Austrian Journal of Forest Science
Centralblatt
für das gesamte
Forstwesen

Importance of tree species composition and forest structure on recreational use – a case study for mountain forests in Upper Styria

Die Bedeutung von Baumartenzusammensetzung und der Waldstruktur für die Erholungsnutzung – eine Fallstudie für Bergwälder in der Obersteiermark

Magdalena Langmaier[1,2*], Eduard Hochbichler[2], Andrea Payrhuber[3,4]

Keywords: tree species composition, forest condition, silviculture, recreational function, climate change

Schlüsselbegriffe: Baumartenzusammensetzung, Waldzustand, Waldbau, Erholungsfunktion, Klimawandel

Abstract

The development of rural tourism is closely linked to the recreational function of the forest and the provision of forest services for recreational purposes. Due to the high share of forest cover (about 50 %), Austria features a large number of such "natural" recreational areas. In rural and urban regions forests are regularly utilized for tourist activities such as hiking or mountain biking. Recreational and landscape-based tourism in forests has become more attractive in Austria, as in many other parts of Europe. Aesthetically pleasing, adaptable and functional forests and landscapes are increasingly attracting tourism. An example of a region rich in forests with different tree species is the district of Murau in Styria, Austria. In this area, there was an ongoing project to promote more Larch (*Larix decidua*) more strongly in mixed stand in order to investigate

[1] Austrian Research Centre for Forests, Department of Forest Growth and Silviculture, Seckendorff- Gudent-Weg 8, A-1130 Vienna, Austria
[2] University of Natural Resources and Life Sciences Vienna, Department of Forest and Soil Sciences, Institute of Silviculture, Peter-Jordan-Straße 82/3, A-1190 Vienna, Austria
[3] University Vienna, Department of Communication, Währinger Straße 29, A-1090 Vienna
[4] University College for Agrarian and Environmental Pedagogy, Angermayergasse 1, A-1130 Vienna
*Corresponding author: Magdalena Langmaier, magdalena.langmaier@bfw.gv.at

i) how the forest in its diversity could be placed increasingly at the centre of tourism considerations,

ii) what recreation seekers think about the "tourism product" forest in general and

iii) which silvicultural strategies and measures are necessary for this.

Therefore, a quantitative survey was carried out in various hiking areas of the region using a standardized questionnaire. The survey took both tourism and forestry aspects into account. Of particular interest was the question 'What influence does the tree species composition and forest condition have on the recreational function?' The results confirm that open mixed stands are very attractive for recreationists. Respondents use the forest for low-intensity recreational activities such as hiking and recreation. The forest is characterised as quiet, slowly relaxing and can be used for fun, play and exercise.

Zusammenfassung

Die Entwicklung des ländlichen Tourismus ist eng mit der Erholungsfunktion des Waldes und der Bereitstellung von forstlichen Leistungen für Erholungszwecke verbunden. Aufgrund des hohen Waldanteils (ca. 50 %) gibt es in Österreich eine große Anzahl solcher "natürlichen" Erholungsgebiete. In ländlichen und städtischen Regionen werden die Wälder regelmäßig für touristische Aktivitäten wie Wandern oder Mountainbiking genutzt. Der Erholungs- und Landschaftstourismus im Wald hat in Österreich, wie auch in vielen anderen Teilen Europas, an Attraktivität gewonnen. Ästhetisch ansprechende, anpassungsfähige und funktionale Wälder und Landschaften ziehen zunehmend den Tourismus an. Ein Beispiel für eine Region, die reich an Wäldern mit verschiedenen Baumarten ist, ist der Bezirk Murau in der Steiermark, Österreich. In diesem Gebiet gab es ein laufendes Projekt zur stärkeren Förderung der Lärche (*Larix decidua*) in Mischbeständen, um zu untersuchen,

i) wie der Wald in seiner Vielfalt verstärkt in den Mittelpunkt touristischer Überlegungen gerückt werden kann,

ii) was Erholungssuchende über das "Tourismusprodukt" Wald im Allgemeinen denken und

iii) welche waldbaulichen Strategien und Maßnahmen dafür notwendig sind.

Dazu wurde eine quantitative Befragung in verschiedenen Wandergebieten der Region mittels eines standardisierten Fragebogens durchgeführt. Die Befragung berücksichtigte sowohl touristische als auch forstwirtschaftliche Aspekte. Von besonderem Interesse war die Frage 'Welchen Einfluss hat die Baumartenzusammensetzung und der Waldzustand auf die Erholungsfunktion?' Die Ergebnisse bestätigen, dass offene Mischbeständen für Erholungssuchende sehr attraktiv sind. Die Befragten nutzen den Wald für Freizeitaktivitäten mit geringer Intensität wie z. B. Wandern und Erholung. Der Wald wird als ruhig, langsam entspannend charakterisiert und kann für Spaß, Spiel und Bewegung genutzt werden.

1 Introduction

Forests in all their variations have always been used and valued by people in many ways. On the one hand, they provide important resources (timber), fulfil a protective function and are a source of income (Stoltenberg, 2009). On the other hand, Austrian forests are considered as 'open access attractions' by law (everyone is allowed to enter private and public forests for recreational purposes (§ 33 ff ForstG). As a consequence, the range of activities undertaken in forests is broad (Elands & van Marwijk, 2012), which is a challenge for the management of the forests (Oliveira *et al.*, 2015). The forest as an ecosystem can be described as an essential basis of life for humans ("At the Human-Forest Interface", 2018; Endreny *et al.*, 2017). The forest has many different functions and services to fulfil, and sustainable management is of great importance for the sustainable development of rural regions. In addition to the ecological and economic benefits of sustainable forest management, the social and cultural benefits are increasingly gaining value for people (Johann, 2004). From the perspective of social science forest research there is a two-way interaction with forest ecosystems conditions and people activities. Firstly, the direct effects of human activities that cause disturbance and maintenance and affect forest ecosystem processes and functions, and secondly, the ecosystem services that the forest provides for human well-being. These have the reverse effect, linking people's socio-economic conditions to forest ecosystem processes and functions (Ali, 2023).

About 48% of Austria's federal territory is covered by forests, which includes numerous natural and recreational areas (Russ, 2019). Forests in general offer ideal space for recreation and relaxation and therefore contribute to human health (Ezebilo *et al.*, 2015; Grieshofer *et al.*, 2011). According to Kulczyk *et al.* (2014), recreation is an important contributor to human well-being and an increasing number of people are spending their recreational time in forests (Burgin & Hardiman, 2012; Elands & van Marwijk, 2012). Forests are not only preferred areas for recreational purposes and related outdoor activities (Oliveira *et al.*, 2015) they are of significant importance for numerous tourist offers (Breman *et al.*, 2010) and human well-being (Füger *et al.*, 2021).

The range of possible recreational activities in forests is broad. These activities have changed from predominantly non-intensive ones, such as walking, relaxation or enjoying nature, to more intensive ones such as skiing or mountain biking (Burgin & Hardiman, 2012; Wilkes-Allemann *et al.*, 2017). The recreational function of forests not only benefits the local population but is also strongly demanded by tourists. Both winter and summer visitors appreciate Austria especially due to its numerous and varied natural areas (Arnberger *et al.*, 2016). Recreational and landscape-based tourism in forests has become more attractive not only in Austria but in many parts of Europe (Bell *et al.*, 2009; Mann *et al.*, 2010).

Another important aspect to be considered in this discussion is the high aesthetical value of forests for recreational purposes. The aesthetics of a landscape are important

from a tourism point of view because it influences the visitor experience and whether and how often people come back (Sheppard & Picard, 2006). Many studies deal with the aesthetics of mountain and agricultural regions and how they are beneficial for tourism purposes (Grunewald & Bastian, 2015; Liu *et al.*, 2023; Othman *et al.*, 2015; Schirpke *et al.*, 2013, 2016). At the same time, there are studies with a focus on forest aesthetics and their importance for the tourism sector (Kohsaka & Flitner, 2004; Ribe, 1989). Some studies are concerned with the forest scenery itself and its effect on visitors (Jensen, 1999; Oku & Fukamachi, 2006; Petucco *et al.*, 2018; Shelby *et al.*, 2005). Some studies have analysed the influence of the structure of the forest on the aesthetics and attractiveness of the forest and whether these differences are important for recreational purposes (Carvalho-Ribeiro & Lovett, 2011; Füger *et al.*, 2021; Gundersen & Frivold, 2008).

In contrast to this, the intensive usage of forests for recreational purposes can quickly become a burden due to various conflicting interests. The forest itself and wildlife are subject to ecological pressure by an increasing number of visitors. Locals and tourists who use the forests for recreational purposes are being confronted with an increasing number of people and might not find the recreational value they are looking for. According to Breman´s *et al.* (2010) an increase in conflicts among different user groups, such as hikers, cyclists, horse-riders or hunters can be observed. In addition, the owners of the forests are often faced with a lack of economic benefits from tourists and other forest visitors (Górriz-Mifsud *et al.*, 2017).

