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CONSIDERATIONS IN THE STUDY OF TROPHIES: THE EFFECT OF SKULL CUTTING ON THE REAL VALUE OF ROE BUCK TROPHIES

RAZMATRANJA U TROFEJISTICI: UČINAK REZA LUBANJE NA STVARNU VRIJEDNOST TROFEJA SRNJAKA

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SUMMARY

Roe deer is Laurasiatherian mammal from the family of Cervidae. It is autochthonous and one of the most valued trophy game species in Croatia (Zorić 2014.). Antlers (left and right branch) with complete or part of the skull are regarded as trophy. Despite the fact that roe deer antlers are easily accessible trophies, formulas for their evaluations are still largely debated. It is a consequence of large number of elements that need to be evaluated, possible use of coefficient instead of measuring volume and mass, and potential differences in trophy preparation. Guidelines of the International Council for Game and Wildlife Conservation (CIC) instructs that skulls should be cut through the eye cavities leaving intact nasal bones on the trophy. If otherwise cut or left intact with maxillar teeth, deduction of 65 or 90g is foreseen. Considering the fact that weight and density of bones varies between populations, we hypothesize that above mentioned deductions do not represent real values. Therefore the aim of this research was to determine the deviations from actual mass. A total of 40 roe buck skulls originating from the area of Central Croatia were analysed. All skulls were weighed 3 times, initially when intact, after shallow cut and after proscribed cut. Obtained data were statistically analysed. Following the shallow cut, skull is lighter for 25 to 52 g, which is 11 g less than proscribed 65 g. In other words application of shallow cut will result in the loss in trophy value. In cases of intact skulls loss in weight is related to gross skull mass. In this case even 68 to 70% of variability are explained by gross skull mass (R^2=0.680; p<0.0001 – linear function, or R^2=0.699; p<0.01 – potency function). According to the intersection of the lines (obligate deduction of 90 g and dependence of mass loss due to the cutting) milestone in the mass is at 310 g gross. In other words trophies lighter than 310 g should be cut according to proscriptions as they will lose less than 90 g, while heavier skulls should be left intact as they will lose more than proscribed 90 g. Regardless of the skull preparation, all obtained masses show statistically significant relation to volume. With increase in volume density of trophies decreases (R^2=0.813; p<0.001), with the fact that cutting of the skull results in removal of denser, heavier parts of the trophy. Application of the coefficient 0.23 depends on the density of the trophy, meaning that its application in the case of heavier antlers with lower volume will increase the trophy value. In the case of porous antlers the real coefficient should be higher, as application of 0.23 results in lower trophy values. In the case of intact skulls we do not advice application of 0.23 coefficient as this will decrease the trophy value.

KEY WORDS: antlers, relative weight, weight, trophy evaluation, CIC, roe deer buck

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INTRODUCTION
UVOD

The antlers of roe deer bucks (*Capreolus capreolus* L.) are relatively easily accessible trophy for most hunters. However, although they are relatively simply constructed, the formula for their evaluation is even today largely debated. According to Reichelt (1986) the current formula for evaluation of roe buck antlers was devised in 1927 by the forestry expert Bieger, 46 years after the first guidelines were adopted for evaluation of red deer (*Cervus elaphus* L.) antlers. It is necessary to mention here that Zoričić (1930) states that, alongside Bieger, Karl Lotze also participated in creating this formula. Guidelines for evaluation of trophies of other European game animals were adopted from a few years to several decades later.

Evaluation of trophies is an "old" discipline which existed before the introduction of internationally recognized formulas. These were introduced in order to standardise the procedure and unify the evaluation of trophies. However, partially due to the vanity of owners of trophies, and partially due to the differences between individual populations, all formulas have certain weaknesses. As a result, the first criticism of "Bieger's" formula appeared in the middle of the 1930's. Nadler's formula for evaluating red deer antlers did not fare any better. Both formulas, in the opinion of some experts, favoured antlers with high trophy value (Lemarie 1935), therefore a major criticism of Bieger's formula was that it favoured mass and volume (Stubbe 1967, Reichelt 1986). Another point of critics was the excessive number of elements evaluated (Mazurek 1997).

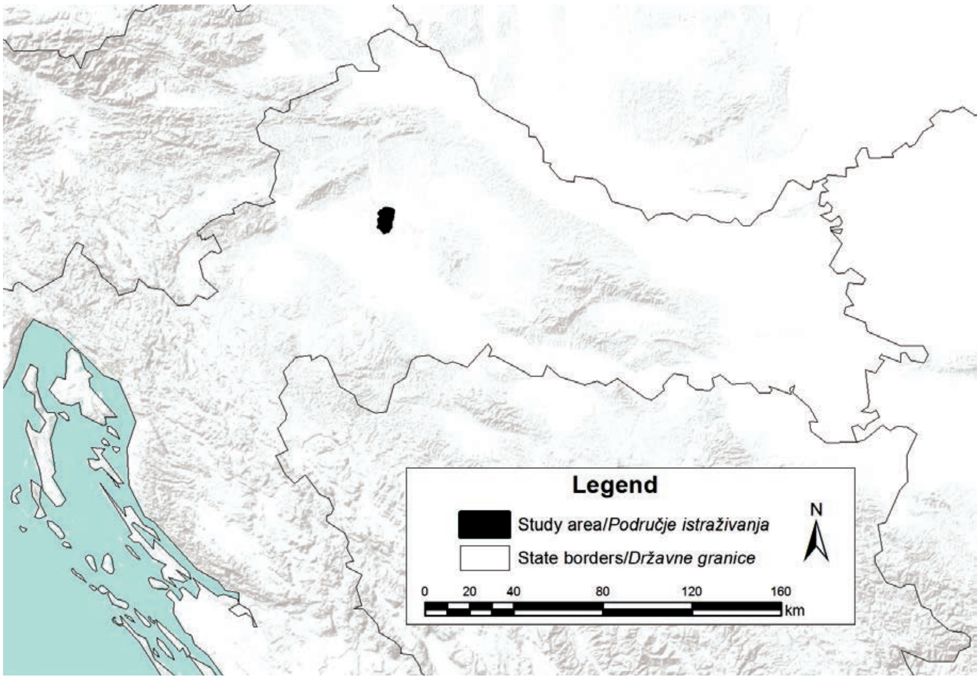
Bearing these failings in mind, already in 1929 Professor Antun Dyk (the president of the Czechoslovakian Chamber of Hunting at that time) at the Forestry Faculty of the University of Brno, proposed a new method for evaluating trophies from red, fallow (*Dama dama* L.) and roe deer (Lemarie 1935). This method was tested at the hunting exhibitions in Brno (1929 and 1930) but it was never accepted by the CIC.

