

1 **The background for common integrated management of large carnivores and**
2 **herbivores in the Carpathians**

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9 Abstract

10 The Carpathians are one of the strongholds of the large carnivore (LC) and large herbivore
11 (LH) populations in Europe and form a cross-border bioregion. In spite of the importance and
12 key-stone role of these species, their public reputation is contradictory, resulting in non-
13 synchronised management among neighbouring countries based on databases and
14 management plans of uncertain quality. LCs are known as generally protected species in
15 Europe, while LHs mainly as game species. We hypothesised that this discrepancy will lead
16 to differences in the quality of their databases, monitoring, and planning systems in the
17 Carpathians. Experts from six Carpathian countries answered questionnaires about those
18 issues related to brown bear (*Ursus arctos*), grey wolf (*Canis lupus*), Eurasian lynx (*Lynx*
19 *lynx*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and chamois (*Rupicapra*
20 *rupicapra*). Those LCs and LHs were under total protection in 61% and 6% of the cases,
21 respectively. No relationship was found between the protection level and the quality of
22 population estimation or harvest data. In most cases data on harvesting exist, but their
23 reliability is considered poor. Although there are monitoring systems for every LH species
24 and for most of the LC species, the monitoring is mainly based on personal opinions and
25 rarely on scientific methods. Conservation/management plans exist in about half of the
26 countries for both groups. The protection level does not affect the quality of planning. The
27 elaboration of a common and reliable monitoring system was identified as the most important
28 among the necessary management measures. Among the research priorities the development
29 of robust, reliable and repeatable monitoring methods and the elaboration of comparable
30 management plans were considered as the most essential ones.

- 31 Key words: large mammal, planning, monitoring, evidence-based conservation, wolf, lynx,
32 bear, deer, chamois
33 Running title: Management of Carpathian large mammals

Introduction

The Carpathians are one of the strongholds of the large carnivore (LC) and large herbivore (LH) populations in Europe. These mountains are important reservoirs of LCs for Europe (Breitenmoser et al. 2000), where the densities of brown bear (*Ursus arctos*), grey wolf (*Canis lupus*) and European lynx (*Lynx lynx*) are among the highest ones in the world (Zibordi et al. 2012). The most common native LHs in the Carpathians are red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and chamois (*Rupicapra rupicapra*) (Apollonio et al. 2010a). Large mammals are essential parts of natural ecosystems and function as key-stone species (Jędrzejewska & Jędrzejewski 2005, Katona et al. 2013, Laundré et al. 2010, Reimoser & Putman 2011, Sinclair et al. 2006, Smit & Putman 2011, Zibordi et al. 2012). They have a wide range of socio-economic impacts, as many of those species belong to the cultural heritage of Carpathian nations and can be exploited by hunting (Bauer & Giles 2002, Kaltenborn et al. 2013, Rigg 2008) or eco-tourism (Wall & Child 2009) - even as an important part of rural development.

On the other hand large mammals have negative economic impact, too. The damage in sheep flocks (Boitani 2000, Mattisson et al. 2014, Swenson et al. 2000) and possible attacks on humans (Linnell et al. 2002, Swenson et al. 2000) by LCs or damage in agricultural products and in forest regeneration by LHs (Reimoser & Putman 2011) could give rise to serious conflicts between large mammals and local people. There are several ways to mitigate these conflicts (Conover 2002, Rigg & Adamec 2008, Rigg et al. 2011), but every activities should be based on relevant studies and well-applicable databases about the problem-causing species.

Due to their trans-boundary distribution ranges and variable management practices, the conservation and management of large mammal populations require a full and efficient cooperation of the neighbouring countries (Apollonio et al. 2010b, Chapron et al. 2014, Silva et al. 2013). The EU encourages the elaboration of conservation/management plans for LCs

and many LIFE projects targeted that before (Silva et al. 2013). The Carpathian Convention also desires appropriate management of LHs and LCs based on compatible monitoring and information systems (Anonymus 2011).

