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Assessing Tourism Carrying Capacity Based on Visitors' Experience Utility: A Case Study of Xian-Ren-Tai National Forest Park, China

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Abstract: Considering the majority of previous assessment perspectives on tourism carrying capacity are limited by "the number of visitors", this paper develops an innovative approach from the "visitors' experience utility" perspective. Using the choice experiment method, tourism carrying capacity is assessed by exploring the marginal utility and sensitivity of visitors to changes in recreational attributes. Xian-Ren-Tai National Forest Park in China is employed as the case park to demonstrate the application of this assessment method. The conclusions are as follows: the carrying capacity threshold of the crowding level in this urban forest park ranges from 20–35 people/100 m^2, the threshold of "vegetation coverage" ranges from 70% to 80%, and the "number of garbage" is 3–10 pieces/200 m. The acceptable traffic accessibility level for visitors is within 3 h. At present, Xian-Ren-Tai National Forest Park as a whole is in a state of "low carrying capacity", there are potential risks of under-utilization in this park. In addition, this paper provides the carrying capacity state of 27 potential recreational attribute sets.

Keywords: carrying capacity; experience utility; choice experiment; urban forest park

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1. Introduction

Following the growth of nature-based tourism, forest parks have become important tourism destinations around the world. However, recreational activities with frequent interactions between visitors and nature trigger huge problems and challenges for the environment and human well-being [1–3]. Tourism carrying capacity (TCC) is the key to releasing the strained relationship between tourism resource utilization and sustainable development [4].

Previous scholars have introduced various discussions on TCC from different perspectives [5–8]. In early studies, the concept of tourism carrying capacity was more related to visitor capacity, which was described as the maximum number of visitors that a destination can tolerate and absorb without pressure or negative impact on the natural environment [9–11]. The concept uses the limit of local production factors as a measure of TCC, which is also a method from a threshold perspective [12,13]. However, this "physical" constraint is unlikely to be reached, as other factors can limit the number of visitors to a lower level [14]. The increasing number of visitors impacts not only ecosystems and the environment but also leads to corresponding changes in visitors' experiences, the surrounding population, and even the local socio-economy. Focusing on the number of visitors alone can lead to a certain degree of imbalance in the tourism system [15,16]. Therefore, the concept of TCC should be gradually extended from visitor capacity to social, psychological, and economic domains [5,17–19].

A consensus among scholars on tourism carrying capacity is that TCC is related mainly to tourism experience, which reflects the intensity of development and utilization of tourism destinations to maintain a certain level of tourism use within a certain period without damaging the environment and affecting visitors' experience. Manning (2007) argues that tourism carrying capacity is the maintenance of a minimum level of tourist satisfaction or a minimum tolerable state of tourism resources [20]. Prato (2009) states that simple visitor capacity or utilization rate alone does not represent TCC, it should be the level of acceptable change of visitors under environmental constraints [21]. Wang et al. (2014) define TCC as the environmental state of a tourism site before unacceptable changes in the natural environment and tourism experience in a certain period of time [16].

Another important reason that we focus on TCC from the visitors' experience perspective is that visitors who are averse to crowding may be attracted by other recreational attributes (e.g., sanitation and transportation facilities) in tourism sites [22]. This requires managers to make trade-offs between ecosystem protection and the development of recreational attributes to achieve a dynamic balance between ecological and economic benefits. In the early 1990s, the US National Park Service proposed several national park management frameworks, such as limits of acceptable change (LAC), visitor experience and resource protection (VERP), and so on [23–25]. The former is based on the management objectives and resource conditions of a tourism attraction site to determine which level of natural resources or environmental quality is the most suitable for tourism activities and thus to design management plans [26]. The latter aims to achieve an effective balance between visitor perception and resource utilization by setting resource indicators and identifying visitor experience criteria [27]. Although they are slightly different, they both applied to explore the lowest level that can be afforded in terms of the environment and visitor experience, to weaken the negative effects of tourism activities, and to maximize the efficiency of resource utilization and visitors' experience.

Therefore, in this paper, we start from the demand of visitors for the park's recreational attributes and assess the TCC state of these attributes under the constraints of visitors' experience. Our study takes visitors as the judge of "unacceptable" and shifts the focus of TCC from "how many visitors are too many" to "what kind of environmental changes are unacceptable". This is a supplement to the basic theory of tourism carrying capacity and its evaluation objects. We set the "net utility" (NU) of visitors as an assessment tool to accurately measure the marginal impact of changes in each recreational attribute in the tourism site. This study reveals the sensitivity of visitors' experience to the change of recreational attributes and contributes to formulating targeted policies to improve the utilization efficiency of tourism resources and thus maximizing the utility of visitors' experiences.

The rest of this paper is organized as follows. Section 2 details the theoretical framework, assessment techniques, and models of TCC based on the visitors' experience utility, presents the study area, and describes the data source. TCC assessment results are presented in Section 3 and discussed in Section 4. In Section 5, this paper concludes with its main findings.

2. Materials and Methods

2.1. Methodological Framework

2.1.1. The Utility-Based Theoretical Framework of TCC

We define the concept of tourism carrying capacity as the limited state of the development of various recreational attributes in a specific period, with the premise of maintaining no negative changes in the visitors' experience utility. Importantly, the effective value of TCC should be changing dynamically and within a resilient range rather than a static threshold. When the intensity of tourism activities exceeds the visitors' experience carrying range, the scenic area is in the "unacceptable" state. Conversely, if the lower intensity of tourism activities does not result in the full utilization of tourism resources, the scenic area is in a "low carrying capacity state". Our research aims to find the range of the "appropriate carrying capacity state" between these two states to maximize visitors' experience utility.

