141. Jahrgang (2024), Heft 2, S. 111–144

Austrian Journal of Forest Science
Centralblatt für das gesamte Forstwesen

Visitors' attitudes and perceptions towards biodiversity conservation in production forests: the case study of University Forest Sailershausen in southern Germany

Besuchereinstellungen und -wahrnehmungen zur Biodiversitätserhaltung in Wirtschaftswäldern: eine Fallstudie im Universitätswald Sailershausen, Süddeutschland

Carlotta Sergiacomi[1*], Jörg Müller[2], Ruth Pickert[2], Marina Wolz[2], Alessandro Paletto[1]

Keywords: Saproxylic habitat sites, deadwood, social acceptance, questionnaire survey, Bavaria

Schlüsselbegriffe: Saproxylische Lebensräume, Totholz, soziale Akzeptanz, Umfragebögen; Bayern

Abstract

In recent years, the social acceptance of biodiversity conservation in forests is taking on increasing importance at an international level, both in the scientific community and among policy makers. In literature, many studies have investigated people's preferences for biodiversity conservation in protected areas, while there is a knowledge gap on the social acceptance of biodiversity conservation in production forests. The aim of this study is to investigate visitors' attitudes and perception towards biodiversity conservation through the creation of a Saproxylic Habitat Sites (SHSs) network in a case study in Germany (University Forest Sailershausen). To this end, a questionnaire survey was administered to a sample of 119 visitors from June to September 2023. The results show that the target of visitors is mainly composed by

[1] Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Research Centre for Forestry and Wood, Italy, p.za Nicolini 6, 38123 Trento (Italy)
[2] Field Station Fabrikschleichach, Department of Animal Ecology and Tropical Biology. Biocenter University of Würzburg, Glashüttenstr. 5, 96181 Rauhenebrach, Germany
*Corresponding author: Carlotta Sergiacomi, carlotta.sergiacomi@gmail.com

young people (under 30 years old) characterized by no or low income (66.1% of total respondents), mainly coming from Würzburg or other cities in Bavaria (86.4%). These visitors consider fauna and flora conservation and climate change mitigation as the most important ecosystem services provided by the University Forest Sailershausen. They perceive deadwood in the forest positively and assign higher aesthetic values to images of the University Forest Sailershausen with a high amount of deadwood (as within the SHSs) compared to images without deadwood. The preliminary results provided by this study can be considered a starting point for future research focused on the social acceptance of biodiversity conservation in production forests.

Zusammenfassung

In den letzten Jahren hat die soziale Akzeptanz des Schutzes der Biodiversität in Wäldern sowohl in der wissenschaftlichen Gemeinschaft als auch bei politischen Entscheidungsträgern auf internationaler Ebene an Bedeutung gewonnen. In der Literatur haben viele Studien die Präferenzen der Menschen für die Erhaltung der biologischen Vielfalt in Schutzgebieten untersucht, während es eine Wissenslücke über die soziale Akzeptanz gegenüber der Erhaltung der biologischen Vielfalt in bewirtschafteten Wäldern gibt. Das Ziel dieser Studie ist es, die Haltung und Wahrnehmung von Besuchern in einer Fallstudie in Deutschland (Universitätswald Sailershausen) hinsichtlich des Schutzes der Biodiversität durch die Schaffung eines Netzwerks saproxylischer Lebensräume (SHS = Saproxylic Habitat Sites) zu untersuchen. Zu diesem Zweck wurde von Juni bis September 2023 eine Fragebogenerhebung bei 119 Besuchern durchgeführt. Die Ergebnisse zeigen, dass sich die Zielgruppe der Besucher hauptsächlich aus jungen Menschen (unter 30 Jahren) zusammensetzt, die über kein oder nur ein geringes Einkommen verfügen (66,1 % aller Befragten) und mehrheitlich aus Würzburg oder anderen Städten in Bayern kommen (86,4 %). Diese Besucher betrachten den Schutz von Fauna und Flora und die Abmilderung des Klimawandels als die wichtigsten Ökosystemleistungen des Universitätswaldes Sailershausen. Sie nehmen Totholz im Wald positiv wahr und messen Bildern des Universitätswaldes Sailershausen mit einem hohen Totholzanteil (wie innerhalb der SHS) einen höheren ästhetischen Wert zu als Bildern ohne Totholz. Die vorläufigen Ergebnisse dieser Studie können als Ausgangspunkt für künftige Forschungen zur sozialen Akzeptanz der Erhaltung der Biodiversität in Wirtschaftswäldern dienen.

