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Assessment of ecosystem services of recreational and health-improving forests in Ivano-Frankivsk Region

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Abstract. Optimising the interaction between society and the environment is one of the fundamental directions of recreational forest management. To improve the efficiency of using ecosystem services of recreational and health-improving forests, there is a need to develop new approaches and tools for management decision-making, a key component of which is

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the assessment of these beneficial goods. The aim of the study is to analyse public opinion regarding the expressed and identified preferences for the characteristics of recreational forests and recreational facilities, as well as to assess the willingness to pay for preferred forest characteristics and the maintenance of recreational facilities in proper condition. The study was conducted from June to August 2022 using a direct and anonymous online survey. It was found that respondents are willing to pay an average of 1-100 UAH/year to create and maintain the preferred characteristics of the forest and 101-500 UAH/year to create and maintain recreational facilities. As for the respondents' perception of forest characteristics that affect the choice of a place to relax, preference is given to mixed forests (74.8%), in which three tree species grow (57.9%), and forests up to 20 meters high (40.2%). On the other hand, only 15.9% of respondents preferred forests taller than 20 meters. The presence of deadwood in the forest is positively perceived by 51.4% of respondents, and 10.3% do not pay attention to the presence or absence of standing dead and drying up trees in the forest. The most important needs for which respondents visit recreational forests were walks, family recreation, and observing forest landscapes. The integration of the identified perceptions and preferences regarding recreational forests and objects into innovative decision-making in the field of forestry ensures a synergy of benefits, such as increasing the attractiveness of recreational forests and forest landscapes, increasing the resilience of forests to climate change, and meeting the local demand for wood biomass

Keywords: forest ecosystem services; nature recreation; survey; nonparametric statistics, contingent valuation method

Introduction

Recreational and health-improving forests play a crucial role in improving people's physical and mental health, as well as in preserving biodiversity and regulating the climate. Assessing ecosystem services will help understand their real value to society, which in turn can promote rational management of forest resources and the development of effective strategies for their conservation and use. In the structure of forest resource use, the social functions of the forest, particularly recreational, sanitary-hygienic, and cultural-aesthetic functions, play an important role. The concept of ecosystem services is an active area of interdisciplinary research, involving representatives from natural and socio-economic sciences.

According to N.Y. Vysotska *et al*. (2019) and V.P. Tkach *et al*. (2023), the total area of Ukraine's forest fund is 10.4 million hectares, of which 9.6 million hectares are covered with forest vegetation. Forests are important for biodiversity and provide a wide range of ecosystem services such as water supply, climate regulation, and recreational opportunities. However, not all forest ecosystem services are equally valued, and often, economic valuation focuses primarily on the provisioning services of forests. The economic value of roundwood trade, employment in forestry, income from secondary uses, and the value of game hunting are included in the concept of the economic value of forests. Under these conditions, recreation and ecotourism, which belong to cultural services, are not taken into account, although world forestry increasingly emphasises these intangible services and goods. Recreational and health-improving forests are the most suitable for recreation due to their proximity to

settlements and low visitation costs. The area of such forests is 1,586.1 thousand hectares or 5.3% of the total forest fund of Ukraine. At the same time, all forests in Ukraine generally have recreational functions.

The non-market values of forest ecosystems are of great importance for the quality of human life, and this awareness should be reflected in the forest management process and their socially optimal use. O. Holubchak *et al*. (2019) argue that one of the main conditions for increasing the level of provision of ecosystem services by recreational and health-improving forests is a deep analysis and monitoring of their state, which will allow developing priority services on a paid basis.

The attractiveness of forest landscapes has been an object of sociological and economic research since at least the mid-20th century. Studies by J. Kamp (2022) and J. Trummer & K.T. Hegetschweiler (2023) on the preferences of recreationists show that forest characteristics directly affect their visual perception of the forest and their desire to visit a particular area. The development of modern technologies makes it possible to use various research methods, such as collecting data in social networks, mapping based on geographic information systems, and involving machine learning (Lingua *et al.*, 2023). Researchers O. Karasov *et al.* (2020) used geolocated data from social media to assess scenic values and landscape preferences. The application of geographic information systems in conjunction with social media data analysis allows for a better understanding of the relationship between landscape structure and scenic perception.

C. Lehto *et al.* (2024) used viewshed analysis and machine learning methods to identify landscape preferences among recreationists. This approach allowed for a deeper understanding of how recreationists perceive natural and cultural landscapes and what landscapes they find attractive. The results of the study open up new possibilities for planning and managing recreational areas in a way that is responsive to the preferences of recreationists.

Economic valuation of forest ecosystem services is a prerequisite for choosing the optimal solution for rational forest management, protection, and conservation. It provides a set of tools for decision-making based on the information obtained and helps to understand the benefits and consequences of interventions that affect forest ecosystems. Yu. Shtyk (2022) investigated that economic valuation should become the basis for the Ukrainian ecosystem services market. However, its functioning requires the solution of economic and legal problems that exist in the field, increasing the investment attractiveness of ecosystem services, as well as transforming the institutional structure and developing a taxation system for users of ecosystem services.

The aim of the study was to identify public perceptions and expressed preferences regarding the characteristics of recreational and health-improving forests and recreational facilities in the Ivano-Frankivsk Region. The novelty of the work was to determine the dependence of the respondents' willingness to overcome a certain distance to visit a forest based on selected characteristics (species composition, age structure, presence of standing dead trees) and the willingness to pay for the desired characteristics and the creation and maintenance of recreational facilities.

Materials and Methods

One of the key methods for valuing ecosystem services is the indirect market valuation method, which is applied in the absence of markets for certain ecosystem products and services – the contingent valuation method. The value of the ecosystem service (in this case, recreation as a cultural service) was determined based

on the results of a questionnaire survey of respondents (n = 140), which concerned the assessment of recreation preferences in the forests of the Ivano-Frankivsk Region. This value was reflected in the price that recreationists are willing to pay for the goods provided by the recreational area. The essence of the method involves constructing a hypothetical market and asking individuals about their willingness to pay for products and goods. The main stages of implementing the contingent valuation method were: assessment, determining the method and obtaining responses to questions or price offers, calculating average values of willingness to pay (or willingness to accept compensation), evaluating the proposed buyer's price curve, analysing the overall willingness to pay, and assessing the success of the method's application.

