Research on the morphology of stray dogs from the hunting funds managed by the "Ștefan cel Mare" University in Suceava

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Abstract. The paper analyzes aspects regarding the morphology of stray dogs in the areas bordering the municipality of Suceava and nearby towns. The study is located on the hunting funds, which are administered by the "Ștefan cel Mare" University in Suceava. Between October 2017 and April 2022, the behavior and type of food consumed by stray dogs captured or found dead on the outskirts of cities in the analyzed area were analyzed. The capture of stray dogs is part of the duties of the specialized technical staff in charge of the protection of game and the protection of hunting funds according to the Law on hunting and the protection of hunting funds no. 407/2006. The research was based on the opportunity to conduct an objective study on the degree of feralization of stray dogs and their influence on wild animals. In this sense, the distribution and density of dogs in the open field was established and their movement routes were followed. Areas where packs of completely wild dogs are camped have also been identified. Along with the patrols and guarding to protect the game, permanent observations were made on the individual and social behavior of the dogs. Thus, 183 stray dogs were captured or found dead and the main morphological parameters such as trunk length, chest circumference and weight were analyzed. At the same time, the morphological sizes of a number of 115 stray dogs from the paddock managed by Suceava City Hall were recorded.

Key Words: chest circumference, correlation, morphology, stray dog.

Introduction. In the 21st century, a major biodiversity conservation objective is to maintain and/or restore the health of natural ecosystems. The realization of this desire is challenged by numerous anthropogenic threats, both in the long and immediate terms.

One of the most important and debated anthropogenic influences on the environment is related to the raising of domestic animals and their impact on the environment and biodiversity. Man has transformed from hunter-gatherer to farmer and breeder of domesticated animals, so that these activities cannot be separated from the existence of humanity. On the other hand, domestic animals create a very high pressure on natural ecosystems, starting with deltaic, steppe, forest-steppe, forest and alpine gap ecosystems. The most obvious disturbance is produced by grazing and free-ranging domestic animals. Practically, the negative impact of domestic animals on biodiversity has multiple economic, social and political implications, mainly on the values of rural populations. In this sense, contradictions can arise between the need to conserve or restore biodiversity and local traditions, which can generate social tensions.

One of the domestic animals that have a major influence on biodiversity is the domestic dog (*Canis lupus familiaris* L.). The dog is the most numerous terrestrial carnivore, with more than 700 million specimens (Hughes & Macdonald 2013). The disturbance that the stray dog can cause to natural ecosystems goes far beyond human-populated areas (Young et al 2011), through predation, disease transmission, disturbance of the peace of wildlife, hybridization and their predation by other wild carnivores. The ways in which dogs impact wildlife are multiple and are only caused by loose, stray or feral dogs. This situation/problem is recorded worldwide, on all continents (except Antarctica), on islands and in all terrestrial ecosystems that can support life.

Studies of these threats are relatively few and inconsistent, with many aspects being poorly understood or unexplained. For example, stray cats (*Felis catus*) have received more attention (Patronek 1998) and stray dogs have received less attention, despite being a major problem (Feldmann 1974). Studies on the association of interaction between wild animals and stray dogs are not focused on population-level impacts. However, the few studies that have analyzed these issues indicate the negative impact of stray dogs on native species. An example is the study on the effect produced by stray dogs on the population of Ethiopian wolves (*Canis simensis*), through disease transmission and hybridization (Laurenson et al 1998). However, no evidence of competition for food and space between the two species was identified (Atickem et al 2009).

The worldwide dog population is estimated to be over 500 million (WHO-WSPA 1990). According to other sources, the population of dogs on the world map would be around 700 million, of which around 75% are classified as stray dogs (Smith et al 2019). Dogs are used for hunting, to protect property, to reduce human-wildlife conflicts, as pets or utility animals, and for entertainment (Khan 2009). Domestic dogs can also improve non-invasive wildlife research and management methods (Cablk & Heaton 2006; Long et al 2007), examples being the detection of the spread of tortoises (*Gopherus agassizii*), species difficult to detect in the wild, such as black bears (*Ursus americanus*), marten (*Martens pennanti*) or lynx (*Lynx rufus*).

When neglected or no longer needed, dogs can become feral or stray. In certain areas, stray dogs become the most abundant carnivores, significantly disrupting ecosystems (Feldmann 1974; WHO-WSPA 1990). Dogs also spread disease, harass or kill wildlife, and compete with endemic species. As carriers of pathogens for diseases such as rabies, parvovirus, leptospirosis, coronavirus (Xia 2020), dogs can cause significant declines in native wildlife populations, many of which are threatened or endangered (Woodroffe 1999); for example, the decline of the population of seals in Lake Baikal (*Phoca sibirica*) (Mamaev et al 1995). Stray dogs come into direct contact with both humans and wild animals, leading to the potential transmission of zoonotic diseases, diseases that would not occur in humans (Salb et al 2008). Apart from being an important source of emerging disease pathogens, stray dogs also act as a junction for parasite exchange between humans, domestic animals and wildlife. At least 60 species of parasites are known to be transmitted to humans, cats and dogs (MacPherson 2005).

Although direct killing of fauna is the most obvious, many dogs track endemic species, which directly results in increased stress and energetically costly behavior for native fauna (Lenth et al 2008). The mere presence of dogs discourages the use and occupation of the respective areas by wild animals (Lenth et al 2008) and may induce negative effects on the reproduction rate of indigenous species such as ungulates (Gingold et al 2009). Small animals such as rodents, as well as large ones such as kudu (*Tragelaphus strepsiceros*) have also been documented to be killed by dogs (Green & Gipson 1994; CDW 1998). In addition, dogs act competitively within the predator complex (Boitani et al 1995; Vanak & Gompper 2009).

In some cases, the effects of predation by feral dogs can be more pronounced than those of wild predators. In a study carried out in the French Pyrenees, a number of 733 domestic sheep were killed, of which 91% were caused by stray dogs, the rest of the percentage being attributed to the brown bear (*Ursus arctos*) (Bouvier & Arthur 1995). Thus, the question arises of the possibility of a higher rate of predation by stray dogs, especially near human settlements. This problem can become more widespread if it is caused by the absence of human settlements, as direct and indirect stocking by humans leads to the creation of higher densities of dogs, which can increase predation pressure on wildlife. This is independent of variations in the size of wild prey populations. High densities of stray dogs can have negative effects on the recovery of small prey populations. The same is true even for low densities of feral dogs (Banks & Bryant 2007). For example, efforts to recover the population of kiwi birds (*Apteryx australis*) are hampered by the high number of mortalities caused by stray dogs – 70% of the 194 dead birds studied (Pierce & Sporle 1997). This case is particularly important, as a single stray dog was implicated in the early decline of the Kiwi species. The stray dog was only discovered when the Kiwi birds were radio-tagged. Another similar study, which used genetic analysis to assess the diets of wolves (*Canis lupus*) in conflict with livestock farmers, found that faecal samples collected as wolf droppings were misidentified as coming from dogs wanderers (Echegaray & Vila 2010).

It can be stated that studies on the stray dog population need to be multiplied and diversified globally. In general, the analyzes and studies carried out so far are punctual, reported on relatively small spaces and are mainly based on the observation method. In Romania, studies on the impact of the stray dog population on the environment are extremely limited. Most of the discussions related to stray dogs are reported in the mass media, most of the time the participants being people without knowledge and practice in the field. Most of the time, discussions are carried out under emotional impulses and have a subjective character. More detailed research on stray dogs has been carried out by students, teachers and researchers from universities of veterinary medicine, and is focused in particular on the ability of dogs to transmit diseases to humans, domestic animals and wild animals (Dascălu et al 2017; Ilie 2018; Miron et al 2019; Clipa 2014). Cases of stray dog attacks on wild and domestic animals are not reported to local authorities or, when they are, the necessary measures are not taken.