Bieger's formula was adopted by the CIC in Prague in 1937, and finally in 1952 in Madrid. From that time until the present day it has not changed very much. In contrast to other wild ruminants, volume of roe deer trophies has remained an element of evaluation. Reading some popular articles (Raić 1970) or handbooks on trophy evaluation (Bieger and Nüßlein 1977) it may be concluded that it was difficult to measure the volume of roe deer antlers, since most hunters or trophy evaluators of that time (especially in hunting societies), did not have hydrostatic scales. Therefore, Raić (1970) made recommendations in the official Croatian hunting journal that capital roe deer trophies should be brought for complete evaluation to the Hunting Association of Croatia. For most wild ruminants, regardless whether they wear horns (Bovidae) or antlers (Cervidae), measurement of volume is compensated for by the girth at one spot (chamois - *Rupicapra rupicapra*) or at several points on the trophy (European Mouflon - *Ovis gmelini musimon*). This kind of measurement has never been widely accepted for roe deer. Instead, in order to simplify the evaluation procedure, a variety of coefficients have been developed, of which the best-known is the coefficient of the mass and volume of the antlers.

Studying the correlation of mass and volume of roe deer antlers, Volz found that it is possible to obtain an approximately accurate combined evaluation of mass and volume of the antlers if they are weighed and multiplied by the factor 0.225 (Bieger and Nüßlein 1977). This coefficient gives an approximately accurate value for antlers of average specific weight. However, lighter antlers gave a lower value using this method, while denser antlers are over-valued.

At the 12th CIC General Assembly, held in Arles (France), another proposal to simplify the evaluation of roe deer antlers have been made (Raić 1967). That is to say, it was permitted for trophies with more than 130 CIC points to determine the weight of the antlers and multiply it by the coefficient 0.25. By that way the points for weight and volume were obtained together. At the international exhibition in Novi Sad (Anonymous 1967) it was noticed that this coefficient results in very imprecise values and a complaint was sent to the CIC. At the exhibition in Paris in November 1969 it was decided to retain the Madrid's formula for evaluation of roe deer, and that volume must be evaluated separately (Raić 1970). Later, at the CIC exhibition in Tehran (1974), the coefficient was reduced to 0.23, or 0.225 in the case of a yearling's trophy (Bieger and Nüßlein 1977).

The other problem is in measuring of the mass of the trophy. According to the CIC rules, the skull of cervids must be cut off at a frontal level running from the occipital bone and its triangular protrusion (*os occipitale, protuberantia occipitalis externa*), and the parietal bone (*os parietale*), through the middle of the eye sockets and the lacrimal bone (*os lacrimale*) to the nasal bone (*os nasale*), which remains intact (Hromas et al. 2008). However, the variations of this cut are also present. Therefore it is permitted to evaluate antlers with an intact skull (preserved maxillar teeth), or those with so called shallow cut (a cut along the incisive bone). If the skull is intact, 90 g is subtracted from the total mass of the trophy. The line of the shallow cut leads from the base of the occipital bone (*os occipitale, pars basilaris*) through the temporal bone (*os temporale, pars petrosa*) then through the external edge of the upper jaw (*maxilla, processus alveolaris)*, to the lower (ventral) part of the incisive bone (*os incisivum*) which remains intact. In that case 65 g must be subtracted from the total mass. In the past the cutting of the skull was so unstandardized that a trophy could be cut at the forehead (the old way of processing trophies), and the evaluator would have to add 20 g to the total mass, whilst



Slika 1. Istraživano područje
Fig. Study area

in cases when only the forehead and the nasal bones remained after cutting, they would add 10 g (Bieger and Nüßlein 1977). This "compensation" of the mass is no longer permitted by CIC rules. In other words, if a large part of the skull is cut off, there are no additions in the evaluation procedure.

The basic task of the study of hunting trophies is to develop the best possible method of objective and standardised trophy evaluation. There are many reasons for this: an objective calculation of the price of a trophy (if price lists are based on trophy value), a basis for evaluation of the quality of an animal population, but also the fact that hunters are sensitive to non-objective evaluation of trophies. In examinations of the antlers at hunting exhibitions, or in the evaluation of trophies, it is possible to observe all three permitted methods for trophy preparation. Hunters very often ask which method of trophy preparation is best, in the sense of maximising trophy value. Therefore, in this paper we analyse the effects of different methods of antlers preparation on the final and objective trophy value.

MATERIAL AND METHODS
MATERIJAL I METODE

The research was undertaken on 40 trophies (roe buck skulls) obtained during the 2017/2018 hunting year, from the open state hunting ground no: I/3 - ''ČRNOVŠĆAK" and the open hunting ground no: I/143 - ''LUPOGLAVSKI ČRET".

These are hunting grounds that border on each other (Figure 1) and are located in the lowland, central part of Croatia, at 100 to 106 m a.s.l. According to Köppen's climate classification the climate is type Cfwbx". This is a temperate, moderately humid climate, precipitation is distributed evenly over the entire year, and the driest part of the year is during the cold period. There is comparative maximum precipitation in the warmer part of the year, which is two-fold, splitting into the maximum in spring (May) and late summer (July or August), between which there is a dry period. Temperatures in the coldest month are above -3 ^{0}C. Mean monthly temperature in the warmest month is below 22 ^{0}C.

The total research area was 4 522 ha. The proportion of forest and arable land in both hunting grounds is about 40% (Table 1). The hunting ground ''LUPOGLAVSKI ČRET" has a larger area of grassland than ''ČRNOVŠĆAK" (17% and 2% respectively), while ''ČRNOVŠĆAK" has a larger proportion of brush land than ''LUPOGLAVSKI ČRET" (8% and 2% respectively).

The roe bucks were hunted as part of the regular basic hunt management, and after shooting the trophies were processed following a standard procedure according to the CIC protocol (Hromas et al. 2008). Saw dust and bone fragments after sawing also were weighed.