The contingent valuation method takes into account public preferences and makes it possible to determine the existence value, which is only partially taken into account by direct market valuation methods. Thus, the contingent valuation method is based on a scenario that describes the attributes of the products or services that should be evaluated and the conditions under which respondents must decide how much they are willing to pay for the described products or services. This method belongs to the methods of stated preference and is used to determine the value of such goods as recreation (visiting parks and forests), and conserving natural goods, the assessment of which is a challenging task.

To conduct the survey, a group of experts developed an illustrative questionnaire that consisted of 5 thematic sections (26 questions). The first thematic section consisted of 4 questions concerning visiting the forest during the past 12 months. The second section (3 questions) concerned the study of respondents' preferences regarding recreational infrastructure and the components of recreational sites, as well as their willingness to pay for the creation and maintenance of a recreational facility. In the third thematic section, respondents were asked to determine the importance of forest characteristics and to choose one of the proposed forest characteristics in 5 illustrated choice sets. In addition, two questions were posed regarding the willingness to pay (UAH/year) and the willingness to travel a distance (km) to visit a forest with the selected characteristics. The fourth section (4 questions) concerned visiting forests during and after quarantine restrictions to prevent the spread of COVID-19. The final section (8 questions) addressed respondents' data: sex, age, presence of children, education level, place of residence and work, and income. All questions were concise, understandable and realistic, which helped to minimise the time required to fill out the questionnaire and motivated the respondents to answer the questions. During the survey, ethical norms outlined in the American Sociological Association's Code of Ethics (1997) were adhered to.

The study was conducted anonymously from June to August 2022 through both face-to-face and online surveys. In total, 140 respondents were surveyed. Nine respondents provided incomplete responses. Of the 131 respondents who provided complete responses, seven were from the Kyiv Region, five were from the Lviv Region, two were from the Chernivtsi Region, nine were from other regions of Ukraine (Volyn, Kharkiv, Khmelnytskyi, Odesa, Kirovohrad, Sumy, and Rivne), and one was from Poland (Krakow). All of these respondents participated in the online survey. The remaining respondents (n = 107) were residents of the Ivano-Frankivsk Region. Further analysis of the responses was conducted for this sample.

The quantitative recording and analysis of questionnaire data was performed using the software package XLStat 2022. For the analysis of respondents' answers, a statistical analysis

of the initial data, which characterises the socio-demographic features of the respondents, was conducted. Specifically, the following indicators were calculated: Mean, Median, Mode, Standard Deviation, Variance, Kurtosis, Skewness, Range, Minimum, and Maximum.

To study the influence of independent variables on the value of willingness to pay, econometric models are proposed. To determine the form and density of the relationship between the values of willingness to pay and the selected independent variables, correlation analysis was performed, and to determine the analytical form of the relationship between the selected independent variables and the values of willingness to pay, the parameters of the multivariate regression model were estimated using the least-squares method. The obtained regression models were checked for multicollinearity and heteroscedasticity using a graphical method, the first of which occurs under the condition of high mutual correlation of independent variables. Heteroscedasticity occurs when the variance of the residuals is variable. Otherwise, homoscedasticity takes place.

To test for statistically significant differences between groups of respondents based on sex, age, education level, and place of residence, the Pearson chi-square test (χ2 test) was applied:

$$C_P = \sqrt{\frac{\chi^2}{n+\chi^2}}, \quad (1)$$

where n is the number of observations; χ^2 is the mean square dependence, which measures the discrepancy between the actual number of observations and the theoretically possible number, and is calculated using the formula:

$$\chi^2 = n\left[\sum_{i=1}^{m_1}\sum_{j=1}^{m_2}\frac{f_{ij}^2}{f_{i0} * f_{j0}}\right], \quad (2)$$

where f_{ij} is the number of observations at the intersection of the i-th row and the j-th column (the frequency of group i in group j); f_{i0} and f_{j0} are the marginal frequencies for characteristic x and characteristic y, respectively.

The 5-point Likert scale was used to determine the level of satisfaction with ecosystem services. Respondents could indicate how important the presence of certain infrastructure or forest characteristics was to them (1 – not important at all; 5 – very important). Respondents were also asked to express their level of satisfaction with forest services (1 – completely dissatisfied; 5 – completely satisfied).

Results and Discussion

Respondents were asked to share their experiences of visiting forests and to describe the needs that they fulfilled during these visits. Additionally, respondents expressed their own preferences for forest ecosystem services. The duration of the interviews typically ranged from 15 to 30 minutes.

Among the respondents, 64.5% were females and 35.5% were males. Their average monthly income at the time of the survey was between 5,000 and 10,000 UAH. Half of the respondents were under 35 years old, 63% lived in cities; the majority (77%) had higher education and 5% had academic degrees. The professional activity of 56% of respondents was related to the forest; 74% of those surveyed had children, including 32% who had three or more children. All respondents visited the forest during the past 12 months. 26.2% of respondents visited the forest once every two to five months and only 9.4% of respondents visited the forest once or twice a week (Fig. 1).

Almost half of the respondents used cars (45.8%) or walked (42.1%) to the forest they wanted to visit. The remaining 12.1% of visitors used other means of transportation (Fig. 2).