From the perspective of visitors' utility change, we use the results of recreational value as the assessment criterion and give visitors' experience a monetized metric tool to efficiently determine the "acceptable" or "unacceptable" states of recreational attributes. Using the typical cost–benefit curve in economics, we combine the experience utility with the determination of the "appropriate carrying capacity state". In Figure 1, the x-axis represents the state of recreational attributes, and the y-axis represents visitors' experience utility under different environmental states, which is also the monetization of the value of recreational attributes. The visitors' net utility value (NU) is equal to the total utility (TU) minus the total cost (TC). Along with the gradual increase in the use level of recreational resources, the marginal utility (MU) of visitors shows an increasing and then decreasing trend, and finally reaches a maximum at recreational state = Q1. When the MU = MC, the NU of visitors reaches the maximum, and when the MU falls to 0 (recreational resource state = Q3), visitors obtain the maximum TU. Thereafter, the utilization level of recreational resources gradually increases to Q4, at which time, TU = TC. Visitors' NU = 0, which is the critical threshold for recreational attributes without a change in experience. As shown in Table 1, we set the tourism carrying capacity state of the scenic area as follows.

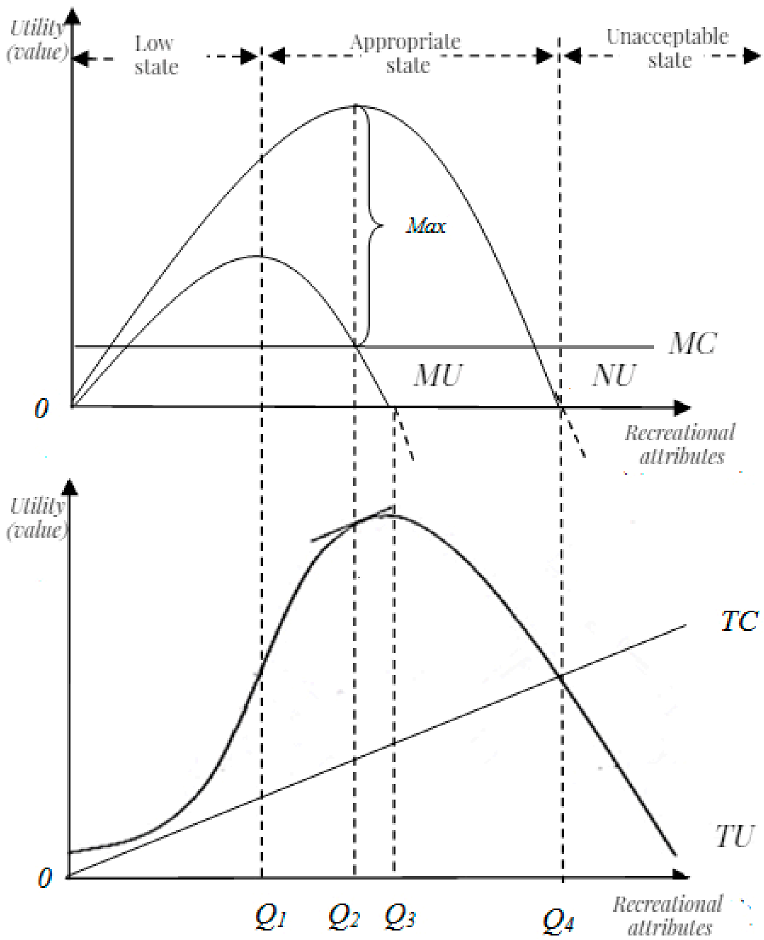

Figure 1. Assessment criteria for TCC based on visitors' experience utility. Note: TU is total utility of tourists, NU is net utility, MU is marginal utility, and TC represents total cost.

Table 1. Assessment criteria of TCC state of recreational attributes.

Environmental Status	Assessment Criterion
Best carrying capacity state	Q2, NU = Max
Carrying capacity threshold	Q4, NU = 0
Low carrying capacity state	0~Q1, NU > 0
Appropriate carrying capacity state	Q1~Q4, NU > 0
Unacceptable state	>Q4, NU < 0

2.1.2. Choice Experiment Method

According to Lancaster's (1966) utility characteristics theory, the utility brought to the user does not come from the goods itself, rather it is derived from the various attributes that make up the goods [28]. Therefore, to accurately measure the value of each recreational attribute's contribution to visitors' experience utility, this paper uses the choice experiment method (CEM) as the assessment methodology. Similar to the contingent valuation method (CVM), CEM uses consumers' stated willingness to pay (WTP), or willingness to accept (WTA) as an implicit price in a hypothetical market to estimate the monetary value of recreational attributes, i.e., the change in consumer surplus [29–32]. The difference is that the CVM generally assesses the marginal utility due to the change in the level of a single recreational attribute, while all other attributes are constant [33–35]. However, in the actual market, visitors' recreational demands are not for a single attribute but rather a comprehensive demand for the various attributes constituting a recreational trip [36]. The total utility of visitors is the result of the joint action of multiple recreational attributes. CEM carries a higher information load, which helps to assess multiple attributes through a single experimental design [37,38].