1 Introduction

Since the early 1990s, the importance of biodiversity conservation has been growing all over the world following the entry into force of the Convention on Biological Diversity (CBD) in 1993 (Ohtani, 2022). The main objectives established by the CBD

were the following (Boisvert and Vivien, 2005):

(i) defining and applying incentives for the conservation of biological diversity;
(ii) favouring the instruments and actions that promote the sustainable use of biodiversity;
(iii) implement tools and mechanisms to enable the access to biological resources and the fair and equitable sharing of the benefits arousing from their utilization.

Therefore, since 1993 biodiversity conservation has also become a priority of policy makers and not only of the scientific community (Herkenrath, 2002).

In 2012, the United Nations (UN) Conference on Sustainable Development (Rio20+) reaffirmed one of the key aspects of the previous international environmental agenda, namely the importance of recognising the "intrinsic value of biological diversity, as well as the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its critical role in maintaining ecosystems that provide essential services, which are critical foundations for sustainable development and human well-being". Consequently, Rio20+ Conference emphasized the connection between biodiversity conservation and other benefits (*i.e.* ecosystem services) provided by natural resources to society (Carrière *et al.*, 2013). In this sense, biodiversity sustaining all life processes and contributing to human health and well-being (Mace *et al.* 2010) is strictly related to the "supporting services" as defined by the Millennium Ecosystem Assessment (MEA) Report (MEA, 2005). In fact, supporting services are the benefits that ecosystems provide in order to maintain the life of other species or, in other words, those related to habitat functioning themselves (*e.g.*, soil formation, primary production, nutrient cycling). These ecosystem services can be considered transversal to the other categories (i.e., provisioning, regulating and cultural services) or as support for the production of other environmental services (De Meo *et al*., 2018). Thus, there is a mutual relationship between supporting services and biodiversity as emphasized by the global strategic plan 2011–2020 of the Aichi biodiversity targets (Harrison, 2014; Liquete *et al*., 2016).

In 2015, the 2030 Agenda for Sustainable Development has included among its 17 goals: sustainable forest management; combating desertification; halting and reversing land degradation; halting biodiversity loss (SDG15). Particularly, target 15.2 of this goal fixed for 2020 the objective to promote sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally. According to this target, biodiversity conservation is a priority in all types of forests, including those primarily intended for timber production or to achieve other objectives. In addition, the target 15.9 set another important objective for 2020: to integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts. This target has taken up what has already been stated by Rio20+ Conference on the close relationship between biodiversity and human well-being and poverty reduction.

At European level, EU 2030 Biodiversity Strategy established in 2020 is the founding pillar of the European Union (EU) policy on biodiversity and is based on the following three principles (EC, 2020):

(i) protecting and restoring nature in the EU, by consolidating a coherent and effective network of protected areas and restoring degraded habitats;
(ii) enabling a new governance framework to ensure co-responsibility and co-ownership by all relevant actors in meeting the biodiversity commitments; and
(iii) adopting a global biodiversity agenda. Then, EU 2030 Biodiversity Strategy emphasized the network approach for biodiversity conservation as-well-as the implementation of restoration interventions on degraded habitats.