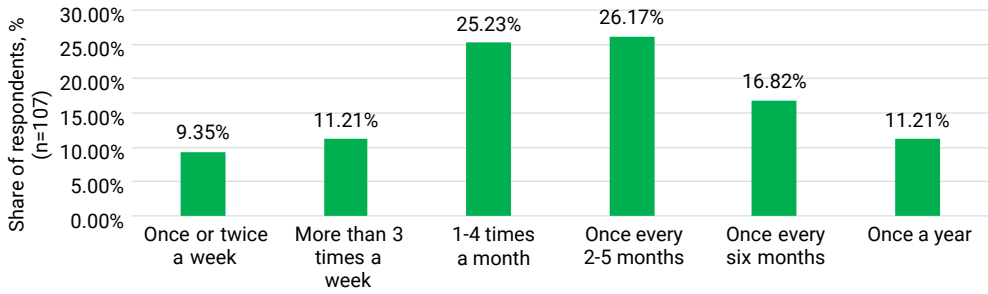

Figure 1. Frequency of forest visits by respondents during the research period

Source: compiled by the authors

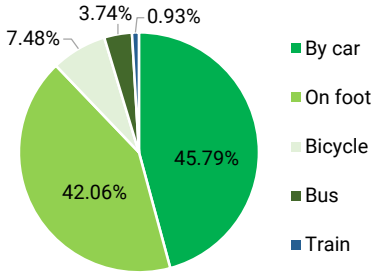

Figure 2. Use of different types of transport by respondents to visit the forest during the research period

Source: compiled by the authors

Further in the text, the results are presented using coefficients obtained on the Likert scale. Respondents indicated the following as the most important forest-related needs: family recreation (average score – 4.44), forest walks (4.33) and landscape observation – 4.20. Additionally, some respondents noted other needs as important, which were not presented in the list of options. These were primarily observing wildlife, picking berries, leisure activities, being in nature away from routine places, improving psychological well-being, clean air, walks, observing and exploring natural phenomena (Fig. 3).

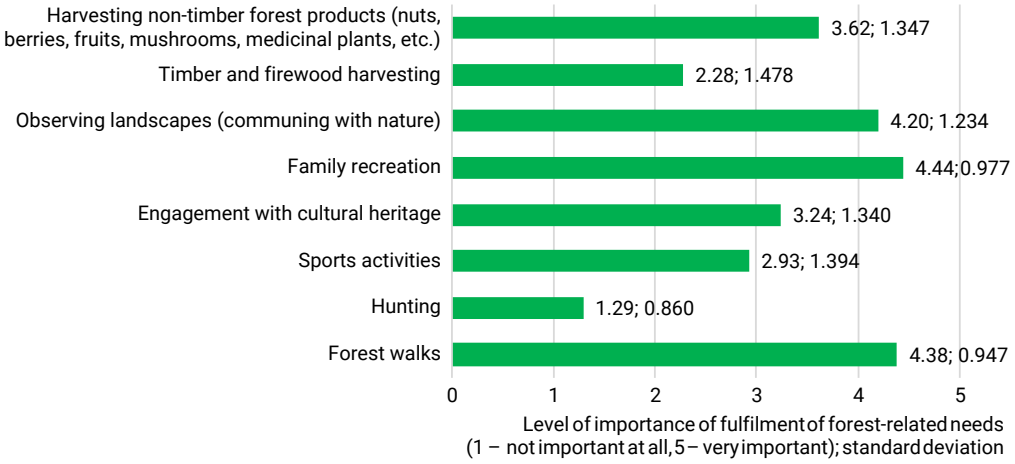

Figure 3. Preferences of respondents for fulfilment of forest-related needs

Source: compiled by the authors

According to the respondents' ratings, the most important components of recreational facilities in the forest are untouched nature and trails (average values of 4.34 and 4.26, respectively). The presence of parking lots (average value 2.97), access to sports and fitness equipment (average value 2.63), and the possibility of buying food (average value 2.49) were found to be the least important. In addition, the respondents noted that bike paths, eco-trails, benches, tables, hotels (ecological homesteads), camping sites, toilets, etc. are also important components for recreation (Fig. 4).

The most important characteristic when choosing a forest for recreation was distance (average value –3.84), while the least attention was paid to the presence and size of dead or drying up trees (average value – 2.68) (Fig. 5).

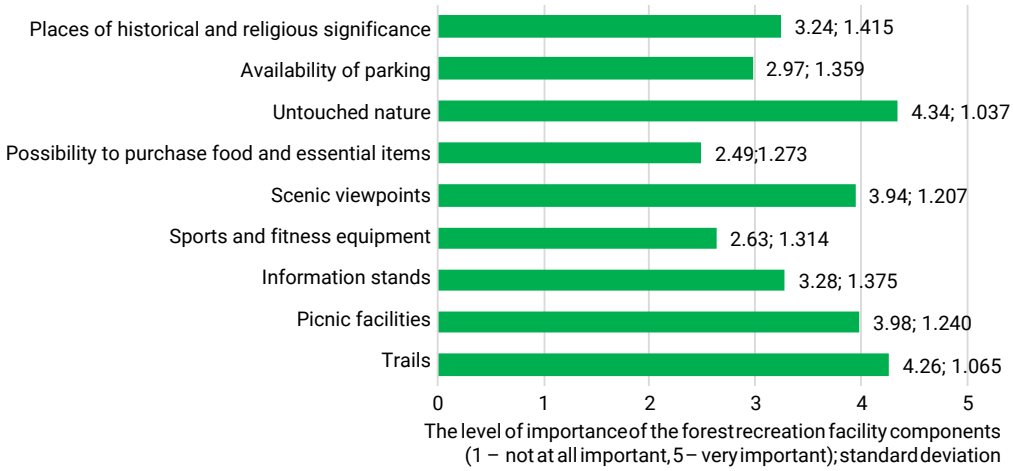

Figure 4. Preferences of respondents regarding the importance of recreation facility components
Source: compiled by the authors

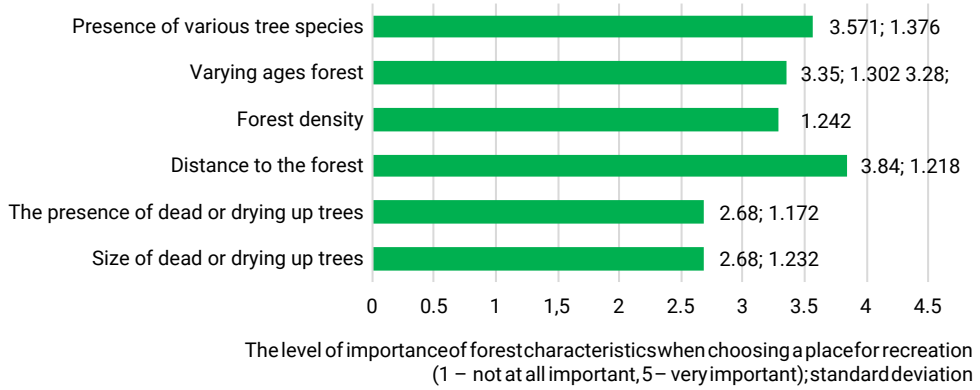

Figure 5. Preferences of respondents regarding the importance of forest characteristics when choosing a place for recreation
Source: compiled by the authors

