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Possibilities for Harmonisation between Recreation Services and Their Production within the Forest Sector—A Case Study of Municipal Forest Enterprise Hradec Králové (CZ)

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Abstract: This paper deals with the possibility of harmonising the needs of society and the possibilities of the forest property manager. The Municipal forest enterprise of the city of Hradec Králové (MLHK) in the Czech Republic (CZ) is an example of this principle, which proves that the intensive development of a recreational service is possible without limiting this principle. The forest enterprise manages 3707 ha of forest in the immediate vicinity of the city with 92,000 inhabitants. The forest enterprise pays the city rent and makes a profit. The data were obtained by analysing the economic data of the surveyed company, the annual observation of the forest attendance, the surveys of the characteristics of the forest visitors and the surveys of selected 16 companies (from seven countries) managing the forests of some European cities. The main results concerning MLHK are as follows: the share of recreational service costs in the total costs of the forestry activities is 19.7%. The recreational services of the forest are financed from 71.5% from revenues from the sale of raw wood, 17.5% from revenues from the sale of sand from its own quarry, 3.9% from revenues from the recreational services and 7.1% from subsidies. The operation of the gravel quarry contributes to the economic result of the forest enterprise roughly by an amount corresponding to the costs of the recreational services. An average annual forest attendance is 243 people/ha. The inhabitants of the city account for 61.5% of the visitors, 20.4% of the visitors live within a distance of up to 30 km, and 18.1% of the visitors live at a distance of more than 30 km. The main results of the survey among the forest enterprises managing the forests of the selected European cities are as follows: the share of costs for the recreational services in the total costs of the forestry activities is 21–72% for cities with a population of over 100,000, and 3–14% for cities with less than 100,000 inhabitants. As a source of financing recreational services, the forest enterprises from mentioned cities with over 100,000 inhabitants, the money especially came from the city budget (70–100%). Forest enterprises from cities under 100,000 inhabitants stated that they fund a recreational service with 95–100% of the revenues from the sale of raw wood. Data on the MLHK show that it is possible to finance a recreational forest service from its own resources if this is the owner's priority. However, this only applies under certain conditions, such as that, in addition to the income from forest management, there are other sources of income (in this case, sand mining or subsidies from public programmes). If the forest owner did not have these resources, they would have to pay for the recreational service from their own other resources (e.g., from the city budget).

Keywords: recreational forest service; timber production forest service; permanent yield from the forest; relationships analysis; municipal forest enterprise Hradec Kralove; Czech Republic



Citation: Jůza, R.; Jarský, V.; Riedl, M.; Zahradník, D.; Šišák, L. Possibilities for Harmonisation between Recreation Services and Their Production within the Forest Sector—A Case Study of Municipal Forest Enterprise Hradec Králové (CZ). *Forests* **2021**, *12*, 13. <https://dx.doi.org/10.3390/f12010013>

Received: 18 November 2020

Accepted: 21 December 2020

Published: 24 December 2020

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1. Introduction

With increasing urbanisation, the importance of suburban recreational forests increases. People find relief in the forest from the stress caused by living in an artificial environment, from a sedentary lifestyle and virtualisation of social relationships [1,2]. During the limitations associated with COVID-19, which caused a further escalation in stress [3], forests were one of the few environments where people could move without

major restrictions. The availability of the forest and its frequent visits are associated with a number of benefits, the most common of which are reducing stress [4–13], stimulating physical activity [14–19], and facilitating social cohesion [20–22]. The proximity of the forests and their sufficient area can reduce the risk of lower respiratory tract diseases, cardiovascular diseases [23,24], negative birth results [25], cancer [26,27], and reduce mortality [28]. The beneficial physiological and psychological effects of visiting forests are documented by a number of studies devoted to forest therapy [29–50]. Suburban forests also bring other benefits. Forest stands reduce air pollution, they reduce the maximum air temperatures in the summer, which, in turn, improves the air quality in cities and the thermal well-being of their inhabitants [51–61]. The use of forests for recreation is becoming increasingly important, but it may jeopardise the principle of a sustainable forest yield on which traditional forestry is based [62–64]. A balanced approach to both is important, as raw wood production is still the main source of income for most forest owners [65–67]. The use of traditional non-wood forest products, such as tan bark or resin, is in competition with synthetic substitutes and forest fruits, medicinal herbs, and ornamental shrubs that are grown in specialised facilities, so their use as a commodity is very limited [68]. Cases of business with wild forest crops are still rather rare [69]. Nevertheless, forest owners are trying to commercialise new forest products and forest services that, at least, partially diversify the income of their forest enterprises [70–73]. In some countries, forest owners are motivated to develop a recreational forest service through financial incentives from public funds [74,75], as the development of the services they could charge for is hampered by the right to freely enter the forest [76–79].

The aim of the research was to analyse the structure and intensity of the active demand in detail based on the research of the visitors carried out with various customer groups throughout the year and to verify whether the supply and intensification of the recreational and related forest services can only be ensured with the help of revenues from the ordinary forest management. Thus, to combine the analysis of the production potential with the analysis of the active demand associated with a visit to the forest, to compare the costs and benefits associated with the recreational service, to analyse the sources of its funding, and answer two research questions:

RQ1: Can the development of a recreational forest service be financed from the forest's own economic resources so that it is not making a loss if the forest owner so decides?

RQ2: Is it possible to develop, in principle, the nonmarket recreational service without limiting the permanent yield from the forest?

2. Characteristics of the MLHK Forest Enterprise

This section describes the characteristics of the main production factors and the economics of the Municipal forest enterprise of the city of Hradec Králové (MLHK) as a fundamental basis for the further analyses and, through a comparison with the average values of the Czech Republic (CZ), the possible specifics of the investigated forest enterprise.

The owner of the forest enterprise is the city of Hradec Králové, which almost has 100,000 inhabitants, that is also the administrative, cultural, and economic centre of the East Bohemian region with 1.1 million inhabitants and an area of 10,000 km².

With an area of 3707 ha, MLHK is one of the largest municipal forest enterprises in the CZ. It lies at an altitude of 227–290 m a.s.l. It belongs among the warmer and drier locations of the CZ. The average annual temperature ranges from 8.5 to 9.0 °C, the average annual precipitation is 580–610 mm (data from the Czech Hydrometeorological Institute: [80]). Figure 1 shows the location of MLHK within Europe.



Figure 1. Location of the Hradec Králové municipal forests on the map of Europe. Source: ESRI, Inc. Redlands, CA, USA, ČÚZK, CZ.

Coniferous species cover 81.0% of the stand area, which includes the predominant Scots pine (*Pinus sylvestris*) that grows on 57.3% of the area, the Norway spruce (*Picea abies* (L.) Karsten) with a 20.7% share, and the European larch (*Larix decidua* Mill.) on 1.4% of the area. Deciduous tree species cover the rest of the area (19.0%), which includes the sessile oak (*Quercus petraea* (Mattuschka) Liebl.) that occupies 5.9% of the area, the silver birch (*Betula pendula* Roth) with a 3.3% share, the black alder (*Alnus glutinosa* (L.) Gaertner) with a 2.6% share, the European beech (*Fagus sylvatica* L.) with a 1.3% share, and the pedunculate oak (*Quercus robur* L.) with a 1.3% share. Compared to the CZ average, there is a significantly higher proportion of Scots pine in the MLHK area (the average being 16.2% [81]) so, conversely, the share of Norway spruce is significantly lower (the average being 50% [81]).