In order to test the normality of distribution, the Kolmogorov-Smirnov test was used, and the Shapiro-Wilk test since the sample size was below 50 (Zar 1999). The results of the tests of normal distribution of data showed that the mass of the antlers with the entire skull (K-S: d=0.09032; p>0.2; S-W: W=0.98545; p=0.878); the mass of the antlers with a shallow cut skull (K-S: d=0.08736; p>0.2; S-W: W=0.98512; p=0.868); the mass of the antlers with the regularly cut-off skull (K-S: d=0.11105; p>0.2; S-W: W=0.97757; p=0.6000);

Tablica 1. Struktura staništa istraživanog područja
Table 2. Land use of study area

Stanišni tip/*land use*	Ploština (ha)/*Area (ha)*			UDIO (%)/*Ratio (%)*		
	Lupoglavski čret	Črnovšćak	Ukupno/*Total*	Lupoglavski čret	Črnovšćak	Ukupno/*Total*
Oranice/*Arable*	870	965	1.835	37	45	41
Travnjaci/*Grasslands*	391	46	437	17	2	10
Ruderalna Staništa/*Ruderal Habitats*	11	8	19	0	0	0
Šume/*Forests*	914	902	1.816	39	42	40
Šikare/*Scrublands*	56	173	229	2	8	5
Močvarna Staništa/*Wetlands*	18	9	27	1	0	1
Kanali/*Canals*	29	7	36	1	0	1
Stalne Stajačice/*Lakes and pounds*	0	6	6	0	0	0
Stalni Vodotoci/*Fresh Waters*	0	2	2	0	0	0
Izgrađeno Zemljište/*Build Up Area*	76	39	115	3	2	3
Ukupno/*Total*	2 365	2 157	4 522	100	100	100

the volume of the antlers (K-S: d=0.17541; p>0.2; S-W: W=0.95450; p=0.10834); the difference in the mass of the antlers after the shallow cut (K-S: d=0.08928; p>0.2; S-W: W=0.97409; p=0.480); and the difference in the mass of the antlers after the regular cut (K-S: d=0.06925; p>0.2; S-W: W=0.98097; p=0.725) have normal distribution and the data may be equalized by a linear function. Therefore, simple linear regression was performed. If the data did not show normal distribution they were transformed using the Box-Cox transformation method (Sakia 1992).

The differences between trends in the trophy parameters were tested using analysis of covariance (ANCOVA). In the analysis of covariance it is desirable for the lines of the researched groups not to show interaction, that is, they should not intersect (Enqvist 2005). If they do (in the case of interaction) it is more difficult to define any differences between the groups. If a significant difference in values is found between the groups then for one group within the determined range of the continuous variable (e.g. volume) the parameter in question shows higher values than in another group, and in another range of the continuous variable the situation is reversed. According to that, this results in the impossibility of drawing a general conclusion (for the entire range of the continuous variable) but the rule only applies within the specific range (Fraas and Newman 1997). Since no statistically significant differences were found in any of the tests between the slope of the lines, the tests were undertaken using the classical analysis of covariance. The data were equalized with the lines (the method of simple linear regression), square function or potency function (the correlation of the gross mass of the antlers and the sawn-off part of the skull). In equalizing the potency function, the correlation between the gross mass and the waste from sawing the skull was found by the Gauss Newton minimization procedure. The data were analysed using the Statsoft 13 Program (TIBCO Software Inc. 2017).

RESULTS
REZULTATI

Depending on the parameters measured, variability differs considerably (Table 2). The smallest variability was shown by the waste from the part of the skull after a shallow cut

Tablica 2. Podaci deskriptivne statistike istraživanih parametara trofeja srnjaka
Table 2. Descriptive statistic of analysed parameters

PARAMETRI	n	Arit. sredina	Min	Max	Std. Dev.	CV
Masa rogovlja s neotpiljenom lubanjom (g)/*Mass of antlers with uncutted scull (g)*	40	307	117	513	84,09	27,39
Masa rogovlja s lubanjom - plitak rez (g))/*Mass of antlers with shallow cutted scull (g)*	40	267	84	461	81,06	30,32
Masa rogovlja s lubanjom – pravilan rez (g))/*Mass of antlers with regular cutted scull (g)*	40	216	63	381	71,74	33,14
Otpad nakon plitkog reza (g)/*Cutting after shallow cut (g)*	40	40	25	52	5,94	14,96
Otpad nakon propisanog reza (g) /*Cutting after regular cut (g)*	40	91	54	132	15,51	17,12
Volumen rogovlja (cm^3) /*Antlers volume (cm^3)*	40	78	12	154	36,48	46,92
Gustoća rogovlja s cijelom lubanjom (g/cm^3)/*Relative density of antlers with uncutted scull (g/cm^3)*	40	4,60	2,78	9,75	1,77	38,40
Gustoća rogovlja s lubanjom – plitak rez (g/cm^3) /*Relative density of antlers – shallow cut (g/cm^3)*	40	3,91	2,46	7,78	1,29	32,93
Gustoća rogovlja s lubanjom – pravilan rez (g/cm^3) /*Relative density of antlers – regular cut (g/cm^3)*	40	3,10	2,03	5,67	0,87	28,00

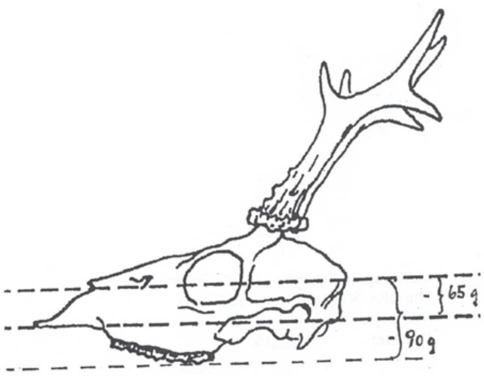


Fig 2. Scull cut directions: downmost line – uncutted scull (deduction 90 g); middle line – shallow cut (deduction 65 g); topmost line – scull cutted according proposition (without deduction)

Slika 2. Pravci rezova lubanje: najdonja linija - neodrezana lubanja (odbitak 90 g); srednja linija – plitak rez (odbitak 65 g); gornja linija – pravilno odrezana lubanja (bez odbitaka)