2.1.3. Random Utility Function and Conditional Logit Model

Assuming the utility of visitor i from visiting a recreational site is expressed as U_i, a rational visitor will make the decision of choosing the site that yields the largest utility or satisfaction [28]. We define the combination of recreational attributes in the jth scenic area as C_i, and U_{ij} is visitor's i utility obtained by choosing the jth combination from the choice set C_i. Based on random utility theory, visitors' experience utility can be divided into observable systematic and unobservable random parts [39,40]. Therefore, we define the latent utility function of visitor i as follows:

$$U_{ij} = V_i(X_j, P_j, \beta) + \varepsilon_{ij} = \beta_j X_{ij} + \beta_p P_{ij} + \varepsilon_{ij}(i = 1, \ldots\ldots, N; j = 1, \ldots\ldots, J), \quad (1)$$

where j denotes different bundles of recreational attributes and V_{ij} denotes the visitor's utility when selecting recreational product j. X_{ij} is the recreational attributes, and P_{ij} is the cost attribute (i.e., entrance price) of the corresponding products. ε_{ij} is a random error term that represents the influence of unobserved factors on visitors' choice. Individual i will choose alternative j over alternative k if and only if $U_{ij} > U_{ik}$. The probability is:

$$P_{ij} = P(U_j > U_k) = P(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}) \ \ (j \neq k, \forall k \in C_i). \quad (2)$$

If ε_{ik} can be assumed to be an independent and identical Gumbel distribution (i.e., IID), then the probability of choosing an accessible recreation product j can be written as:

$$P_i(j|C) = \frac{exp(\beta_j X_{ij} + \beta_P X_{ij})}{\sum_{K \in C_i} exp(\beta_K X_{iK} + \beta_P X_{iK})}, \quad (3)$$

which is referred to as the conditional logit (CL) model and McFadden's choice model [41]. The model parameters are typically estimated using maximum-likelihood estimation with a log-likelihood function:

$$logL = \sum_{i=1}^{N} \sum_{j=1}^{J} y_{ij} log \left[\frac{exp(\beta_j X_{ij} + \beta_P X_{ij})}{\sum_{K \in C_i} exp(\beta_K X_{iK} + \beta_P X_{iK})} \right] \tag{4}$$

where y_{ij} is an indicator variable that equals 1 when visitor i selects recreational product j and is 0 otherwise.

Next, we observe the change in visitors' experience utility by calculating their consumer surplus. Once each attribute parameter vector β is calculated by Equation (4), the value of the utility changes due to the change of recreational attributes can be further measured. For example, when the attribute changes from the initial state X^0 to the new state X^1, the consumer surplus can be expressed as:

$$CS = -\frac{1}{\alpha} \left\{ \ln \left[\sum exp\left(\beta' X_{ij}^1 \right) \right] - \ln \left[\sum exp\left(\beta' X_{ij}^0 \right) \right] \right\}, \tag{5}$$

where α represents the estimated coefficient of the cost attribute. Visitors' WTP for the changes in recreational attributes is equal to the ratio of the corresponding attribute coefficient to the cost attribute coefficient:

$$WTP = -\frac{\beta_j}{\alpha}, \tag{6}$$

when WTP < 0, visitors' NU under this recreational attribute level is negative, and their experience is not satisfactory. In other words, the environment is in the "unacceptable state". When WTP > 0, visitors' NU is positive, and the environment is in the "acceptable state". When WTP = 0, NU = 0, and the environment is in the "carrying capacity threshold".

2.2. Data

2.2.1. Study Area

The Xian-Ren-Tai National Forest Park (NFP), established in December 2002, is located in Anshan City, China. It is a large topographically changing location of 2931 ha and proximity to Qianshan Scenic area, which is known as one of the first batch of "China National Parks and scenic sites". This park is a typical natural forest type scenic area, and particularly famous due to its distinctive tourism resources, such as ancient pine, characteristic crags, and numerous species of flora and fauna. The highest peak, Xian-Ren-Tai, at an altitude of 708.3 m, is the best platform to view the sunrise in the early morning. According to the annual statistical report assembled by the Department of Anshan Tourism Administration, on average, there are more than 3.6 million people choose to visit this park every year. The management of this park, such as ticket pricing, visitor control, infrastructure construction, and natural resource protection, are under the jurisdiction of the Anshan Municipal Government.

National forest park is the highest level of forest park in mainland China and is an important part of China's natural protected area system. Most of them are located in the city boundaries or outer suburbs, which are important places to develop urban tourism and promote the physical and mental health of local community and visitors. As noted by Miller (1988), if the woody and associated vegetation are in and around dense human settlements, then they could be defined as "urban forest" [42]. Another study by Deng et al. (2017) also state that urban forest should significantly add the beauty of urban spaces and provide the recreational experiences for visitors [43].

The reason we chose Xian-Ren-Tai NFP to represent the urban forest tourism is that the park is considered as the best urban tourism destination in Anshan city for recreational activities such as sightseeing, hiking, and birding. The scenic area, with urban forests as its main "selling point", brings huge economic, socio-cultural, and aesthetic benefits. It is no wonder that this park is a good fit to investigate visitors' experiences of urban forest tourism. However, in the past decade, the increasing number of visitors has brought serious challenges to park management. According to Kang et al. (2019)'s field survey, Xian-Ren-Tai NFP is facing serious challenges in relation to nature protection and recreational use, such as garbage accumulation, infrastructure destruction, and land use changes, visitors' experience utility has declined substantially [38]. Therefore, managers must pay more attention to the use of park recreational resources to maximize visitors' experience utility within the carrying capacity.

2.2.2. Survey Design

In the preparation phase, with reference to the research of Lyu (2017) and field survey, we selected the following five representative recreational attributes as assessment indicators of TCC [44]. The recreational attributes and variable names are shown in Table 2. Variables with "*" indicate the baseline of this park, which was also determined through focus group discussions with park managers.