The CZ is one of the countries where the obligation to manage forests (properties over 50 ha) is legislated in accordance with forest management plans. One of the binding provisions is the maximum total amount of the harvested timber. The current forest management plan 2015–2024 sets the maximum total decennial felling rate of 172,200 m³ (4.7 m³/year/ha of forest land) for the MLHK area. In the period of 2015–2018, the total amount of felling was 4.6 m³/year/ha of forest land. In the CZ, the amount of logging was 7.4 m³/year/ha of forest land in the same period.

Climate change, which has manifested significant impacts on the forests in Central Europe after 2014 [82,83], has contributed to an ever-increasing share of salvage felling. The share of salvage felling in the total production of the MLHK area was 37.8% (2015), 68.8% (2016), 64.6% (2017), 77.2% (2018), and 86.8% (2019). According to the data provided by the Forest Research Station Opočno (Forestry and Game Management Research Institute/VÚLHM v. v. i., VS Opočno), this negative development was mainly caused by temperature abnormalities in the region from 2014–2019, associated with low rainfall, especially in the spring months. The reduced water availability led to the weakening of the

trees that were attacked by other pathogens (European mistletoe *Viscum album* L., jewel beetles Buprestidae, bark beetles Scolytinae) and withered in larger numbers. Throughout the CZ, the share of salvage felling in the total sum of timber harvesting had a similar upward trend: 50.4% (2015), 53.4% (2016), 60.5% (2017), and an even catastrophic 89.6% (2018) [81].

The costs of selected operations of forestry enterprises in the CZ are compared in Figure 2, which cover the period of 2013–2018. Compared to the CZ, the costs fluctuate between 46.8% and 89.0%. The national economic data are taken from the “Information on Forests and Forestry in the Czech Republic” (2013–2018) published by the Ministry of Agriculture. The economic data on the MLHK forest enterprise were taken from annual reports and other internal sources. In the case of forest regeneration, the main reason for the lower costs is the long-term high share of the natural regeneration of 49.1%. The lower pruning costs are due to timely and intensive clean-ups in the undergrowth, which significantly reduce the number of the individual trees removed during the subsequent pruning. The lower logging costs are due to the lower rate of pine trees compared to the other woody plants, which is the predominant woody plant in MLHK, as well as the well-accessible flat terrain. Low approach costs are due to the high density of transport routes (29.85 bm/ha of vegetation land), the efficiency of the access and the well-accessible flat terrain. The low costs for the repairs to the forest roads are due to the use of repair material (gravel) from their own quarry and their own repair techniques—grader and vibrating plate for compaction (source: MLHK internal data).

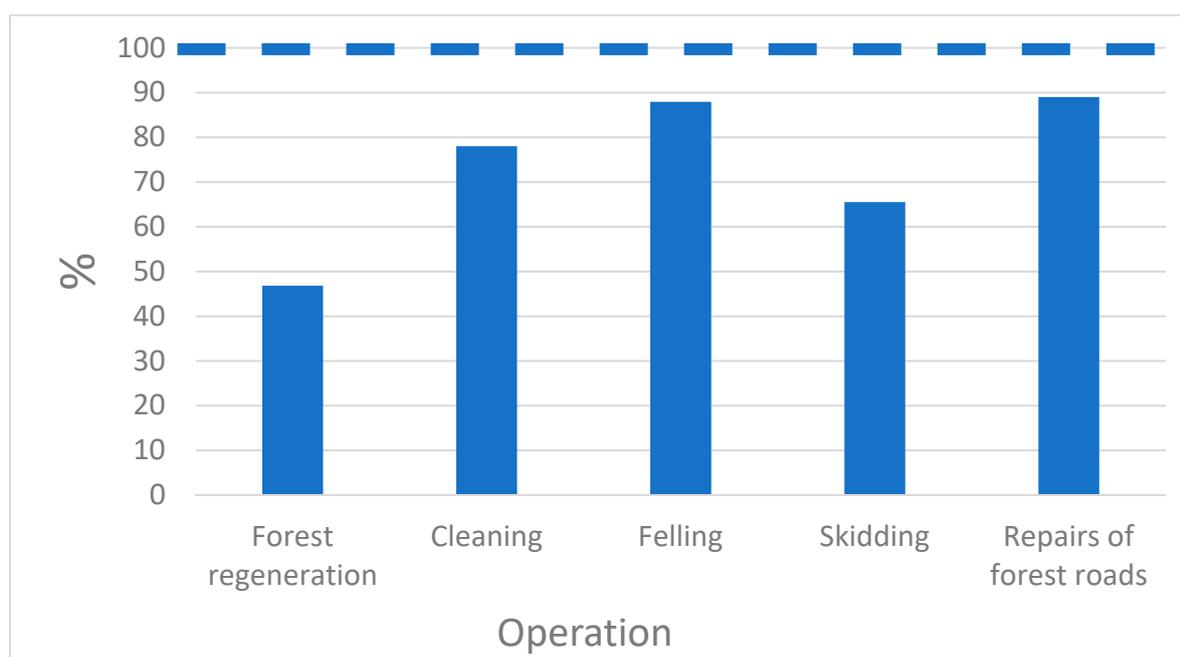


Figure 2. Average individual costs of the main services in the period of 2013–2018 compared to the average in the Czech Republic (100%).

The average monetisation of the timber is strongly influenced by the proportion of a particular tree species in the total felling volume. In the period of 2013–2018, spruce accounted for 78.5% of the total harvest in the Czech Republic (35.3% in MLHK) and Scots pine accounted for 8.3% in the Czech Republic (54.6% in MLHK). The price of pine assortment in relation to the price of spruce assortment varied as follows: assortment of the III A/B class: 74.9–87.7%, assortment of the III C class: 76.2–97.2%, assortment of the III D class: 80.9–94.6% of the average price of the spruce assortment. The prices in the monitored period were balanced in timber class V only, i.e., 97.1–102.9% of the average price of the spruce assortment [81].

Figure 3 shows a comparison of the monetisation of the forest company's timber to the average in the Czech Republic in 2013–2018. The comparison shows that despite the assumptions (lower average monetisation of pine assortment in the Czech Republic compared to spruce assortment), the MLHK forest enterprise, in the period 2013–2018, has a 16.7% on average better monetisation of wood than the average in the Czech Republic. The MLHK forestry enterprise trades in wood itself, without other intermediaries.

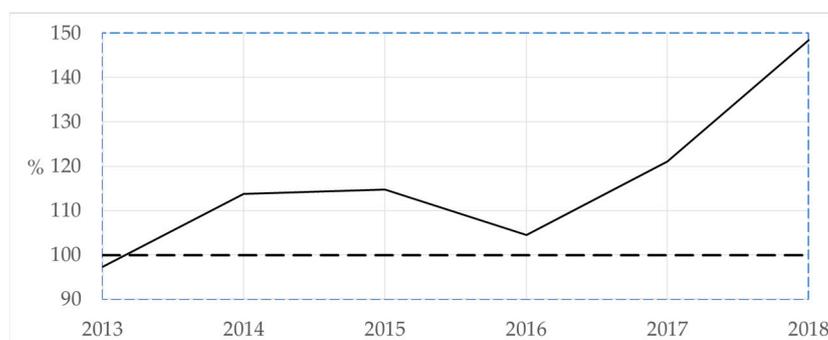


Figure 3. Monetisation of wood compared to the average in the Czech Republic (100%) in the years 2013–2018.

Overall, the MLHK situation can be characterised as follows: the production potential of the MLHK forests in the Czech Republic is slightly below average. This disadvantage is compensated for, by the forest enterprise, with the lower average individual costs for the main forest services and higher monetisation of wood. The forest enterprise's share of the incidental logging caused by climate change is similar to the average in the Czech Republic.

3. Methodology

As the research is focused on several methodologically separate areas, the used methodological procedures are characterised separately for the individual areas.