As a consequence, the increasing exploitation of forests in general and the use of forests for recreational purposes in particular, must be brought into a sustainable balance (Pröbstl & Wirth, 2011). To avoid, or at least decrease the amount of possible conflicts, it is important to acknowledge recreational functions in forest management (Ezebilo *et al.*, 2015). Especially in hunting areas and forests that are used intensively for wood production, forest recreation infrastructure should be managed properly (Wilkes-Allemann *et al.*, 2017). Conflicts arise when recreation seekers leave marked footpaths and roads (Breman *et al.*, 2010). Although forests and forest roads are used for recreational purposes, forest owners are only responsible for the conservation of forests and not for the maintenance or provision of such recreational infrastructure (Wilkes-Allemann & Ludvig, 2019).

Other variables such as the degree of "naturalness" of a forest or the environmental quality of a forest are important factors for people to enjoy spending time in the forest, but it also increases the biodiversity of the forest (Bernasconi & Schrott, 2008; Lapin *et al.*, 2021). The percentage of old trees and the presence of natural parks or protected areas in a forest are positively linked to the willingness to pay of tourists and visitors (Bartczak *et al.*, 2008; Scarpa *et al.*, 2000).

At the same time, in recent years many forest owners have decided to move from intensive forest use to multifunctional forest management, which supports the ab-

ove-mentioned increasing demand among visitors and tourists for 'naturalness'. The backgrounds for these changes in management are different. On the one hand, climate change will alter the tree species composition in the forest in the coming decades and this will result in new forest patterns (Allgaier Leuch *et al.*, 2017; Reif *et al.*, 2010; Wissenschaftlicher Beirat für Waldpolitik, 2021). A possibility to counteract this with foresight is to rely on site-appropriate tree species composition, natural regeneration and different forest structures. (Allgaier Leuch *et al.*, 2017; Wissenschaftlicher Beirat für Waldpolitik, 2021). And furthermore on the other hand increasing number of forest owners are realizing that the shift from pure stocks to mixed forests has many advantages (Grilli *et al.*, 2016). Mixed forests have a lower financial risk than pure stocks (Knoke *et al.*, 2008).

The advantages of mixed forests are both higher growth rates (Piotto, 2008) and more valuable forests in terms of habitats and biodiversity (Grilli *et al.*, 2016; Liang *et al.*, 2016). Liang *et al.*, (2016) show in their study that mixed stands have higher timber growth and are more productive than pure stocks. Mixed forests represent a higher recreational value for tourists (Grilli, 2014), although the forest itself, for example certain tree species, is often not of primary interest for visitors. It serves rather as background scenery for recreational activities such as hiking, mountain biking or other sports (Petucco *et al.*, 2018). Furthermore, forest visitors appreciate the peace and quiet, the good air and the calming environment of the forest (Bernasconi & Schrott, 2008). In other words, the forest becomes a framework for tourist activities, but it is important to note that tourists are primarily interested in the forest as a place of recreation and do not view the forest from a forestry perspective.

In forest management, based on site-ecological conditions, economic aspects are in the foreground. Economic considerations are often of higher importance than the aesthetic value of forests, which is, however, often decisive for a visit to the forest (Stölb, 2012). According to a study by Othman *et al.* (2015), an aesthetically attractive, flexible and functional landscape motivates people to visit it. A wide range of aesthetic landscape elements define an area as "relaxing" (Othman *et al.*, 2015). As an example, larch meadows are an important aesthetic element of forest-landscapes. Due to their high aesthetic quality, larch meadows are of great importance for recreation and tourism (Norz, 2014; Sailer *et al.*, 2017). One example are the Larch-forests in Vinschgau, which characterise the region in terms of landscape aesthetics and cultural history (Delvai, 2015).

Another example of a densely wooded region is the Holzwelt Murau with a forest coverage of about 70%. The dominating tree species are spruce (*Picea abies*), larch (*Larix decidua*), and swiss stone pine (*Pinus cembra*), with larch accounting for about 19% of the area. The current silvicultural management recommendations forecast an increase of larch proportion in mixed stands up to 30% (Langmaier *et al.*, 2019). This can be considered a significant change regarding the share of larch and subsequently constitutes a change of tree and structural diversity. Consequently, it is of particular interest how this change on stand and landscape level will be evaluated by tourists.

The existing and current literature shows that the state of knowledge on the relationship between forest structures and tree species composition and the interests of recreationists is still unsatisfactory, especially for spruce-larch mixed forests in the Inner Alpine Forests. This work was designed to improve the state of knowledge. The objectives of this paper are to investigate

i) how the forest in its diversity could be placed increasingly at the centre of tourism considerations and
ii) what guests think about the "tourism product" forest in general and
iii) which silvicultural strategies and measures are necessary for this.

These considerations led to the following research question: What influence does the tree species composition and forest condition have on the recreational function?

And derived from this, the following hypothesis can be made: The tree species composition is not relevant for the recreational function. Society perceives the forest only as part of nature.

2 Research and conceptual framework

This study was conducted as part of a research project in the Holzwelt Region Murau. The research project itself dealt with various aspects of forest management in this region. After the windthrow calamities of 2007/2008 (hurricane Kyrill and storms Emma and Paula), a higher proportion of larch was planted with the aim of mitigating the risks in mixed larch stands for the next decades. For this purpose, it was discussed what influence the increasing larch proportion in the stands and in the regions will have on the restoration targets. t aimed at how the share of the mixed tree species larch can be promoted. Furthermore, different aspects of biodiversity, seed production and recreation aspects in the forest were surveyed. The research project focused on a variety of objectives. These included the preservation and promotion of mixed stands of spruce, larch and swiss stone pine, the adaptability of forest ecosystems to climate change, the protection as a habitat for plants and animals, and the protection as a recreational area for the population and tourism.

For the present study, the focus was on recreation aspects:

1) forest function (in particular productive and recreational function),
2) forest composition (in particular the mixture of tree species and the structure of the stand) and
3) forest visitors and tourists an which significance (for example only work or also recreation) and characterisation (for example the forest is loud or calm) the forest should fulfil in order to support the recreational effect (figure 1).
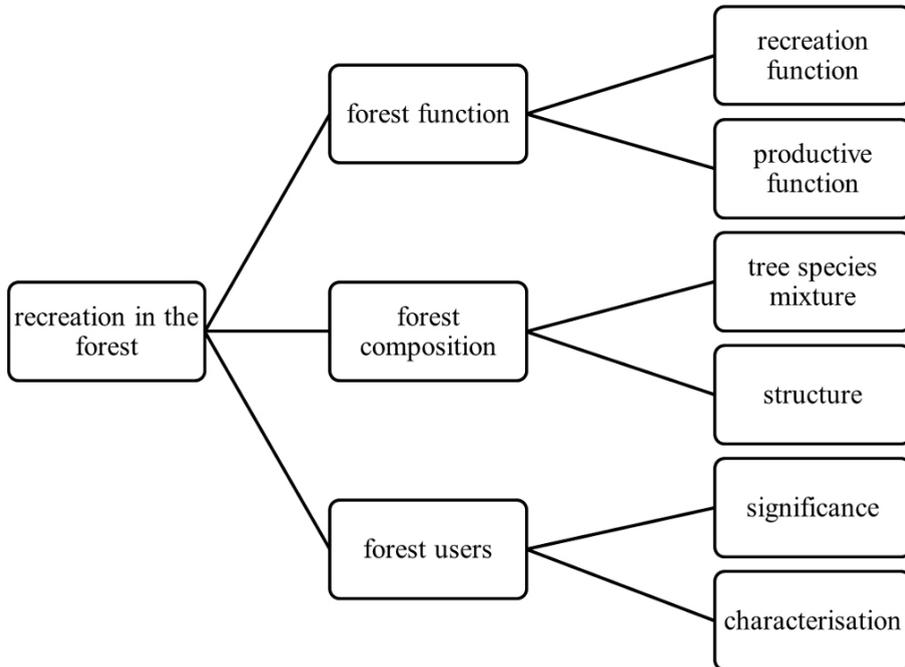
Figure 1: Conceptual framework of the study.

Abbildung 1: Konzeptioneller Rahmen der Studie.

In addition, the study focused on the fact that forests in Austria are mostly private forests and how forest owners can manage the forest under aspects of climate change and the recreational effect in order to maintain structured and tree species-rich stands. The productive function of these stands should not be disregarded. The forest has not only an important value regarding the productive function but also the recreational function and is therefore visited by different people. Therefore, questions were asked to find out what value the forest has and what attributes (significance and characterisation of the forest) people associate with the forest.