In addition, the importance of involving all stakeholders is a key point to ensure efficient and effective biodiversity protection (Hermoso *et al*., 2022). Also the new EU Forest Strategy for 2030 has included protection and restoration of EU's forests to reverse biodiversity loss among its priorities. This Strategy underlined the importance of implementing dedicated actions for the production and the use of long-lived wood products, in the full respect of biodiversity objectives. As already stated by SDG15, also the new EU Forest Strategy for 2030 underlines the need to consider biodiversity conservation measures in all types of forests, even those intended for timber production.

From a practical point of view, there is a trade-off between timber production and biodiversity conservation in production forests as highlighted by many authors (Faith *et al*., 1996; Boncina, 2011; Duncker *et al*., 2012). To reconcile critical trade-offs between these two ecosystem services, integrating nature conservation measures into production forests can be a useful tool in this regard. The integration approach is characterized by several possible strategies, including the preservation of Saproxylic Habitat Sites (SHSs) also known as veteran tree islands or *îlot de senescence* (Aerts, 2013; Mason and Zapponi, 2015). SHSs are defined as small and permanently unmanaged patches capable of providing sustainable habitats for saproxylic organisms (Lachat and Bütler, 2008). A network of SHSs located in production forests is aimed at the conservation of some target saproxylic species (*e.g.*, Black woodpecker, Western barbastelle, Rosalia longicorn, European stag beetle, Hermit beetle) through the creation and maintenance of tree microhabitats. In Europe, a network of SHSs has been implemented in some countries on both a national scale (*i.e.*, Switzerland) and local scale (*i.e.*, Cansiglio in Italy, Mont-Ventoux massif and Vosges massif in France) (Rose and Callot, 2007; Lachat and Bütler, 2008; Mason *et al*., 2016). However, from the visitors' perspective SHSs may appear as the result of neglected management and even a threat to the forest ecosystem (Sacher *et al*., 2022).

In the international literature, some studies investigated people's preferences and attitudes for forest ecosystem services. Particular attention is given to the monetary assessment of ecosystem services, with regard to those services not traded on a real market, such as biodiversity conservation (Martín-López *et al*., 2007; Sagoff, 2008;

Garcia *et al*., 2011). Several studies highlighted the importance recognised to supporting services in forests (Nikodinoska *et al.*, 2015; Pastorella *et al.*, 2016a, Howley *et al*., 2011; Lupp *et al*., 2016; Ranacher *et al*., 2017). In particular, some studies focused on the perception of biodiversity conservation measures mainly in protected areas (Thu Le *et al.*, 2016; Aseres and Sira, 2020; Bhat and Sofi, 2021), while other research focused on the characteristics of forests related to natural diversity (Paletto *et al.*, 2013; Langmaier *et al.*, 2023). In addition, some studies have focused on the perception that visitors have of lying deadwood and standing dead trees (Golivets, 2011; Paletto *et al.*, 2022; Tyrväinen *et al.*, 2003). However, there is a knowledge gap on the social assessment of biodiversity conservation in forests with another priority function (*e.g.*, timber production, protection against natural hazards, tourism and recreation).

In the light of these considerations, the objective of this study is to investigate visitors' attitudes, preferences and perception towards biodiversity conservation, achieved through the creation of SHSs and the maintenance of deadwood and tree microhabitats in production forests. The study was conducted within the LIFE SPAN project (LIFE19 NAT/IT/000104) aimed at preserving saproxylic biodiversity in two production forests (*i.e.* Cansiglio Orientale Forest in Italy and University Forest Sailershausen in Germany). The present study focuses on investigating visitors' preferences and perceptions towards biodiversity conservation within SHSs in the University Forest Sailershausen in Bavaria (Germany).

2 Materials and methods

2.1 Study area

The study area is the University Forest Sailershausen (50°55'46" N, 10°44'34" E) located in the northern of Bavaria, in southern Germany (Figure 1). This study area was chosen because it is a typical broadleaved mixed forest of Central Europe heterogeneous in stand structure, age, and tree species composition, managed primarily for timber production and located within agricultural land for crop production. The area is managed by the forestry enterprise of the University of Würzburg, taking into account the principles of multifunctionality at the landscape level and the interactions between biodiversity and ecosystem functions (Müller *et al*., 2022; König *et al*., 2023).