The harmonized, international management measures should be concrete strategic approaches and actions that can be implemented by one or more target stakeholder groups, directly contributing to the long-term favourable conservation status of a biodiversity asset (in this case the large mammal populations). They should be generic and potentially common enough to be relevant across the entire range of the asset (subject to local variations and adaption) and specific enough to be practical, measurable (monitorable) and commonly understood by all relevant target groups (so-called “Common Integrated Management Measures” (CIMMs), see Appleton & Meyer 2014).

Management and conservation of large mammals should be based on systematic review of evidences and databases (Pullin et al. 2004). Considering this evidence-based paradigm (Sutherland et al. 2004) and the different ecological and economic impacts of LCs and LHs, we aimed to investigate the differences in the legal status, the scientific background and the necessary measures of their conservation and management in the Carpathians.

In our present study we carried out a data collection to answer the following questions: (1) Does the general protection level of LCs and LHs differ in the Carpathians? (2) Do the availability/accessibility and reliability of databases, monitoring systems and management plans of LCs and LHs differ in the investigated countries? (3) What should be the most important management measures (CIMMs) and research priorities regarding large mammal species?

Materials and Methods

Target species

In the present study we investigated six target large mammal species (3 LCs and 3 LHs): brown bear, grey wolf, Eurasian lynx, red deer, roe deer and chamois. Those species were selected as they are ecologically and economically important large mammal species in the Carpathians. They face with different threats, provide several values and cause numerous conflicts, so their conservation and management are variable among the Carpathian countries.

Survey method

Questionnaire surveys and interviews could be useful techniques when studying the public attitudes to LCs (Lescureux & Linnell 2010, Wechselberger et al. 2005) or the general folk knowledge on LCs and LHs (Ulicsni et al. 2013). In our study a single detailed questionnaire was answered by officially designated experts of six countries of the Carpathians (Czech Republic, Hungary, Romania, Serbia, the Slovak Republic and Ukraine). Therefore, among Carpathian countries only Poland was not included in this study. The interviewed experts were members of research institutions, NGOs, hunting unions and governmental bodies. They dominantly represented nature conservation (83%) and partly game management/hunting (17%). They were delegated to represent their countries in the host project (SEE BioREGIO Carpathians) of our study based on their practical knowledge and scientific appreciation, consequently we aimed to have objective answers. We asked the experts to give answers based on the official databases and information of available conservation and/or management plans. For each questions we obtained 18 data (6 countries x 3 species) for LCs and 16 data for LHs (chamois was reported to be lacking in Ukraine and Hungary, although harvestable in the latter).

Quality of the available databases

109 We assessed the population estimation and also harvest data based on the availability (how
110 detailed data exist), accessibility (how easy to acquire the existing data), reliability (how can
111 we trust the data in further applications, e. g. decision making) and applicability to the
112 Carpathian Region of the individual countries (how easy to separate or identify the data on the
113 Carpathian Region from other regions of the country). The experts had to score in the related
114 questions between 0 and 5 (worst and best).

115

116 Monitoring methods

117 The experts provided information on the existence of monitoring systems and the groups
118 responsible for them. They categorized the monitoring systems based on the applied methods
119 divided to scientifically tested and subjective (personal opinions, guesses) ones. They scored
120 the reliability of the operating monitoring systems between 0 and 5 (worst and best) based on
121 the applied methods.

122

123 Planning systems

124 The assessment of the conservation/management planning systems - similarly to the available
125 databases - was based on the accessibility (how easy to acquire the existing plans), reliability
126 (how reliable are the data that the plan is based on) and application of the plans in practice
127 (how the actions in the plan were executed) - each item was scored from 0 to 5.

128

129 Management measures and fields of research

130 Experts compiled a list both on research priorities and CIMM proposals, then they were asked
131 to rank the elements of these two lists based on their importance.

132

133 Statistical analysis

We applied Mann-Whitney U-test to compare the answers between LCs and LHs. To examine the results of multiple choice questions we conducted Fisher's exact test. In case of CIMM ideas and research priorities we calculated mean (1SD) values to rank them based on the given importance scores. In the statistical analysis we used InStat v3.05 (GraphPad Software Inc.) software.