3 Material and method

3.1 Study area

The study was carried out in Austria in various hiking areas of the district of Murau in Styria (figure 2). The region is located in the eastern part of the European Alps and

is characterized by its mountainous topography. The district covers an area of 1,384 km² with a forest coverage of about 70%. The dominant tree species are *Picea abies (L.)H.Karst.* (spruce), *Larix decidua Mill.* (larch), *Pinus cembra L.* (swiss stone pine), *Betula pendula ROTH* (silver birch) and *Acer pseudoplatanus L.* (mountain maple). Typical for the forests of the region is the high proportion of *Larix decidua*, which makes the district one of the *Larix decidua* richest regions in Central Europe (Langmaier *et al.*, 2019). According to the Austrian Forest Inventory, *Larix decidua* represents 18.9% of the total stock in Murau compared to an average of 6.6% in Austria (Bundesforschungszentrum für Wald, 2009). The two main economic pillars of the region are the raw material wood (including wood processing) and tourism.
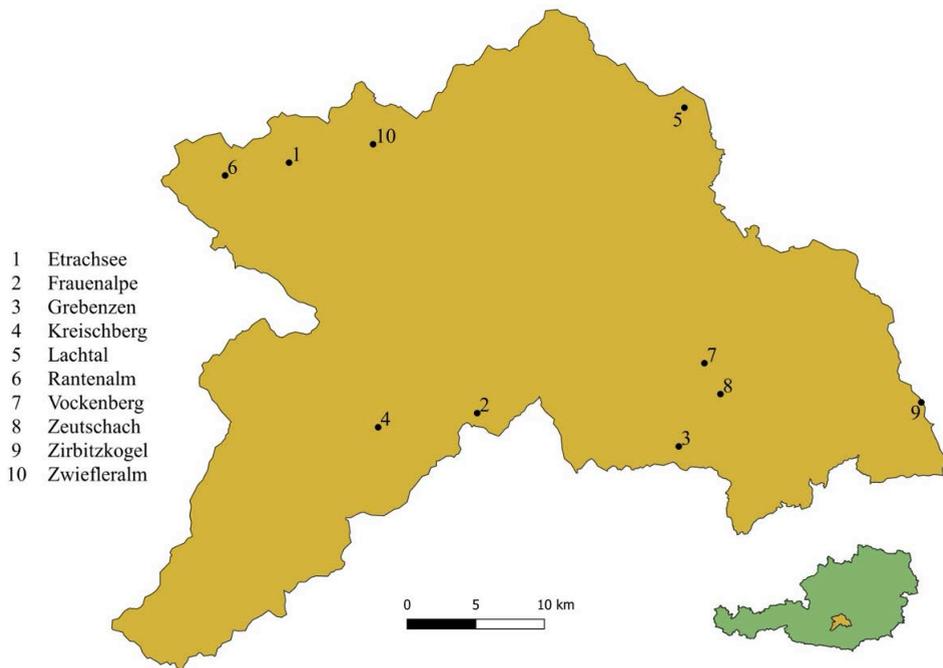

1	Etrachsee
2	Frauenalpe
3	Grebenzen
4	Kreischberg
5	Lachtal
6	Rantenalm
7	Vockenberg
8	Zeutschach
9	Zirbitzkogel
10	Zwiefleralm

Figure 2: Overview of the study area, district Murau- Styria, and the location of the survey points. The numbers represent the individual areas oft he survey.

Abbildung 2: Übersicht über das Untersuchungsgebiet, Bezirk Murau-Steiermark, und die Lage der Befragungspunkte. Die Zahlen stellen die einzelnen Gebiete dar.

3.2 Design of the survey

3.2.1 Structure of the questionnaire

A quantitative survey was carried out using a standardised questionnaire. The questionnaire was a mix of open, closed and semi-open questions (Döring & Bortz, 2016).

The questionnaire was divided into four sections, including:

(1) a short introduction with general questions about the stay in the region,
(2) questions about the use of forests for recreational purposes with special attention to the role of different types of forests and the tree species *Larix decidua*
(3) selection and evaluation of pictures
(4) questions about the respondents' socio-demographic characteristics.

1) At the beginning of the questionnaire, the project was briefly introduced and what the survey was concerned with. Furthermore, it was pointed out that the evaluation and survey would be anonymous. After this introduction, the respondents were asked about their stay in the Murau region. The questions covered the following aspects: with who they are on holiday (multiple response answer scale), for how long they are on holiday (the number of overnight stays) and in which accommodation they are staying (single response answer scale). This part of the questionnaire filtered out whether the respondent was a local or a tourist.

2) In the second part of the questionnaire different questions about recreational purposes in the forests were queried. The questions were dealing for what recreational purposes people go to the forest (multiple response answer scale), if they know the tree species *Larix decidua* (dichotomous response scale) and what they associate with this tree species (single response answer scale). The last question of this part was that people must value the forest with different attributes. This question was presented as a semantic differential. Respondents could fill in their answers using a scale.

3) In the third part, participants were asked to rank four woodscape images which illustrate different types of forests (cf. figure 3). The four images all had the same format when surveyed. Two were in portrait format and two in landscape format with the size 17 cm x 11 cm. The pictures were selected with the aim of covering various single-species and mixed stands and to find out, which type is preferred by recreation seekers for what reason. The single-species stands were stands with *Larix decidua* and the mixed stands were stands with the three tree species *Picea abies*, *Larix decidua* and *Pinus cembra*. The pictures either represented a dense or open and a single-species or mixed stand. The pictures had to be ranked from the most preferred to the least preferred. In addition, participants had to give a reason for their preferences. The pictures were real, non-manipulated images, taken in the study area under the same weather and light conditions during the summer. In general, the use of pictures for landscape research is an accepted analytical tool (Daniel, 2001; Zoderer *et al.*, 2016b).

4) The last part of the questionnaire queried socio-demographic aspects. Gender, age, place of residence, level of education and net household income were asked (single response answer scale; place of residence was to enter).
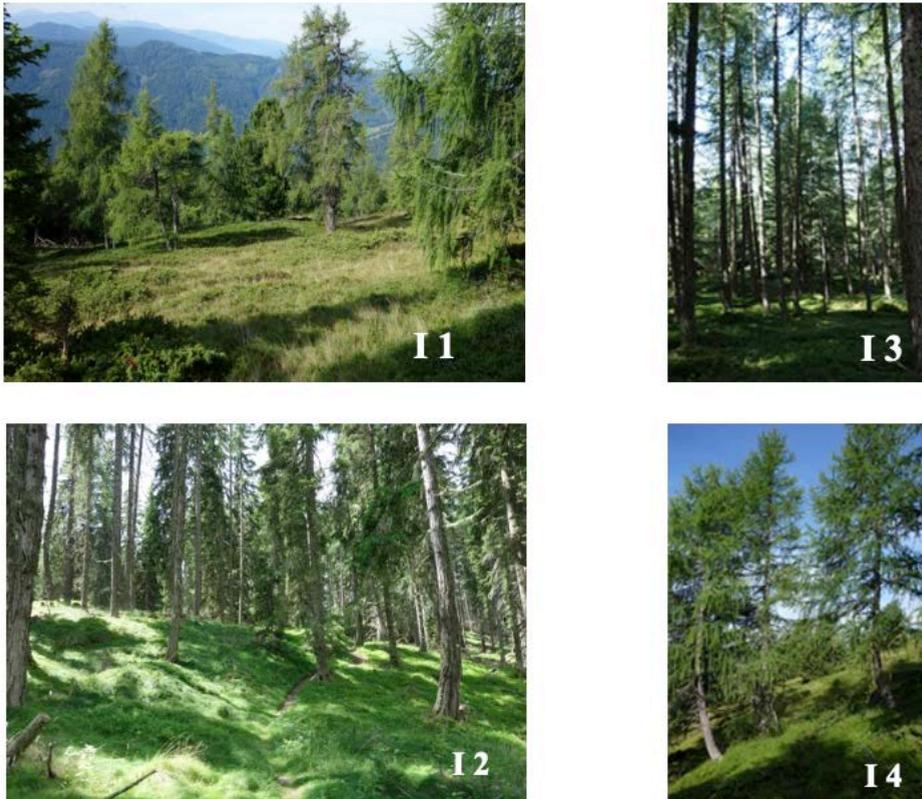

Figure 3: Visualization of the different forest types and the attributes; I1) Image 1 – Mixed stand and open crown cover, I2) Image 2 – Mixed stand and closed crown crown cover, I3) Image 3 – Single-species stand and closed crown cover, I4) Image 4 – Mixed stand and closed crown cover.

Abbildung 3: Darstellung der verschiedenen Waldtypen und ihrer Eigenschaften; I1) Bild 1 – Mischbestand und offenes Kronendach, I2) Bild 2 – Mischbestand und geschlossenes Kronendach, I3) Bild 3 – Reinbestand und geschlossenes Kronendach, I4) Bild 4 – Reinbestand und geschlossenes Kronendach.

3.2.2 Implementation of the survey

The survey was conducted in 10 popular hiking areas in the region of Murau. The selected forest types in these hiking areas represent a typical picture of the region

(figure 2). It was important to interview people directly in the forest under the assumption that they are recreation seekers in the forest. The participants were selected randomly and asked to complete the questionnaire ("Paper Pencil" survey). No questionnaires were given to children (Age from 0 to 13 years). Everyone who was encountered at one of the survey locations during the survey period was asked to fill out a questionnaire. The participants completed the questionnaire on their own and approached the interviewers only in case of questions and uncertainties.