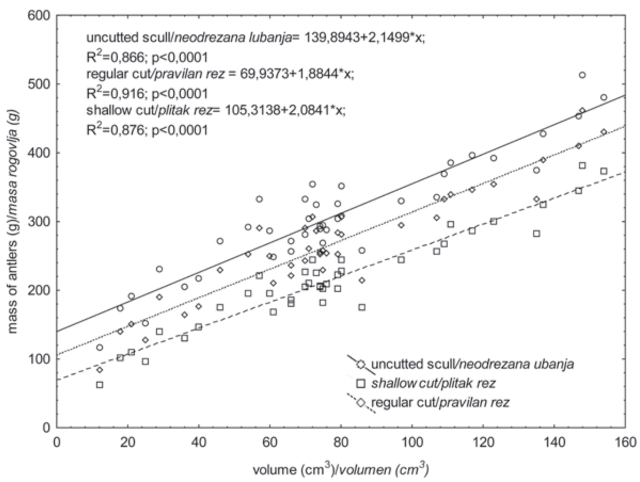


Fig 3. Regression between volume and mass of antlers according to ways of trophy preparation

Slika 3. Regresijski pravci ovisnosti volumena i masa rogovlja srnjaka s obzirom na način rezanja lubanje

(CV = 14.96%), whilst the greatest variability was shown by volume (CV = 46.92%). Since for each trophy the gross mass (the mass of the uncut skull) and the volume were measured, it may be concluded that the trophy mass is relatively consistent (CV=27.39%). Therefore, it is logical that the density of the antlers shows high variability (from 28.00% in trophies cut according to the prescribed criteria, to 38.40% for intact trophies).

The parts of the skull cut off show less variability (the coefficient of the variability of waste after the shallow cut is 14.96%, and after the prescribed cut 17.12%), than the mass of the skull which is part of the trophy (the coefficient for the skull mass with a shallow cut is 30.32%, and with the prescribed skull cut, 33.14%).

Regardless of how the skull is treated (intact skull - deduction of 90 g, shallow cut - deduction of 65 g, or the prescribed skull cut - no deduction), all three types of skull mass show significant correlation with volume (Figure 3). Volume may explain almost 90% of the variability in the mass of the skulls, but it is not the same for all three methods of skull processing. The greatest variability in mass is shown by intact skulls (R^2=0.866), slightly less is found in shallow cut skulls (R^2=0.876), and the least in completely cut skulls (R^2=0.916). This indicates that the cut-off parts of the skull are either not uniformly cut, or have very different density.

According to the results of the analysis of covariance, there is almost no difference in the coefficients of the slope of the lines of the cutting methods compared (F=1.3591; p=0.261). On average the difference between uncut and correctly cut skulls is 43 grams, and between shallow cut and correctly cut skulls, 4 grams.

The density of the antlers, depending on how the trophy is processed, differs significantly. Figure 7 shows the trend of the decreasing density of trophies with the increase in vo-

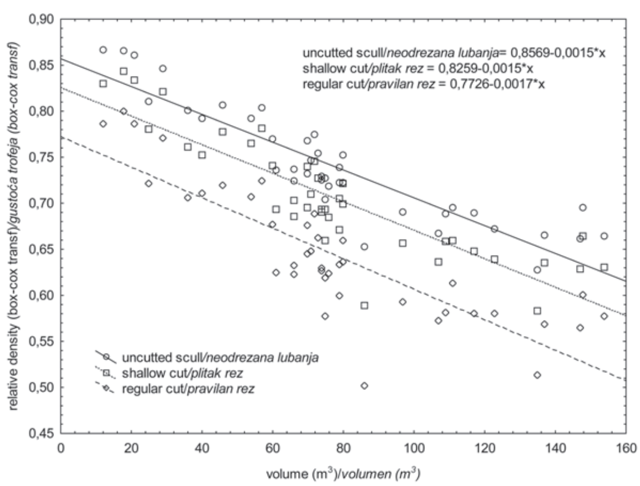


Fig. 4. Correlation between relative density (g/cm³) and volume of roe buck trophies

Slika 4. Ovisnost gustoće trofeja (g/cm³) o volumenu rogovlja

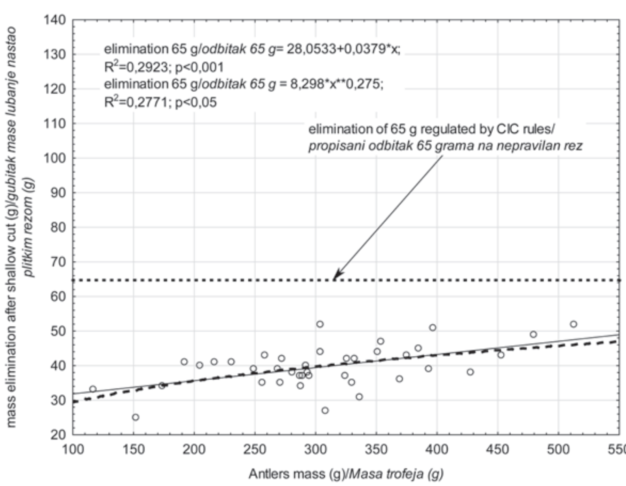


Fig. 5. Correlation between eliminated part of shallow cutted sculls and trophy mass of uncutted sculls

Slika 5. Ovisnost mase plitko odrezanog dijela lubanje o masi neodrezane lubanje

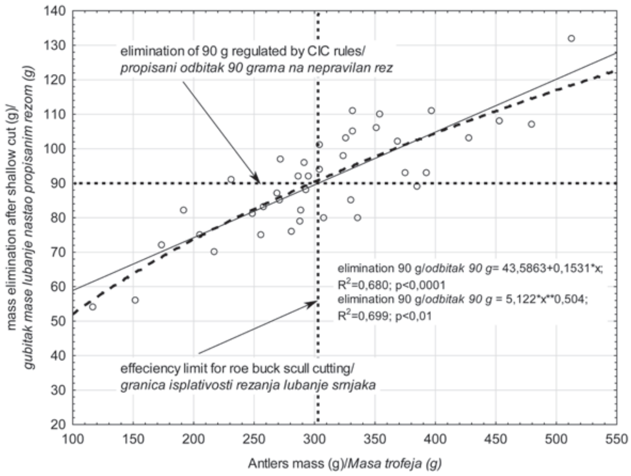


Fig. 6. Correlation between eliminated part of sculls and trophy mass for uncutted trophies

Slika 6. Ovisnost mase odrezanog dijela lubanje o masi trofeja kod neodrezanih lubanja