Results

General protection level of the examined species in the Carpathians

LCs and LHs were under total protection in 61% and 6% of the cases, respectively. Among LCs lynx was reported being under total protection the most frequently. The chamois was the only LH that was not harvestable in a single case (Table 1).

Quality of the available databases

One of our alternative hypotheses was that the protection level relies on knowledge of the main population parameters. Therefore, we predicted that the generally protected LCs with international interest can be characterized by better scores than generally harvestable LHs regarding the available data on estimated population size. But there was no difference between the two groups according to the Mann-Whitney U-test (Table 2). The average scores of the data on population size were only about a medium. Reliability of the available population data had the worse scores in both groups (Fig. 1).

On the other hand we face with the opinion frequently, that we know the LHs species - which are usually game species - better, because we can rely on the hunting reports. The answers of our experts did not support this statement, since there was no significant difference between the bag data quality of LCs and LHs (Mann-Whitney U-test, Table 3). According to the scores

given by the experts, data on the harvesting exist in most cases, but accessibility and reliability scores were at a medium level. The available data can be generally applied to the Carpathian Region (Fig. 2).

Monitoring methods

There are monitoring systems for every LH and in the most cases (82.4%) for LCs too, so the existence of monitoring systems shows no significant difference between the two mammal groups (Fisher's exact test, $P=0.23$) in the Carpathians. The tasks in monitoring surveys are divided among several groups, however governments and hunters play a major role (for LCs: 50% and 28%; for LHs: 37% and 47%, respectively).

The monitoring methods are based on personal, subjective opinions and guesses in 62.5% for LCs and in 64.3% for LHs. Scientifically tested methods (e. g. snow tracking, howling, counts on sample plots) are used less frequently. The Fisher's exact test ($P=1$) showed no difference in the above mentioned (subjective and scientific) categories of the applied monitoring methods between LCs and LHs. Even the methods, which were listed among the "scientific" ones are often quite far from the requirements of an objective, replicable survey relying on representative sampling. It is impossible to determine the bias, accuracy and precision of these methods.

These weaknesses are clear if we examine the reliability of the existing monitoring systems, which were under medium score for both groups [LC: $n=17$, mean 2.38 (1SD: 1.17); LH: $n=16$, mean 2.31 (1SD: 1.14)].

Planning systems

According to the Fisher's exact test ($P=0.73$), there was no difference in the amount of the prepared plans between LCs and LHs. Some kind of conservation/management plans exists in half of the cases for LHs and 60% of the cases for LCs.

The quality of conservation planning was not different between the two groups (Mann-Whitney U-test, Table 4). The average scores were only about a medium value for all variables. Plans of the LCs are applied in practice very weakly (Fig. 3).

According to our experts the plans are taken into account mainly in game management, nature conservation and forestry; but only in a few cases, when the other sectors - which have a strong impact on large mammals - prepare their own plans (Table 5).

Management measures and fields of research

We asked the experts to define Common Integrated Management Measure ideas and also to rank them by importance scores (Fig. 4). The elaboration of common monitoring system using reliable and replicable methods obtained the highest score. The establishment of common scientific information background was ranked at second place, and the application of uniformly structured management plans achieved the third highest score from the experts. Measures related to the improvement of monitoring methods, planning, compensation systems, anti-poaching, public awareness, financing, supporting habitat connectivity and lobbying for the lynx priority status were considered also to be important.

Among research priorities (Fig. 5), the experts considered the development of monitoring methods to be the most important topic. Researches on habitat use and suitability had the second highest score and the collection of data on the connectivity of areas was ranked at third place.

Discussion

207 General protection level of the studied species in the Carpathians

208 The protection status of LCs and LHs is variable in Carpathian countries. Their protection
209 status and management should be adapted to national conditions and the population status but
210 these connections are not always clear. The results support the critics against EU directives,
211 i.e. that categories of protection level seem to be too rigid and not easily applicable to the
212 whole region (Salvatori & Linnell 2005).