3.1. Economic Data of the Forest Enterprise

The economic data were methodically obtained from the accounting reports of the forest enterprise, where activities related to the support and development of the recreational service of the forest are conducted under a separate output, further divided into suboutputs. The costs of the forest road maintenance due to the recreational service are managed separately by the forest enterprise (under a separate suboutput) from their maintenance (due to the timber transport). They consist of the costs of regular mowing of grass along the roads and the year-round maintenance of the crown of forest roads in a quality corresponding to their use for hiking and cycling, which is carried out beyond the maintenance of the forest roads for the transport of wood. The software GIST Intelligence Manager program (<http://www.gist.cz/en/products/business-intelligence>) was used to summarise the production and accounting data, in which the management of the forest enterprise obtains economic outputs from the forest management records and accounting reports. Furthermore, data from the annual financial statements and annual reports of the forest enterprise were used.

3.2. Methodology of the Forest Visitors' Attendance

A census of visitors who entered the MLHK forest took place once a month for 12 months (six times on Wednesdays, six times on Saturdays) between 1 May 2016 and 30 April 2017 at 20 of the preselected forest's main entrances. The dates were set several months in advance without any influence of the weather forecast. The planned date was always kept. The survey days were chosen on the assumption that the level of attendance during a pair of consecutive months was similar (January and February, March and April, etc.). The surveyors recorded data on the forest attendance on preprinted record files.

Within each hour (6:00–6:59, 7:00–7:59, etc.) the forest visitors were divided by type of mobile activity into pedestrians, joggers, inline skaters, cyclists, infants in prams, skiers, and others, as well as by their gender. The category of “others” included horseback riders, wheelchair users, skateboarders, scooter riders, and others. The dogs accompanying the visitors were recorded too. The calculation of the attendance was based upon the registered number of visitors on 12 survey dates (days). The attendance data from Wednesdays were used to calculate the number of visitors on the weekdays. The data from Saturdays were used to calculate the traffic on the weekends and public holidays.

The linear model with a square root transformation of the rate attendance was used to evaluate the statistical significance of the factors influencing the rate of attendance

$$\sqrt{y} = \beta_0 + \sum_{i=1}^k \beta_i x_i \quad (1)$$

where y is the number of recorded visitors, explaining the variables x_i , $i = 1, \dots, 5$, which includes two continuous variables—the average daily temperature and total daily precipitation—and three categorical variables—the identification number of the forest entry, the hour in which the measurement took place and an indication of whether it was a working day or a day off. The meteorological data for Hradec Králové were obtained from the Czech Hydrometeorological Institute [80].

The linear model with a square root transformation of the rate attendance explains the largest part of the data variability and meets the relevant assumptions.

3.3. Methodology of Research of the Visitors to MLHK Forests

The characteristics of the forest visitors were ascertained by means of a survey (the complete questionnaire is given in Appendix A).

A questionnaire type survey was conducted from 18 June 2016 to 30 September 2016. The questionnaires were distributed, filled out, and handed over during four survey days at the main entrances to MLHK (25.9%); most of the questionnaires (74.1%) were distributed, filled in and handed over at the major hubs in the forest (where people usually gather or stop). Before filling out the surveys, the respondents were asked whether they had not already filled in the questionnaire—to avoid duplicates. One of the questions required the respondents to assess the significance of their purpose for the forest visits. The respondents evaluated the significance of their particular purposes on a six-point scale (5—the most significant, 0 points—insignificant). The respondents who did not reply to this particular question were not included in the calculation of the significance of the forest visit. The level of significance was evaluated as a weighted arithmetic mean of the respondent’s chosen degree of significance. At the end of the questionnaire, the respondents were given space to write a message or a comment related to the topic of the survey.

The results are presented by descriptive statistics methods. The selected results, namely the relationship between sociodemographic characteristics and the visitor attitudes, are illustrated by a mosaic display—a graphical method developed by [84]. In a mosaic display, each of the cell counts of the contingency table is represented by a tile proportional to the cell frequencies. The relative size of a tile becomes an indicator for whether the observed data deviates from the hypothesised mode [85].

Pearson’s chi-square test was used to evaluate the statistical significance of the potential deviates from the hypothesised independence of the factors.

3.4. Methodology of the Research of the Forest Visitors’ Safety

The forest attendance issues include a very important point about the safety of forest visitors, which is often underestimated in research. We did include it in our research, though. In the MLHK forest, rescue points are established and distinctly marked for visitors in emergency situations. There are 16 of them and the Integrated Rescue System (IRS) vehicles have them in their database. When alerted, the Hradec Králové Municipal

Police will arrive in the MLHK forest within 5 min, the Hradec Králové Region Emergency Medical Service ambulance within 5–8 min, and the Czech Fire Rescue Service within 12 min. The IRS units were asked to provide data on the number and nature of interventions during our annual forest visit survey from 1 May 2016 to 30 April 2017.

3.5. Comparison with Selected Enterprises in Urban Forests

To compare the situation of financing the recreational forest service and the discussion part, a selected group of forest enterprises managing forests in some European cities was addressed in the form of an e-mail questionnaire. The inquiries focused on the following information: the area of the forest property, the amount of land, the share of recreational service costs in the total costs of the forestry activities, the source of financing for the recreational services and any other details. The forest enterprises of large cities, in which it was assumed that they were dedicated to the development and support of the recreational services of the forest, were addressed.

4. Results

Similar to the methodology, the results are presented in separate sections.

4.1. Financing of Recreational Services by MLHK

4.1.1. The Cost of Providing Recreational Forest Services

The total annual costs of providing the recreational forest service in 2013–2019 ranged from 2,570,000 to 6,563,000 CZK/year with an annual average of CZK 4,576,000, which represents 19.7% of the total cost of the forestry activities. These were mainly the costs of the above-standard maintenance of the forest roads (53%), the construction and maintenance (42%) of equipment (covered fireplaces, gazebos, benches, information signs, road markings), and waste collection (5%). The main item is the cost of the maintenance of the forest roads, carried out due to the forest visitors (more frequent trimming of road edges and systematic maintenance of the crown of roads with a plate vibratory compactor and grader). In the accounting, this maintenance is kept separately and is distinguished from the maintenance of forest roads carried out due to normal forest management. The density of forest transport routes is high, 29.85 bm/ha of stand soil.

The costs of the forest road maintenance can be divided according to their purpose into the different types of roads used for the different recreational activities. Here, we see (Table 1) that the maintenance costs are significantly higher for the roads mainly used by pedestrians (+runners) than for the roads mainly used by cyclists (+skaters).

Table 1. Amount spent per visitor by type of recreational activity.

	Costs from 2019 (CZK)	Average Costs in 2013–2019 (CZK)
Pedestrians	57.02	120.60
Pedestrians + runners	48.51	102.59
Cyclists	43.10	92.57
Cyclists + skaters	37.86	81.32

4.1.2. Source of Financing the Recreational Service of the Forest

Foreign (External) Sources

In order to improve and develop the recreational forest service, subsidies were drawn by the forest enterprise in the period of 2013–2019 for the following purposes: renewal of the asphalt surface of the road also used for in-line skating (CZK 1,153,000), forest gyms (CZK 456,000), forest repair wells (CZK 393,000), a trail according to the book *Legends of Hradec Králové Forests* (CZK 140,000), Forest Technology Day (CZK 78,000), and a compactor for repairing forest roads (CZK 48,000). The annual average of these subsidies was CZK 324,000. The providers of the subsidies were the city of Hradec Králové (64.8%), the EU (20.1%), the Czech Republic (9.5%), the region (3.7%), and sponsors (1.9%).