The results of the study of the respondents' perception of forest characteristics (Table 1) showed that they prefer mixed forests (74.8%), coniferous forests (19.6%), and deciduous forests (5.6%). In terms of species composition, respondents prefer stands with three tree species (57.9%), stands with four or more species (17.8%), two species (11.2%), one species (10.3%), and for 2.8% of respondents, species composition is not important. Stands up to 10 m high were chosen by 36.4% of respondents, up to 20 m – 40.2%, more than 20 m – 15.9%, 7.5% – did not determine their preference. 69.2% of respondents preferred uneven-aged forests, 13.7% preferred even-aged forests, and 17.1% had no preference. The presence of deadwood in the forest is positively perceived by 51.4% of all respondents, and negatively by 38.3%. Among them, 43% preferred medium-sized standing dead and drying up trees (less than 40 cm in diameter), while 10.3% of respondents did not pay attention to the presence or absence of standing dead and drying up trees in the forest.

Table 1. Preferences of respondents regarding different forest characteristics

Forest characteristics	Share of respondents, %
Amount of tree species	
One type of tree	10.3
Two types of trees	11.2
Three types of trees	57.9
Four types of trees	17.8
Does not matter	2.8
Total	**100**
Forest composition	
Coniferous (only coniferous trees)	19.6
Deciduous (only deciduous trees)	5.6
Mixed (deciduous and coniferous trees)	74.8
Does not matter	-
Total	**100**
Tree height	
Trees up to 10 metres high	36.4
Trees up to 20 metres high	40.2
Trees over 20 metres in height	15.9
Does not matter	7.5
Total	**100**
Age of the trees	
Trees of the same age and height	13.7
Trees of two ages and heights	37.6
Trees of different ages and heights	31.6
Does not matter	17.1
Total	**100**
Presence of deadwood	
There are no standing dead or drying up trees	38.3
Medium-sized standing dead and drying up trees (less than 40 cm in diameter)	43.0
Medium-sized standing dead and drying up trees (more than 40 cm in diameter)	8.4
Does not matter	10.3
Total	**100**

Source: compiled by the authors

The data obtained taking into account the socio-demographic characteristics of the respondents regarding the preferences for the main characteristics of forest communities, are presented in Table 2. Statistically significant differences in preferences regarding the species composition of forests were found for different gender groups and groups based on place of residence. Respondents with a specialist diploma and those with an academic degree overwhelmingly preferred mixed forests. Respondents with incomplete higher education and a master's degree equally preferred these forests (both 75%); among those with secondary education, 37.5% preferred mixed forests. Respondents' preferences regarding the age structure of forests were found to be unequal: respondents with secondary and incomplete higher education, as well as people who lived in rural areas, preferred even-aged forests to all categories of respondents. Stands of two ages and heights were preferred by all categories of respondents, except for males and urban residents, who in most cases chose forests of varying ages and heights as the most attractive for recreation.

Table 2. Assessment of statistically significant differences between socio-demographic groups of respondents in terms of preferences for the main characteristics of forest communities

Socio-demographic characteristics of respondents	Forest species composition, %			χ2 test (p-value)	Forest age structure, %			χ2 test (p-value)
	coniferous	deciduous	mixed		same age and height	two ages and heights	different ages and heights	
Sex:								
males (n = 38)	28.95	7.89	63.16	4221 (p = 0.129)	23.68	31.58	44.74	6532** (p = 0.038)
females (n = 69)	14.49	4.35	81.16		10.14	55.07	34.78	
Education level:								
secondary education (n = 8)	37.50	12.50	50.00	5270 (p = 0.672)	25.00	50.00	25.00	10256 (p = 0.228)
incomplete higher education (n = 12)	16.67	8.33	75.00		25.00	58.33	16.67	
Specialist diploma (n = 2)	0.00	0.00	100.0		0.00	100.0	0.00	
Master's degree (n = 80)	20.00	5.00	75.00		13.75	48.75	37.50	
academic degree (n = 5)	0.00	0.00	100.0		0.00	100.0	0.00	
Place of residence:								
city (n = 40)	16.42	1.49	82.09	7638** (p = 0.017)	8.96	38.81	52.24	7366** (p = 0.024)
village (n = 67)	25.00	12.50	62.50		25.00	45.00	30.00	
Total (n = 107)	19.63	5.61	74.77		13.68	37.61	31.62	

Notes: * significance level $\alpha = 0.05$, ** statistically significant estimates (p-value<0.05)
Source: compiled by the authors

Statistically significant differences were found in the responses of gender groups ($\chi 2$ test: $p = 0.038$, $\alpha = 0.05$) – females expressed their preferences more clearly than males regarding the age structure of forests. Statistically significant differences were also found for groups of respondents by place of residence. Respondents from urban areas more clearly expressed their preference for mixed forests ($\chi 2$ test: $p = 0.17$, $\alpha = 0.05$). The $\chi 2$ test did not reveal statistically significant differences in the species and age structure of forests in the responses of different age groups of respondents. Most often, respondents are willing to pay (WTP) for the creation and maintenance of the desired characteristics of the forest and recreational facility up to 500 UAH/year (Fig. 6). Only 11.9% of respondents are willing to pay more than 1000 UAH/year for the creation and maintenance of a recreational facility with the desired characteristics, and 8.4% of respondents – for the creation and maintenance of the desired characteristics of the forest. 12.3% of respondents are not willing to pay at all.