In the case of hunting funds, their managers, through the game wardens, record in the terms of service the events of attack and harassment by stray dogs on the game specimens under management. All these records are not reported to a higher regional or national forum for centralization, similar to record systems in other states (Wierzbowska et al 2016). The relevant Romanian legislation (H.G. 1679 of 2008) does not currently provide a centralization of the number of specimens of wild and domestic animals killed by stray dogs. Current regulations only provide the identification and reporting of damage caused by large carnivores to both wild and domestic species (Bouriaud 2010). In the case of feral dogs, there is no exact statistic of the deaths caused by them to other animals, wild or domestic. Official reports are inconclusive, as there are few recorded complaints accusing stray dogs of specific livestock damage. In 2015, as part of the WolfeLife project financed by the European Community, the Association for the Conservation of Biological Diversity (ACDB) proposed in the project report firm measures to reduce the herds of stray dogs in the area of the Eastern Carpathians. This report was drawn up following professional evaluation and analysis studies of stray dog populations in the area proposed for research (ACBD 2015).

Another eloquent study regarding the unstable management of herd dogs in the Caransebeș area and the Țarcului Mountains, is the one from the bison introduction analysis made by Monica Vasile and Ștefan Voicu. In this study, the phenomena that can occur due to the large number of herd dogs, on a project for the sustainable management of the bison population, are presented (Voicu & Vasile 2019). The most recent study at national level was carried out in February 2022 by the "Societatea Română de Salbăticie", in partnership with the "Federation Coaliţia Natura 2000 Romania" and the "Association for Community Partnership Braşov", with the financial support of Active Citizens Fund Romania, program funded by Iceland, Liechtenstein and Norway through EEA Grants 2014-2021. The study was carried out within the project, "Roaming and stray domestic animals in Romania. Defining the social and environmental problem through a participatory approach and social innovation". The project included an opinion survey, by completing an online questionnaire. A number of 678 questionnaires were validated, which were completed voluntarily, individually or with the support of field operators. The sample of respondents had the following composition: 34% men and 64% women, of which 32% from rural areas and 68% from urban areas. The fact that stray and stray domestic animals are a problem which needs to be solved was approved by 92% of the respondents. Also, 85% of respondents stated that they have a positive attitude towards these animals and feel "pity" for them. Worryingly, 70% of people surveyed were unaware that stray cats and dogs cause damage to wildlife, disrupting biodiversity. Although this survey is not quite conclusive, from the point of view of the homogeneity of the people surveyed (the online survey involving people with a certain intellectual status), it can be considered a start in opening a dialogue with the community (Opincaru & Vasile 2022).

In Romania, research in the field of ethology of stray dogs is few and recent. The political, economic and social turmoil in Romania, amplified by the extremist environmentalist and protectionist attitude of various organizations, foundations and non-profit associations, creates confusion and misinforms through all media. The point of view of specialists, which is based on objective scientific data, on niche research, is perceived as a sterile and far too technical report. Because of this, the impact on the population is insignificant, receiving the emotional, easy-to-understand information that creates the rating.

The mechanisms by which many dogs become free are multiple and only related to the human factor. Most often, disinterest in keeping and caring for a dog leads to its release, so that it is forced to procure its own food. Thus, after a few generations, dogs appear adapted to survive in complete freedom, either near people, or in semi-wild or total wildness.

From a practical point of view, it is of interest to accurately identify the tracks of dogs in the field, by differentiating their tracks from the tracks of other canids. The tracks of dogs are often confused with those of wolfs, foxes or jackals. Differentiation, however, is very easy to achieve (Figure 1).

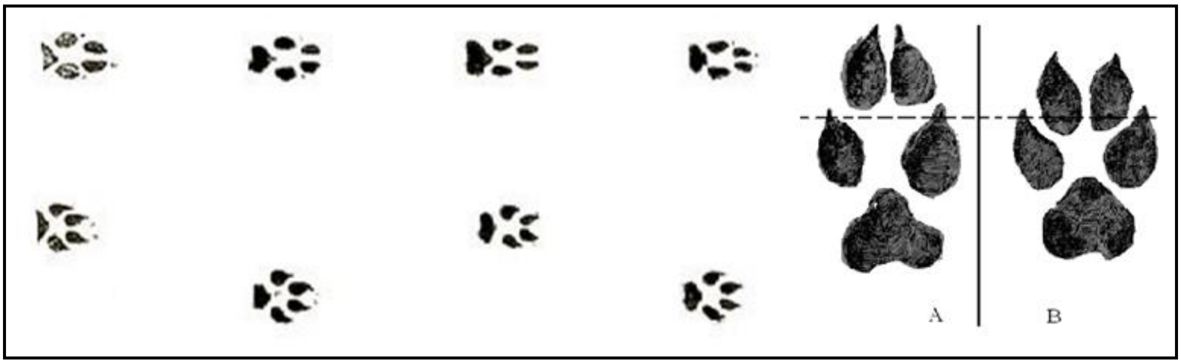

Figure 1. Top: wolf trace; down: dog trace; A - wolf trace; B - dog trace.

The toe marks on the dog's forelimbs are further apart than those of other canids. The shape of the trace is rounder in the dog. In the dog track, if a line is drawn at the base of the claw roots, it will intersect the pads of the front toes, while in other canids this line will not touch the pads of the front toes. There are also differences in the trail, with the dog's tracks being zigzag, while the wolf's and fox's tracks being in a straight line (Figure 1).

From the point of view of biological analysis, the first step for a study could be the morphological analysis, which involves measurements such as lengths, circumferences, weights, heights, etc. In this sense, for practical reasons, people have been looking for solutions to estimate the body weight of animals through various empirical formulas, without using the scale. These relationships can be used when the weighing effort is too high (very large animals, considerable distances to the nearest scale, direct assessment in the field without carrying a scale, etc.). These methods use certain morphological sizes of the analyzed animals in the empirical weight calculation formula. The method of calculating the weight of a mammal based on certain body dimensions is called barymetry. These methods were designed to compensate for the visual estimation and inconvenience of mechanical weighing. Pioneers of barymetry were Adolphe Quetelet and Jules Crevat. In 1890, Jules Crevat created a zoometric formula and a measuring tape, which bears his name, in order to easily and quickly estimate the weight of cattle to obtain a subsidy.

$$G = 80 \times (PT)^3$$

Where: G – weight (kg); PT - chest circumference (m).

The created formula is a simplification of the formula obtained by Quetelet for determining weight in men:

$G = (11/80) \times PT^2 \times LC$

Where: PT - chest circumference (cm); LC- trunk length (cm).

These relationships are still used nowadays, for educational purposes in zootechnical schools.

The most accurate and simple barymetric formula was approved in 2004 in the USA. The formula was created by Alyssa Hapgood, following measurements taken on horses over five years. The formula takes into account height at withers (HG), chest girth (PT) and body length (LC) (Clay 2004).

$\text{Weight} = (PT \times 1.64 \times HG \times 0.95 \times LC \times 0.40)/278$

The formula is valid with weight expressed in pounds, and dimensions are in inches, with an accuracy of 98% (Clay 2004).

The purpose of the present research is to assess the morphological structure of the roaming dog populations on the study hunting grounds, as well as to identify a barymetric relationship for determining the weight of the dogs, directly on the ground.

Material and Method. The study area was chosen taking into account the fact that urban agglomeration is one of the main factors for the dispersion of stray dogs in the outskirts, in areas with important forest zones, agricultural and pasture ecosystems (Figure 2, Table 1).