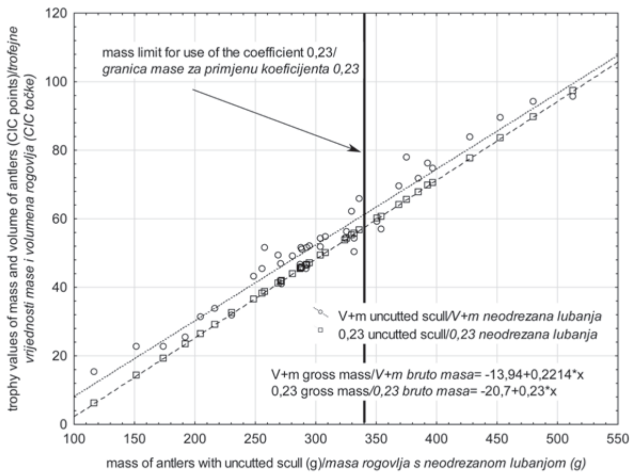


Fig. 8. Correlation between eliminated part of sculls and coefficient 0.23 on trophy mass for uncutted trophies

Slika 8. Ovisnost trofejnih vrijednosti mase i volumena rogovlja te koeficijenta 0,23 o masi rogovlja s neodrezanom lubanjom

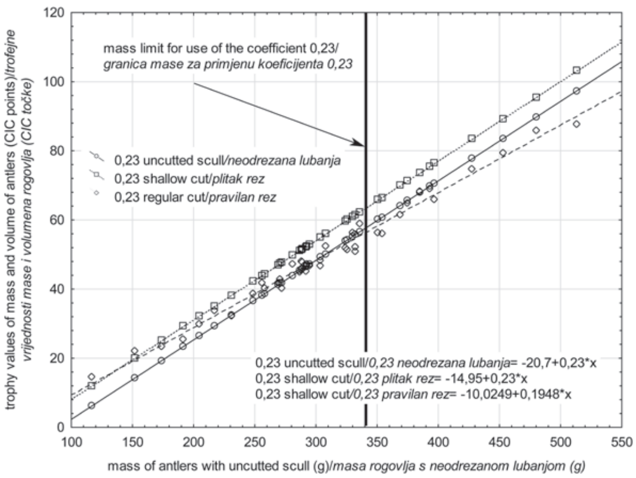


Fig. 7. Correlation between mass and volume of trophies prepared on three different ways and trophy mass for uncutted trophies

Slika 7. Ovisnost trofejnih vrijednosti mase i volumena rogovlja obrađenih na tri različita način o masi rogovlja s neodrezanom lubanjom

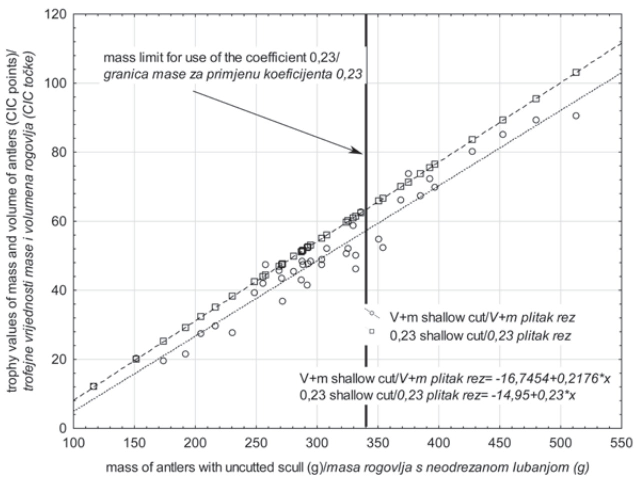


Fig. 9. Correlation between eliminated part of sculls and coefficient 0.23 on trophy mass for shallow cutted trophies

Slika 9. Ovisnost trofejnih vrijednosti mase i volumena rogovlja o masi rogovlja s neodrezanom lubanjom kod trofeja odrezanih na plitak rez

lume (R^2=0.813; $p<0.001$), which is logical. However, the density of the trophy changes significantly in relation to way of preparation (ANCOVA; g: $p<0.05$). Since the Box-Cox transformation of data from Figure 4 was performed, the density values cannot be used directly but they must be recalculated to their original values. According to them, the intact trophies are 2.86 g/cm^3 denser than the correctly cut ones, and 2.40 g/cm^3 denser than the shallow cut trophies, whilst the shallow cut trophies have 0.45 g/cm^3 lower density than the intact ones. This indicates that cutting removes the denser, more solid parts of the skull.

The correlation of the mass of the cut part of the skull and the gross mass of the trophies differs between the two forms of trophy processing. For the shallow cut, that correlation is lower whereby the gross mass of the trophies explains only 29 % of the variability (R^2=0.2923; $p<0.001$) if equalization is conducted by linear regression, or 28 % (R^2=0.2771; $p<0.05$) if the methods are equalized using the curve of potency (Figure 5). Regardless of the choice of curve or line of equalization, after cutting by the shallow cut, the skull is between 25 and 52 grams lighter (Table 2, Figure 8), which is almost 11 g less than when 65 g is subtracted from the antlers for the irregular cut. Therefore, in case of trophies of medium values (below capital value limit of 105,00 CIC points), they should be cut according to the CIC rules to increase the aesthetic value of the trophy.

The loss of trophy mass occurring due to the prescribed cut is within much larger boundaries (from 54 to 132 g, Table 2), and is far more dependent on the gross mass of the skull (Figure 6). Here as much as from 68 % to 70 % of the varia-

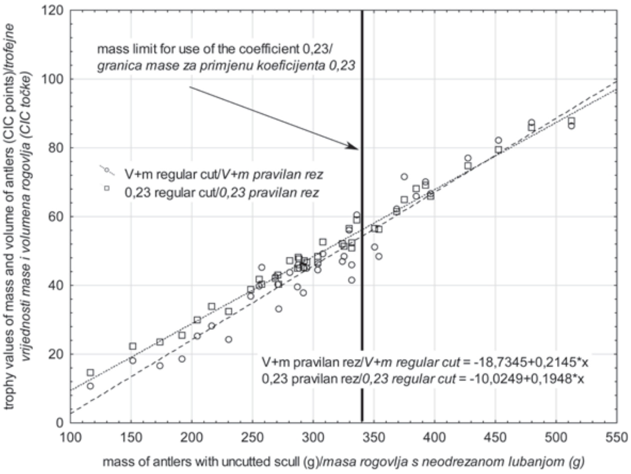


Fig. 10. Correlation between eliminated part of sculls and coefficient 0,23 on trophy mass for regular cutted trophies