The University Forest Sailershausen (hereinafter referred to as UFS) covers a total land area of 2,346 ha, thus divided: 2,176 ha of forest area with a growing stock of 600,000 m^3 (276 m^3 ha^{-1}) of which 547 ha are part of FFH/Natura 2000 network and the remaining 1,629 ha of production forest, 120 ha of extensively managed agricultural land, and 50 ha of human infrastructure (*i.e*., roads and paths). As for visitors, the area is mainly suitable to outdoor activities, while the presence of shops selling local products (*e.g*. food and wine or handicrafts) is quite low. The forest area consists of

74% deciduous forests and 26% coniferous forests: 10% Norway spruce, 16% pine, larch, Douglas fir, 21% European beech, 19% oak, 11% hornbeam, 19% noble hardwood (with high commercial value wood) and 4% other hardwood species. The forest management system supports old-grown trees as well as natural tree microhabitats, deadwood enrichment, rare and red list species. The focus of silvicultural treatments of the UFS management lies on old hardwood stands in very long-term regeneration periods, while maintaining the value growth on the individual stem and considering the nature conservation objectives. The group selection management (*Femelschlag* in German) is applied in order to encourage the natural regeneration of forest and at the same time to diversify the vertical stand structure. Oak species is given special consideration in all silvicultural interventions due to its outstanding economical, conservational, and cultural-historical importance.

Thus, being part of the University of Würzburg, several excursions for students take place at the UFS, for example from the Technical University of Munich, the FH Weihenstephan-Triesdorf, the Technical University of Dresden and the University of Bayreuth. Further, the UFS has a training cooperation with the Forestry School Lohr am Main. Since 2018, there is a cooperation with the Department of Animal Ecology and Tropical Biology of the University of Würzburg, where the canopy structure was experimentally enhanced in a large-scale experiment (Müller *et al*., 2023). Several Bachelor, Master and PhD theses are based on those study site at the University of Würzburg.

For 2023, the recreational-educational attendance of the site was characterized by eight field trips, with about 170 students in total, and by six forest tours with kindergarten, forestry enterprises and the population, with approximately 150 people in total. In addition, the UFS is regularly frequented by the inhabitants of neighbouring cities for leisure and recreation activities.

During the activities of the LIFE SPAN project, a network of 25 SHSs for the conservation of saproxylic species have been created on an area corresponding to 5% of the managed UFS. In the SHSs, thinning interventions, the creation of microhabitat trees and the opening of gaps of 0.15 ha have been carried out (see Figure 1). In addition, a marteloscope site – a research plot in the forest where all trees are measured and associated software are related to provide a framework for in-forest training in selection and marking (Kruse *et al*., 2023) – was developed and set-up for educational-demonstrative purposes.