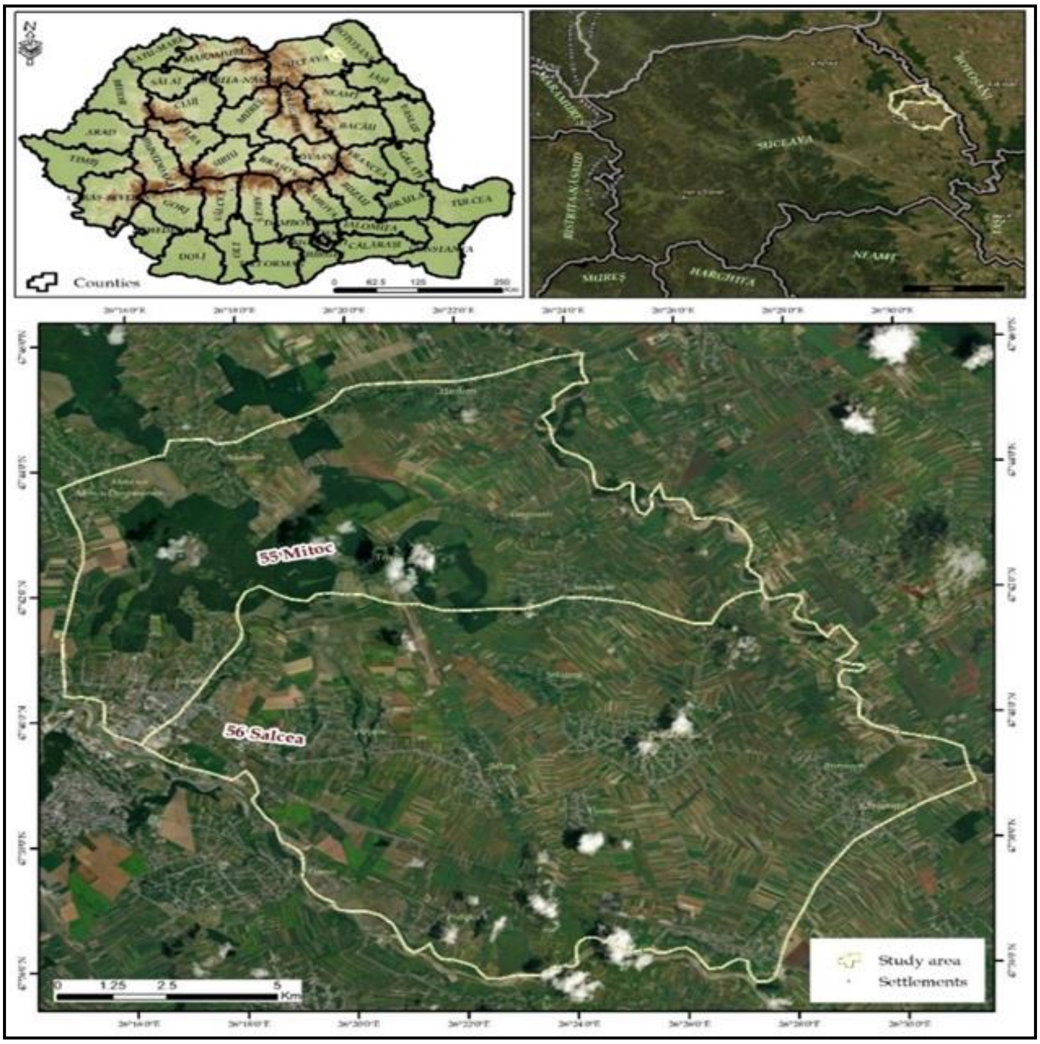

Figure 2. Geographical location of the study area.

Table 1

Area of hunting grounds by categories of use and total study area

Hunting fund	*Measurement unit*	*Hunting productivity for:*						*Unproductive hunting*	*Total*
		The swamp game	*Rest of game*						
		Water sheen (watercourses, canals, ponds, lakes, etc.)	*Forest*	*Arable, hay fields, vineyards, orchards, etc.*	*Pastures*	*Mountain hollow*	*Total*		
55	Ha	-	2550	350	2750	-	5650	1510	7160
Mitoc	%	-	36	5	38	-	79	21	100
56	Ha	50	56	1200	9287	-	10547	1705	12302
Salcea	%	-	-	10	76	-	86	14	100
Total	Ha	50	2606	1550	12037		16197	3215	19462
	%	-	13	8	62	-	83	17	100

From an administrative point of view, the study area includes several administrative territorial units (TAUs), namely the Municipality of Suceava, the City of Salcea and the communes of Mitocul Dragomirnei, Adâncata, Dumbrăveni, Verești, Siminicea and Hănțești. From the point of view of the forestry administration, the forest bodies in question are managed by the Adâncata Forestry and the Pătrăuți Forestry.

The research took place on the territory of two neighboring hunting funds, managed by the University of Suceava through the Faculty of Forestry, and which are adjacent to the municipality of Suceava (Dănilă et al 2016). From a hunting point of view, the uses encountered in the studied territory are: forest - 2606 ha (13%), arable land - 1550 ha (8%) and pastures - 12037 ha (62%) (Table 1). Of the total studied area of 19462 ha, 83% represents productive hunting area, 16197 ha. The area occupied by the forest represents 13% of the productive hunting area and is concentrated on the Mitoc hunting grounds, in the northwestern part of the analyzed region. From the point of view of physical and phytogeographical conditions, according to the Geographical Morphology of the P.R.R., the territory of the Dragomirna Plateau belongs to the East European Province, Moldovei Plateau Subprovince, Sucevei Plateau District (Seceleanu 2000). From an altitudinal point of view, the studied area is between 340 m at the Siret river and 425 m in Culmea Romanoaia, with an average altitude of 380 m. About 70% of the area is between 200 m and 400 m altitude. The vast majority of surfaces, over 75%, are sunny and partly sunny, and the slopes have values below 16%. The climate is generally harsh, with average annual temperatures between 6 and 8^{o}C, with early frosts and high humidity (600-700 mm annually). The climatic elements are favorable for native game species. Unfavorable are the excess precipitations that affect the rabbit herds, or the thick layer of snow that affects the deer population. Indirectly, the climate is also favorable in that it allows the optimal development of the main woody species and a relatively large variety of shrubby and grassy species.

In terms of biodiversity, the main forest wood species are beech (*Fagus* sp.*)*, hornbeam (*Carpinus betulus)* and oak (*Quercus robur)*, alongside cherry (*Prunus avium)*, sycamore (*Acer pseudoplatanus*), elm (*Ulmus* sp.) and ash (*Fraxinus* sp.) species that are well represented. The natural regeneration of the stands is appropriate, this being an advantage for wild animals, the thickets formed by the regeneration constituting a place of refuge and shelter, food and peace. Among the species of grassy plants, we can mention the water lilies (*Convallaria majalis*), the shepherd's sedge (*Capsella bursa-pastoris*), lady's bedstraw (*Galium verum*), peach-leaved bellflower (*Campanula persicifolia*), two-leaf squill (*Scilla bifolia*); medicinal plants: greater plantain (*Plantago major*), chamomile (*Matricaria recutita*), St. John's wort 9 (*Hypericum perforatum*), great mullein (*Verbascum thapsus*), dead nettle (*Lamium purpureum*), mallow (*Malva sylvestris*), yarrow (*Achillea millefolium*), horsetail (*Equisetum*), chicory (*Cichorium intybus*), coltsfoot (*Tussilago fárfara*), wormwood (*Artemisia absinthium*). On the edge of the forest you can find acacia (*Robinia pseudoacacia*), wild apple (*Malus* sylvestris) and wild cherry (*Prunus avium*), and along the rivers you can find sedge (*Cyperus polystachyos*), bulrush (*Typha latifolia*), reed beds (*Phragmites australis*) common knotgrass (*Polygonum aviculare*). The natural meadows include species of *Festuca*, *Rubra*, *Foa transesis*, *Lolium perene*, *Agrestis tenuis*, *Trifolium*, etc., in the composition of the mesophilic grassy vegetation of the meadows there are also species of: sedge, marsh sedge, field grass, etc.