MLHK's Own (Internal) Sources

In the period of 2013–2019, MLHK's most important (own) source of financing for the recreational forest services was revenues from the sale of wood (CZK 3,273,000 per year) and sand (CZK 802,000 per year). A less significant source was its own revenues from recreational forest services, consisting of the revenues from paid recreational services (CZK 177,000 per year), i.e., fees for renting forest land for the operation of refreshment stalls (29.0%), a rope and canine centre and a paintball field (20.4%), for subleasing land under the foreign owned cottages in the forest (10.3%), for renting forest cottages owned by MLHK (14.8%), for allowing motor vehicles to enter the forest (10.3%), for permitting mass events (6.2%) and for participation in forest pedagogy (9.0%). However, these fees were only sufficient to compensate for the costs of cleaning up the garbage left by forest visitors and the maintenance of forest furniture.

Overview of Sources of Financing the Recreational Forest Service

An overview of the sources of financing the recreational forest services is given in Table 2. The predominant share of MLHK's own resources, which for the period 2013–2019 is 92.9%. Foreign sources make up only 7.1% (subsidies and sponsorship donations).

Table 2. Overview of the sources of financing the recreational forest services (thousands of CZK in columns 2–6, thousands of EUR in column 7).

Year	Foreign Resources		Own Resources		Total in CZK	Total in EUR *
	Subsidy	Recreation Service	Sales			
			Sand	Firewood		
2013	1153	120	682	4608	6563	253
2014	393	137	446	4018	4994	181
2015	0	189	685	4354	5228	192
2016	188	143	1576	3228	5135	190
2017	0	130	868	2873	3871	147
2018	236	213	847	2372	3668	143
2019	298	307	507	1458	2570	100
Ø	324	177	802	3273	4576	173
%	7.1	3.9	17.5	71.5	100	

* The average annual exchange rate was used for conversion to EUR. All monetary transactions took place in CZK, due to the fluctuating exchange rate, the conversion would distort the results.

4.1.3. Share of Operations on the Economic Result

MLHK has been profitable in the long term (CZK 722,000 on average per year, see Table 3). In addition to financing the forest recreational services (CZK 4,576,000 per year), MLHK pays an average rent of CZK 3,166,000 per year to the owner. The MLHK economic activity is mainly based on timber production, see Table 3. The second most important commodity is sand. Revenues from forestry and the sand quarry cover the costs of the forest recreational services, subsidise other activities, and generate profit, see Table 3. The economic results in 2018 and 2019, which were higher than in previous years, were generated thanks to saving the road network maintenance costs because the roads reached a technical standard that no longer required high subsequent maintenance costs that they did in previous years. We present the economic result after taxes, which represents the profit of the company.

Subsidies were drawn to support the forest management. Subsidies supporting the timber production forest service were related to regenerating, establishing, and tending to the forest stands that are under 40 years of age, to the ecological and nature-friendly technologies in the forest management, to the regeneration of the stands after wind calamities, to the mitigation of drought and the subsequent insect pest infestation, and to the acquisition of forestry machinery. In 2013–2019, the subsidies amounted to an average of CZK 4,716,000 per year and accounted for 27.9% of the economic results of MLHK.

Compared to the subsidy supporting the forest recreational service (CZK 324,000) in the same period, this subsidy is 15 times higher.

Table 3. Proportion of activities contributing to the economic result (thousands of CZK in columns 2–6, thousands of EUR in column 7).

Year	Forest Management ¹	Sand Quarry	Other Activities ²	Overhead Costs	Rent Paid to the City	Economic Result ³	
2013	20,383	3012	−6503	−12,838	−3231	823	31.7
2014	23,948	2674	−4607	−18,193	−3166	656	23.8
2015	17,752	2802	−3452	−13,409	−3156	537	19.7
2016	9510	4656	815	−11,262	−3142	577	21.3
2017	14,961	4518	−2623	−13,163	−3139	554	21.0
2018	11,948	4261	581	−12,682	−3159	949	37.0
2019	19,827	6892	−2951	−19,640	−3167	961	37.4
Ø	16,904	4116	−2677	−14,455	−3166	722	27.3

¹ Including subsidies supporting timber production forest service. ² Accommodation service, maintenance of the gamekeeper's lodge, fishery, fish farming, gamekeeping, etc. ³ The average annual exchange rate was used for conversion to EUR. All monetary transactions took place in CZK, due to the fluctuating exchange rate, the conversion would distort the results.

4.2. Recreational Forest Service

4.2.1. Attendance of the Forest

From the surveyed data, the annual number of visitors to the forest was derived, amounting to 825,689 persons. The weight of the weekdays and weekend days during the year was taken into account. An expert estimate established that 7% of the forest visitors were not recorded during the survey because they entered the forest either before or after the survey time, or by other than the 20 monitored entrances. People entering the forest by car were not counted. These were fuelwood self-suppliers, hunters, and gamekeepers. According to internal MLHK data, a total of 2544 visits of fuelwood self-suppliers, 14,200 visits of hunters and gamekeepers were recorded in the given territory between 1 May 2016 and 30 April 2017. Calculation: $825,689 \times 1.07 + 2544 + 14,200 = 900,231$, rounded to 900,000 people/year, which means 243 persons/ha/year in a forest area of 3707 ha.

According to internal MLHK data, from 1 May 2016 to 30 April 2017, 18,916 people participated in organised or mass sports events (cross-country, cycling, orienteering, dog sledding, hiking). If these events took place on the survey day, the participants were included in the number of visitors to the forest. In relation to the total annual attendance of 825,689 people, calculated from the number of people detected on the survey days, the total annual number of participants in the collective events represents 2.3%. Participants in organised and collective events held on the survey days accounted for 1.8% of the total annual attendance of the 825,689 people.

If we divide the total calculated annual attendance by the forest area of 3707 ha, we get 243 persons/ha/year. Men and women accounted for 56.2% and 43.8% of the total number of visitors, respectively. The men clearly predominated among cyclists (62.0% men, 38.0% women) and runners (men 61.5%, women 38.5%) in our survey. Among the pedestrians though, the women slightly predominated (46.6% men, 53.4% women). The numbers of both genders were balanced among the skiers and others.

According to the type of activity, cyclists (bikers) clearly predominated, see Table 4. This is related to the overall high popularity of cycling in the Czech Republic and locally to the excellent interconnection of urban and forest cycle routes and a dense network of forest roads suitable for cyclists (260 km). The 16 km of asphalt forest transport routes were extremely attractive for in-line skaters. However, attendance of cyclists and skaters is uneven during the year, more than 85% of their visits were recorded from June to September.

Table 4. Distribution of the visitors according to the activity and season (in %).

Month	Biker	Walker	Children	Skater	Runner	Skier	Other Activity	All Activities
1	0.4	12.7	4.4	0.0	5.6	99.4	0.7	6.9
2	0.1	2.3	2.6	0.0	2.4	0.6	0.9	1.0
3	0.9	4.3	1.8	0.4	8.2	0.0	17.7	2.3
4	2.9	5.1	2.5	1.7	7.6	0.0	8.5	3.6
5	7.1	5.9	9.2	8.5	10.9	0.0	6.9	7.1
6	24.4	14.7	18.2	23.3	11.3	0.0	13.4	19.8
7	22.2	15.6	19.1	27.7	9.5	0.0	16.3	19.3
8	14.6	11.4	14.0	18.2	12.8	0.0	15.7	13.5
9	23.9	14.9	21.5	18.6	7.9	0.0	12.8	19.5
10	1.5	3.8	2.1	0.7	6.9	0.0	4.3	2.3
11	0.9	5.7	2.8	0.6	14.1	0.0	1.3	2.9
12	0.9	3.5	1.9	0.3	2.9	0.0	1.6	1.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Share of activity	49.0	25.2	10.4	6.8	4.4	2.8	1.4	100.0

Runners (fitness and regular sports) had the most balanced attendance during the year, in January and February some of them devoted themselves to cross-country skiing. The attendance of skiers is a seasonal affair. With sufficient snow cover, the routes are modified for them.