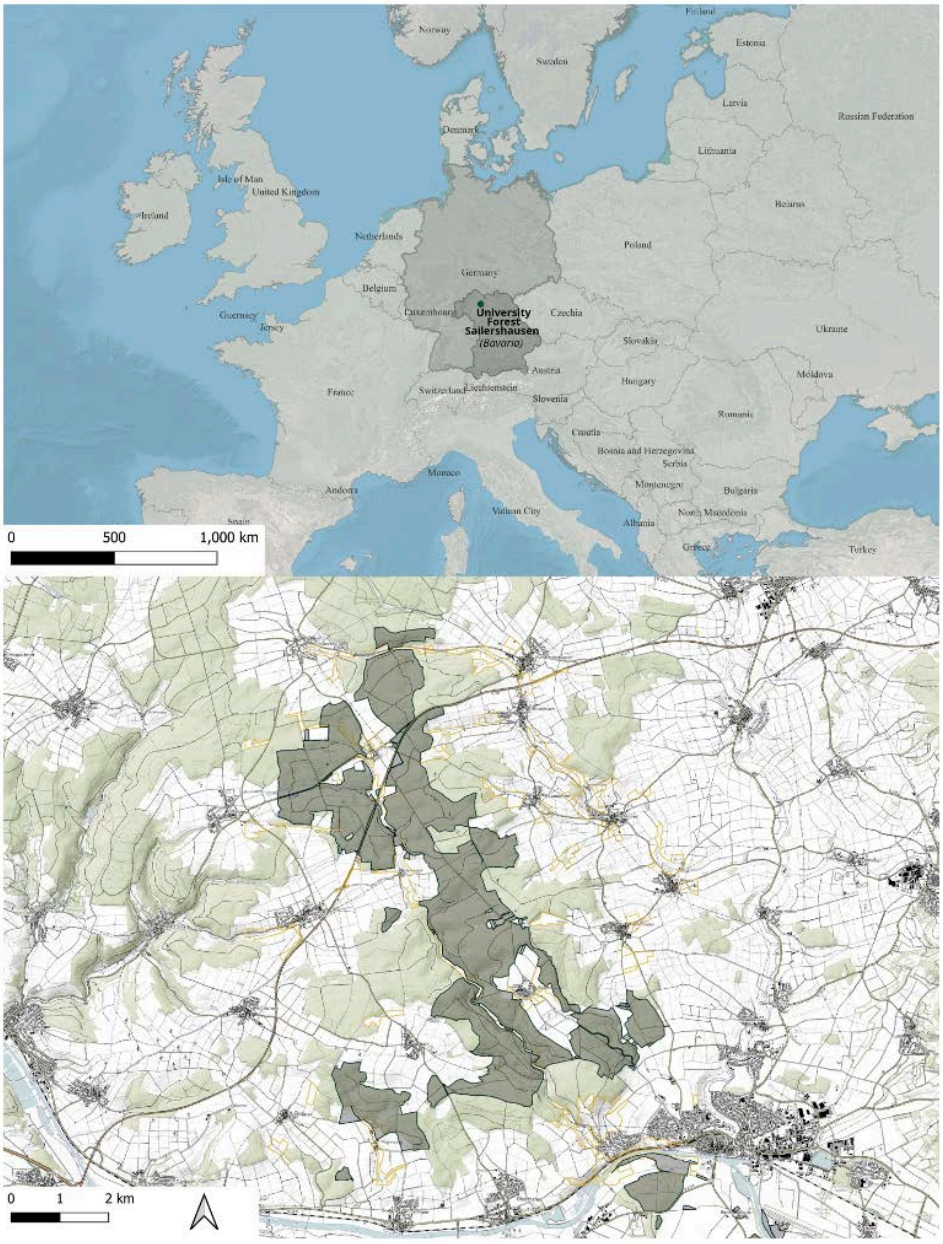


Figure 1: Location of the study area – University Forest Sailershausen (UFS) – in Bavaria (Germany).

Abbildung 1: Lage des Untersuchungsgebiets – des Universitätswaldes Sailershausen - in Bayern (Deutschland).

2.2 Research framework

The study aimed to investigate the attitudes, preferences and perceptions of visitors to the UFS was structured in three steps:

(1) preparation and pre-testing of the survey (semi-structured questionnaire);
(2) sampling and face-to-face administration of the questionnaire to a sample of visitors;
(3) statistical processing of data collected with the questionnaire.

Step 1

From early February to late April 2023, the preliminary version of the questionnaire was prepared by the research team of the LIFE SPAN project. In May 2023, the draft questionnaire was pre-tested with three students of the University of Würzburg, in order to highlight weaknesses and poorly formulated questions. After the pre-test phase, two questions have been changed to simplify them, while one question was eliminated because it was considered redundant. The final version of the questionnaire was made up of 19 questions divided in three thematic sections (see Annex 1).