The species of autochthonous fauna existing in the analyzed area are the red deer (*Cervus elaphus*), the roe deer (*Capreolus capreolus*), the fallow deer (*Dama dama*), the wild boar (*Sus scrofa*), the common rabbit (*Lepus europaeus*), the roe deer (*Meles meles*), the otter (*Lutra lutra*), the ferret (*Mustela putorius*), the tree marten (*Martes martes*), the stone marten (*Martes foina*), the weasel (*Mustela nivalis*), the ermine (*Mustela erminea*), the wild cat (*Felis silvestris*), and among birds, the partridge (*Perdix perdix*), mallard (*Anas platyrhynchos*), gray heron (*Ardea cinerea*), cormorant (*Phalacrocorax carbo*), swan (*Cygnus olor*), species of thrushes (*Turtidae*), etc. Migratory or passage bird species are also found, such as the quail (*Coturnix coturnix*), the starling (*Sturnus vulgaris*), the tit (*Scolopax rusticola*), the little duck (*Anas crecca*), the spoon duck (*Anas clypeata*), the quack duck (*Anas querqurdula*), summer goose (*Anser anser*), etc. Birds of prey from the Falconiformes and Strigiformes orders are also found: the buzzard (*Buteo buteo*), the pigeon buzzard (*Accipiter gentilis*), the red falcon (*Falcon tinnunculus*), the woodpecker (*Asio otus*), the little buzzard (*Strix aluco*), nightshade (*Athene noctua*) etc. The existence of predator species, mammals and birds, demonstrates that food chains are complete, which also shows that ecosystems are relatively "healthy".

Even if the area of interest is heavily anthropized, the forest ecosystems, hayfields, pastures and agricultural lands offer good conditions for the existence and development of a wide range of herbaceous and woody plants. Primary plant producers support and provide relatively good conditions for mammal and bird populations, which are well represented both numerically and in density. Agricultural land also represents, at certain times of the year, areas that provide food, shelter and peace for wild animals and birds that have adapted to this type of ecosystem.

The methods used for data collection were direct observations and measurements on the specimens captured from the field during the actions carried out by the technical staff, as well as observations and measurements carried out on stray dogs from the shelters in the municipality of Suceava (Figure 3). The analyses were carried out on each individual hunting fund and on the total analyzed surface. This way of research is also interesting from a hunting point of view, because the impact of the population of stray dogs on the species of hunting interest must also be taken into account, subsidiary to the general interest in the impact on the fauna. The observations were carried out between October 2017 and May 2022 by trained teams consisting of two to five members. The technical staff from the hunting department, teaching staff, collaborators, students and volunteers participated in the activities in the field, on the hunting funds managed by the Faculty of Forestry.

Figure 3. Measurements performed on dogs.

Quantitative measurements were made through direct observations, i.e. determination of length, chest circumference and weight, sex, color, approximate age, state of health, vigor, as well as other observations regarding some anomalies or other particularities were recorded.

The following information was recorded in the observation sheet:

Date: dd/mm/year
GPS coordinates: grd/min/sec/N - grd/min/sec/E
Age: A - Adult (after 12 - 14 months)/ P - Puppies (up to 4 months)/ J - Juvenile (between 4 - 14 months)
Sex: male (M), female (F)
Size: Large (>23 kg), Medium (9-23 kg), Small (<9 kg)
Trunk length: the distance measured from the tip of the muzzle to the base of the tail

Chest circumference: measured at the level of the maximum convexity of the chest after the front limbs
Weighed weight
Photo code: the number automatically assigned by the camera to the photo taken;
and so on.

The following devices and equipment were used to collect field data: Docter 8x58 B/CF binoculars – usually used for direct observations; camera with built-in GPS system, Sony DSC-HX60V - used for recording field data acquisitions and recording coordinates; Pulsar Axion Key XM30 – used for direct, day and night observations with the possibility of recording; Garmin GPSMAP 65 GPS – used for recording accuracy and information storage; tool kit for measurements.

As a result of the field actions, 183 specimens of stray dogs were captured from the productive hunting area of the hunting grounds (121 specimens on FC 55 Mitoc and 62 specimens on FC 56 Salcea). Of these, 19 specimens were found dead from unknown causes, or as a result of car accidents. The capture of stray dogs is part of the duties of the specialized technical personnel who deal with the protection of game and the guarding of hunting grounds according to the Law on hunting and the protection of hunting grounds no. 407/2006. The research was based on this opportunity to conduct an objective study on the morphological analysis of stray dogs. The capture location of the stray dog specimens was recorded in GPS coordinates.

For the morphological analyses, a distinction was made between the population of stray dogs identified in the wild and the population of dogs in shelters. For this reason, the measurements were made on a population of 183 free-ranging individuals, to which are added 67 shelter dogs, totaling 250 stray dogs.

To determine a barymetric relationship, in order to precisely estimate the weight of the dogs, the data measured for the 250 specimens, both from freedom and from the shelter, were used. Thus, the data resulting from the measurements of all 183 stray dogs captured were used, plus the data from 67 dogs measured in shelters, so a total of 250 specimens. This represented the statistical analysis population. To verify the barymetric relationship, the measurements performed on another 48 dogs in the shelter were used, whose measurements were not used for the calculation of the regression model.

The analysis and recording of the collected data regarding the location of the captured specimens was done in the office, using photo processing with the ArcGIS computer platform (ESRI). Each photo has geographic coordinates attached - latitude, longitude and altitude.

Using the Kernel Density method, the density and distribution of the identified stray dogs was calculated. The distribution of dogs in space and by gender was also analyzed.

The Excel (Microsoft Office) application was used for the primary and statistical data processing. The main statistical processing considered the distribution and analysis of correlations between different morphometric elements of the analyzed dogs.

Results and Discussion. Through specific processing, using the ArcGis computer platform, the spatial distribution of stray dog specimens was achieved. Thus, one can observe the distribution in the analyzed area, the concentration and dispersion in the field of stray dogs captured from the wild (Figure 4).

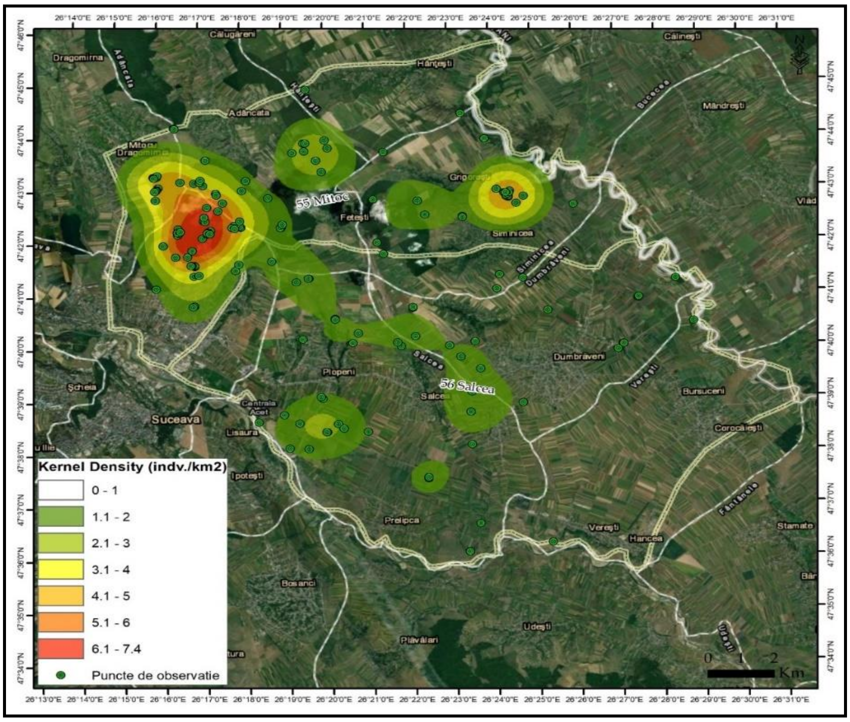

Figure 4. Spatial distribution of stray dogs on the total researched area.