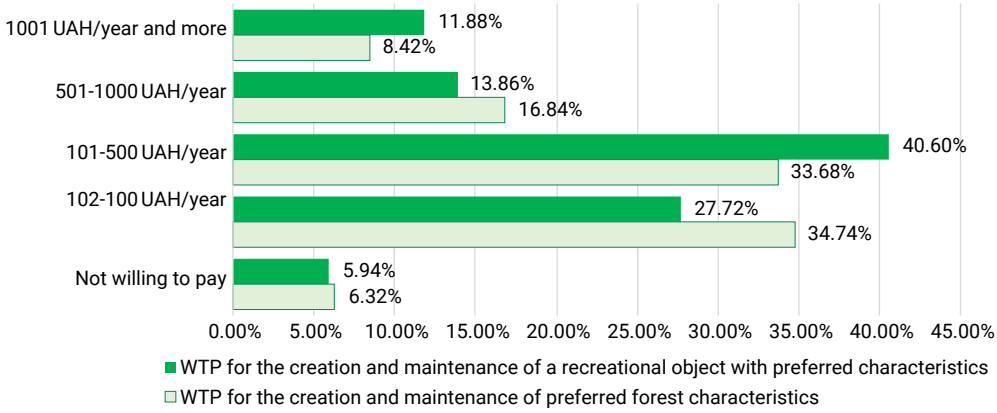

Figure 6. The willingness of respondents to pay for the creation and maintenance of a recreational facility and forest with the preferred characteristics

Source: compiled by the authors

Accordingly, in the proposed econometric model, the following factors influence the value of respondent's willingness to pay for the creation and maintenance of the desired characteristics of the forest (Y1, UAH/year) and recreational facilities (Y2, UAH/year):

- sex: 1 – male, 2 – female (X1);
- age: years (X2);
- presence of children: 1 – no, 2 – yes (X3);
- education level: 1 – no education, 2 – secondary, 3 – college, 4 – higher (X4);
- work relation to forestry: 1 – no, 2 – yes (X5);
- average monthly income: UAH/year (X6);
- place of residence: 1 – village, 2 – city (X7);
- frequency of forest visits: 1 – rarely, 2 – often, 3 – very often (X8).

A statistical analysis of the initial data is presented in Table 3. On average, respondents are willing to pay 1-100 UAH/year for the creation and maintenance of the forest according to their preferences, and 101-500 UAH/year for recreational facilities. The average age of the respondents was 39 years, and the average income was 5-10 thousand UAH/month. Among the respondents, females under the age of 35 who live in rural areas, have higher education

and are mothers were the most common. Their average monthly income was 5 thousand UAH at the time of the survey, and their work was related to forestry.

Table 3. Statistical analysis of the initial research data

Indicators	WTP for forest creation and maintenance, coefficient 1-	WTP for the creation and maintenance of a recreational facility, coefficient 1-	Sex	Age, years	Presence of children	Education	Profession	Income, coefficient 1-	Place of residence	Frequency of visits
	Y1	Y2	X1	X2	X3	X4	X5	X6	X7	X8
Mean	2.16	2.95	1.64	38.90	1.74	3.58	1.45	3.00	1.63	2.07
Median	2.00	3.00	2.00	37.00	2.00	4.00	1.00	3.00	2.00	2.00
Mode	3.00	3.00	2.00	35.00	2.00	4.00	1.00	2.00	2.00	2.00
Standard deviation	1.04	1.07	0.48	13.59	0.44	1.01	0.52	0.94	0.49	0.70
Sample variance	1.19	1.14	0.23	184.75	0.20	1.02	0.27	0.89	0.24	0.48
Kurtosis ratio	-0.17	-0.35	-1.65	-0.60	-0.81	1.25	-1.36	-0.67	-1.75	-0.91
Skewness	0.27	0.33	-0.61	0.38	-1.10	-1.54	0.42	0.41	-0.53	-0.10
Range	4	4	1	58	1	4	2	4	1	2
Minimum	1	1	1	18	1	1	1	1	1	1
Maximum	5	5	2	76	2	5	3	5	2	3

Note: willingness to pay and income are stated as of 2021-2022
Source: compiled by the authors

One of the statistical indicators of the obtained data is the kurtosis coefficient, which serves as a numerical characteristic of the probability distribution of a real random variable. Its negative coefficient for willingness to pay, as well as for independent variables, indicates a relatively flatter distribution. A relatively steeper distribution is observed for the dependent variable Y1 and all independent variables except X4 (education).

The asymmetry indicator characterises the deviation of the distribution from symmetry and in this study case significantly differs from zero for all independent variables (Xn = 1:8) and dependent variables (Y1 and Y2). Therefore, the distribution of values is asymmetric, which means that most respondents are willing to pay less than the average value of willingness to pay. The smallest amount that respondents are willing to pay for forest maintenance according to the desired characteristics was 0 UAH/year, the largest – 1000 and more UAH/year (in prices of 2021-2022); the youngest respondent was 18 years old, and the oldest – 76. To determine the form and density of the relationship between the values of willingness to pay and independent variables (Xi, i = 1:8), a correlation analysis was performed (Table 4, 5).

Table 4. Correlation coefficient values between independent variables Xi and dependent variable Y1

Marking of the factor	Y1	X1	X2	X3	X4	X5	X6	X7	X8
Willingness to pay, **Y1**	1.00								
Sex, **X1**	-0.16	1.00							
Age, **X2**	-0.21	-0.02	1.00						
Presence of children, **X3**	-0.03	-0.01	-0.17	1.00					
Education level, **X4**	-0.01	0.07	**0.32**	-0.13	1.00				
Profession, **X5**	-0.02	0.00	-0.13	-0.08	**-0.29**	1.00			
Average monthly income, **X6**	**0.30**	-0.25	**-0.26**	0.02	-0.02	0.22	1.00		
Place of residence, **X7**	0.23	0.04	-0.07	-0.06	0.13	0.12	0.21	1.00	
Frequency of forest visits, **X8**	0.06	0.20	0.16	-0.09	0.11	**0.24**	0.06	0.23	1.00

Source: compiled by the authors

Table 5. Correlation coefficient values between independent variables Xi and dependent variable Y2

Marking of the factor	Y2	X1	X2	X3	X4	X5	X6	X7	X8
Willingness to pay, **Y1**	1.00								
Sex, **X1**	-0.09	1.00							
Age, **X2**	-0.23	-0.03	1.00						
Presence of children, **X3**	0.09	0.00	-0.21	1.00					
Education level, **X4**	-0.11	0.10	**0.30**	-0.10	1.00				
Profession, **X5**	0.01	0.00	-0.11	-0.10	**-0.29**	1.00			
Average monthly income, **X6**	**0.28**	-0.25	**-0.26**	0.02	-0.02	0.21	1.00		
Place of residence, **X7**	0.24	0.03	-0.09	-0.02	0.14	0.07	0.21	1.00	
Frequency of forest visits, **X8**	0.09	0.19	0.12	-0.15	0.04	0.31	0.08	0.18	1.00