Slika 10. Ovisnost trofejnih vrijednosti mase i volumena rogovlja o bruto masi rogovlja kod trofeja odrezanih pravilnim rezom

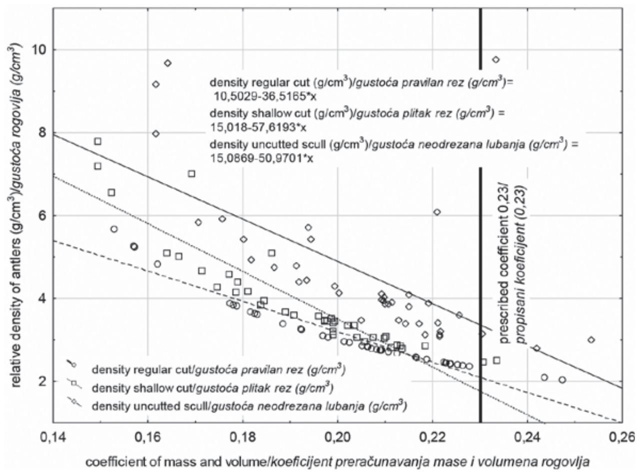


Fig. 11. Correlation among relative densities, way of trophy preparation and coefficient of mass and volume conversion

Slika 11. Ovisnost gustoće rogovlja, načina obrade trofeja srnjaka i koeficijenta pretvorbe mase i volumena u trofejne vrijednosti

bility is explained by the gross mass of the skull (R^2=0.680; p<0.0001 – linear function, or R^2=0.699; p<0.01 – potency function). According to the intersection of the line of the mandatory deduction of 90 g for the irregular cut, and the curve of the correlation of the loss of mass due to the prescribed cut (Figure 5), the turning point for the need to cut occurs with a gross antler mass of 310 grams. Therefore it is better to cut trophies with a gross mass less than 310 grams according to the prescribed line, because they will lose up to 90 grams, whilst the trophies with a mass of over 300 g, or 305 g, should not be cut using the shallow cut, because they will lose more than 90 g, which is more than the evaluator has to deduct for the irregular cut. In our case, 4 samples with gross mass of more than 300 g would in fact lose up to 90 g in mass by cutting, whilst 16 samples, would lose much greater trophy mass than the prescribed amount (90 g) if they were cut off.

Although according to the rules for evaluation of trophies, the International Council for Game and Wildlife Conservation (the CIC), when calculating the combined points of trophy value of mass and volume of the antlers, it is not permitted to use the method of multiplication of the net mass of the antlers by the coefficient 0.23, instead of weighing them on hydrostatic scales, in this country (Croatia), according to the Regulations on Methods of Evaluation of Game Trophies, the Trophy List Form, and Keeping Records of Game Trophies and Reports on Trophy Evaluation (Anonymous 2008) it is permitted, but only for roe buck trophies where the net mass of the antlers does not exceed 250 grams. The procedure for calculation is:

The coefficients of the slope of the line of equalization of the trophy values obtained by using the coefficient 0.23 for correctly sawn off and intact trophies do not differ from each other, whilst the line of equalization of dependence of data obtained by using the coefficient 0.23 for the correctly cut trophies shows a slightly smaller slope (Figure 7). However, for all three methods of trophy preparation, the correlation of the data is extremely high (the coefficient of multiple determination is from 0.985 for a correctly sawn off trophy, to 1.00 for intact or shallow cut antlers; p<0.0001). If when calculating the mass and volume of a roe deer trophy the coefficient 0.23 is used, then it is better to use it for a trophy cut using the shallow cut with respect for the net mass of 250 g (or gross mass of 340 g). That is to say, if the coefficient 0.23 is used for these trophies, then 5.75 CIC points are given for the higher trophy value of the elements of mass and volume than if the coefficient 0.23 is used for an uncut skull. If the coefficient 0.23 is used for a correctly sawn-off skull a slightly higher trophy value is obtained in comparison to a skull cut using the short nose cut, and for a trophy with gross mass greater than 150 g the trophy value is lower for mass and volume together, than for a trophy sawn off using the shallow cut. Comparison of the lines using a coefficient of 0.23 between the uncut and the correctly sawn off skull shows that it is worth cutting trophies with a gross mass up to 300g using the prescribed cut (because using the coefficient 0.23 gives a higher value in evaluation of mass and volume) but for trophies with a mass greater than 300 g it is not.

Further, from Figure 8 is can be seen that if the trophy is left intact, it is not worth using the coefficient 0.23, but the trophy value is established on the basis of the actual mass and volume measured, because by the correct procedure additional 6.7 CIC points are obtained. For trophies prepared using the shallow cut, it is recommended to establish the trophy value using the coefficient 0.23 because in this way a value 1.7 CIC points higher is obtained than by using the prescribed procedure (Figure 9). The same is true for trophies treated according to the CIC proposals, but it must be pointed out that, because the lines of equalization are not parallel, the difference decreases with the increase in the trophy mass (Figure 10).

From Figure 11 it is clear that coefficient 0.23 actually depends on the density. Using the coefficient 0.23 raises the trophy value in the case of trophies with higher mass and lower volume (denser trophies). For porous trophies the real coefficient should be much greater. Therefore it is understandable why the use of coefficient 0.23 for shallow cut or correctly cut skulls leads to a lower trophy values. That why it "open" new additional study.

DISCUSSION
RASPRAVA

Deductions for incomplete skull cutting are often the subject of debate between hunters. Unfortunately, of the studies dealing with this issue, the only available is one done by Metz (1996). According to his research, the loss of antler mass caused by the shallow cut is from 41 to 50 g, while the loss of mass in correctly cut trophies is from 82 to 102 g, which is similar to this study (although Metz did not undertake a statistical analysis, but the sample was also from lowland hunting grounds). However, the cut has many advantages, which are almost exclusively aesthetic or practical in nature, for example precisely sawn-off antlers sit better on the plate without leaving any gaps. Further, for antlers of low value (short and/or thin beams, with short tines or without them) the entire skull should not be retained because the mass of the antlers would not be in line with the mass of the skull. In contrast, extremely strong antlers (long and/or solid beams with long tines, well-developed pearls and burr) are not in harmony with the skull if cut using the prescribed guidelines, because in that case that part of the skull is small and the antlers are too large. Finally, it is easier to clean the brain cavity on sawn-off antlers, so the trophy does not have an unpleasant odour.