Table 2. The definition of recreational attributes and levels.

Attribute	Attribute Description	Attribute Level	Type of Variable	Variable Name
Vegetation coverage	The vegetation coverage rate	70% 80% 90%	0, 1 0, 1 0, 1	Forest * $Forest^{Better}$ $Forest^{Best}$
Support facility	Elements including eco-lavatory, wood path, parking lot, service center, and special eateries and shops, each item earns 1 point	Inferior =1 Medium = 2 Excellent = 3	0, 1 0, 1 0, 1	Support * $Support^{Better}$ $Support^{Best}$
Garbage	No. of garbage cans distributed per 200 m	>10 3–10 <3	0, 1 0, 1 0, 1	$Garbage^{more}$ Garbage * $Garbage^{Less}$
Crowding	No. of people observed in a visible scope (per 100 m^2)	<10 20 35 50 >60	0, 1 0, 1 0, 1 0, 1 0, 1	$Crowding^{Best}$ Crowding * $Crowding^{middle}$ $Crowding^{worse}$ $Crowding^{worst}$
Traffic condition	Time spent traveling from city to park	Less convenient: >3 h Partially convenient: 1–3 h Convenient: <1 h	0, 1 0, 1 0, 1	Traffic * $Traffic^{Better}$ $Traffic^{Best}$
Entrance Price	Admission fee	¥30 *, ¥35, ¥40, ¥50, ¥80	Continuous	Entrance Price

Note: Variables with "*" indicate the baseline.

A total of 2025 combinations of attributes were derived from a full factorial permutation procedure ($3^4 \times 5^2 = 2025$). Clearly, the number of choice sets was too large to be feasible for questionnaire design, and excessive cooperative burden will discourage participants' interest in taking part in the survey interview [45–47]. Therefore, an orthogonal experimental design procedure was executed, which resulted in a total of 27 potential combinations [48]. Finally, nine versions of choice sets were made with each set including three potential combinations and the present attribute combination, i.e., the status quo. In the survey process, each interviewee was asked to select a choice set from a randomly assigned choice set scenario. To help interviewees better differentiate one choice set from another so that their real preference toward various attribute combinations could be truly reflected in their selection, colorful images were attached to each corresponding choice set in the survey questionnaire. A sample task card of one version is shown in Figure 2.

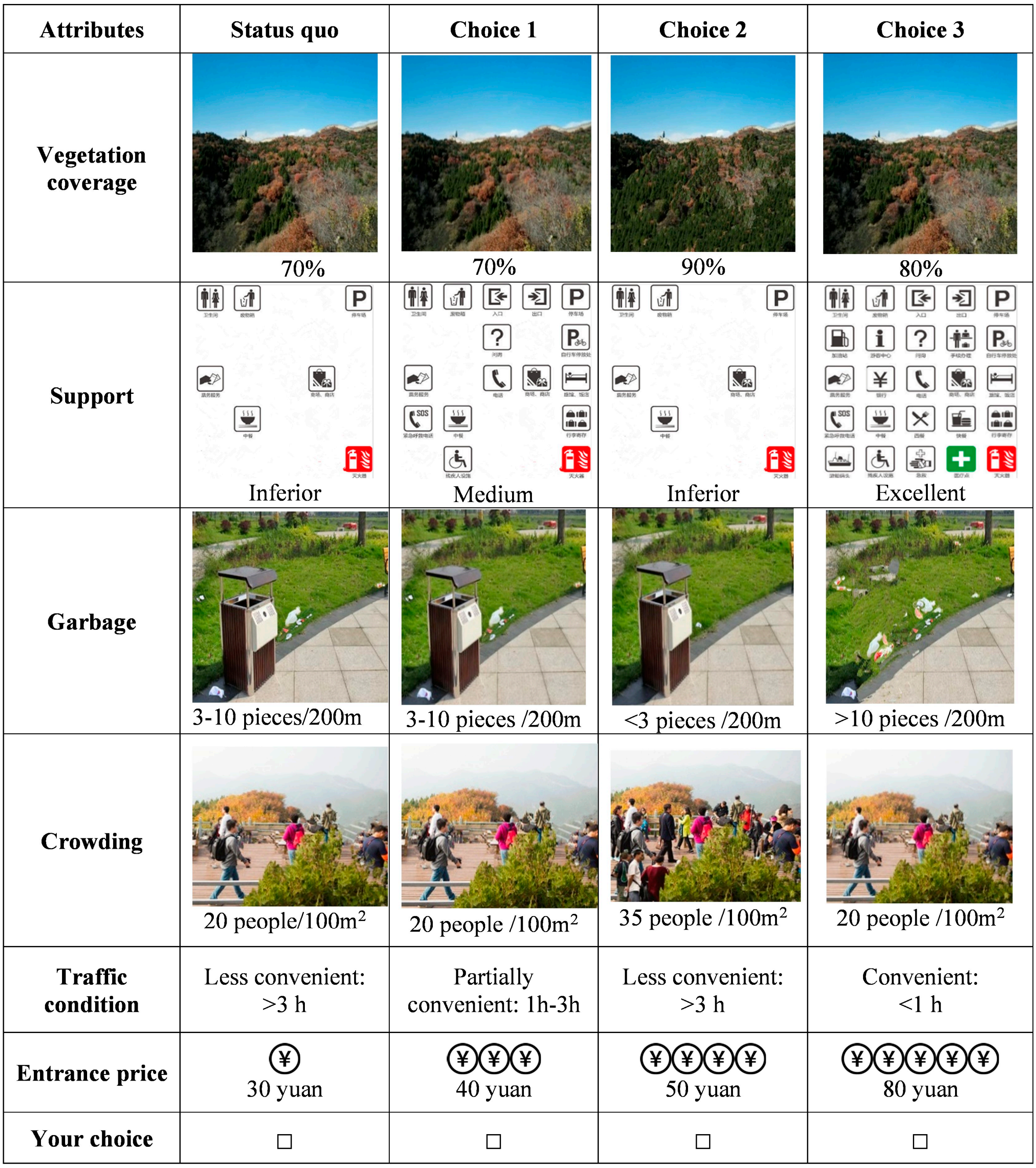

Figure 2. An exemplary choice set with attached images.