Source: compiled by the authors

The results of the correlation analysis showed that there is a direct relationship between the value of willingness to pay (Y1) and such variables as the respondent's income (X6), type of residence (X7), and frequency of forest visits (X8), and an inverse relationship with others. The most significant relationship of the dependent variable (Y1) with the independent variable was found to be with the factor of the respondent's average monthly income (X6) r = 0.30. There is a moderate inverse relationship between willingness to pay (Y1) and the respondent's age (X2) and a moderate direct relationship between their place of residence (X7). Since the calculated correlation coefficients between the value of willingness to pay and such factors as sex, presence of children, education level, profession, and frequency of forest visits are close to zero, it can be stated that there is no statistically significant linear relationship between these variables.

The results of the correlation analysis showed that there is a direct relationship between the value of willingness to pay (Y2) and such variables as profession (X5), respondent income (X6), type of residence (X7), and frequency of forest visits (X8), and an inverse relationship with others. The most significant relationship of the dependent variable (Y2) with the independent variable was found to be

with the respondent's income (X6): $r = 0.28$. A close relationship is also observed between the value of willingness to pay and such factors as the respondent's age (X2) and their place of residence (X7). Since the calculated correlation coefficients between the value of willingness to pay and such factors as sex, presence of children, profession, and frequency of forest visits are close to zero, it can be stated that there is no statistically significant linear relationship between these variables.

To determine the analytical form of the relationship between the eight mentioned factors and the value of willingness to pay for the creation and maintenance of preferred forest characteristics (Y1), the parameters of multivariate regression models were evaluated using the least-squares method. The obtained regression model is formulated as follows:

$$Y_1 = -0.09X1 - 0.01X2\ 8X8 + 2.50,$$
$$(-0.41)\ (-1.18)\ (0.51)\ (-1.25)\ (-1.11)\ (2.06)$$
$$(2.08)\ (0.51)\ (2.62) \qquad (3)$$

$R^2 = 0.16$; corrected $R^2 = 0.09$; $F = 2.35$

The regression model is statistically significant with a probability level of 0.95 since the calculated value of the Fisher-Snedecor *F*-criterion is 2.35, which is greater than the table value of the Fisher-Snedecor *F*-criterion (2.25) for a probability level of 0.95. The coefficient of determination is 0.16, which indicates that 16% of the variance of the total variance is explained by the independent variables represented in the model. Comparing the calculated and table values of the Student's *t*-criterion $t_{105;0.05} = 1.98$, the estimates of all parameters of the regression model (3) are statistically insignificant, except for the respondent's income (X6) and the type of place of residence of the respondents (X7).

To analyse the obtained regression model (3), it was checked for multicollinearity and heteroscedasticity. Multicollinearity occurs when there is a high correlation between the independent variables. In Table 4, there is a noticeable average correlation density between the presence of children (X3) and the education level of the respondents (X4): $r = 0.30$. The rest of the correlation density estimates between the independent variables are significantly lower, which is the basis for the absence of multicollinearity in the model (3). Heteroscedasticity occurs when the variance of the residuals is a variable. Otherwise, there will be homoscedasticity.

Analysis of the constructed graphs of the dependence of the square of the residuals and the independent variables of the respondent's age, education, and income revealed the instability of the variance of the residuals, which serves as the basis for further verification of the model. Heteroscedasticity was found for the obtained regression model of the study (ratio 3). Therefore, the estimates of the model parameters obtained by the least-squares method under conditions of heteroscedasticity will be unbiased and consistent but inefficient, meaning they will have large variance and, as a result, will not be *BLUE* – estimates (*best linear unbiased estimator*). The parameter estimates of the model under conditions of heteroscedasticity lead to inefficient predictions due to increased confidence intervals of the parameters and errors when using t-tests and *F*-tests. Therefore, it was necessary to remove statistically insignificant independent variables from the regression model.

Using the stepwise regression analysis method, considering the magnitude of the *t*-statistic and the *P*-value, statistically insignificant independent variables X1 (sex), X8 (frequency of forest visits), X3 (presence of children), X5 (profession), X4 (education level), and X2 (age) were removed from regression model (3). The results of the stepwise regression analysis are presented in Table 6.

Table 6. Results of the stepwise regression analysis

Regression model	*F*	R^2	Corrected R^2
Y1=-0.09X1-0.01X2+0.12X3-0.14X4-0.24X5+0.24X6+0.45X7+0.08X8+2.50, (-0.41) (-1.18) (0.51) (-1.25) (-1.11) (2.06) (2.08) (0.51) (2.62)	2.35	0.16	0.09
Y1=-0.01X2+0.12X3-0.14X4-0.24X5+0.26X6+0.44X7+0.07X8+2.34, (-1.13) (0.50) (-1.31) (-1.13) (2.30) (2.08) (0.43) (2.69)	2.68	0.16	0.1
Y1=-0.01X2+0.11X3-0.14X4-0.21X5+0.26X6+0.46X7+2.38, (-1.08) (0.49) (-1.28) (-1.05) (2.32) (2.18) (2.76)	3.12	0.16	0.11
Y1=-0.01X2-0.14X4-0.23X5+0.26X6+0.45X7+2.64, (-1.19) (-1.33) (-1.13) (2.33) (2.18) (3.90)	3.73	0.16	0.12
Y1=-0.01X2-0.11X4+0.23X6+0.44X7+2.30, (-1.24) (-1.04) (2.14) (2.09) (3.79)	4.33	0.15	0.11
Y1=-0.01X2+0.23X6+0.40X7+2.09, (-1.65) (2.11) (1.95) (3.65)	5.40	0.14	0.11
Y1=0.28X6+0.41X7+1.45, (2.57) (2.00) (3.41)	6.65	0.11	0.10

Source: compiled by the authors

The value of the coefficient of determination (R^2) of the obtained regression model is 0.11, which indicates that 11% of the variance of the willingness to pay for the creation and maintenance of preferred forest characteristics can be explained by the variance of the presence of the place of residence and the average monthly income of the respondents. The value of the *F*-criterion increased from 2.35 to 6.65, which indicates an increase in the statistical significance of the regression model. Therefore, this model can be used for analysis and forecasting with 95% confidence.