Data sampling took place between July 24th and August 13th 2017. Of these 21 days, interviews could be made on 17 days. On the four days where no survey took place, the weather was rainy or thundery and not suitable or too dangerous for surveys in a mountain and hiking region. The minimum requirement set was to conduct questionnaires on at least 14 days and to interview at least 100 women and 100 men. The weather in the study area was on these 17 days stable and sunny. This time was chosen for several reasons. Firstly, all trees are fully developed at this time. Especially in a region with a high proportion of *Larix decidua*, it is important to take care not to influence the respondents subjectively. In autumn, the needles of the larch turn a bright yellow-orange colour. This natural spectacle is beautiful to observe, but it influences the respondents because they pay special attention to the larch and disregard other tree species. After discolouration, the larch loses its needles and is needleless from winter into spring. This again represents an influence for the respondents to believe that the forests are diseased or not intact. At the interview time *Larix decidua* was fully developed and juicy green. Therefore, a time was chosen when all tree species were fully developed from the tree physiology. The survey took place during daytime from 7 am to 5 pm.

3.3 Data processing and analyses

Data were analysed with IBM SPSS Statistics version 24 and Microsoft Excel 2016 software. Descriptive statistics, cross tables, Chi-square tests, Mann-Whitney-U-tests and t-tests were used and calculated.

The differences in recreational purposes between women and men as well as between local and tourists are calculated using the Pearson Chi-square test. To get an idea of which characteristics the respondents attribute to the forest, a semantic differential was created. Apart from the graphical processing, which was done in Excel, an independent t-test was calculated for the statistical evaluation. An explorative factor analysis was done to make the large number of items collected in the semantic differential, which were necessary to fully capture the construct, tangible via a corresponding dimensional reduction and subsequent index formation (Backhaus *et al.*, 2021). After this we did a reliability analysis to determine the Cronbach's Alpha. And in a last step we calculated the index (mean value) to be able to derive the ranking of

importance for recreationists.

The Bradley-Terry-Luce model (hereinafter BTL-model) was used to evaluate the order of the images. The participants had to rank four images illustrating different forest stands. The aim was to get an idea of the preferred type of forest for leisure purposes. Based on the ranking of the images, the BTL-model was used to calculate which type of forest is preferred by locals and tourists. The ranking of the images was tested by using Kendall's concordance analysis. A pairwise comparison of the images was performed.

Mann-Whitney-U-tests were used twice, first to determine the differences between male and female respondents and second between tourists and locals regarding the type of forests and recreational activities. In addition, the Mann-Whitney-U-test was used to analyse whether the choice of forest correlated with recreational activities respondents were engaged in. In this study, the primary interest was to investigate whether men and women, or tourists and locals, rate the questions asked differently. Regardless of the fact that age and salary were not of interest, the data was examined in this context and no correlation was found.

4 Results

4.1 Survey sample

Out of 342 questionnaires, 338 were completely filled out in this study. This is a response rate from 98,8%. Table 1 gives an overview of some classification features. 245 of the interview partners were from Austria, 56 from Germany, 22 from the Netherlands and 15 from other countries. Consequently, 71% of the tourists surveyed came from Austria and 29% were from abroad. All participants from the district of Murau and the neighbouring districts (Tamsweg, St. Veit, Murtal and Liezen) were considered as locals. 33% of the tourists visited Murau for the first time. 26 % of the tourists are regular guests and visit Murau almost once a year. On average, tourists stayed 7.2 nights in the region (min. 1 night; max. 28 nights).

The participants included 150 (44.4%) women and 180 (53.3%) men. 8 people did not state their gender. The respondents were between 14 and 82 years old, with an average age of 49 years. The majority of respondents were visiting with their partner (41.3%). 36.3% were accompanied by their children or other family members and 5.4% travelled on their own.

Table 1: Overview of classification features.

Tabelle 1: Überblick über die Klassifizierungsmerkmale.

Overview of classification features		Female		Male		not specified	
		Local	Tourist	Local	Tourist	Local	Tourist
		47	103	50	130	1	7
Age in years	mean value	41,7	49,2	51,0	51,3	45,0	50,0
Current state of residence	not specified	0	1	0	1	0	0
	Australia	0	1	0	0	0	0
	Austria	47	64	50	81	1	2
	Belgium	0	0	0	1	0	0
	France	0	0	0	1	0	0
	Germany	0	24	0	28	0	4
	Hungary	0	3	0	2	0	0
	Italy	0	1	0	1	0	0
	Latvia	0	1	0	0	0	0
	Netherlands	0	8	0	13	0	1
	Slovenia	0	0	0	1	0	0
	USA	0	0	0	1	0	0
Where did you stay?	De Luxe Class	0	1	0	0	0	0
	First Class	0	14	0	11	0	0
	Comfort class	1	22	0	35	0	3
	Standard	0	46	0	52	0	3
	Accommodation with family/friends or relatives	0	11	0	16	0	1
	At home - Local	46	8	50	13	1	0
What is your highest completed education or training?	Compulsory school leaving certificate	0	0	0	1	0	0
	Apprenticeship and apprenticeship certificate	16	17	24	35	0	1
	School leaving certificate without high school graduation	5	20	11	12	1	0
	School leaving certificate	17	26	9	34	0	1
	University degree	9	39	6	47	0	4

4.2 Recreational activities and forest perceptions

The first step was to investigate the motives for a stay in the forest. The most popular activities in the forest are mainly recreational activities with low intensity such as hiking (97.6%), relaxing (72.4%), enjoying the nature (68.5%) or walking (43.6%). Recreational activities with high intensity would be for example mountain biking, climbing and skiing (table 2). The data show that the respondents actively use the forest for recreation and that the recreational activities are broad, ranging from more intensive to not-intensive recreational activities. Table 2 illustrates the differences between female and male respondents and between locals and tourists in terms of recreational purposes. There are significant differences between female and male respondents in the following activities: rest and relaxation, walking, collecting berries and mountain biking. For the other activities such as hiking, enjoying nature, collecting mushrooms, skiing climbing and hunting, no significant difference could be found between the recreational purposes preference of women or men. Among locals and tourists there is a significant difference in the activity of collecting mushrooms. Moreover, there are significant differences in the activities of hiking and collecting berries and highly significant differences in the activities of skiing and hunting. All mentioned activities are mainly practiced by locals. Among the interviewed tourists, none uses the forest for hunting.

Table 2: Differences in recreational purposes between women and men as well as between locals and tourists [n = 330].

Tabelle 2: Unterschiede in der Freizeitgestaltung zwischen Frauen und Männern sowie zwischen Einheimischen und Touristen [n = 330].

Recreational purposes	Number of respondents selecting this purpose	Female	Male	p-value	Local	Tourist	p-value
Hiking	322	96%	95%	0.66	90%	98%	**0.00**
Enjoying the nature	239	77%	65%	0.02	67%	72%	0.39
Rest and relaxation	226	74%	61%	**0.01**	65%	68%	0.70
Walking	144	50%	36%	**0.01**	54%	38%	0.06
Collecting mushrooms	122	41%	33%	0.11	49%	31%	**0.02**
Skiing	88	28%	23%	0.33	40%	20%	**0.00**
Collecting berries	59	25%	12%	**0.03**	49%	31%	**0.00**
Mountain biking	49	10%	18%	**0.04**	19%	13%	0.10
Other activities	36	9%	12%	0.49	15%	9%	0.08
Climbing	19	7%	4%	0.38	7%	5%	0.44
Hunting	13	2%	6%	0.10	12%	0%	**0.00**

Figure 4 illustrates the semantic differential based on characteristics respondents attribute to the forest. The graph illustrates a clear pattern of how respondents perceive the forest. There are only minor differences between locals and tourists and between female and male respondents, which is recognisable because the individual icons are close to each other. When choosing the attributes, it is obvious that the forest is characterised on the one hand as quiet, slowly relaxing. On the other hand, the forest can be used for fun, play and movement. The forest is characterised as something exciting, as adventure. The forest was not characterised with negative attributes. This diverse positive characterisation is reflected in the diverse use of forests. Table 3 illustrates the characteristics with a significant difference between women and men as well as the mean for women and men. Between locals (mean, 0.55) and tourists