213

214 Quality of the available databases

215 According to the expert opinions there was no difference in the availability, accessibility and
216 reliability of population estimation and harvest data of LCs and LHs.

217 The basis of the management of a species should be the knowledge on its biology, ecological
218 needs, population size and occurrence (Sinclair et al. 2006). In spite of this, the reliability of
219 the data concerning the size of a population was usually regarded moderate by experts. In case
220 of the studied species the following typical mistakes occurred generally.

221 Data on the national level usually do not originate from regular and systematic monitoring,
222 but from expert guesses. It suggests there were no good quality data during the decision
223 making about the species conservation status (Pullin et al. 2004). The Large Carnivore
224 Initiative for Europe (2004) also reported this problem.

225 Previously published data are accepted and used by everyone - as a kind of consensus -, but
226 often without any critical assessment (Sutherland et al. 2004). Pullin et al. (2004) also stated
227 that the majority of conservation actions in the UK rely heavily on traditional knowledge,
228 because many management interventions remain unevaluated and evidence-based practices
229 are not accessible.

230 In case of such conflict species as LCs, conservation measures are based on these uncertain
231 data. It makes planning and executing the actual management strategy very difficult in a real

conflict situation. As a further result, local stakeholders will lose their trust and interest in protecting these species, because their experiences are frequently in sharp contrast with the official data and authority actions (Lescureux & Linnell 2010, Wechselberger et al. 2005). Although the harvest data could be more reliable than the population estimation ones (Solberg et al. 1999), harvest data could be missing or not easily available, especially regionally. Several experts noted that there are culling records, but it is very complicated and takes long time to receive them from the concerned administration. We can agree with the Large Carnivore Initiative for Europe (2004) that more detailed, reliable, GIS based and easily accessible databases are needed.

Monitoring methods

Although there are operating monitoring systems in most cases for both LCs and LHs, their reliability is considered low. We can conclude that the applied methods with few exceptions - e. g. synchronous track counts in Romania and genetic studies recently initiated in Slovakia (Rigg & Adamec 2008) - are often not scientifically tested. We do not know the bias, accuracy and precision of these methods, therefore they cannot provide reliable data, only population abundance guesses. We obtained very similar results in a Hungarian LIFE project on LCs - titled as „Funding the base of long-term carnivore protection in Hungary” (LIFE00/NAT/H/7162) -, when we surveyed the monitoring methods in Western and Central Europe in 2005.

Evaluation of the success of protection or the suitability of the management methods can be carried out by perceiving and monitoring the changes of population sizes and distribution areas (Large Carnivore Initiative for Europe 2004). In order to be able to monitor the changes, it would be necessary to provide that, the measured data have the least possible bias and deviation. Thus, we recommend to develop and maintain a jointly formed and financed

monitoring system with common reliability criteria in all countries concerned (Kutal & Rigg 2008). The expert estimations and various national data collections - which have been used so far - should be replaced by this common system resulting in a unified database. Sutherland et al. (2004) suggested establishing unified web-databases for conservation purposes.

Planning systems

We revealed that management plans for LCs and LHs were lacking in half of the cases. The experts reported limited accessibility and reliability of the existing plans. Moreover, the integration of management plans of LCs into the everyday practice was considered weak.

Very important sectors that strongly influence the conservation of large mammals, like tourism, land use planning, agriculture, livestock breeding or infrastructure and settlement development (as also listed by Reimoser & Putman 2011), are not interested in conservation actions and ignore the conservation requirements in many cases (Kutal & Rigg 2008).

Sometimes the main stakeholders - like forest managers - ignore the benefits of large mammals and are not sensitive to conservation issues (Reimoser & Putman 2011). It would take longer investigation to better understand the whole complicated relationships between different stakeholders and large mammals, but it must be a challenge of the near future. We assume that the more stakeholders are involved, the more satisfactory and feasible plans can be prepared. The involvement of stakeholders in the planning process is one of the main conditions for a successful conservation (Silva et al. 2013).