Regarding the spatial distribution and density of dogs by sex (Table 2; Figures 5 and 6), an uneven distribution of males and females can be noted, even if the sex ratio is balanced.

Table 2

Density of stray dogs by sex at the level of the study area

Sex	*F*	*M*	*Total stray dogs*	*Area (ha)*	*Density per 1000 ha*		
					F	*M*	*Total*
Mitoc	56	65	121	5650	9.9	11.5	21.4
Salcea	30	32	62	10547	2.8	3	5.9
Total	86	97	183	16197	5.3	6	11.3

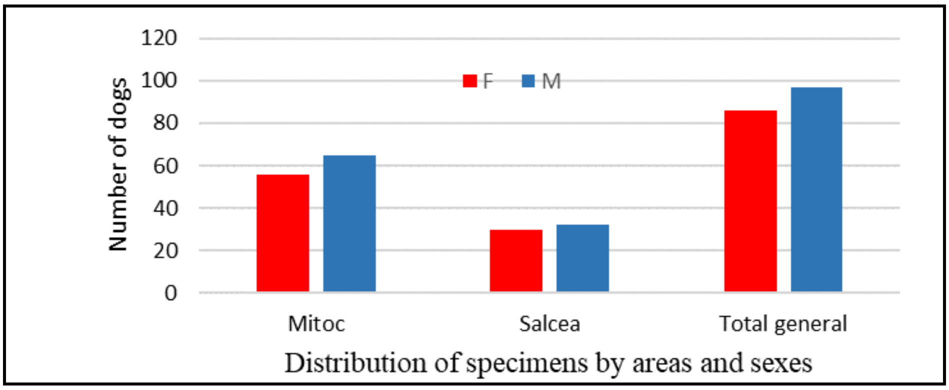

Figure 5. Distribution of stray dogs by sex.

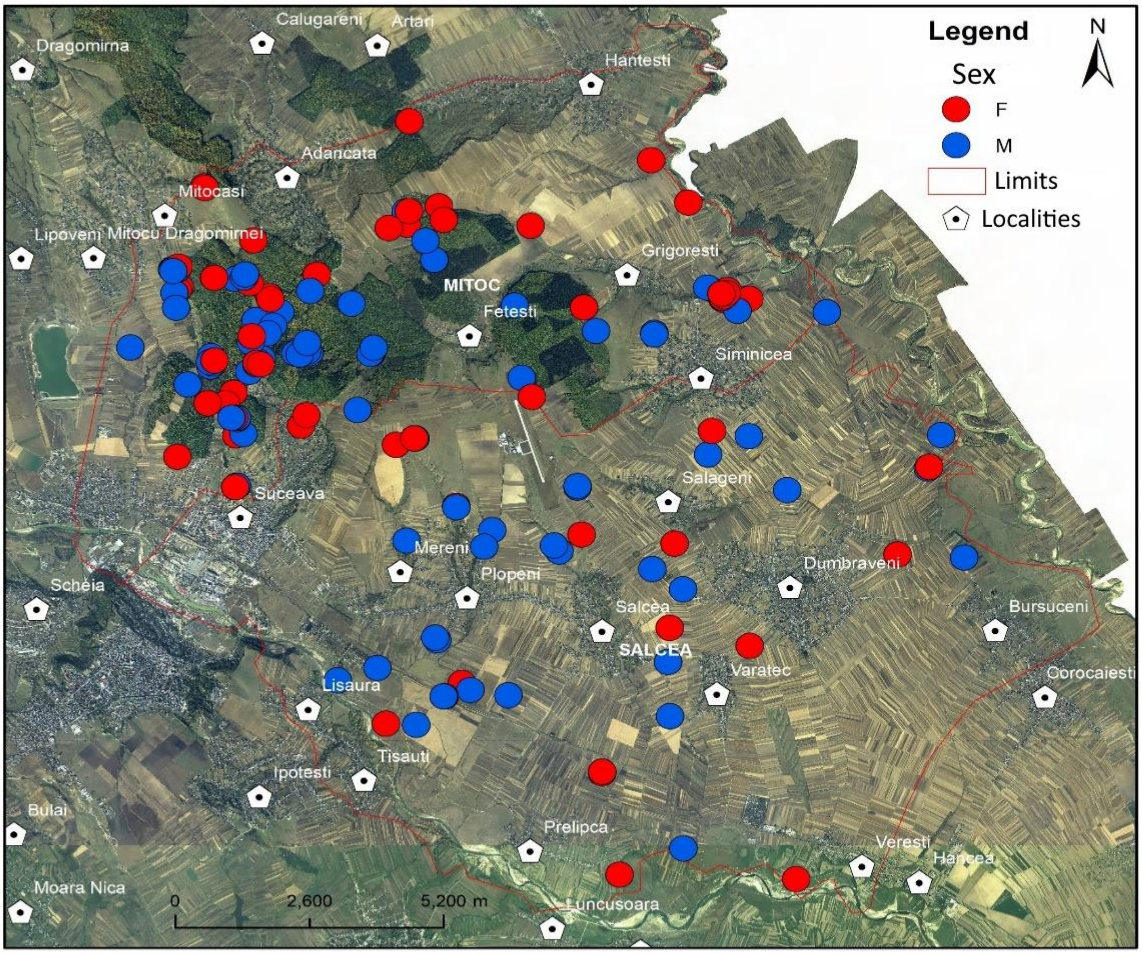

Figure 6. Spatial distribution of stray dogs by sex on the total researched area.

From a waist point of view, the results are shown in Table 3.

Table 3

Distribution of stray dogs by size

Waist	*Small*	*Medium*	*Big*	*Total*
F	11	55	20	86
M	8	68	21	97
Grand total	19	123	41	183

The morphological study involved the analysis of the different anatomical sizes of the measured dogs, both for stray dogs captured in the wild and for those in the shelter.

Thus, the correlation of chest circumference with weight (Figure 7), but also of trunk length with weight (Figure 8), was carried out, separately, for each hunting ground, but also for the total studied area (Figure 8A, 8B). Also, the correlation between the length and chest circumference of the specimens was determined (Figure 9).

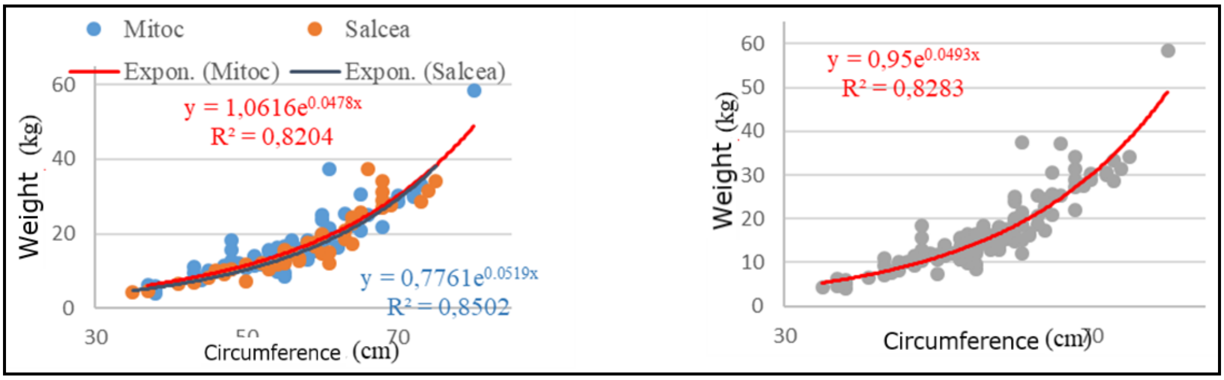

Figure 7. The correlative link between weight and circumference for each hunting ground (7A) and on the total analyzed area (7B).