(mean, 1.27) there is a highly significant difference (p-value, 0.00) in the characteristics adventure (more tourists) and everyday life (more locals). All other characteristics indicate no statistically significant differences between locals and tourists.
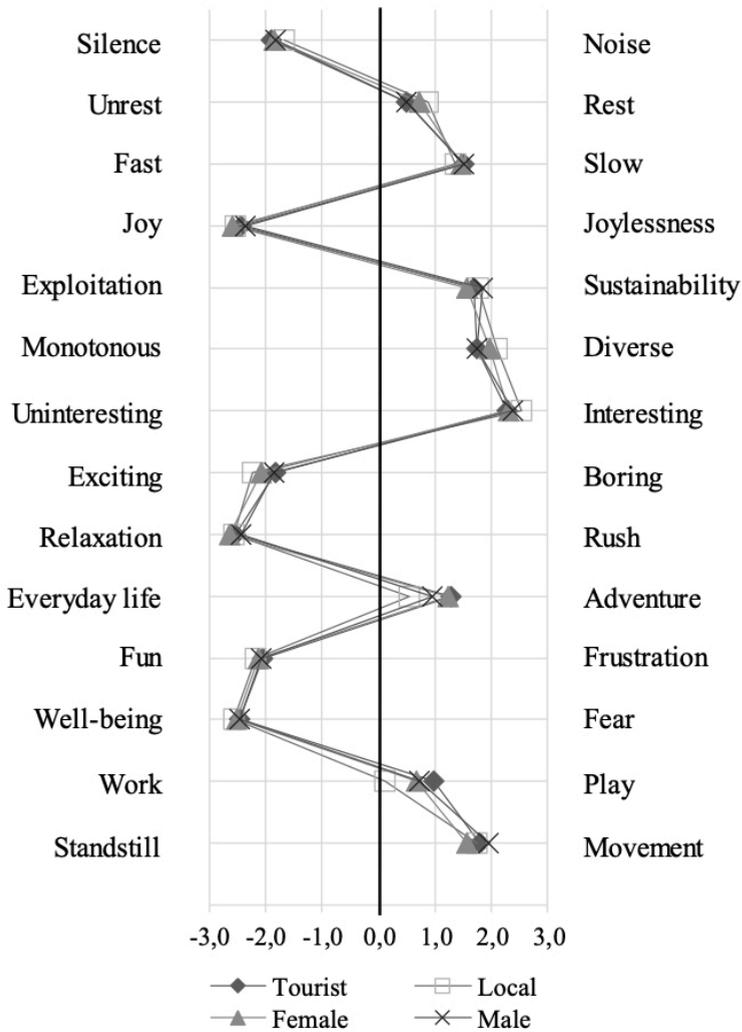

Figure 4: Semantic differential in which the characteristics of the perception of a forest are presented according to women, men, locals and tourists.

Abbildung 4: Semantisches Differential, in dem die Merkmale der Wahrnehmung eines Waldes nach Frauen, Männern, Einheimischen und Touristen dargestellt sind.

Table 3: Mean value and statistical significance of the characteristics of how a forest is perceived between men and women.

Tabelle 3: Mittelwert und statistische Signifikanz der Merkmale wie ein Wald empfunden wird zwischen Männern und Frauen.

Comparison	Sig.	Mean	
		Female	Male
Silence-Noise	0.55	-1.85	-1.83
Unrest-Rest	0.82	.71	.50
Fast-Slow	0.56	1.47	1.51
Joy-Joylessness	**0.02**	**-2.60**	**-2.36**
Exploitation-Sustainability	**0.03**	**1.56**	**1.85**
Monotonous-Diverse	0.33	1.98	1.75
Uninteresting-Interesting	0.32	2.31	2.38
Exciting-Boring	0.10	-2.07	-1.84
Relaxation-Rush	**0.01**	**-2.63**	**-2.44**
Everyday life-Adventure	0.47	1.23	0.95
Fun-Frustration	0.97	-2.13	-2.07
Well-being-Fear	0.68	-2.50	-2.47
Work-Play	0.51	0.66	0.74
Standstill-Movement	**0.00**	**1.58**	**1.95**

With the help of an explorative factor analysis, the variables of the semantic diffe-rential, which strongly correlate are summarized into four factor groups (first factor group: "impression" (Cronbachs Alpha 0.625), second factor group "forest image" (Cronbachs Alpha 0.592), third factor group "activity"(Cronbachs Alpha 0.470), fourth factor group "motion" (Cronbachs Alpha 0.559). One variable, namely movement and standstill, could not be assigned to any factor group (table 4). The importance of the factor groups can be derived from the indexation. The weakest Cronbach's alpha was calculated for the factor group "activity". The highest priority was calculated for the factor group "impression"with an average index of 2.25. The factor group "forest image" with an average index of 1.97 represents a similar priority. Finally, the factor groups "motion" with an average index of 1.04 and "activity" with an average index of 0.90 represent a similar priority. The factor group "impression" (relaxation, well-being, fun, silence ...) represents the most relevant characteristics of the forest for visitors, whereas the factor group "activity" (play, adventure ...) represents the most irrelevant characteristics of the forest for visitors. For this part of the survey, it can be summarised for the two factors with the highest priority that the factor "impression" had the greatest importance. It mainly comprised characteristics of the forest that were linked to a personal impression and feeling of oneself. In other words, how the effect of the forest affects personal feeling. The factor "forest image", on the other hand, mainly included the characteristics that described the forest and had nothing to do with human perception.

Table 4: Explorative factor analysis for the semantic differential, in which the characteristics of how a forest is perceived are listed.

Tabelle 4: Explorative Faktorenanalyse für das semantische Differential, im welchen die Merkmale wie ein Wald empfunden wird, dargestellt sind.

Rotated component matrix[a]					Name of factor group	Index
	component					
	1	2	3	4		
Rush_Relaxation	.69				Impression	2.25
Fear_WellBeing	.68					
Frustration_Fun	.59					
Noise_Silence	.55					
Boring_Exciting	.55					
Joylessness_Joy	.47					
Interesting_Uninteresting		.75			Forest image	1.97
Diverse_Monotonous		.74				
Sustainability_Exploitation		.58				
Play_Work			.77		Activity	0.90
Adventure_EverydayLife			.75			
Movement_Standstill			.40		-	-
Slow_Fast				.81	Motion	1.04
Rest_Unrest				.79		
Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization.[a]						
a. The rotation has converted into 5 iterations.						

4.3 Forest stand preferences

In this study, four images with different forest attributes were used to determine the preferred type of forest for recreational purposes. As illustrated in figure 5, image 1 (estimated parameter 1.244; standard deviation 0.075) is the image most often ranked in 1st place. Image 4 (estimated parameter 1.063; standard deviation 0.066) and image 2 (estimated parameter 1.052; standard deviation 0.064) are ranked second together. Image 3 (estimated parameter 0.640; standard deviation 0.053) is ranked last by most respondents. To make this result clearer, figure 6 shows the ranking for each image. Image 1 has been mentioned 154 times as the most popular forest for recreational purposes. Image 2 was ranked 104 times on place 1. Images 3 and 4 were selected 21 and 64 times respectively as the preferred types of forest. Although Image 2 and image 4 in the BTL-model were equally ranked, figure 6 shows that the selections by the respondents were different. Furthermore, image 3 was clearly voted at last place with 233 votes. The Mann-Whitney-U-test was not able to calculate a significant difference between women and men and between locals and tourists in the selection of images. The two groups prefer the same type of forests for their recreational activities.
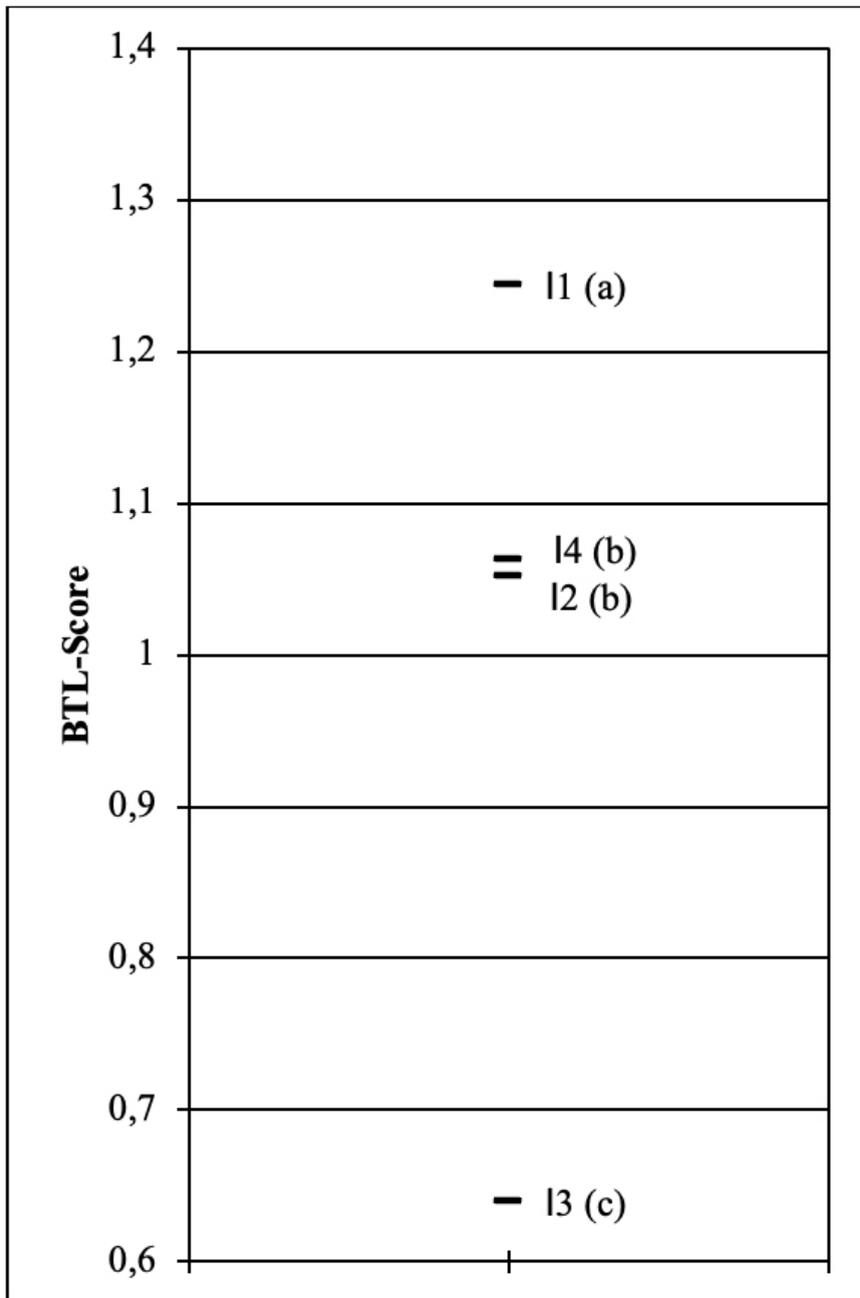
Figure 5: BTL-model [I1 = image 1; I2 = image 2; I3 = image 3; I4 = image 4].