Overall, the highest attendance was from June to September, see Table 4. During these four months, 72.2% of the visitors visited MLHK. The daily attendance at the observation dates ranged from 331 (Wednesday, February 8, 2017) to 6357 (Saturday, 18 June 2016) visitors. On weekdays, the average attendance was 1563 people, on weekends (Saturdays, Sundays, holidays), the average attendance was 3783 people. The majority of the visitors entered MLHK between 1 pm and 6 pm. The second attendance peak was around 10 am in the morning.

We also see different uses of MLHK by different groups of visitors. Men generally tend to predominate over women in the morning, and in the afternoon the ratio tends to be more balanced. Let us mention, for example, the ratio between male and female cyclists during the whole year—Figure 4. These differences are statistically significant (Pearson’s chi-square test statistics is 76.26 on 13 degrees of freedom, critical value at significance level of 0.05 is 22.36, *p*-value is 6.10–11).

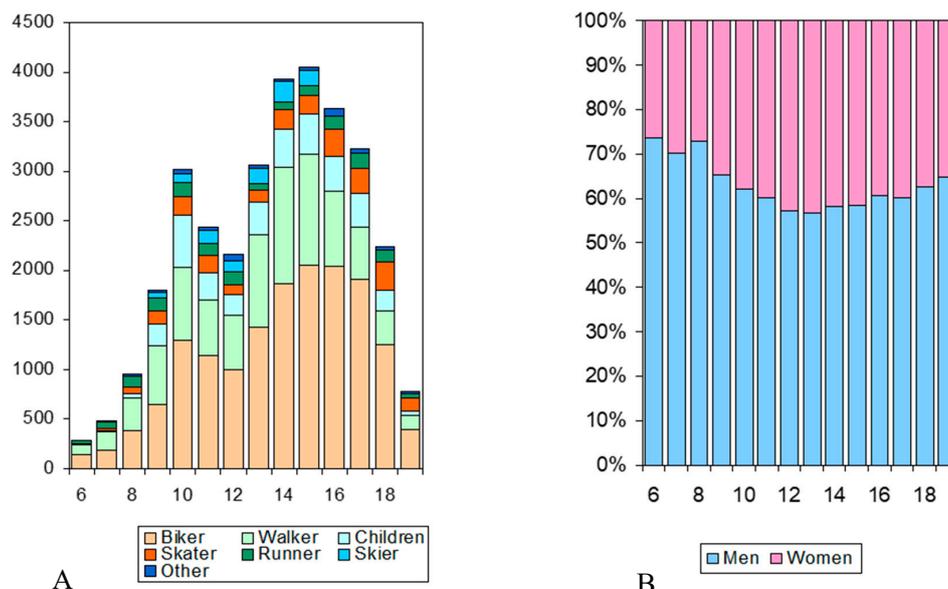


Figure 4. Time frame for the Municipal forest enterprise of the city of Hradec Králové (MLHK) attendance during the whole year—a summary picture for all types of activities (A) and a detailed view of the cyclists (B).

Attendance shows considerable variability. To explain it, we used a linear model with the square root transformation of the rate attendance (1). The model, as a whole, explains 65.5% of the data variability and is statistically highly significant (F-statistics: 122.3 on 35 and 2252 degrees of freedom, critical value at significance level of 0.05 is 1.43, p -value < 2.10^{-16}). The results for the individual variables are given in Table 5.

Table 5. Visitors by type of activity.

Term	Coefficient	Explained Variability (%)	p -Value
Temperature	0.709	4.2	< 2.10^{-16}
Precipitation	−2.395	3.0	< 4.10^{-12}
Day (Sat–Wed)	10.144	3.6	< 2.10^{-16}
Control stand		32.0	
Time		7.9	

4.2.2. Characteristics of Forest Visitors

From 18 June 2016 to 30 September 2016, a questionnaire survey was conducted. A total of 2608 completed questionnaires were obtained from the respondents. MLHK was visited by people from all over the Czech Republic, who came because of the wide range of services provided. The inhabitants of Hradec Králové accounted for 61.5% of the number of visitors. The share of visitors who have a permanent residence at a distance of more than 10 km was 29.4%. To the next question, what kind of regions are they from, 14.0% of the respondents answered that they live outside the East Bohemian region. These data confirm that MLHK is an important recreational background of the East Bohemian region with a significant overlap and beyond. The presence of visitors from outside Hradec Králové also has a positive effect on the fact that accommodation capacities, including the MLHK accommodation and swimming opportunities, are offered right on the edge of the forest. A total of 59% of all the respondents stated that they visit MLHK at least once a week. Of the respondents residing in Hradec Králové, 75% answered.

The relationship between the place of residence and the attendance rate is shown by a mosaic graph (Figure 5). It is worth noting that respondents residing more distantly visit MLHK more often than residents of Hradec Králové. The relationship between the residence and attendance rate tested by Pearson's chi-square test is statistically significant (test statistics: 1277.7 on 36 degrees of freedom, critical value at significance level of 0.05 is 51.0, p -value < 2.10^{-16}).

In evaluating the significance of the purpose of the visit (5 highest, 1 lowest, 0 none), the respondents attached the highest significance to mental and physical relaxation (3.68). By contrast, collecting forest crops (1.72) and exploring and studying nature (1.50) are of less than half in significance. They attributed the lowest importance to the collection of firewood (0.20). Figure 6 indicates the motivation of the respondents with a remote residence to visit MLHK often—this group is characterised by a relatively higher evaluation of the importance of sports activities. The relationship between the residence and evaluation of the importance of sports activities tested by Pearson's chi-square test is statistically significant (test statistics: 45.45 on 30 degrees of freedom, critical value at significance level of 0.05 is 43.78, p -value = 0.035). The respondents with a remote residence, on the other hand, evaluate, in comparison with the inhabitants of Hradec Králové and the surrounding area, the collection of forest crops as less important (see Figure 7). The relationship between the residence and the importance of crop collection tested by Pearson's chi-square test is also statistically significant (test statistics: 128.2 on 30 degrees of freedom, critical value at significance level of 0.05 is 43.78, p -value = 4.10^{-14}).

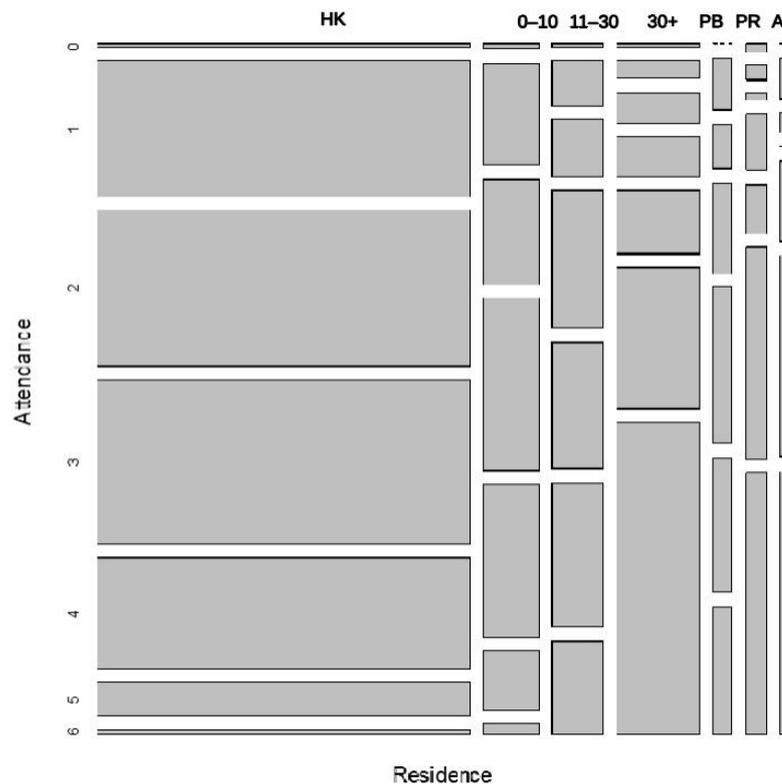


Figure 5. Relationship between the respondents’ residence and their attendance in MLHK. Distance from city Hradec Králové (HK) in km; PB—city of Pardubice; PR—city of Prague; A—from abroad.