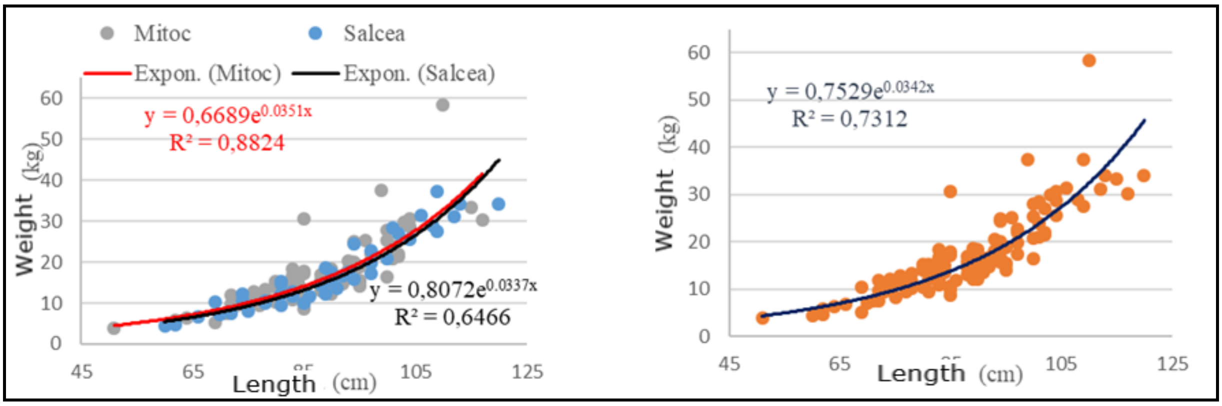

Figure 8. Correlation between weight and length for each hunting ground (8A) and for the whole analyzed area (8B).

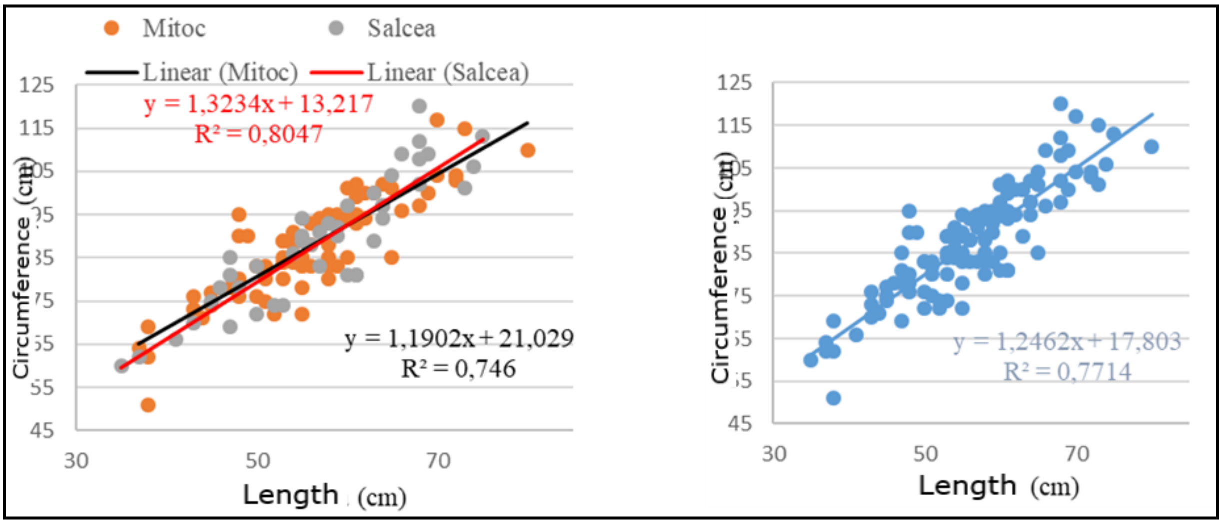

Figure 9. Correlation between circumference and length for each hunting ground (9A) and for the whole analyzed area (9B).

Next, the correlation between the three morphological elements, weight, chest circumference and length, was analyzed for the dog population from the Suceava shelter (Figures 10, 11, 12).

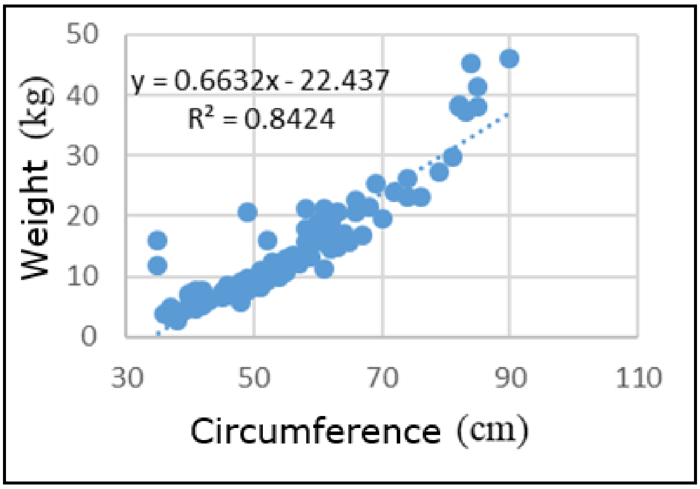

Figure 10. Correlation between circumference and weight for shelter dogs.

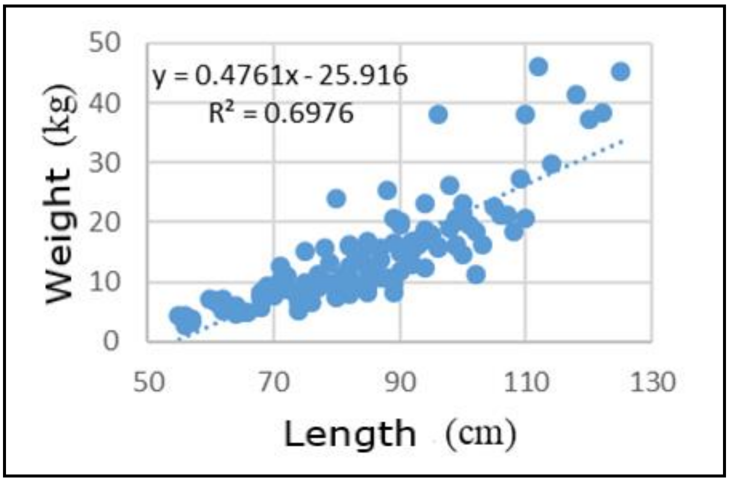

Figure 11. Correlation between weight and length for shelter dogs.

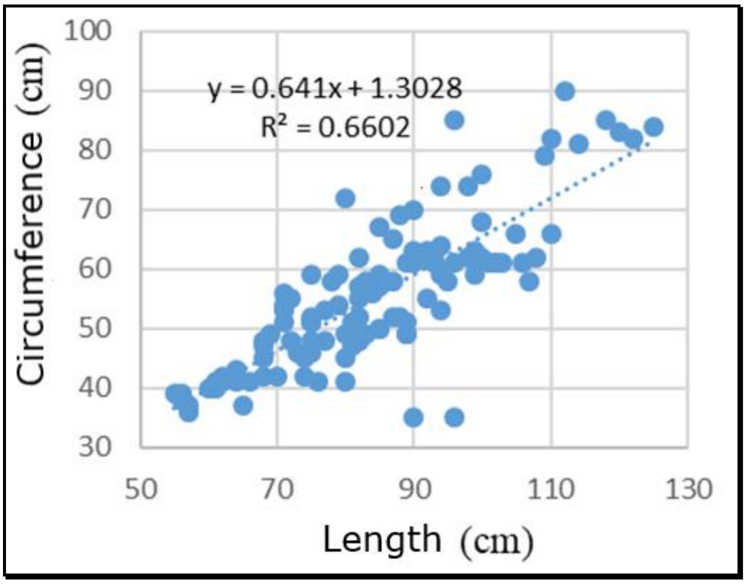

Figure 12. Correlation between length and circumference for shelter dogs.