Abbildung 5: BTL-Modell [I1 = Bild 1; I2 = Bild 2; I3 = Bild 3; I4 = Bild 4].
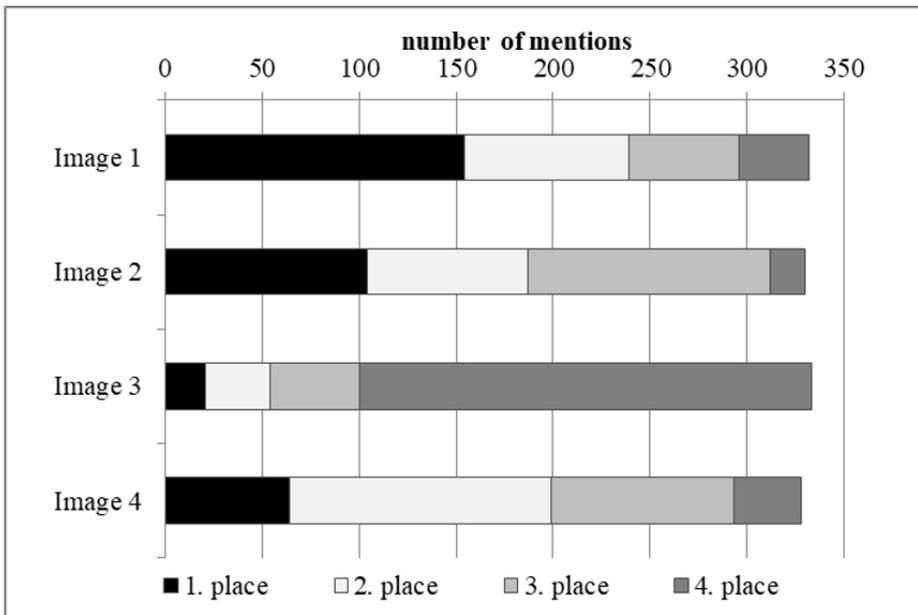
Figure 6: Ranking analysis about the four forest types that were available for selection.

Abbildung 6: Ranking-Analyse über die vier Waldtypen die zur Auswahl standen.

The preferred type of forest was the open mixed stand. The closed single tree stand was the least favoured. With regard to the preference of certain types of forests, no difference between men and women and between locals and tourists was identified. The Kendall's coefficient of concordance gave a value of 0.285 (kendall-w) for the model and was with 0.000 highly significant. The pairwise comparison of the images showed that the ranks of the images of images 1 and 2 differ significantly (0.027), of image 2 and 4 not significantly (0.178), all other pairwise comparisons of the images differ highly significantly from each other.

In addition, the Mann-Whitney-U-test was used to analyse whether the choice of forest correlated with recreational activities respondents were engaged in. There were two statistically significant results. Interviewees, who prefer picking mushrooms (with a statistical significance of 0.03) or berries (with a statistical significance of 0.05) do not prefer the closed mixed forest type in image 2. There was no statistical significance with the other types of forests and recreational activities.

5 Discussion

5.1 Recreational activities and forest perceptions

A big trend of active recreational activities, as described by Burgin and Hardiman (2012) or Wilkes-Allemann and Ludvig (2019), could not be confirmed in this study. 27% of the interviewees go skiing in forest-like areas (skiing slopes are not forest per se). Other active recreational activities, such as mountain biking, which is referred to by Wilkes-Allemann and Ludvigs (2019) study, were only mentioned by 15% of the respondents. The fact that the interviewees mainly come to the forest for passive activities is also underlined by the semantic differential. Among other things, the respondents characterized the forest as quiet, slow and restful. However, Opaschowski (1991) already pointed out that it is above all trees that shape the aesthetics and benefits of the forest when, a few decades ago, the death of the forest in Europe was a topical issue and various tree species were affected to varying degrees.

5.2 Forest stand preferences

Several studies have already shown that stands with different tree species are preferred by those seeking recreation (Edwards *et al.*, 2012b, 2012a; Filyushkina *et al.*, 2017). Furthermore, Filyushkina *et al.* (2017) and Edwards *et al.* (2012a) proved in their study that deciduous forests are preferred over coniferous forests. An investigation of this relation was not part of this study, since there is a very low proportion of hardwood in the study area (6.8%) (Bundesforschungszentrum für Wald, 2009). The difference between men and women and between locals and tourists was also not further surveyed in other available studies (Filyushkina *et al.*, 2017; Giergiczny *et al.*, 2015).

Edwards *et al.* (2012b) point out that the type of tree species itself does not have a strong influence on the selection of forests for recreational purposes. Liu *et al.* (2023) were able to find out in their study that the autumnal colour change of deciduous trees is highly attractive for tourists. In the region studied here, this can be a positive indication for promoting *Larix decidua*, as it turns golden yellow in autumn. According to Ribe (1989) moderately stocked more open stands are preferred by recreation seekers. In addition, Giergiczny *et al.* (2015) state that forests with irregularly spaced trees are preferred. They also found out that respondents prefer older stands with a vertical structure (Giergiczny *et al.*, 2015).

All mentioned results and studies lead to the discussion how forests for recreational purposes should be treated from a silvicultural point of view. For forest owners, adapted silvicultural measures can create an aesthetic type of forest both in a sustainable and touristic way. On the one hand different tree species must be used. On the other hand, open spaces are important, that the appearance of a forest does not give a too

dense and dark impression (see image 3 at figure 3) (Edwards *et al.*, 2012b, 2012a; Giergiczny *et al.*, 2015; Ribe, 1989). Füger *et al.*, (2021) discovered that pure and dense spruce forests scored worst among respondents. Forests with several tree species scored best in their survey. Especially regarding climate change, it is important to spread the risk among different tree species (Gilsa von, 2008; Spellmann *et al.*, 2011). Furthermore, it is important to structure the stand (Giergiczny *et al.*, 2015). This measure is often used in forestry as principle of adaptation for climate change (Brang *et al.*, 2016).

Both from a forestry point of view and from a touristic point of view, it is important that forest measures do not cause any damage to the stand or the soil (Edwards *et al.*, 2012b; Kaae *et al.*, 2010; Ribe, 1989). It is important to pay attention to a well thought design in intensively managed forests, such as feeling areas, forest roads and other managed features (Kaae *et al.*, 2010). In the end, it must be noted that many forest owners are currently aiming to adapt their forests to climate change. However, it certainly shows that many of these measures make the forest more inviting for recreation seekers. This double benefit is advantageous for everyone in terms of the various functions that the forest is supposed to fulfil.

6 Conclusion for tourism and forest management

When interpreting the results, it should be noted that this is a regional study. The study was conducted once in a limited period of time. For a more in-depth study, it is therefore suggested to consider other regions in order to be able to represent a broader visitor clientele and their interests. Forest management should adapt silvicultural strategies that focus on the landscape level and the stand level. Measures focusing on the landscape level may include the spatial distribution of different mixed forest and/or agroforest types (*e.g.* figure 3/image) and at the stand level they may include the conservation and promotion of different tree species through thinning and/or regeneration activities in different stages of growth (*f.e.* figure 3/image). They should be stands that are stable and healthy against the background of climate change and thus also have an aesthetic effect on recreational users.

For forest owners, adapted silvicultural measures can create an aesthetic type of forest both in a sustainable and touristic way. Especially with regard to climate change, it is essential to spread the risk among different tree species. It is important to structure the stand; this measure is often used in forestry as principle of adaptation for climate change. Open spaces are crucial for tourism, so that the appearance of a forest does not appear too dense and dark. Both from a forestry point of view and from a touristic point of view, it is important that forest measures do not cause any damage to the stand or the soil. It is important to pay attention to a well thought design in intensively managed forests, such as feeling areas, forest roads and other managed fea-

tures. The forest has many functions to fulfil that are in demand by society and thus compensation can be considered in the case of intensive use of the forest by tourism.

References

Allgaier Leuch, B., Streit, K., & Brang, P. (2017). Naturnaher Waldbau im Klimawandel. Merkblatt Für Die Praxis, 59.1, 8. https://www.dora.lib4ri.ch/wsl/islandora/object/wsl:13997

Ali, A. (2023). Linking forest ecosystem processes, functions and services under integrative social–ecological research agenda: current knowledge and perspectives. Science of The Total Environment, 892(April), 1–16. https://doi.org/10.1016/j.scitotenv.2023.164768

Arnberger, A., Grieshofer, A., Embacher, H., Pikkemaat, B., Preier, B., Ramskogler, K., Sekot, W., Stock, W., Wibmer, D., & Weinberger, W. (2016). Destination WALD – Das Handbuch zur Entwicklung forsttouristischer Angebote. Bundesforschungszentrum für Wald. Vienna.