Management measures and fields of research

The most important CIMM ideas for Carpathian LCs and LHs were consistent with the principles of evidence based conservation (Pullin et al. 2004, Sutherland et al. 2004). There was a clear demand for reliable data and information to support management decisions. The

experts emphasized the elaboration of common monitoring system, the establishment of common scientific information background and the development of national multi-sectorial species conservation and management plans of large mammals based on overall common framework.

In the adequate management of large mammals, lacking of suitable knowledge is one of the main problems, as also reported by Salvatori & Linnell (2005). The most urgent issue is the development of reliable monitoring methods suited to the various local conditions. More and coordinated research is needed to study the population parameters, habitat use and requirements of each species, causes and possible solutions of conflicts. Furthermore, the socio-economical background should be revealed and models for the implication of large mammal conservation and management in rural development in the Carpathians should be elaborated (Bösze & Meyer 2014).

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421 Table and figure captions

422

423 Table 1. Legal status of the studied large mammal species in the investigated countries (the

424 values show the number of positive answers reported by the different countries)

425

426 Table 2. Comparison of the population data quality between the LCs and LHs based on the

427 scoring of our experts (Mann-Whitney U-test)

428

429 Table 3. Comparison of the harvest data quality between the LCs and LHs based on the

430 scoring of our experts (Mann-Whitney U-test)

431

432 Table 4. Comparison of planning between the LCs and LHs based on the scoring of our

433 experts (Mann-Whitney U-test)

434

435 Table 5. Integration of the species management/conservation plans into the planning of other

436 sectors (the values show the number of positive answers reported by the different countries)

437

438 Figure 1. Comparison of the population data quality between the LCs and LHs based on the

439 scoring (mean + SD) of our experts (Score: 0: very poor, 5: excellent)

440

441 Figure 2. Comparison of the harvest data quality between the LCs and LHs based on the

442 scoring (mean + SD) of our experts (Score: 0: very poor, 5: excellent)

443

444 Figure 3. Comparison of planning between the LCs and LHs based on the scoring (mean +

445 SD) of our experts (Score: 0: very poor, 5: excellent)

446

447 Figure 4. Ranking of the Common Integrated Management Measure (CIMM) ideas according
448 to the experts (mean + SD; 1: the least important; 6: the most important)

449 a) Timing between spring monitoring and quotas

450 b) Common database

451 c) Synchronization of management plans

452 d) Common structure of management planning

453 e) Common scientific information background

454 f) Common monitoring system

455

456 Figure 5. Ranking of the fields of research according to the experts (mean + SD; 1: the least
457 important; 7: the most important)

458 a) Research on interspecies interactions

459 b) Calibration of different methods to each other

460 c) Socio-economic survey on values of ecosystems

461 d) Research on population genetics and dynamics

462 e) Data/information about connectivity of areas

463 f) Research on habitat use and suitability

464 g) Development of monitoring methods

465 Tables

466

467 Table 1.

Species	Harvestable - limited protection	Total protection
Wolf (<i>Canis lupus</i>)	4	2
Lynx (<i>Lynx lynx</i>)	1	5
Bear (<i>Ursus arctos</i>)	2	4
Chamois (<i>Rupicapra rupicapra</i>)	3	1
Red deer (<i>Cervus elaphus</i>)	6	0
Roe deer (<i>Capreolus capreolus</i>)	6	0
Total LC	7	11
Total LH	15	1

468

469

470 Table 2.

	Availability		Accessibility		Reliability		Applicability to Carpathian Region of the country	
	LC	LH	LC	LH	LC	LH	LC	LH
n	17	16	17	16	17	16	17	15
U-statistic	105		118		122.5		107	
p	0.27		0.52		0.64		0.45	

471

472

473 Table 3.

	Availability		Accessibility		Reliability		Applicability to Carpathian Region of the country	
	LC	LH	LC	LH	LC	LH	LC	LH
n	8	16	8	16	8	16	8	15
U-statistic	45		44		40		55.5	
p	0.25		0.22		0.14		0.79	

474

475

476 Table 4.

	Accessibility		Reliability		Application in practice	
	LC	LH	LC	LH	LC	LH
n	11	5	11	8	11	3
U-statistic	17		34		9.5	
p	0.25		0.44		0.31	

Table 5.