According to Krapinec et al. (2014), in comparison with capital bucks from most countries, Croatian roe deer with the same trophy value have a statistically significantly smaller trophy mass, whilst in comparison with roe deer from Bosnia and Herzegovina, bucks from Croatia have a significantly greater antler mass. Apart from mass, the volume of the antlers also grows with the increase in trophy value, and as in the case of the antler mass, roe deer found in Croatia with the same trophy value have statistically significantly smaller antler volume in comparison with roe deer found in Austria, Hungary and Germany. Here, in all four cases there is interaction so it may be said that the significant difference in the antler volume arises above a trophy value of 92.17 CIC points (if the volumes of the antlers of Croatian roe deer are compared with the volumes of the antlers of roe deer from Hungary) or after 112.35 CIC points (if the volumes of the antlers of roe deer are compared with the volumes of antlers of roe deer from Austria). As well as the statistically significantly lower mass and volume, Croatian bucks, in comparison with roe deer from Bulgaria, Czech Republic, Hungary, Poland, Romania, Serbia, Sweden, Switzerland and the United Kingdom, also have significantly lower antler density (Krapinec et al. 2014). Roe deer from Croatia only have denser antlers than roe deer from Bosnia and Herzegovina. In the other cases no statistically significant differences were found in the indicators. Apart from what was found in relation to most countries, roe deer trophies found in Croatia have significantly lower mass, a significantly small proportion of antler mass in Croatian roe deer in the total trophy value was found in comparison with those from Hungary, Romania, Serbia, Switzerland and the United Kingdom, whilst roe deer from Croatia have a significantly greater proportion of antler mass in the total trophy value than those in Bosnia and Herzegovina (Krapinec et al. 2014). However, if the proportion of the volume in the total trophy value is considered, it may be noticed that roe deer from Croatia have a significantly higher proportion of volume in the total trophy value than those from Slovenia and Switzerland, and less than the roe deer from Bosnia and Herzegovina, Poland, Romania, Slovakia and the United Kingdom (Krapinec et al. 2014). Therefore, the proportion of volume in the total trophy value of our roe deer is still lower than the proportion in roe deer from most of the countries compared. Finally, the proportion of mass and volume together in the total trophy value is significantly greater in roe deer from Germany, Poland and Slovakia. This would mean that with the same trophy value bucks from Croatia have antlers of lower mass and volume (porous antlers, thinner beams and a less well developed burr) but with longer beams than those from these countries, because the difference in mass and volume must be compensated for by the other elements of measurement, of which there are few in roe deer. Therefore it is no wonder that one of the best trophy evaluators in this country, Lazar Raić, in 1960's tried to implement the 0.25 as the coefficient of transformation.

Stubbe (1977) established that the specific weight of roe deer antlers shows much greater deviation than the specific weight of red deer and fallow deer antlers. According to Stubbe (1977) bucks have undoubtedly heavier antlers than red deer and fallow deer, but no difference was found in the specific weight of the antlers of red deer and Siberian roe deer (*Capreolus capreolus pygargus*). However, it is true that the density of roe deer antlers shows greater variability in comparison to the other two species from the deer family. It is still unknown whether the differences in the specific weight of roe deer antlers are the result of genetic or environmental factors. Regarding the correlation between the parameters for evaluating antlers, it is necessary to point out that antler mass and volume show the greatest correlation with the length of the beams (r=0.87; Stubbe, 1977) whilst this correlation is much smaller, for example, with specific weight, the diameter of the pedicle and the circumference of the burr. According to Stubbe (1977), a high correlation between the mass and volume of the antlers and the length of the beams was also found in red deer (r=0.91; and r=0.89 respectively).

Volmer and Herzog (1995) established that roe deer aged from 1 to 5 years have antler density of 1.61 to 1.70 g/cm^3. However, the density of beams of roe deer from different habitats is from 1.57 to 1.76 g/cm^3 and, according to Pis et al. (1994), from 1.60 to 1.84 g/cm^3. In summarizing the results of antler density (without the skull) it may be concluded that the density of the beams does not exceed 2.00 g/cm^3. That is to say, these authors expressed the specific weight as the quotient of the skull mass without the lower jaw, together with the antlers, whilst the specific weight of the antlers alone, without the skull, according to Stubbe (1967) was from 4.63 to 4.91 g/cm^3. In general the specific weight of the skull bones without the antlers is much lower.

At the age when roe deer achieve the highest values of antler mass and volume, the density of the antlers is lowest, and in fact highly capital trophies are on average porous (Szederjei 1966, Pis et al. 1994). Moreover, Szederjei (1966) mentions that when evaluating roe deer through a telescope, it is best to evaluate the trophy value on the basis of volume. This is logical, because large trophies (with greater volume) seems strong when observing on a distance. Eiberle (1965, 1980) did not find a statistically significant correlation between specific weight and beam length. However, in general, specific weight decreases with age and is at its lowest in roe deer at the age of 4 years. This, in fact, indicates that the growth in antler volume in youth is much greater than the increase in mass, resulting in porous antlers. The physical development of roe deer ends at two years of life.

By measuring individual parameters of roe deer trophies, Eiberle (1980) also came to the conclusion that antler mass grows more quickly than volume, but points out that it is difficult to make a uniform rule regarding the development of antlers, because they are affected by a large number of factors. In open hunting grounds the increase in antler mass alongside the increase in body mass in roe deer is much more intense, and it has been shown that there is a positive correlation between the length of the lower jaw and the quality of the antlers, or body mass and the antler mass (Eiberle 1980)

Since the formula for evaluation of trophies should favour the elements indicating the quality of the animal, it seems that the choice of mass and volume was correct, since both of these elements account for a very large proportion of the total trophy value. Vogt (1937) and Passarge (1965) concluded that the antler mass may even be calculated from the body mass. Vogt (1937) found that the antler mass was from 1.5 to 3% of body mass, and Passarge (1965), from 1.1 to 1.3 % of body mass. Later, Passarge (1971) showed that in yearlings this percentage was only 0.4 to 0.8%.