At the human-forest interface. (2018). Nature Communications, 9(1153), 1–2. https://doi.org/10.1038/s41467-018-03586-1

Backhaus, K., Erichson, B., Plinke, W., Weiber, R. (2021). Multivariate Analysemethoden: Eine anwendungsorientierte Einführung (16. Auflage). Springer Verlag. Heidelberg.

Bartczak, A., Lindhjem, H., Navrud, S., Zandersen, M., & Zylicz, T. (2008). Valuing forest recreation on the national level in a transition economy: The case of Poland. Forest Policy and Economics, 10(7–8), 467–472. https://doi.org/10.1016/j.forpol.2008.04.002

Bell, S., Simpson, M., Tyrainen, L., Sievanen, T., & Pröbstl, U. (2009). European forest recreation and tourism a handbook (S. Bell (Ed.); 1. publ.). Taylor & Francis. London.

Bernasconi, A., & Schrott, U. (2008). Freizeit und Erholung im Wald. Grundlagen, Instrumente, Beispiele. In Umwelt-Wissen (Vol. 0819). Bundesamt für Umwelt (BAFU). Bern https://www.bafu.admin.ch/bafu/de/home/themen/wald/publikationen-studien/publikationen/freizeit-erholung-wald.html

Brang, P., Küchli, C., Schwitter, R., Bugmann, H., & Ammann, P. (2016). Waldbauliche Strategien im Klimawandel. In A. R. Plues, S. Augustin, & P. Brang (Eds.), Wald im Klimawandel. Grundlagen für Adaptationsstrategien (pp. 341–365). Bundesamt für Umwelt BAFU, Bern; Eidg. Forschungsanstalt WSL, Birmensdorf; Haupt. Bern-Stuttgart.

Breman, P., Baur, B., Bürger-Arndt, R., Hegetschweiler, T., Hunzinker, M., Picard, O., Pröbstl, U., & Wirth, V. (2010). Central Region. In U. Pröbstl, V. Wirth, B. Elands, & S. Bell (Eds.), Management of Recreation and Nature Based Tourism in European Forests (pp. 73.95). Springer. Heidelberg Dordrecht London New York https://doi.org/10.1007/978-3-642-03145-8

Bundesforschungszentrum für Wald. (2009). Österreichische Waldinventur. Österreichische Waldinventur Ergebnisse 2007/09. https://www.waldinventur.at/#/

Burgin, S., & Hardiman, N. (2012). Extreme sports in natural areas: Looming disaster or a catalyst for a paradigm shift in land use planning?. Journal of Environmental Planning and Management, 55(7), 921–940. https://doi.org/10.1080/09640568.2011.634228

Carvalho-Ribeiro, S. M., & Lovett, A. (2011). Is an attractive forest also considered well managed? Public preferences for forest cover and stand structure across a rural/urban gradient in northern Portugal. Forest Policy and Economics, 13(1), 46–54. https://doi.org/10.1016/j.forpol.2010.09.003

Daniel, T. C. (2001). Whither scenic beauty? Visual landscape quality assessment in the 21st century. Landscape and Urban Planning, 54(1–4), 267–281. https://doi.org/10.1016/S0169-2046(01)00141-4

Delvai, M. (2015). Untersuchungen zur Verjüngungsentwicklung der Europäischen Lärche (*Larix Decidua L.*) an Schutzwaldstandorten auf dem Sonnenberg im Südtiroler Vinschgau. Universität für Bodenkultur. Masterarbeit. Wien.

Döring, N., & Bortz, J. (2016). Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften (5. Auflage). Springer Verlag. Heidelberg.

Edwards, D., Jay, M., Jensen, F. S., Lucas, B., Marzano, M., Montagné, C., Peace, A., & Weiss, G. (2012a). Public preferences across Europe for different forest stand types as sites for recreation. Ecology and Society, 17(1), 1–11. https://doi.org/10.5751/ES-04520-170127

Edwards, D., Jay, M., Jensen, F. S., Lucas, B., Marzano, M., Montagné, C., Peace, A., & Weiss, G. (2012b). Public preferences for structural attributes of forests: Towards a pan-European perspective. Forest Policy and Economics, 19(June 2012), 12–19. https://doi.org/10.1016/j.forpol.2011.07.006

Elands, B. H. M., & van Marwijk, R. B. M. (2012). Policy and management for forest and nature based recreation and tourism. Forest Policy and Economics, 19(2012), 1–3. https://doi.org/10.1016/j.forpol.2012.03.004

Endreny, T., Santagata, R., Perna, A., Stefano, C. De, Rallo, R. F., & Ulgiati, S. (2017). Implementing and managing urban forests: A much needed conservation strategy to increase ecosystem services and urban wellbeing. Ecological Modelling, 360(September 2017), 328–335. https://doi.org/https://doi.org/10.1016/j.ecolmodel.2017.07.016

Ezebilo, E. E., Boman, M., Mattsson, L., Lindhagen, A., & Mbongo, W. (2015). Preferences and willingness to pay for close to home nature for outdoor recreation in Sweden. Journal of Environmental Planning and Management, 58(2), 283–296. https://doi.org/10.1080/09640568.2013.854196

Filyushkina, A., Agimass, F., Lundhede, T., Strange, N., & Jacobsen, J. B. (2017). Preferences for variation in forest characteristics: Does diversity between stands matter? Ecological Economics, 140(2017), 22–29. https://doi.org/10.1016/j.ecolecon.2017.04.010

Füger, F., Huth, F., Wagner, S., & Weber, N. (2021). Can visual aesthetic components and acceptance be traced back to forest structure? Forests, 12(6), 1–21. https://doi.org/10.3390/f12060701

García-Llorente, M., Martín-López, B., Iniesta-Arandia, I., López-Santiago, C. A., Aguilera, P. A., & Montes, C. (2012). The role of multi-functionality in social preferences toward semi-arid rural landscapes: An ecosystem service approach. Environmental Science and Policy, 19–20(2012), 136–146. https://doi.org/10.1016/j.envsci.2012.01.006

Giergiczny, M., Czajkowski, M., Zylicz, T., & Angelstam, P. (2015). Choice experiment assessment of public preferences for forest structural attributes. Ecological Economics, 119(2015), 8–23. https://doi.org/10.1016/j.ecolecon.2015.07.032

Gilsa von, H. (2008). Waldbau und Klima - was tun? In FVA einblick+ (pp. 44–45). Forstliche Versuchs und Forschungsanstalt BadenWürttemberg. Freiburg.

Górriz-Mifsud, E., Marini Govigli, V., & Bonet, J. A. (2017). What to do with mushroom pickers in my forest? Policy tools from the landowners' perspective. Land Use Policy, 63(2017), 450–460. https://doi.org/10.1016/j.landusepol.2017.02.003

Grieshofer, A., Arnberger, A., Muhar, A., & Eder, R. (2011). Wald und Tourismus – eine bislang wenig genutzte Beziehung. In Wald: Biotop und Mythos 23 (pp. 273–282). Böhlau Verlag. Wien.

Grilli, G. (2014). Economic Valuation of Forest Recreation in an Alpine. Baltic Forestry, 20(1), 167–175.

Grilli, G., Jonkisz, J., Ciolli, M., & Lesinski, J. (2016). Mixed forests and ecosystem services: Investigating stakeholders' perceptions in a case study in the Polish Carpathians. Forest Policy and Economics, 66(2016), 11–17. https://doi.org/10.1016/j.forpol.2016.02.003

Grunewald, K., & Bastian, O. (2015). Ecosystem assessment and management as key tools for sustainable landscape development: A case study of the Ore Mountains region in Central Europe. Ecological Modelling, 295(2015), 151–162. https://doi.org/10.1016/j.ecolmodel.2014.08.015

Gundersen, V. S., & Frivold, L. H. (2008). Public preferences for forest structures: A review of quantitative surveys from Finland, Norway and Sweden. Urban Forestry and Urban Greening, 7(4), 241–258. https://doi.org/10.1016/j.ufug.2008.05.001

Jensen, F. S. (1999). Forest recreation in Denmark from the 1970s to the 1990s. In The Research Series (Vol. 26, Issue 26). Danish Forest and Landscape Research Institute. Hørsholm. https://sl.ku.dk/rapporter/forest-landscape-research/FLR_26_1999.pdf

Johann, E. (2004). Soziale und kulturelle Dimensionen einer nachhaltigen Waldwirtschaft: Neue Chancen für die Forstgeschichte in Europa? | Social and cultural aspects of sustainable forest management: a chance for forest history in Europe? Schweizerische Zeitschrift Fur Forstwesen, 155(8), 338–344. https://doi.org/10.3188/szf.2004.0338

Kaae, B. C., Pröbstl, U., Wirth, V., Bell, S., McCormack, A., & Birgit, E. (2010). Good Practice in European Recreation Planning and Management. In Management of Recrea-

tion and Nature Based Tourism in European Forests (pp. 175–285). Springer. Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-03145-8

Knoke, T., Ammer, C., Stimm, B., & Mosandl, R. (2008). Admixing broadleaved to coniferous tree species: A review on yield, ecological stability and economics. European Journal of Forest Research, 127(2), 89–101. https://doi.org/10.1007/s10342-007-0186-2

Kohsaka, R., & Flitner, M. (2004). Exploring forest aesthetics using forestry photo contests: Case studies examining Japanese and German public preferences. Forest Policy and Economics, 6(3–4), 289–299. https://doi.org/10.1016/j.forpol.2004.03.016

Kulczyk, S., Wozniak, E., Kowalczyk, M., & Derek, M. (2014). Ecosystem Services in Tourism and Recreation. Revisiting the classification. Economics and Environment, 4(51), 84–92.