	Game management	Nature conservation	Forestry	Land use planning	Agriculture	Water management	Livestock breeding	Other
LC	8	10	5	1	0	0	0	0
LH	5	3	5	0	1	1	0	0

Figures

Figure 1.

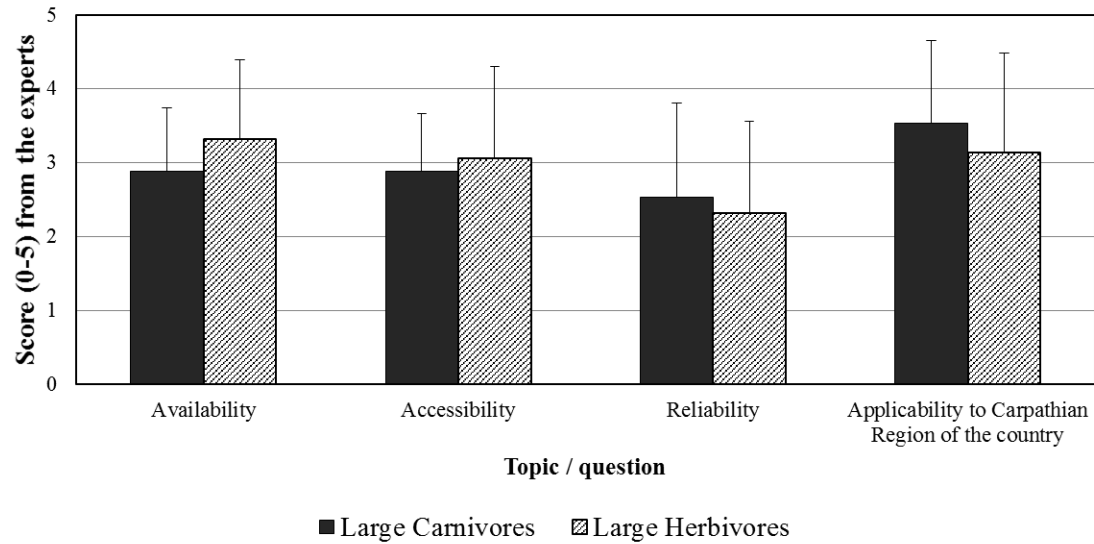


Figure 2.

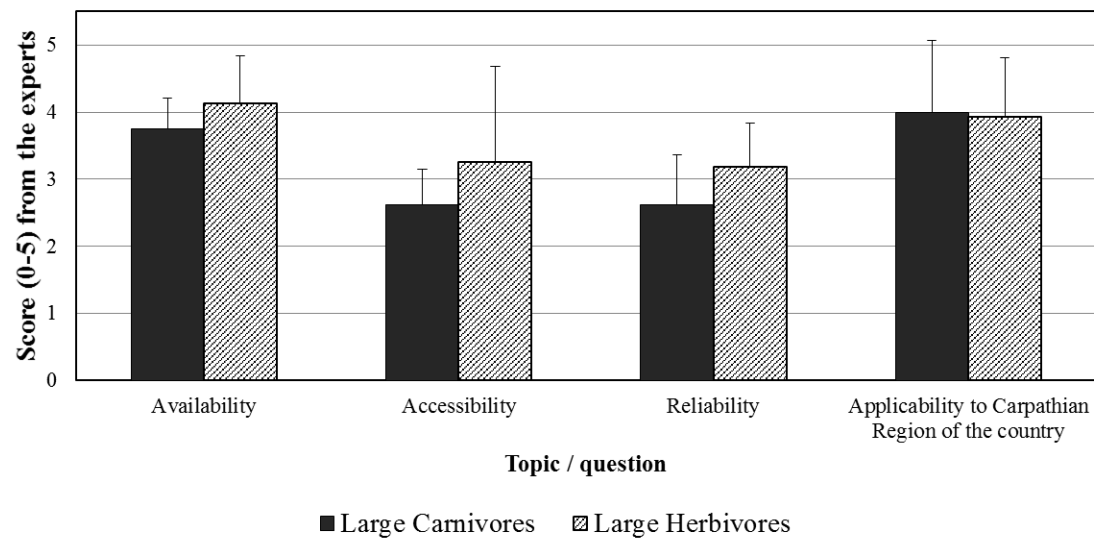


Figure 3.