2.2.3. Data Collection

We conducted a five-day tourist questionnaire survey of this park from 1–10 May 2017, during China's International Labor Day holiday. A total of 35–45 copies of each version of the choice sets were distributed. A total of 365 questionnaires were distributed, of which 328 were recovered, yielding an 89% effective response rate. With four choice sets reviewed per interviewee, this resulted in 1312 total observations. The number of valid questionnaires for each of nine different versions was roughly the same. Descriptive statistics of the samples are shown in Table 3.

Table 3. Socioeconomic characteristics of the sampled tourists.

Variable	Characteristics	N	%	Variable	Characteristics	N	%
Gender	Male	179	54	Marital status	Unmarried	98	30
	Female	149	45		Married (children = 0)	22	7
					Married (children > 0)	208	63
Age	18–24	63	19	Education	Junior high school	30	9
	25–40	113	34		High school	65	20
	41–60	134	41		Undergraduate	220	67
	61 or more	18	5		Graduate and above	13	4
HH Income (per year; ¥′000)	≤¥40	137	42	Life satisfaction	Completely dissatisfied	7	2
	¥40–100	139	43		Dissatisfied	12	4
	¥100–200	44	13		Neither dissat. nor satis.	90	27
	¥200 or more	8	2		Satisfied	127	39
					Completely satisfied	92	28

3. Results

3.1. Carrying Capacity of Individual Recreational Attributes

In Table 4, we use the conditional logit model to initially construct the attribute preference framework of visitors. As expected, the "entrance price" coefficient is significantly negative at the 99% confidence level. The higher the ticket price is, the lower the probability that the corresponding choice set will be selected, which is also the result of complying with the law of demand. Except "Support^{Better}" and "Garbage^{less}", the coefficients of other nonprice recreational attribute levels show significant statistical correlation. Among them, improvement in all levels of the "Vegetation coverage" and "Traffic condition" attributes increase the probability of visitors' choice, which indicates that excellent forest resources and convenient traffic conditions are more likely to attract visitors. Analysis of "Crowding" shows that when the visitors' density of the park rises from the current state to 35 people/100 m^2, the probability of selecting the corresponding choice set decreases. In contrast, the visitors' density of 10 people/100 m^2 increases visitors' experience utility.

Table 4. The calculated results of the CL model for recreational attributes.

Attributes	Attribute Levels	Coeff.	S.D.	z-Statistics	Net Utility/ RMB Yuan
Vegetation coverage	Forest *	−1.034	-	-	−39.315
	Forest ^{Better}	0.5201	0.183	2.85	19.801
	Forest ^{Best}	0.513	0.221	2.32	19.514
Support facility	Support *	−0.813	-	-	−30.921
	Support^{Better}	0.265	0.246	1.08	10.085
	Support^{Best}	0.548	0.288	1.9	20.835
Garbage	Garbage^{more}	−1.567	0.287	−5.46	−59.576
	Garbage *	1.468	-	-	55.815
	Garbage^{Less}	0.098	0.202	0.49	3.761
Crowding	Crowding^{Best}	0.400	0.228	1.75	15.220
	Crowding *	1.819	-	-	69.148
	Crowding^{middle}	−0.834	0.241	−1.38	−31.711
	Crowding^{worse}	−0.723	0.306	−2.36	−27.487
	Crowding^{worst}	−0.662	0.287	−2.31	−25.170
Traffic condition	Traffic *	−1.211	-	-	−46.035
	Traffic^{Less}	0.287	0.184	1.55	10.919
	Traffic^{Least}	0.924	0.251	3.68	35.116
Entrance price	Entrance Price	−0.0263	0.007	−3.82	-

Table 4. *Cont.*

Attributes	Attribute Levels	Coeff.	S.D.	z-Statistics	Net Utility/ RMB Yuan
Log-likelihood				−383.461	
McFadden Pseudo R^2				0.154	
Number of observations				1312	
Prob > chi2				0	

Note: * indicate statistical significance at the 0.1 levels.

In column 6 of Table 4, we use Equation (6) to report the estimated visitors' NU for each recreational attribute. When the crowding level of the park increases from 20 people/100 m^2 to 35 people/100 m^2, the NU shows a reverse change, and visitors' utility drops to a negative value. According to the TCC assessment criteria proposed above, when the net utility value brought to visitors is reduced to 0, the utilization of recreational resources reaches the TCC threshold, and the corresponding recreational attribute level is the maximum use limit of the scenic area. Therefore, the TCC threshold of the crowding level in the Xian-Ren-Tai NFP ranges from 20 to 35 people/100 m^2. Similarly, we can judge the carrying capacity threshold range of other recreational attributes: vegetation coverage is 70–80%, the number of garbage is 3–10 pieces/200 m, and acceptable transportation accessibility is within 3 h. Since the setting of the support facility attribute is not quantified in our study, a specific threshold is not reported. According to these results, the order of TCC of the five recreational attributes in the Xian-Ren-Tai NFP is as follows: crowding state > garbage state > support facility > vegetation coverage > traffic condition.