Langmaier, M., Hochbichler, E., Petzlberger, J., Huber, C., Wieser, G., Fritz, K., Schöggl, W., Dorfer, A., & Kraxner, H. (2019). Ein Leitfaden zur Bewirtschaftung – Die Lärche im Bezirk Murau. Druckhaus Thalerhof. Murau.

Lapin, K., Schüler, S., Oettel, J., Georges, I., Haslinger, R., & Benger, C. (2021). Maßnahmen Katalog – Managementindikatoren zur Erhaltung und Förderung der Biodiversität in österreichischen Wäldern. Gugler GmbH. Wien.

Liang, J., Crowther, T. W., Picard, N., Wiser, S., Zhou, M., Alberti, G., Schulze, E. D., McGuire, A. D., Bozzato, F., Pretzsch, H., De-Miguel, S., Paquette, A., Hérault, B., Scherer-Lorenzen, M., Barrett, C. B., Glick, H. B., Hengeveld, G. M., Nabuurs, G. J., Pfautsch, S., … Reich, P. B. (2016). Positive biodiversity-productivity relationship predominant in global forests. Science, 354(6309), 196–208. https://doi.org/10.1126/science.aaf8957

Liu, W. Y., Tsao, C., & Lin, C. C. (2023). Tourists' preference for colors of forest landscapes and its implications for forest landscape planning policies. Forest Policy and Economics, 147(November 2022), 1–10. https://doi.org/10.1016/j.forpol.2022.102887

Mann, C., Pouta, E., Gentin, S., & Jensen, F. S. (2010). Outdoor recreation in forest policy and legislation: A European comparison. Urban Forestry and Urban Greening, 9(4), 303–312. https://doi.org/10.1016/j.ufug.2010.06.004

Norz, C. (2014). Sukzession in Lärchenwiesen in Tirol – Der Einfluss von Bewirtschaftung und Standortsfaktoren auf den Ablauf von Sukzession. Universität für Bodenkultur. Masterarbeit. Wien.

Oku, H., & Fukamachi, K. (2006). The differences in scenic perception of forest visitors through their attributes and recreational activity. Landscape and Urban Planning, 75(1–2), 34–42. https://doi.org/10.1016/j.landurbplan.2004.10.008

Oliveira, F., Pintassilgo, P., Pinto, P., Mendes, I., & Silva, J. A. (2015). Segmenting visitors based on willingness to pay for recreational benefits: The case of Leiria National Forest. Tourism Economics, 23(3), 680–691. https://doi.org/10.5367/te.2015.0526

Opaschowski, H. W. (1991). Ökologie von Freizeit und Tourismus. VS Verlag für Sozialwissenschaften. Opladen.

Othman, N., Mohamed, N., & Ariffin, M. H. (2015). Landscape Aesthetic Values and Visiting Performance in Natural Outdoor Environment. Procedia – Social and Behavioral Sciences, 202(December 2014), 330–339. https://doi.org/10.1016/j.sbspro.2015.08.237

Petucco, C., Jensen, F. S., Meilby, H., & Skovsgaard, J. P. (2018). Visitor preferences of thinning practice in young even-aged stands of pedunculate oak (*Quercus robur L.*): comparing the opinion of forestry professionals in six European countries. Scandinavian Journal of Forest Research, 33(1), 81–90. https://doi.org/10.1080/02827581.2017.1329455

Piotto, D. (2008). A meta-analysis comparing tree growth in monocultures and mixed plantations. Forest Ecology and Management, 255(3–4), 781–786. https://doi.org/10.1016/j.foreco.2007.09.065

Pröbstl, U., & Wirth, V. (2011). Nachhaltige Waldbewirtschaftung im Naturpark Mürzer Oberland. Eigenverlag. Wien

Reif, A., Brucker, U., Kratzer, R., Schmiedinger, A., & Bauhus, J. (2010). Waldbau und Baumartenwahl in Zeiten des Klimawandels aus Sicht des Naturschutzes. BfN-Skripten, 272(1), 124. http://www.bfn.de/fileadmin/MDB/documents/service/Skript272.pdf

Ribe, R. G. (1989). The aesthetics of forestry: What has empirical preference research taught us? Environmental Management, 13(1), 55–74. https://doi.org/10.1007/BF01867587

Russ, W. (2019). Mehr als 4 Millionen Hektar Wald in Österreich. BFW Praxisinformation, 50(2019), 3–7.

Sailer, M., Baumgartner, A., & Fella, G. (2017). Regionalprogramm (REP) betreffend landwirtschaftliche Vorsorgeflächen im Planungsverband Inntal – Mieminger Plateau. Umweltbericht. Amt der Tiroler Landesregierung – Sachgebiet Raumordnung. Innsbruck.

Scarpa, R., Hutchinson, W. G., Chilton, S. M., & Buongiorno, J. (2000). Importance of forest attributes in the willingness to pay for recreation: a contingent valuation study of Irish forests. Forest Policy and Economics, 1(3–4), 315–329. https://doi.org/10.1016/s1389-9341(00)00026-5

Schirpke, U., Leitinger, G., Tasser, E., Schermer, M., Steinbacher, M., & Tappeiner, U. (2013). Multiple ecosystem services of a changing Alpine landscape: Past, present and future. International Journal of Biodiversity Science, Ecosystem Services and Management, 9(2), 123–135. https://doi.org/10.1080/21513732.2012.751936

Schirpke, U., Timmermann, F., Tappeiner, U., & Tasser, E. (2016). Cultural ecosystem services of mountain regions: Modelling the aesthetic value. Ecological Indicators, 69, 78–90. https://doi.org/10.1016/j.ecolind.2016.04.001

Shelby, B., Thompson, J. R., Brunson, M., & Johnson, R. (2005). A decade of recreation ratings for six silviculture treatments in Western Oregon. Journal of Environmental Management, 75(3), 239–246. https://doi.org/10.1016/j.jenvman.2004.12.004

Sheppard, S., & Picard, P. (2006). Visual-quality impacts of forest pest activity at the landscape level: A synthesis of published knowledge and research needs. Landscape and Urban Planning, 77(4), 321–342. https://doi.org/10.1016/j.landurbplan.2005.02.007

Spellmann, H., Albert, M., Schmidt, M., Sutmöller, J., & Overbeck, M. (2011). Waldbauliche Anpassungsstrategien für veränderte Klimaverhältnisse. AFZ-Der Wald, 11(2011), 12–19.

Stölb, W. (2012). Waldästhetik über Forstwirtschaft, Naturschutz und die Menschenseele (2. Auflage). Paperback.

Stoltenberg, U. (2009). Mensch und Wald – Theorie und Praxis einer Bildung für eine nachhaltige Entwicklung am Beispiel des Themenfeldes Wald. oekom. München.

Wilkes-Allemann, J., Hanewinkel, M., & Pütz, M. (2017). Forest recreation as a governance problem: four case studies from Switzerland. European Journal of Forest Research, 136(3), 511–526. https://doi.org/10.1007/s10342-017-1049-0

Wilkes-Allemann, J., & Ludvig, A. (2019). The role of social innovation in negotiations about recreational infrastructure in forests – A mountain-bike case study in Switzerland. Forest Policy and Economics, 100(July 2018), 227–235. https://doi.org/10.1016/j.forpol.2019.01.002

Wissenschaftlicher Beirat für Waldpolitik. (2021). Die Anpassung von Wäldern und Waldwirtschaft an den Klimawandel. Gutachten des Wissenschaftlichen Beirates für Waldpolitik. Berlin.

Zoderer, B. M., Lupo Stanghellini, P. S., Tasser, E., Walde, J., Wieser, H., & Tappeiner, U. (2016a). Exploring socio-cultural values of ecosystem service categories in the Central Alps: the influence of socio-demographic factors and landscape type. Regional Environmental Change, 16(7), 2033–2044. https://doi.org/10.1007/s10113-015-0922-y

Zoderer, B. M., Tasser, E., Erb, K. H., Lupo Stanghellini, P. S., & Tappeiner, U. (2016b). Identifying and mapping the tourists' perception of cultural ecosystem services: A case study from an Alpine region. Land Use Policy, 56(2016), 251–261. https://doi.org/10.1016/j.landusepol.2016.05.004