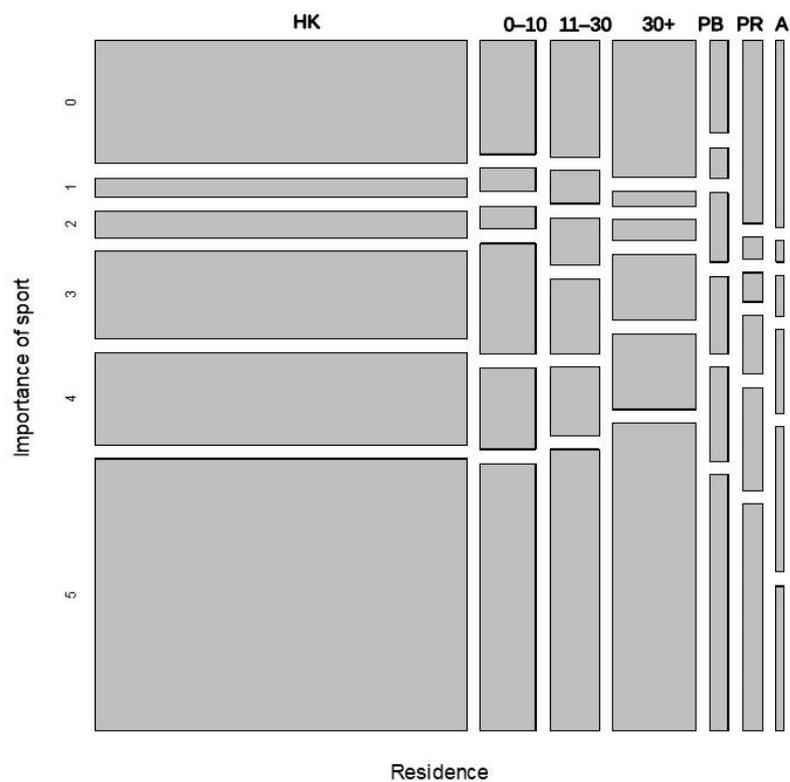


Figure 6. Relationship between the respondents’ residence and their perception of sport importance. Distance from city Hradec Králové (HK) in km; PB—city of Pardubice; PR—city of Prague; A—from abroad.

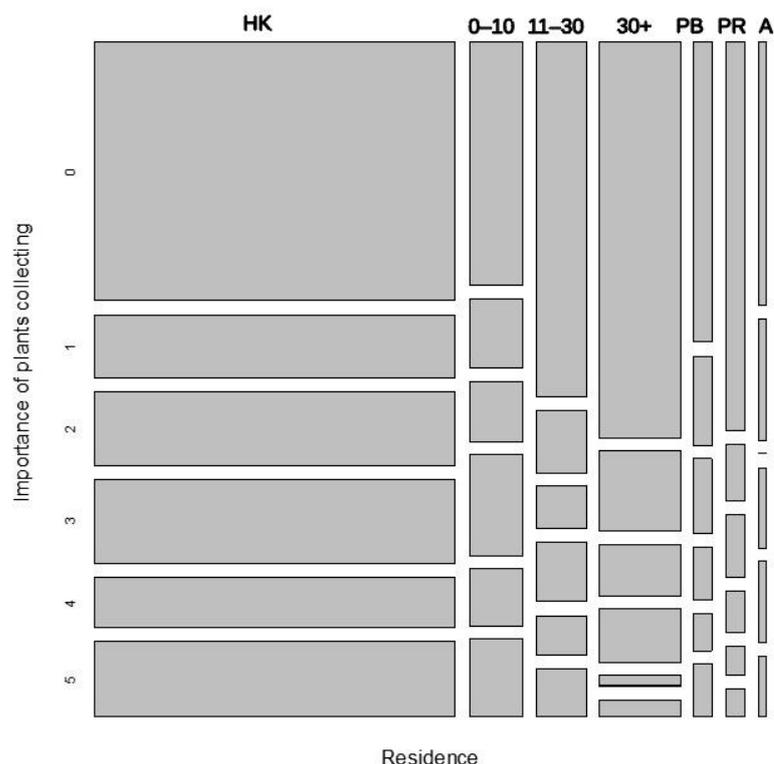


Figure 7. Relationship between the respondents' residence and their perception of collecting plants importance. Distance from city Hradec Králové (HK) in km; PB—city of Pardubice; PR—city of Prague; A—from abroad.

A total of 623 respondents used the possibility of voluntary communication, the respondents especially appreciated the possibility of refreshments in three stalls with refreshments, the enclosures with wild pigs (3.24 ha), Dybowski's sika deer (1.68 ha), fallow deer and mouflons (1.30 ha), and the possibility of starting a fire on 13 public fireplaces. Parents of small children appreciated the wooden "Knight's Fortified settlement" (0.13 ha).

4.2.3. Safety of the Forest Visitors

As far as safety is concerned, it is apparent from the data provided by the IRS units, that cases of injuries or other health problems of forest visitors occur extremely rarely, and that MLHK is a safe area. During the forest attendance survey from 1 May 2016 to 30 April 2017, the Police of the Czech Republic intervened only once (bicycle theft); the Municipal Police of Hradec Králové dealt with two cases of a dog attacking roe deer and one case of making a fire where prohibited. The Fire Brigade of the Hradec Králové Region intervened only once to extinguish a minor fire (2 × 3 m, probably from a cigarette) and the Emergency Medical Service of the Hradec Králové Region intervened 10 times in cases of falls from a bicycle or inline skates.

4.3. Comparison with Selected Forest Enterprises in Europe

A total of 16 forest enterprises from seven countries replied to the questionnaire, see Table 6 (sorted by city population). Most of them were forest enterprises managing forests owned by the respective city. In the case of Hamburg, the forest is owned by the Free and Hanseatic City of Hamburg, in the case of Mainz it was a special purpose association (Zweckverband) managing 700 ha of suburban forest consisting of the forests of Mainz and Bundesheim (450 ha) and the forests of the Land Rhineland-Palatinate (250 ha). In Hungary, forests are not owned by cities. The data in Table 6 representing Budapest refer to the Budapest woods, the Pilisi Parkerdő Zrt. Forest plant, one of the 19 state forest enterprises in Hungary. In the case of Vienna, the assessment concerns part of the forest property of

the City of Vienna, its urban forest. The Viennese forests in the water protection zone in Styria and Lower Austria were not included in the assessment. The source of financing for the recreational service was divided into wood (from revenues from the sale of raw wood), the city (from the city budget), and others.

Table 6. Share of recreational service costs in the total costs of forestry activities and sources of its financing in some urban forests.