3.2. Carrying Capacity of the Recreational Attribute Sets

Using the net utility values corresponding to each attribute level obtained in Table 4, we calculate the net utility levels of 28 recreational choice sets (including 27 potential recreational attribute sets and 1 status quo) in nine versions used in the survey process. As shown in Table 5, the current net utility level of the park is 8.69 yuan/person/trip, which is CNY 30 less than the park entrance price. Overall, the park is in a "low carrying capacity state". The net utility value of visitors in Alternative-27 has a minimum value of −166.55 yuan/person/trip. In this case, the park is seriously overloaded. The maximum utility value of 165.82 yuan/person/trip appears in Alternative-23, at which time the park achieves the "best carrying capacity state" and is also the best acceptable level for visitors.

Table 5. Net utility under different recreational attribute sets.

Alternative	Vegetation Coverage	Support Facility	Garbage	Crowding	Traffic Condition	Net Utility
Alternative-1	70%	Inferior	3–10 pieces/200 m	35 persons/100 m^2	1–3 h	−35.212
Alternative-2	90%	Inferior	<3 pieces/200 m	50 persons/100 m^2	1–3 h	−24.212
Alternative-3	80%	Inferior	>10 pieces/200 m	50 persons/100 m^2	>3 h	−144.218
Alternative-4	80%	Inferior	<3 pieces/200 m	35 persons/100 m^2	<1 h	−3.954
Alternative-5	70%	Excellent	3–10 pieces/200 m	50 persons/100 m^2	<1 h	44.965
Alternative-6	70%	Inferior	3–10 pieces/200 m	>60 persons/100 m^2	1–3 h	−28.672
Alternative-7	90%	Inferior	<3 pieces/200 m	35 persons/100 m^2	>3 h	7.668
Alternative-8	80%	Medium	<3 pieces/200 m	35 persons/100 m^2	1–3 h	12.854
Alternative-9	70%	Medium	>10 pieces/200 m	20 persons/100 m^2	1–3 h	−8.739
Alternative-10	70%	Medium	<3 pieces/200 m	<10 persons/100 m^2	>3 h	−56.283
Alternative-11	80%	Medium	3–10 pieces/200 m	>60 persons/100 m^2	<1 h	95.646
Alternative-12	90%	Excellent	<3 pieces/200 m	>60 persons/100 m^2	1–3 h	29.860
Alternative-13	70%	Excellent	>10 pieces/200 m	35 persons/100 m^2	1–3 h	−98.848

Table 5. *Cont.*

Alternative	Vegetation Coverage	Support Facility	Garbage	Crowding	Traffic Condition	Net Utility
Alternative-14	70%	Medium	<3 pieces/200 m	>60 persons/100 m^2	1–3 h	−39.719
Alternative-15	80%	Medium	3–10 pieces/200 m	20 persons/100 m^2	>3 h	108.813
Alternative-16	80%	Excellent	>10 pieces/200 m	20 persons/100 m^2	<1 h	67.509
Alternative-17	80%	Excellent	3–10 pieces/200 m	<10 persons/100 m^2	1–3 h	122.590
Alternative-18	70%	Medium	3–10 pieces/200 m	20 persons/100 m^2	1–3 h	−46.936
Alternative-19	90%	Medium	>10 pieces/200 m	<10 persons/100 m^2	<1 h	20.359
Alternative-20	70%	Inferior	<3 pieces/200 m	20 persons/100 m^2	<1 h	37.789
Alternative-21	80%	Medium	<3 pieces/200 m	50 persons/100 m^2	1–3 h	17.079
Alternative-22	90%	Excellent	<3 pieces/200 m	<10 persons/100 m^2	>3 h	13.296
Alternative-23	90%	Medium	3–10 pieces/200 m	20 persons/100 m^2	1–3 h	165.482
Alternative-24	80%	Inferior	3–10 pieces/200 m	<10 persons/100 m^2	1–3 h	70.834
Alternative-25	80%	Inferior	<3 pieces/200 m	>60 persons/100 m^2	1–3 h	−21.610
Alternative-26	80%	Excellent	>10 pieces/200 m	20 persons/100 m^2	1–3 h	61.126
Alternative-27	70%	Medium	>10 pieces/200 m	35 persons/100 m^2	>3 h	−166.553
Status quo	70%	Inferior	3–10 pieces/200 m	20 persons/100 m^2	>3 h	8.692

To display the TCC status of all choice sets more intuitively, we rank the corresponding net utility values in Figure 3. The net utility brought by Alternatives 23, 17, 15, 11, 24, 16, 26, 5, 23, and 20 exceeds the entrance price paid, and the park is in the "appropriate carrying capacity state". Although the net utility of Alternatives 12, 19, 21, 22, 8, and 7 and the status quo are positive, the tourism resources are underutilized and are in a "low carrying capacity state". Alternatives 4, 9, 25, 2, 6, 1, 14, 10, 13, 3, and 27 bring negative experience utility, which leads to an "unacceptable state".