In the first thematic section, the recreational use of the UFS was investigated in order to target visitors through questions concerning the characteristics of the visits (*e.g.* duration, means of transports, travel distance, costs incurred). In addition, the reasons for the visit were examined, distinguishing between a series of alternatives (*e.g.* hiking/trekking, sport activities, relaxing into the nature, *etc.*). The respondents assigned the importance of the above reasons using a 5-point Likert scale (1 not important, 2 not very important, 3 neutral, 4 important, 5 very important).

The second thematic section considered the visitors' attitudes and preferences towards the UFS. In particular, the perceived importance of the ecosystem services provided by the study area was investigated using a 5-point Likert scale (1 not important, 2 not very important, 3 neutral, 4 important, 5 very important). The ecosystem services to be evaluated have been selected on the basis of a preliminary literature review (D'Amato *et al.*, 2016; Aznar-Sánchez *et al.*, 2018; De Meo *et al.*, 2018).

After that, three images of the UFS with an increasing gradient of deadwood amount were shown to the respondents, in order to investigate their perception towards this component of forest ecosystem. Photos have not been edited and showed real views of the study area. Photo 1 shows the UFS without lying deadwood and standing dead trees, while in Photo 2 the same forest is represented with a medium-high amount of deadwood and in Photo 3 with a high amount of deadwood as within the SHS. Respondents were asked to assign their preferences from an aesthetic point of view using a 5-point Likert scale format (1 very ugly aesthetic landscape, 2 ugly aesthetic

landscape, 3 neutral aesthetic landscape, 4 pleasant aesthetic landscape, 5 very nice aesthetic landscape). Then, respondents selected one or more alternatives, indicating whether they considered deadwood as a positive or negative element for the forest ecosystem.

In the last thematic section, data concerning the socio-demographic characteristics of the respondents were collected (*e.g.*, gender, age, level of education, personal annual income, *etc.*).

Step 2

In the second step, the final version of the questionnaire was administered both to groups of organized visitors and to individual visitors to the study area (18 years old and older) between June and September 2023. The questionnaire was administered to organized groups of mainly undergraduate students and forest tours after visiting the site, while individual visitors were sampled at a survey point near the site access. Therefore, both types of visitors – individuals and organized groups – were involved in the survey with the aim of better targeting the attendance of the site. As regards the method of sample selection, participants in the organised groups were all involved, while for individual visitors, one person in two was systematically selected at the sampling points where questionnaires were administered. The respondents were asked to complete the questionnaire by themselves, even if the interviewers remained available for clarification.

Step 3

In the last step, the collected data were processed to produce the main descriptive statistics: mean, median and standard deviation (SD) for the data collected using the Likert-scale format; percentage of frequency distribution (%) for other types of question.

For the data concerning the importance of ecosystem services (Q2.1), two non-parametric tests were performed to highlight statistically significant differences between groups of respondents. In particular, the non-parametric Kruskal-Wallis test (α=0.05) was used to highlight statistical significant differences considering gender, age, level of education, income; while the non-parametric Mann-Whitney test (α=0.05) was used to point out statistical significant differences between local visitors (from Würzburg) and non-local visitors (from other German regions or abroad), and between members and non-members of environmental NGOs. The non-parametric tests were applied, rather than parametric tests, for the following two reasons: the sample size is

not large enough (119 questionnaires collected); the assumption of normality is violated (Shapiro-Wilk test: W=0.879, p<0.0001). All statistical test was performed using the XLStat 2020 software.

A Principal Component Analysis (PCA) was implemented to classify the target visitors to the UFS based on: the frequency of visits (Q1.1); the travel distance between the visitors' home and the site of visit (Q1.4); the reasons for the visit (Q1.9).