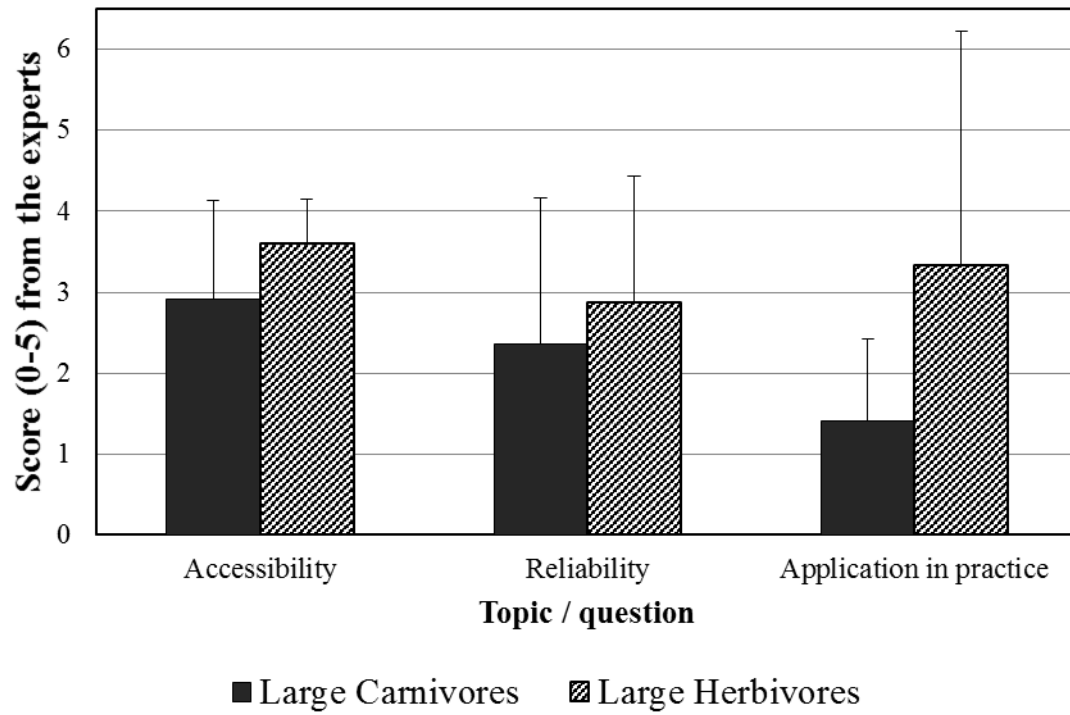


Figure 4.