A requirement for antler mass of 700 grams is a net body mass of about 23 kg. Although roe deer from the eastern part of the area are also known for higher values according to Vogt (1937), the upper limits for individual elements of measurement of trophies are as follows: a) Antler mass – 700 to 800* g, b) Beam length - 35 cm and c) Body mass up to 30 kg.

However, in defining the formula for evaluating trophies, the geographical characteristics of roe deer were definitely not taken into consideration. That is to say, in natural habitats with a colder climate (the northern and eastern parts of the area) the antler mass decreases with increased body mass. The reason for this is the lack of food during the growth of the antlers, limiting the growth of strong antlers (secondary gender indicator). In the same way, no close correlation was found between antler volume and body mass (Stubbe 2008).

On the other hand, according to Reichelt (1986), who analysed trophies at hunting exhibitions, the formula for evaluating roe deer antlers favours mass, since the proportion of points for beam length in roe deer is 7% (for all other wild ruminants it is a minimum of 18%), the proportion of mass is 34%, whilst the proportion of volume is 52%. Studies so far dealing with the influence of individual environmental factors on the length of beams have shown that size is influenced by population density (Pélabon et al. 1998) or climate factors (Mandarić 2011). It is hard to believe that the formula for evaluation of roe deer trophies will change, however, from an anthropocentric point of view, roe deer antlers that are attractive to the eye are in fact porous. Whether this is the result of a lack of minerals in the habitat or some other factors, is still a matter for research.

CONCLUSIONS
ZAKLJUČCI

From all mentioned we can conclude that deduction of 65 or 90 g does not correspond to the real weight of the removed, denser parts of the skull. Deduction of 65 g for a

* In later years in some countries (e.g. in England) roe deer were shot whose antler mass was over 1000 g (Krapinec and Konjević, 2010)

shallow cut of the skull is greater than the actual loss by cutting, whereby the trophy loses value. If the skull is left intact, the loss of weight depends on the gross mass of the skull. It is advisable to use proscribed cut in the case of trophies with a gross weight less than 310 g, as they will lose up to 90 g. Heavier trophies lose more than 90 g when sawn, which is more than an evaluator should deduct for an irregular cut. In the case of a shallow or correctly sawn antlers, it is not advisable to use a coefficient 0.23 since this gives a lower trophy value.

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SAŽETAK

Srna obična je zavičajna divljač iz nadreda Laurasiatheria i porodice Cervidae te je ujedno jedna od najcjenjenijih vrsta divljači. Trofej srnjaka čini rogovlje (lijeva i desna grana) s cijelom ili dijelom lubanje. Iako je rogovlje srnjaka većini lovaca relativno lako dostupan trofej, formula za njegovo ocjenjivanje i dalje je predmet rasprava. Tome pridonosi velik broj elemenata ocjene trofeja, izmjera volumena, moguća kompenzacija volumena i mase odgovarajućim koeficijentom te mogućnost pripreme trofeja rezanjem lubanje na različitim udaljenostima od reza kroz očne duplje. Prema uputama Međunarodnoga savjeta za lovstvo i zaštitu prirode (CIC) pravilna obrada lubanje uključuje rezanje iste na način da rez prolazi kroz očne duplje i ostavlja netaknute nosne kosti. Ukoliko se vlasnik trofeje ne odluči na ovakvu obradu, predviđaju se odbici od mase lubanje u iznosu 65 g (kada rez ostavlja dio kostiju ispod orbita) te 90 g kada se ostavlja čitava gornja čeljust. S obzirom da mase i gustoće kostiju variraju od populacije do populacije, pretpostavka je da navedeni odbici ne predstavljaju stvarne iznose te je cilj bio utvrditi koji rez iznosi koliko odstupanje od stvarne mase. Obrađeno je ukupno 40 lubanja srnjaka s područja Zagrebačke županije. Sve su lubanje tri puta vagane, prije reza, nakon plitkog reza i nakon pravilnoga reza. Dobiveni podaci obrađeni su statističkim metodama. Nakon piljenja na plitak rez, lubanja je lakša za 25 do 52 g, što je za gotovo 11 g manje nego da se rogovlju oduzme propisanih 65 g. Drugim riječima plitak rez znači veći gubitak na trofejnoj vrijednosti. U slučaju ostavljanja cijele gornje čeljusti na trofeji gubitak mase rogovlja kreće se u daleko većim granicama (od 54 do 132 g) i daleko je ovisniji o bruto masi lubanje. Ovdje je čak od 68 % do 70 % varijabilnosti objašnjeno bruto masom lubanje (R^2=0,680; p<0,0001 – linearna funkcija, odnosno R^2=0,699; p<0,01 – funkcija potencija). Ravnajući se prema sjecištima pravca obveznog odbijanja 90 g zbog nepravilnog reza i krivulje ovisnosti gubitka mase zbog propisanog reza, prekretnica potrebitosti reza nastupa kod bruto mase rogovlja od 310 grama. Naime, rogovlje bruto mase manje od 310 grama bolje je odrezati prema propisanom pravcu rezanja lubanje jer će izgubiti do 90 grama, dok lubanju rogovlja mase preko 300 g (ako se lovac ravna prema funkciji potencija), odnosno 305 g (ako se lovac ravna prema funkciji pravca) nije uputno piliti jer će izgubiti više od 90 grama, odnosno više nego što bi mu ocjenjivač trebao oduzeti zbog nepropisnog reza (odnosno obrade trofeja). Neovisno o načinu obrade lubanje, sva tri tipa mase lubanje pokazuju statistički značajnu ovisnost o volumenu. S porastom volumena gustoća trofeja pada (R^2=0,813; p<0,001), uz činjenicu da se rezanjem lubanje uklanjaju gušći, odnosno masivniji dijelovi trofeja. Primjena koeficijenta 0,23 ovisi o gustoći trofeje, tako njegova primjena kod rogovlja veće mase i manjeg volumena podiže trofejnu vrijednost, jer bi stvarni koeficijent bio daleko manji. Kod poroznog rogovlja stvarni koeficijent bi trebao biti veći, te primjena koeficijenta 0,23 daje nižu od stvarne vrijednosti. U slučaju neotpiljenih lubanja nije uputno primjenjivati koeficijent 0,23 jer daje nižu ocjenu.

KLJUČNE RIJEČI: rogovlje, specifična težina, masa, ocjenjivanje lovačkih trofeja, CIC