, 2012), the species proved to be tolerant to the logging to a some extent and, so, its protection should be assured not only in the conserved forests, but in whole coniferous and mixed woods from the suitable area, maintaining plots of mature trees within the exploited areas.

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