Based on the equation of the obtained regression model, it can be stated that with a probability of 95%, a change in the respondent's place of residence will increase their willingness to pay by 0.28 UAH/year; with an increase in the respondents' monthly income by 100 UAH/year, the value of their willingness to pay will increase by 41 UAH/year.

To determine the analytical form of the relationship between the eight mentioned factors and the value of willingness to pay for the creation and maintenance of p recreational facilities (Y2), the parameters of multivariate regression models were evaluated using the least-squares method. The obtained regression model is formulated as follows:

$$Y_2 = -0.37X1 - 0.02X2 + 0.20X3 - 0.03X4м - 0.38X5 + 0.28X6 + 0.46X7 + 0.20X8 + 2.93,$$
$$(-1.38)\ (-1.79)\ (-0.72)\ (-0.23)\ (-1.46)\ (1.97)\ (1.74)\ (1.01)\ (2.54) \quad (4)$$
$$R^2 = 0.18;\ \text{corrected } R^2 = 0.11;\ F = 2.56$$

The regression model is statistically significant with a probability level of 0.95 since the calculated value of the Fisher-Snedecor *F*-criterion is 2.56, which is greater than the table value of the Fisher-Snedecor *F*-criterion (2.25) for a probability level of 0.95. The coefficient of determination is 0.18, which indicates that 18% of the variance of the total variance is explained by the independent variables represented in the model. Comparing the calculated and table values of the Student's *t*-criterion $t_{105;0.05} = 1.98$, the estimates of all parameters of the regression model (4) are statistically insignificant.

Overall, the research results show that respondents expressed a higher preference for mixed forest stands (74.8% of all respondents), where there are three or more tree species (57.9% of all respondents). Respondents also favoured uneven-aged forests (37.6% of

all respondents) and very uneven-aged forests (31.6% of respondents); the largest percentage of respondents preferred forests up to 20 meters high (40.2%). Regarding the presence of deadwood, the majority of respondents (51.4%) expressed a positive attitude towards its presence in the forest.

The applied approaches of the contingent valuation method, statistical analysis, and calculated nonparametric statistics criteria for studying the public's perception of forest plantation characteristics based on the expressed preferences of respondents allowed to identify the demand for the species and age structure of forests. In particular, the results of the Kruskal-Wallis nonparametric test showed that respondents highly value the recreational resources of the forest and consider the forest ecosystem an important element of natural capital that meets their life needs.

Statistically significant differences were found using Pearson's chi-squared test in preferences regarding the species structure of forests for respondent groups by place of residence (χ^2 test: $p = 0.017$, $\alpha = 0.05$); regarding the age structure of forests for gender groups (χ^2 test: $p = 0.038$, $\alpha = 0.05$) and for respondent groups by place of residence (χ^2 test: $p = 0.024$, $\alpha = 0.05$). Respondents with a low level of education and living in rural areas preferred even-aged forests. Females expressed their preferences more clearly than males. Respondents with a specialist diploma and an academic degree preferred mixed forests. In general, 74.8% of respondents preferred mixed forests.

The willingness of respondents to pay for the creation and maintenance of preferred forest characteristics and recreational facilities was assessed using the correlation-regression analysis method. It was found that respondents are willing to pay an average of 1-100 UAH/year for the creation and maintenance of forests in accordance with their preferred characteristics and 101-500 UAH/year for recreational facilities. The obtained estimates of the willingness to pay for the creation and maintenance of preferred forest characteristics showed that the respondents' income and type of place of residence were statistically significant. The variance of these factors explains 11% of the variance of the willingness to pay for forest maintenance in accordance with the expressed preferences ($R^2 = 0.11$). Such factors as sex, frequency of forest visits, presence of children, connection of profession with forestry, level of education and age were found to be statistically insignificant, as well as the assessment of the willingness to pay for the creation and maintenance of recreational facilities.

The obtained results of assessing respondents' preferences regarding recreation in the forests of the Ivano-Frankivsk Region will contribute to optimising forestry measures aimed at enhancing the attractiveness of recreational forests and creating suitable conditions to meet the socio-economic needs of the population. They will also shape the necessary strategies for forestry enterprises to create recreationally appealing forests.

Economists often assess the monetary value of forest ecosystem services, although the concept of economic value is not necessarily based on monetary expression. According to researchers L.H. Goulder & D. Kennedy (1997), this cannot be done, since ecosystems and species have the right to exist regardless of whether they are used by society. The counterargument is that the inability to assess the monetary value of forest ecosystem services can lead to their depletion or even loss. The inability to determine the economic value of wildlife habitat and the value of hydrological or recreational services of forest ecosystems can lead to an "emphasis" on logging with a clearly expressed economic value – to the detriment of the unvalued ecosystem services of forests, as reflected in the

work of R. Costanza *et al.* (1997). Researchers noted that studying the value of ecosystem services allows for the assessment of nature's contribution to human well-being and sustainable development. Understanding the value of natural capital promotes the rational use of resources and the preservation of biodiversity for future generations.

There are corresponding relationships between services, cost, and methods of economic valuation, which were considered by R.S. de Groot *et al.* (2002) and L.C. Braat & R. de Groot (2012). The researchers found that the classification of ecosystem services promotes the integration of the worlds of natural science and economics, conservation and development, and public and private policy. This is an initiative that aims to balance the use of natural resources with their conservation for future generations. It promotes the development of strategies that take into account the interests of all stakeholders for sustainable development.

Research by H. Wittme *et al.* (2013) and O.R. Pelyukh & L.D. Zahvoyska (2017) shows that many factors influence people's preferences for forest characteristics and, therefore, their willingness to pay for the creation and maintenance of preferred forest characteristics and recreational facilities. Different studies have identified different preferences, suggesting that they are partly shaped by cultural, regional, and socioeconomic factors. People's preferences for forest characteristics may be influenced by their membership in certain social groups (CICES – Common International Classification of Ecosystem Services, n.d.), age, sex (Babí Almenar *et al.*, 2023), and recreational activity (Millennium Ecosystem Assessment, 2005).