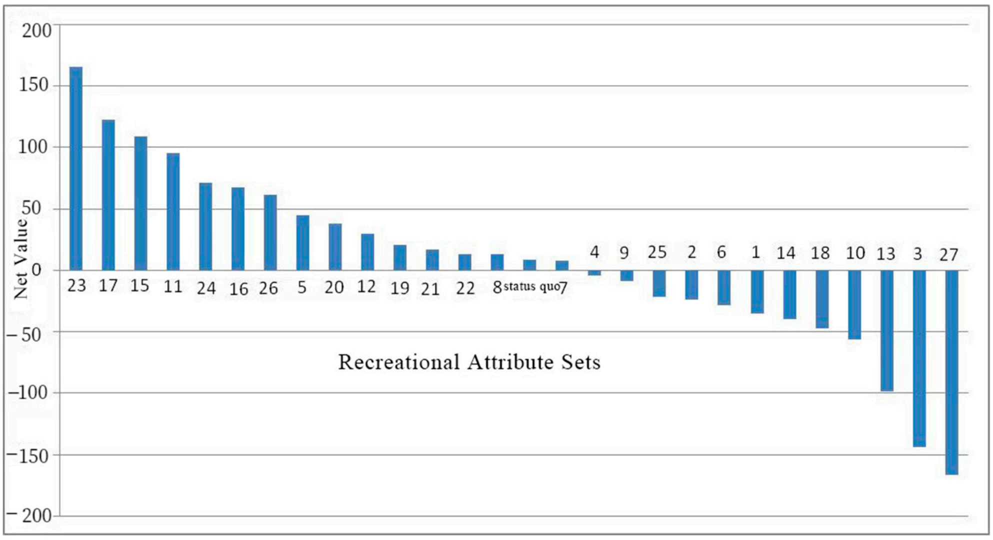

Figure 3. Net utility corresponds to different recreational attribute sets.

In Table 6, we show the TCC state of each recreational attribute set. The net utility corresponds to Alternative 4 and is −3.95 yuan/person/trip, which is closest to 0. Therefore, we defined this alternative as the "carrying capacity threshold" of Xian-Ren-Tai National Forest Park. Although the net utility of 8.69 yuan/person/trip for the current state of the park is greater than the threshold value of 0, it is close to the TCC threshold, which means that there is still a large planning space in the park, and it is imperative to improve the status quo.

Table 6. Assessment of TCC for each recreational attribute set.

Alternative	TCC Status	TCC Characteristic	Alternative	TCC Status	TCC Characteristic
Alternative-1	Unacceptable state		Alternative-15	Appropriate state	
Alternative-2	Unacceptable state		Alternative-16	Appropriate state	
Alternative-3	Unacceptable state		Alternative-17	Appropriate state	
Alternative-4	Unacceptable state	Carrying capacity threshold	Alternative-18	Unacceptable state	
Alternative-5	Appropriate state		Alternative-19	Low state	
Alternative-6	Unacceptable state		Alternative-20	Appropriate state	
Alternative-7	Low state	Close to threshold	Alternative-21	Low state	
Alternative-8	Low state		Alternative-22	Low state	
Alternative-9	Unacceptable state		Alternative-23	Appropriate state	Best carrying capacity state
Alternative-10	Unacceptable state		Alternative-24	Appropriate state	
Alternative-11	Appropriate state		Alternative-25	Unacceptable state	
Alternative-12	Low state		Alternative-26	Appropriate state	
Alternative-13	Unacceptable state		Alternative-27	Unacceptable state	Lowest carrying capacity state
Alternative-14	Unacceptable state		Status quo	Low state	Close to threshold

4. Discussion

4.1. The Interpretation of TCC Based on Visitors' Experiences Utility

The approach developed to assess TCC for recreational resources in this study is through determining the unacceptable levels of visitors' experience utility within the context of a forest park. It captures the feature that the "unacceptable changes" in the visitors' experiences precede the threshold of the natural physical environment [49]. An advantage of using perceived experience indicators as input variables for the TCC framework is the provision of a more complete picture of a park's recreational conditions. This is a supplement to the basic theory of the Limits of Acceptable Change (LAC) [23,50]. Because previous LAC assessment studies generally use either descriptive indicators [51] or local community attitude [24] for their measurements. Few have provided a quantitative procedure to determine visitors' preference for recreation-related issues. In accordance with Salerno et al. (2013), different stakeholders may have different perceptions of "what is unacceptable" [52]. Therefore, the LAC framework should have complicated discussions about visitor recreational experiences, and their interactions with biophysical processes and conditions [53].

This study demonstrates that the recreational resources comprised at least five indicators of attributes in the national forest park. The multiple indicators perspective is also consistent with the core idea of the LAC theory. Previous research has shown that the third step of the LAC framework, identifying the most important conditions of a study site and then the specific indicators that might best monitor change in that conditions is the most challenging one of the nine steps. According to Roman et al. (2007), only by considering both environmental, economic, and social aspects can the performance of TCC be improved [54]. Some indicators, such as site infrastructure [23], trail width [55], and number of people encountered [51], have been widely used in LAC studies to describe the variation of recreational conditions of a tourism site. Therefore, on the basis of LAC, this study expands the indicators of TCC assessment from a single quality measure to more completed multiple recreational parameters. For example, referring to Manning and Leung's (2005) methodology for visualizing congestion studies, we use the number of people a visitor encountered within 100 m^2 as an indicator of the degree of crowding [56].

The regression results based on visitors' preferences reveal the important attributes that impose significant effects on visitors' travel demand. For example, we found that convenient traffic conditions increase the probability of visitors choosing the corresponding choice set. This is echoed by the study of Zeng et al. (2022), who stated that traffic accessibility had the largest marginal contribution to the formation of visitor attraction, reaching 0.35 [57]. Our results indicate an increase in the number of people a visitor encounters exhibits negative effects on respondents' welfare. Similarly, the research of Wang et al. (2014) opined that typical visitors may feel more comfortable when they see fewer visitors in a forest park [16].