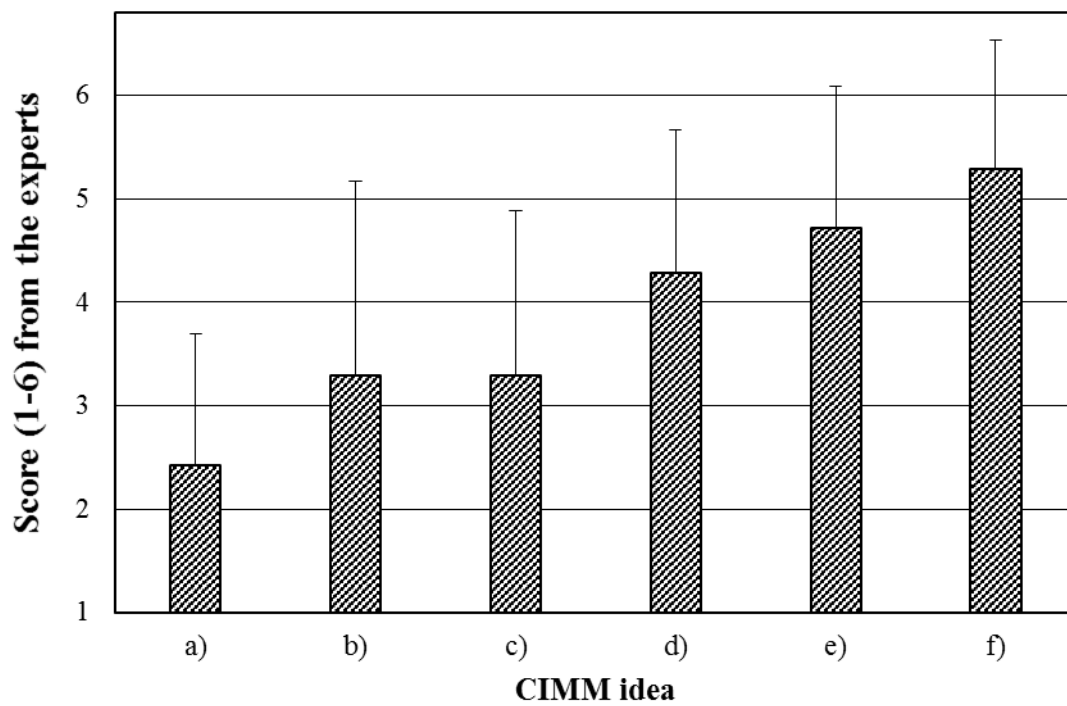
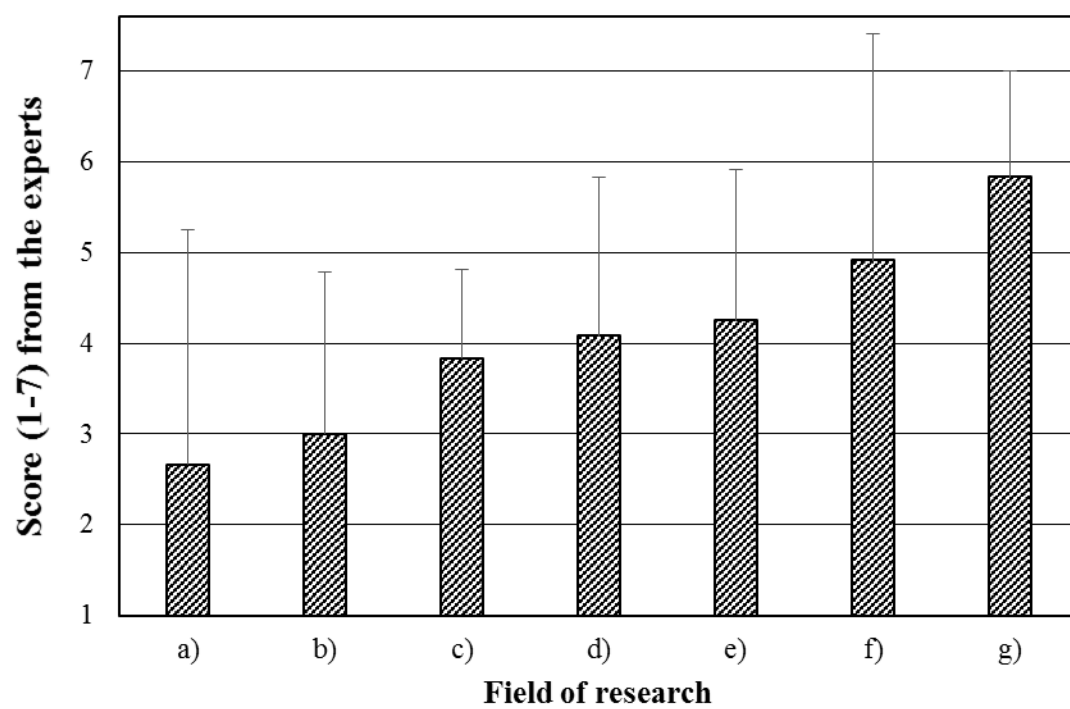


Figure 5.



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