Among the factors influencing public preferences, ecological knowledge holds a prominent place. Psychological studies conducted by S. Pagiola *et al.* (2004) confirm that people with sufficient knowledge about forest ecosystems (people with higher education, people who often visit forests, or people who actively participate in forest management planning) are more likely to prefer visiting natural forests. In recent studies by A. Filyushkina *et al.* (2017) and V. Gundersen *et al.* (2019) regarding preferences for specific characteristics of boreal landscapes with a predominance of coniferous species, respondents preferred forests with the participation of deciduous species, the introduction of which contributed to greater forest heterogeneity, which improved recreational value. In this case, the respondents also preferred mixed forests.

Considering the results of these studies, a hypothesis is formulated regarding the form of the regression model and the nature of the relationship between the dependent and independent variables. Based on a study of the literature on the assessment of economic value, it can be assumed that the willingness to pay for the creation and maintenance of preferred forest characteristics and recreational facilities is influenced by the material well-being of the population, age, sex, education, the presence of children in the family, type of place of residence, occupation in the forestry sector and the frequency of forest visits. It can also be assumed that there is a direct relationship between the value of willingness to pay and factors such as annual income, level of education, presence of children, and age, meaning that as the values of these factors increase, the value of willingness to pay also increases.

Conclusions

The negative impact of anthropogenic pressure and climate change on the viability and productivity of forest ecosystems of the Ukrainian Carpathians requires the development of appropriate measures for their conservation,

rational use, and reproduction. It is necessary to implement innovative approaches aimed at strengthening interdisciplinary research and taking into account the value of forest ecosystem services. Based on the analysis of the theoretical foundations and methods of assessing the economic value of ecosystem services, a contingent valuation method was proposed and tested, which belongs to the methods of expressed preferences for assessing the recreational value of the forests in the Ivano-Frankivsk Region.

The results of a study of people's preferences for recreation in the forests of the Ivano-Frankivsk Region showed that the most important needs were family outings, forest walks, and landscape viewing. The most significant components for recreation in the forest were the presence of trails, and the least important were parking spaces, access to sports activities, and the possibility to buy food. The most important characteristics when choosing a forest as a recreation object were distance, and the least attention was paid to the presence and size of dead trees, or trees that are drying up.

The results of the study on the public's perception of forest characteristics showed that respondents prefer mixed forests (74.8% of respondents) where there are three or more tree species (75.7% of respondents); 2.8% of respondents indicated that the number of tree species does not matter to them. In terms of age structure, respondents prefer uneven-aged forests (69.2% of respondents). The presence of deadwood in the forest is positively perceived by 51.4% of respondents and negatively by 38.3%. However, most respondents (43%) prefer standing dead and drying up trees of medium size (less than 40 cm in diameter), and only 8.4% of respondents like large standing dead and drying up trees (more than 40 cm in diameter); 10.4% of respondents do not pay attention to the presence or absence of standing dead and drying up trees, and 7.5% to the height of the trees and 17.8% to the age of the stand.

Based on correlation-regression analysis, it was found that respondents are willing to pay an average of 1-100 UAH/year for the creation and maintenance of the forest in accordance with their preferred characteristics and 101-500 UAH/year for recreational facilities. The results of the willingness to pay for the creation and maintenance of preferred forest characteristics showed that the income of respondents and their place of residence were statistically significant. The variance of these factors explains 11% of the variance of the willingness to pay for forest management in accordance with the expressed preferences ($R^2 = 0.11$). Such components as sex, frequency of forest visits, the presence of children, occupation related to forestry, education level and age were found to be statistically insignificant. The obtained estimates of the willingness to pay for the creation and maintenance of recreational facilities were also found to be statistically insignificant. The results of the study will help to solve further tasks related to increasing the attractiveness of recreational and health-improving forests and forest landscapes.

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None.

Conflict of Interest

None.

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Анотація. Оптимізація взаємодії між суспільством та навколишнім середовищем є одним із базових напрямів рекреаційного лісокористування. Для покращення ефективності використання екосистемних послуг рекреаційно-оздоровчих лісів виникла необхідність розробки новітніх підходів та інструментів для прийняття управлінських рішень, ключовою складовою яких є оцінка цих корисних благ. Метою дослідження є аналіз суспільної думки стосовно висловлених та виявлених переваг ознак рекреаційних лісів і рекреаційних об'єктів, а також оцінка готовності платити за вподобані характеристики лісу та підтримання у належному стані рекреаційних об'єктів. Дослідження проведено з червня по серпень 2022 року шляхом прямого та анонімного онлайн-опитування. Встановлено, що респонденти готові щорічно платити в середньому 1-100 грн/рік за створення і підтримання вподобаних характеристик лісу та 101-500 грн/рік за створення та підтримання рекреаційних об'єктів. Щодо сприйняття респондентами характеристик лісу, які впливають на вибір місця відпочинку перевага надається мішаним лісам (74,8 %), у складі яких зростає три деревних види (57,9 %) та лісам висотою до 20 метрів (40,2 %). Натомість лісам висотою більше 20 метрів перевагу віддали усього 15,9 % респондентів. Наявність мертвої деревини у лісі позитивно сприймають 51,4 % респондентів, а 10,3 % респондентів не звертають увагу на

наявність чи відсутність сухостійних і всихаючих дерев у лісі. Найважливішими потребами задля яких респонденти відвідують рекреаційні ліси були прогулянки, відпочинок із сім'єю та споглядання лісових ландшафтів. Інтеграція виявлених уявлень та уподобань щодо рекреаційних лісів та об'єктів у інноваційне прийняття рішень у сфері лісового господарства забезпечує синергію переваг, таких як підвищення привабливості рекреаційних лісів та лісових ландшафтів, підвищення стійкості лісів до змін клімату та задоволення місцевого попиту на деревну біомасу

Ключові слова: послуги лісових екосистем; відпочинок на природі; опитування; непараметрична статистика; метод умовного оцінювання