City	Country	Population (tis)	Acreage (ha)	Annual Allowable Cut m ³ /ha/year	Rec./Total Cost (%)	Source of Financing (%)		
						Wood	City	Other
Vienna	A	1911	8650	N/A	N/A	13	75	21 ¹
Hamburg	D	1899	4365	3.5	N/A	-	2	-
Warsaw	PL	1791	3264	0.9	36	-	100	-
Budapest	H	1752	5450	3.0	11	100	-	-
Prague	CZ	1324	2746	4.7	60	-	100	-
Krakow	PL	779	606	2.5	40	-	100	-
Dresden	D	556	958	3.7	35	-	100	-
Poznan	PL	536	2566	2.1	60	-	100	-
Bratislava	SK	438	3061	1.7	72	20 ³	80	-
Zurich	CH	434	2225	9.5	50	-	N/A	-
Augsburg	D	295	7700	8.5	10	98 ⁴	-	2 ⁵
Mainz	D	219	700	3.0	50	10	70	20 ⁶
Pilsen	CZ	175	4111	4.7	21	-	100	-
Hr. Králové	CZ	92	3707	4.7	19.7	71.5	-	28.5 ⁷
Ban. Bystrica	SK	78	7625	4.1	3	95	-	5 ⁸
Zvolen	SK	43	1558	5.3	11	100	-	-
Landsb. am L.	D	29	2307	6.9	14	100	-	-

¹ Revenues from rentals and leases. ² Revenue from the sale of wood is not enough, cofinanced from the state budget. ³ Revenues from the sale of timber and rentals. ⁴ Revenues from the sale of wood and subsidies. ⁵ Revenues from recreational services. ⁶ Revenues from recreational services, sale of game and compensation for management restrictions. ⁷ Revenues from the sale of sand 17.5% ⁸ Revenues from the rental of forest cottages. A—Austria, CH—Switzerland, CZ—Czech Republic, D—Germany, H—Hungary, PL—Poland, SK—Slovakia. Rec.—recreational services costs.

Table 6 shows that all the evaluated forest enterprises have a significant share of recreational services costs. For cities with a population over 100,000, this share is higher (21–72%) than in cities with a population below 100,000 (3–14%). For cities over 100,000, only Budapest, with an 11% share is the direct cost of the Budapest woods and does not include the costs incurred by the superior forest plant, and Augsburg with a share of 10% can be included. Banská Bystrica has a significantly small share of 3%. This forest enterprise manages in extreme terrain conditions, where the share of cableway terrains with a slope above 50% is 82%. Some respondents stated in their answers that the recreational use of the forest limits the production of raw wood, either by reducing the amount (Hamburg, Warsaw, Bratislava) or by not filling the info in (Prague). As a source of financing the recreational services, the respondents from the mentioned cities with a population over 100,000 mainly use the city budget (70–100%). Budapest, where the recreational service is financed by the state forest enterprise from sales of timber, and Augsburg, whose forest enterprise manages 7700 ha of forest with a state of 8.5 m³/ha/year are the exceptions. The respondents from cities under 100,000 residents stated that they finance the recreational service from 95–100% of revenues from the sale of raw wood.

5. Discussion and Conclusions

The indicator of the success of the recreational services of the forest is the amount of the forest attendance. In the Czech Republic, at the time of our survey, the average forest attendance was 105.1 people/ha/year (2016) and 87.8 people/ha/year (2017) [81]. The MLHK attendance of 243 people/ha/year is 2.3–2.8 times higher in comparison with the attendance in the Czech Republic. It is comparable to the number of visitors to the suburban forest of a much larger urban agglomeration, such as Vienna, where the forest of the Donau-Auen National Park has an area of 2400 ha and connects to the city from the east, which is visited by 600,000 visitors a year [86], which means an attendance of 250 people/ha/year. The Lainzer Tiergarten, which has an area of 2450 ha per year, is visited by 800,000 visitors a year, which means an attendance of 327 people/ha/year [87]. On a regional scale, there

is an interesting comparison with the annual attendance of all cultural institutions founded and established by the city of Hradec Králové (two theatres, philharmonic, library, city cultural and educational society, including all their establishments), which in 2015–2018 had 789,000 visits per year on average (source: City Hall), which represents 88% of the annual attendance of MLHK.

Forest accessibility is an important factor in facilitating social cohesion. Forests are a recreational background for all ages. This is confirmed by the results of the research conducted in the Czech Republic, which dealt with visitors to three selected forest recreational areas and found that the age structure of the visitors to these three selected recreational forest areas corresponds very closely with the age structure of the Czech population [88]. The same fact was confirmed by our research in MLHK in relation to the age structure of the population of the city of Hradec Králové. In terms of gender, the attendance of forests is quite balanced. In MLHK, men accounted for 56.2% and women for 43.8%. The above-mentioned research conducted in the Czech Republic also found a slight numerical predominance of men (men 52.9%, women 47.1%) [88]. A similar result was obtained by the research in the urban forests of Zurich, where the share of men was 52%, women 48% [87]. Urban forests are not only recreational facilities for the inhabitants of the respective city. Of the respondents interviewed in the MLHK, only 61.5% were inhabitants of Hradec Králové. Similarly, of the respondents surveyed in the urban forests of Zurich, only 86% of the city's population were inhabitants of the city [89]. A total of 14% of the respondents interviewed in MLHK stated that their residence is outside the East Bohemian region, proving that due to the recreation possibilities in the urban forest, people are willing to come from a greater distance. The importance of the MLHK visits for the visitor's physical and mental health is evidenced by the result of the evaluation of the importance of the purpose of the visit where the mental and physical relaxation had the highest rating (3.68). This corresponds to the results of previous research, which dealt with the number of visitors to three selected forest recreational areas in the Czech Republic, where mental and physical relaxation was on average 3.2 points which was attributed by the respondents using the same scale [88]. This also corresponds to the results of a nationwide survey conducted in the Czech Republic, where 14.7% of the respondents answered the question "what is the most important topic related to forests": "a place of rest and recreation" [65]. Our research also showed that for the inhabitants of Hradec Králové, visiting urban forests is a constant and important part of their lifestyle, 75% of respondents surveyed in the forest and living in Hradec Králové stated that they visit it at least once a week. In Sweden, previous research has shown that Swedes visit the forest at least every other week [90]. A total of 85% of the population of the Czech Republic [91], 70% of the population in Germany [92], and 88% of the population in Zurich [89] visit the forest at least once a year.

The forest is perceived as a public good by visitors, to which free entry should be maintained. In a survey conducted in Switzerland, 79% of the respondents rejected the question of whether forest visitors should contribute financially to the recreational use of the forests [93]. In a survey conducted in Zurich, 71% of the respondents rejected the entrance fee to the forest and do not consider that the use of the forest for leisure activities is a private matter [89]. As part of a survey conducted at MLHK, the vast majority of visitors disagreed with a payment for entry into the forest [94]. As part of a survey conducted in three selected forest recreational areas in the Czech Republic, 20% of the respondents answered the question "from what source should the recreational forest service be financed" that the recreational forest service should be paid for from the sale of wood. Most of the respondents believed that the recreational forest service should be paid for from public sources (state budget, regional budget, municipalities, EU). However, most respondents also stated that they would not agree to reimbursing the costs of the recreational service from residents' fees [95]. The general public's demand for greater public funding coverage of ecosystem services was also confirmed by an interview survey of 1000 German households [96]. Our survey of 16 urban forest enterprises from seven European countries showed that they all have a significant share of the cost of the recreational services.