In order to have a more eloquent result, the above anatomical sizes were also correlated for all 250 specimens, those captured and those from the Suceava shelter (Figures 13, 14, 15).

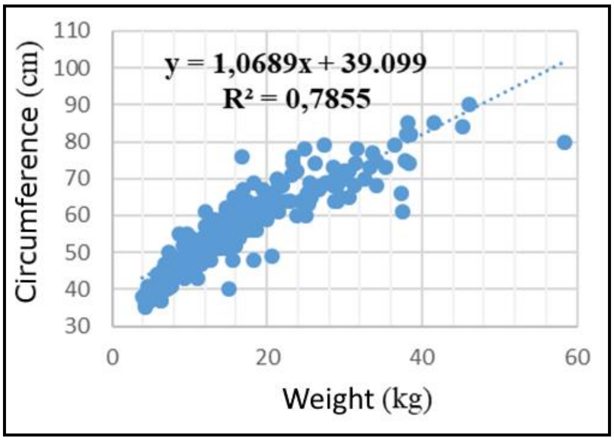

Figure 13. The correlative link between weight and circumference for total dogs (captured and sheltered).

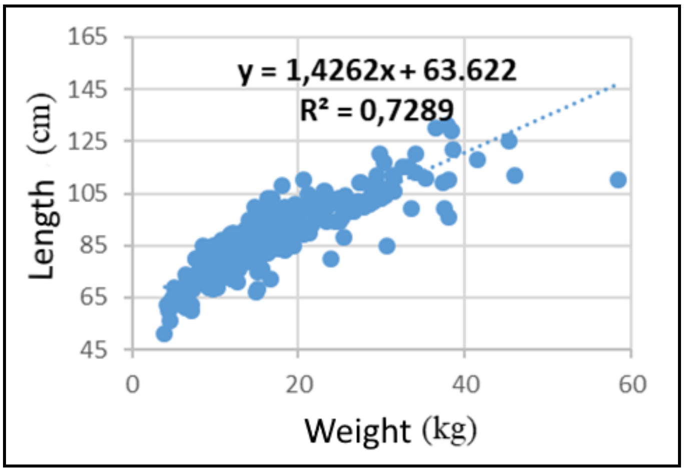

Figure 14. The correlative link between weight and length for total dogs (captured and sheltered).

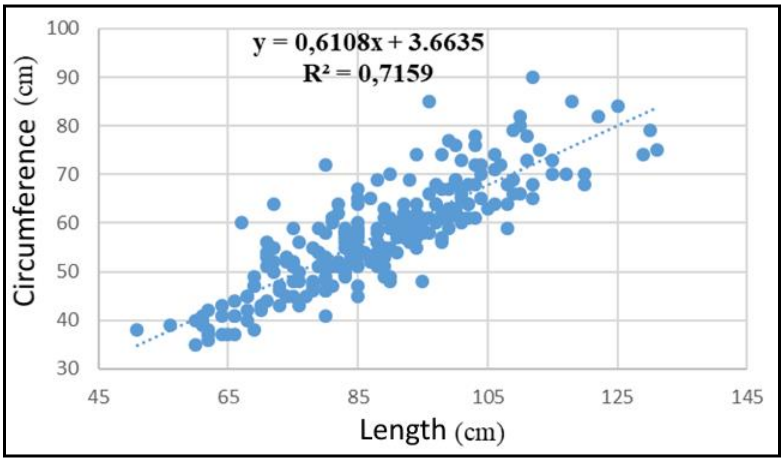

Figure 15. The correlative link between length and circumference for total dogs (captured and sheltered).

In order to determine a barymetric relationship, the statistical analysis resulted in the values presented in Figure 16.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	**0.903938954**							
R Square	0.817105633							
Adjusted R Square	0.815624707							
Standard Error	3.81386044							
Observations	250							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	16051.08603	8025.543014	551.7531647	**7.61624E-92**			
Residual	247	3592.74627	14.54553146					
Total	249	19643.8323						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-29.86340109	1.465871531	-20.37245451	**8.40698E-55**	-32.75060328	-26.97619889	-32.750603	-26.9761989
Lungime trunchi (cm)	0.27516916	0.024570172	11.19931767	**8.18332E-24**	0.226775387	0.323562933	0.22677539	0.323562933
Circumferinţă torace (cm)	0.396661566	0.03283575	12.08017376	**1.04088E-26**	0.331987789	0.461335344	0.33198779	0.461335344

Figure 16. Multiple linear correlation analysis for total number of dogs (captured and sheltered).

The form of the regression equation determined, for the estimation of weight according to length and chest circumference, is:

$$G = -29.86 + 0.27*L + 0.39*C$$

Where: G – weight in kg; L – length (without tail) in cm; C – circumference (immediately after the front legs) in cm.

To verify the determined barymetric relationship, the measurements performed on a number of 48 stray dogs from the shelter, which were left for verification, were used (Figure 17).

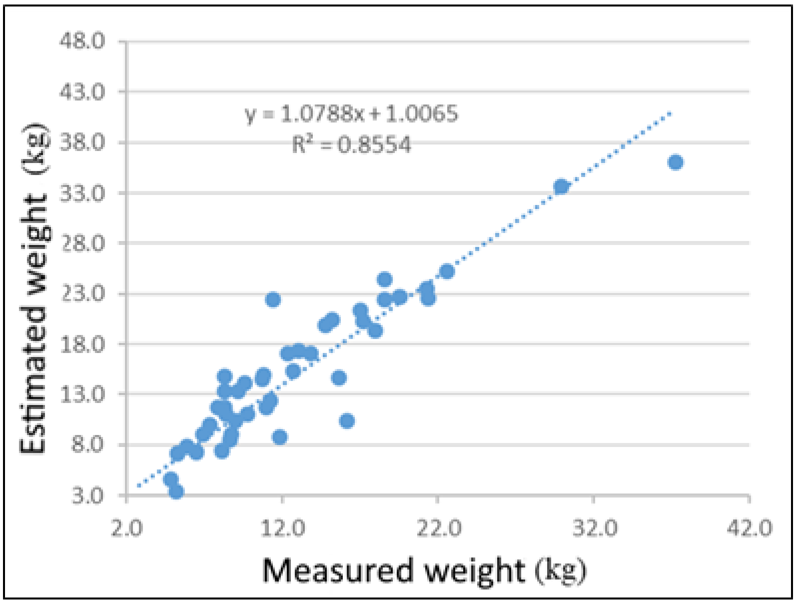

Figure 17. The correlative link between the measured weight and the model-estimated weight.

Finally, a multifactorial dummy analysis was also carried out, the variables being length, chest circumference and sex. The coefficients presented in Figure 18 emerged.

Model Fit Measures

				Overall Model Test			
Model	R	R^2	Adjusted R^2	F	df1	df2	p
1	0.908	0.825	0.823	387	3	246	< .001

Model Coefficients - greutate

			95% Confidence Interval				
Predictor	Estimate	SE	Lower	Upper	t	p	Stand. Estimate
Intercept [a]	-29.642	1.4181	-32.435	-26.849	-20.903	< .001	
lungimea	0.254	0.0281	0.198	0.309	9.023	< .001	0.4282
circumferința	0.426	0.0388	0.350	0.503	10.997	< .001	0.5223
sex: M – F	-0.129	0.4750	-1.065	0.807	-0.272	0.786	-0.0147

[a] Represents reference level

Figure 18. Dummy statistical analysis for all dogs of the statistical population (183 captured free and 67 from the shelter, a total of 250 dogs).