The TCC assessment results provide the key information on the carrying capacity threshold of five recreational attributes in Xian-Ren-Tai NFP. The current amount of garbage and the level of crowding in the park have positive utility for visitors, which means that the current condition of these two attributes is still within the range of the "appropriate carrying capacity state". However, we also found the over-load signals in TCC of support facility, vegetation coverage, and traffic status. In other words, the current conditions of these three attributes are confronted with a potential risk of being overloaded. As pointed out by Dogantan and Kozak (2019), a stronger resilience of carrying capacity is based on fully utilized tourism resources [58]. As a result, sustainable utilization can be achieved not only by limiting the increase of tourism load but also by the expansion of tourism carriers to alleviate it.

Furthermore, our results based on the choice experiment also quantitatively reflect the TCC under different recreational attribute sets scenarios. Because there is a consensus around tourist attractions that they are composed of various types of tourism resources [59]. The 27 potential recreational attribute sets designed in our survey can represent different development situations of the Xian-Ren-Tai NFP. Their corresponding TCC values help park managers properly monitor the tourism resource status, thus effective policies can be taken for matching the TCC need. In other words, if the TCC of a choice set is overloaded, the park managers should control the tourist load or improve the utilization of tourism resources to maintain the stability of carrying capacity.

The methodology developed to assess TCC in our study also demonstrates the potential to be applied to other case studies. It provides a rapid, referable assessment framework when the time and budget are limited as it typically only requires adjusting the recreational attributes and levels according to the characteristics of the park being studied. However, tourism resources vary from park to park, so which attributes are proper enough to represent the study area should be noted [49]. Because the attributes selected in this study, such as vegetation coverage and traffic status, only provide a basic profile for characterizing Xian-Ren-Tai NFP. Furthermore, an extended questionnaire considering both visitors and other stakeholders together can improve the validity of the performance of TCC.

4.2. Policy Implications for Forest Park Management

As an important measure of the coordinated development of human tourism activities and recreational resources, the assessment results of the TCC can provide valuable references for formulating tailor-made policies to further promote the sustainable development of national forest parks. On the one hand, it can help management departments rectify and manage those environmental resources that are on the verge of being used to unearth potential recreational resources in parks that are underutilized or undeveloped. On the premise that the environment is not damaged, the economic benefits of tourism resources reach maximization. As indicated by the assessing results of the status quo in Figure 3, the tourism resources in this park are in a "low carrying capacity state" and there is still a large development space. Park management personnel could supplement new recreational activities by using the advantages of the forest ecosystem, such as birding, forest therapy, water entertainment, and charge-associated activity fees, to obtain additional economic supplements. On the other hand, the identification of visitors' preference for recreational attributes and the measurement of carrying capacity state also have irreplaceable reference values for revealing the marginal impact of attribute changes on visitors' experience utility and improving their satisfaction level.

4.3. Research Limitations and Further Studies

Inevitably, some research limitations remain. First, although we have made great efforts in park management practices and the existing literature to select as many attributes as possible that represent the tourism characteristics of Xian-Ren-Tai NFP, the carrying capacity assessment based on only these five attributes cannot provide sufficient information for the management of national parks. Other non-natural resources, such as the number of hiking trails, noise level, signposting, locations for birding, historical relics, and so on, may also play important roles in attracting visitors to the forest park. Those attributes that have been confirmed by other studies to influence tourism utility are no exception. Second, our assessment is based on one-time survey data, and the carrying capacity information only being useful to the short-run management analysis. As time goes by, the visitors' experience utility over the recreational attributes may be changed considerably. For example, our field survey was conducted during China's "May 1st Golden Week", a period when a larger number of people make travels and visitors face worse sanitation and a higher level of congestion. For this reason, the tracking of the changes in the visitor's experience using multiple surveys within a year must be noted in order to rigorously reveal the carrying capacity of the forest park. Third, the tradeoff between the carrying capacity state under visitors' experience utility and the bearing threshold of the natural environment supported by eco-physical data requires further discussion.

5. Conclusions

Tourism carrying capacity can serve as a powerful management tool for the control of progressive tourism development or in other words can be used as a guideline for policy interventions in sustainable development. In this study, we propose adding the dimension of visitors' experience utility to the TCC and developing an assessment criterion from the perspective of combining recreational value with the utility to measure the acceptable range for different recreational attributes. The carrying capacity state of each recreational attribute set is described by the CEM and conditional logit model.

There are two main conclusions from our research. First, the carrying capacity threshold of the crowding level of Liaoning Xian-Ren-Tai National Forest Park is 20–35 people/100 m^2, the carrying capacity threshold of vegetation cover is between 70% and 80%, the amount of garbage is between 3 and 10, and the acceptable traffic accessibility level for visitors is within 3 h. Except for the crowding level and garbage quality of the park, which are still within the TCC range, the other three recreational attributes of vegetation cover, traffic condition, and support facility are close to their TCC thresholds. The utilization of recreational resources in this park needs urgent improvement. Second, according to the assessment criterion of tourism experience carrying capacity derived from the correlation between marginal utility MU and marginal cost MC, Xian-Ren-Tai National Forest Park is currently in a "low carrying capacity state", and the utilization level of tourism resources clearly lags behind the optimal level. According to the net utility of 27 potential recreational attribute sets considered in the experimental study, the "best carrying capacity state" is reflected by Alternative-23. Alternative-27 is the worst carrying capacity state, and Alternative-4 is the maximum use limit that visitors cannot accept.

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