These costs are paid either by the forest owner from other sources (from the city budget) or from the forest company's own resources (from revenues from the sale of raw wood). The share of other sources was marginal. The MLHK forest enterprise covers most of the costs associated with the recreational services from its own resources (92.9%), pays rent to the forest owner and generates a profit. However, it has the undeniable advantage over other forest enterprises in that it operates a sand quarry, the operation of which contributes to the positive economic result roughly to cover the cost of the recreational service. If it did not have this resource, the company's management would have to look for other resources. It should also be emphasised that subsidies to support forest management play an important role in the economic result of MLHK forestry (on average 27.9%). Their average annual amount (CZK 4,716,000) represents roughly the amount of forestry financed annually by the forest services for recreational services (CZK 4,576,000). If these subsidies were not available and the forest owner would demand payment of rent and the creation of a profit in the same amount, the forest enterprise would no longer be able to afford to financially support the recreational services. If these subsidies were not available and the forest owner demanded that the forest enterprise continue to develop the recreational services, as before, then it would have to give up the rent (so far CZK 3,166,000 per year), the forest enterprise would no longer make a profit (so far CZK 722,000 per year on average) and the owner would have to contribute CZK 828,000 per year to the recreational services or even more if a forest enterprise is to make a profit, see Table 2. As stated in the introduction to this article, the possibility to charge for recreational services is hampered by the right to enter the forest freely [76–79]. Some authors disagree and argue that a major obstacle to strengthening the importance of ecosystem services as a source of self-financing is not the right to freely enter the forest, but the limitations of forest legislation, which has, in the past, been driven by the outdated belief that only sales of raw wood are important [96]. This is also confirmed by our research. In the period 2013–2019, the financial contributions drawn by MLHK for the support of forest management were 15 times higher in comparison with the amount of the drawn subsidies for the support and development of the recreational forest services. However, should the forestry legislation become relaxed in the sense, as proposed in Germany [96,97], that fencing parts of the forest where recreational forest services are provided in connection with the collection of entry fees was possible provided that the relevant recreational forest services are offered in the public interest, it would significantly contribute to the internalisation of forest externalities and to the diversification of income of the forest enterprises at a time when raw wood prices on the market are not developing favourably. The proposed measures should, of course, not cause significant damage to the forest ecosystem and safeguards should also be put in place to ensure that the measures in favour of the development of leisure activities do not jeopardise the right of free access to the forest. Although the forest is perceived by the public as a public good and the recreational services of the forest are still gaining in importance, forest owners are still fundamentally involved in its financing. The uniqueness of the forest as a recreational background was clearly shown in connection with the limitations associated with COVID-19, however, the higher attendance of the forest was immediately reflected in the higher costs for collecting and disposing of the garbage. For example, in April to June 2020, the forests of the capital city of Prague had three times higher costs for collecting and disposing of the garbage than in the same period in previous years (source: Forests of the capital city of Prague).

The aim of the research project was to analyse the extent to which it is possible to harmonise the needs of society with the possibilities of the administrator of a multifunctional forest enterprise in the city of Hradec Králové (MLHK) in the Czech Republic and answer two key research questions:

RQ1: Can the development of a recreational forest services be financed from the forest's own economic resources so that it is not does not make a loss, if the forest owner so decides? Answer: Yes.

Findings: The MLHK forest enterprise covers most of the costs associated with the recreational service from its own resources, pays rent to the forest owner, and generates a profit. The company's management makes a constant effort to introduce innovations—to maximise the diversification of the forest enterprise revenues, including searching for new options to charge for the multifunctional forestry ecosystem services. However, compared to other forest enterprises, the MLHK forest enterprise has the undeniable advantage of operating a sand quarry, the operation of which contributes to the economic result roughly in an amount corresponding to the cost of the recreational services. If it did not have this source, the recreational services would have to be paid for by the forest owner (from the city budget). The decision of the forest owner whether they want to support and develop the recreational services of the forest is crucial.

RQ2: Is it possible to develop, in principle, the nonmarket recreational services without limiting the permanent yield from the forest? **Answer:** Yes.

Findings: The management method of the Hradec Králové municipal forests proves that even in a forest with high attendance, it is possible to manage without limiting the permanent yield from the forest. The forest enterprise makes full use of the framework set by the maximum total decennial logging amount (etat). Revenues from the sale of raw wood are the main source of financing the recreational services of the forest.

The forest enterprise Městské lesy Hradec Králové is an example of good practice. The results of the solved research project could serve the company's management in its decision-making on one hand, but as a benchmark for similar research activities also.

Author Contributions: Conceptualisation, R.J., methodology, R.J. and L.Š., writing—original draft preparation, R.J., V.J., L.Š. and M.R.; software, D.Z. and R.J.; supervision, V.J.; coordinating the research project, M.R. and V.J.; project administration, M.R.; reviewed version R.J., M.R., D.Z. and V.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by National Agency for Agricultural Research of the Czech Republic NAZV, grants no. QK1920272 and QK1820041 and by the Operational Programme Research, Development, and Education (OP RDE) of the Ministry of Education of the Czech Republic, grant no. CZ.02.1.01/0.0/0.0/16_019/0000803.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Questionnaire for visitors of the municipal forests of Hradec Králové.

Dear visitor, welcome to the municipal forests of Hradec Králové. Please, fill in this short anonymous questionnaire to provide important information for the statutory city of Hradec Králové and for us. Thank you.

Department of Sociology of the Philosophical Faculty of the University of Hradec Králové and the Municipal Forests of Hradec Králové a.s.

1. How often do you visit the municipal forests of Hradec Králové? (Circle the letter for one option.)
 - (a) More than 3 times a week
 - (b) 2 or 3 times a week
 - (c) Once a week
 - (d) Once a month
 - (e) 1 or 2 times a year
 - (f) My first visit here
2. For what purpose do you visit the municipal forests of Hradec Králové and what significance do you attach to this purpose? (Circle on a scale of 5 to 1 where 5 = most significant, 1 = least significant, 0 = insignificant for you)
 - (a) Sport 5 4 3 2 1 0
 - (b) Mental and physical relaxation 5 4 3 2 1 0
 - (c) Exploring and studying nature 5 4 3 2 1 0

- (d) Collection of forest fruits 5 4 3 2 1 0
(e) Collection of firewood 5 4 3 2 1 0
(f) Other purpose (specify): 5 4 3 2 1 0
3. You visit the municipal forests of Hradec Králové as: (Circle a letter, more options are possible)
- (a) Pedestrian
(b) Jogger
(c) Cyclist
(d) Skater
(e) With a dog
(f) Parent with preschool child/children
(g) Other:
4. What type of forest do you prefer when visiting the municipal forests of Hradec Králové? (Circle the letter for one option)
- (a) Pine
(b) Spruce
(c) Deciduous
(d) Mixed
(e) I don't know/I don't care.
5. In which region is your permanent residence? (Circle the letter for one option.)
- (a) Hradec Králové Region
(b) Pardubice Region
(c) Other
6. Please indicate where your permanent residence is located. (Circle the letter for one option.)
- (a) Hradec Králové
(b) Pardubice
(c) Municipality within 10 km from Hradec Králové
(d) Municipality 11–30 km from Hradec Králové (e.g., Třebechovice, Týniště n. O., Borohrádek, Chlumeč n. C., Nový Bydžov, Nechanice, Hořice, Smiřice, Opočno, Holice, Jaroměř)
(e) Municipality more than 30 km from Hradec Králové, except Prague
(f) Prague
(g) Abroad
7. What is your age group? (Circle the letter for one option.)
- (a) 15–19 years
(b) 20–29 years
(c) 30–44 years
(d) 45–59 years
(e) 60 years and more
8. Your gender?
- (a) Female
(b) Male
9. If you wish, you can leave a message or comment here:
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