At a first analysis of the spatial distribution, one can notice an obvious concentration of stray dogs in areas covered with forest vegetation, as well as in the vicinity of household waste deposits (waste pits). This fact also emerges from the value of the density of stray dogs. Thus, on the 55 Mitoc hunting ground, 121 dogs were found on 5650 ha of productive hunting area, with a density of 21.4 dogs per 1000 ha. In the case of hunting fund 56 Salcea, this value was 5.9 dogs per 1000 ha. The high density in the Mitoc area is explained by the relatively large forest area, over 2500 ha. The preference of feral dogs for forested or near-forested areas is highlighted. Forested areas provide them with more opportunities for feeding, shelter and breeding compared to agricultural pasture land. It is obvious that, in forested areas, there is a higher concentration of wild animals, which attracts any type of predator.

In the analyzed area, ungulate species (deer, wild boar) have no natural predators, so this ecological niche can be occupied by wild dogs. Through their natural abilities, including that of hunting in packs, they put predation pressure, especially on roe deer (*Capreolus capreolus*, Figure 19), but also affect the young contingent from the wild boar species (*Sus scrofa*).

From the Kernel distribution analysis, the maximum concentration is in the Adâncata forest area located in the north-west of the area (red color), in the vicinity of Grigorești-Simincea localities. Secondary, some smaller nuclei - orange and green - orange color - near the town of Plopeni (Figure 4), near the waste pit and the agricultural lands in the north of the town where there is small game, are highlighted.

In the area devoid of forest vegetation in the Salcea area, dogs have a relatively uniform distribution and a much lower density, with predation/feeding pressure being concentrated on smaller animal species such as rabbits and various other rodents. Partridge nests destroyed by canid species, probably by stray dogs, have also been reported. The deer population in the study area has a density of 7.4 deer per 1000 ha, the wild boar density is 4.2 specimens per 1000 ha, and the rabbit density is 7.5

specimens per 1000 ha. The average density of stray dogs in the entire analyzed area is 11.3 dogs per 1000 ha. This value is very high, if we compare it with the density of wild species.

Figure 19. Roebuck specimens preyed on/eaten by stray dogs.

Regarding the spatial distribution of stray dogs by sex, a higher density of males can be found in areas without forest vegetation (about 35 males and 26 females). A balanced, almost equal number (about 62 males and 61 females) is observed in the areas with forest bodies. This discrepancy is caused by the fact that females need sheltered areas to raise their young.

In general, the ratio between sexes gives us information about the potential for population growth (the case of more females than males), or the increase in the intensity of natural selection (the case of more males than females) (Negruțiu 1983). Overall, the difference is relatively small, males predominating with 53%, compared to 47% females. However, the fact that males predominate indicates a potential increase in the intensity of natural selection, which can be amplified over time.

Regarding the waist, it is considered that a small waist includes specimens weighing less than 9 kg, medium waist falls between 9 and 23 kg, and large waist over 23 kg (Salt et al 2017). In this sense, the majority of 67% of the analyzed dogs are of medium size, 23% are of large size and 10% of small size. Obviously, the individuals with larger talons are the ones that adapt much more easily to the wild environment.

For the morphological analysis through the prism of the correlative link between weight and girth, very significant correlations result, for each fund separately, but also for the total. Thus, for the Mitoc hunting fund, in the correlation between weight and chest circumference, a high coefficient of determination (R^2=0.82) was obtained, which shows us that the statistical link between the two variables is defined by an exponential curve of the type Y=1.0616x0.478X. High coefficients of determination were also obtained in the correlation of weight with trunk length, with values of R^2=0.73, the statistical model being defined by an exponential curve whose relationship is Y=0.7529x0.034X. It can also be observed that the correlative links between weight and girth/length were modeled by exponential regression equations, and the correlation coefficients are highly significant.

For the correlation between circumference and length, the linear equations modeled this dependence better, in all three cases, with the same high value of the coefficient. For the Mitoc hunting fund, the correlation between circumference and length is highlighted, the coefficient of determination being R^2=0.8, and the linear model is defined by the relationship y=1.323x + 13.21. For shelter dogs, the strength of the correlation between weight and girth is the strongest (R^2=0.84), the weakest being between length and girth (R^2=0.66).

For the entire population of 250 specimens, strong significant correlation coefficients were found. In this case, the correlations were defined by linear functions, with correlation index values between 0.72 for the correlation between length and weight, and 0.78 for the correlation between circumference and weight. The correlation between circumference and length is expressed by a coefficient of determination R^2=0.71. The value obtained in the correlation between girth and weight is relevant, showing that approximately 88.62% of the measured dogs can be defined according to the linear model defined by the relationship y=1.0689x + 39.099. The lowest coefficient of determination R^2 has a value of 0.71, which represents a correlation coefficient R of 0.84. According to the table with the significant limit values of the correlation coefficient (Horodnic 2004), the experimental value is much higher than the theoretical value for the significance threshold of 0.1%, which confirms a strong significance of the index, for 248 degrees of freedom.

The weight is most strongly influenced by circumference of the trunk/chest, the influence of the length being lower. The morphological diversity of the analyzed wandering dogs is very diverse, as it also appears from the primary data. The diversity derives from the fact that there is a wide variety of breeds, sizes and weights from 1-2 kg to 70-80 kg. Through successive cross-breeding, this high-amplitude variability was reached. Wild species of the canid family have very little variability, and the sizes of adult males and females vary within very small limits. In some species, this variation cannot be noticed even between sexes. For example, in foxes and jackals sexual dimorphism is almost non-existent, and when several specimens are observed in the pack, it is very difficult to distinguish the sex of the individuals, since all members of the pack seem to be the same size.

Finally, we conclude that all other values of the correlation coefficient, for all cases analyzed (weight-length, weight-circumference, length-circumference) are strongly significant. This fact gives us the possibility to look for a barymetric relationship between the three morphological parameters. For the determined barymetric relationship, a multiple correlation coefficient of over 0.9 can be noted, respectively a determination coefficient of about 82%. Also, the coverage probability is very high, over 99%, and the significance of the regression coefficients is very high in all three cases. The correlation between the weights estimated by the found equation and the actual, weighed weights was checked. It resulted in a correlation coefficient of $R=0.92>0.443$, which represents the significance threshold of the bilateral test of 0.1%, in a population of 47 individuals (Horodnic 2004). The correlation coefficient is strongly significant (fig. 14). Through a dummy type analysis, it was found that males (M) have an average weight higher by 0.129 kg compared to females (F).

Conclusions. Following the research carried out on the stray dogs bordering Suceava Municipality regarding the morphological elements, the following results were obtained. The morphometric determinations were made for 183 stray dogs in the wild and 67 dogs from the Suceava shelter, with a total of 250 individuals. The determinations made on 48 stray dogs were used for further checks. For the analysis of the distribution by sex and by size class, the data of the population of dogs caught in full freedom were used (183). The analysis of the gender ratio shows that males predominate with 53% compared to 47% females. From the analysis of the waist size of the dogs, the majority of 67% are of medium size, 23% are of large size and 10% of small size. From the analysis of the correlative links between weight-chest circumference, weight-length and length-chest circumference for the entire statistical population (250 individuals), very strong correlation coefficients emerged, greater than 0.8 with linear modeling. From the analysis of the correlative links between weight-chest circumference, weight-length and length-chest circumference for females and males separately, the same type of correlations also emerged. Barymetric relationships were made to determine weight according to chest circumference and length. It turned out a multiple correlation coefficient of over 0.9, respectively a determination coefficient of 82%, with the probability of transgression of over 99%, and the significance of the coefficients very high for each coefficient. The equation determined using the population of 48 dogs that did not have an inoculation in the initial analysis was verified and resulted in a correlation coefficient of R=0.92. The same was done for females and males separately with similar results. A multifactorial dummy analysis was also carried out, the variables being length, chest circumference and sex. It turned out that males have an average weight of 0.129 kg higher compared to females.

Conflict of Interest. The authors declare that there is no conflict of interest.

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