3 Results

3.1 Socio-demographic characteristics of respondents

At the end of data collection, 119 visitors to the UFS filled out all the thematic sections of the questionnaire. Table 1 shows the socio-demographic characteristics of respondents. The results showed that the sample of respondents was composed by 48.7% of females, 47.8% of males, and 3.5% of non-binary. Regarding the age, the majority of respondents were aged between 21 and 30 years old, followed by those between 31 and 40 years old and between 18 and 20 years old. The majority of respondents have a high level of education, but a low annual income. In addition, it is interesting to highlight that approximately a quarter of the respondents were members of an environmental NGOs. Considering the city of origin, the majority of respondents came from Würzburg city (37.0%) or other cities and towns of Bavaria (49.4%), while the remaining 13.6% came from other parts of Germany or other countries.

Table 1: Socio-demographic characteristics of the respondents.

Tabelle 1: Soziodemografische Merkmale der Befragten.

Variables	**Mode**	**% (*n*=119)**
Gender	Male	49%
	Female	48%
	Non-binary	3%
Age	< 20	9%
	21-30	65%
	31-40	10%
	41-50	3%
	51-60	5%
	61-70	6%
	>70	2%
Personal annual income	No income	29%
	< 15.000 €	37%
	15.000 – 30.000 €	12%
	30.000 – 45.000 €	16%
	> 45.000 €	6%
Educational level	Elementary school degree	8%
	Technical or middle school degree	10%
	High school degree	32%
	University or post-University degree	50%

3.2 Target visitors of the University Forest Sailershausen

The findings indicated that the majority of respondents declared they generally visit forests "at least once a week" (57.0%), followed by those who declared "at least once a month" (21.9%), "every day" (20.2%), and "at least once a year" (0.9%). Specifically considering the UFS, the results about the visitors' attendance showed that most of the respondents had never visited the study area before the day of the investigation (33.0%), followed by those who had been there only once in the last 12 months (22.3%). However, it is worth noting that 22.3% of the respondents were "regular" visitors who had been in the study area more than 12 times in the last 12 months. The sample actually consisted of 81.2% of daily hikers and the remaining 18.8% of tourists, who stayed in local accommodation facilities for one night (6.8%) or two or more nights (7.7%). With regards to the visit in progress, the majority of respondents stayed in the forest more than 4 hours (43.7%), followed by those who remained between 2 and 4 hours (37.8%) and those less than 2 hours (18.5%). The visitors reached the UFS mainly by car (77.3%), while the remaining arrived on foot (3.4%), by public transport (2.5%), bike (1.7%), or tour bus (15.1%). The latter were university and post-university students of Biology and Forest Science, who participated in educational excursions to the study site. Regarding the costs incurred for the visit in progress, the outcomes highlighted that a high number of visitors did not incur any costs for accommodation (88.2%), for meals (25.6%), for travel (24.1%) or for the purchase of local products (64.5%). The highest cost items were related to the travel (10.1% supported travel costs between € 11 and € 20 and 3.8% between € 21 and € 30), and to the meals (72.1% spent between € 1 and € 10). With reference to the latter cost item, visitors declared they mostly dined with a packed lunch (82.9%) and only less than 1% at a local restaurant. All cost items incurred for the visit undertaken at the time of the investigation are summarized in Table 2.

Table 2: Distribution (%) of costs incurred for today's visit to the University Forest Sailershausen.

Tabelle 2: Verteilung (%) der Kosten, die für den jeweiligen Besuch im Universitätswald Sailershausen anfallen.

Costs	None	€ 1-10	€ 11-20	€ 21-30	More than € 30
Accommodation	88.2%	2.9%	1.5%	5.9%	1.5%
Meals	25.6%	72.1%	1.2%	1.2%	0.0%
Travel	24.1%	48.1%	10.1%	3.8%	13.9%
Purchase of local products and others	64.5%	32.3%	3.2%	0.0%	0.0%

Observing the data on the reasons for visiting the study area, the results evidenced that (Table 3): education visit was the most important reason for visiting UFS with an average value of 4.07 (SD=1.97) in a scale from 1 (not important) to 5 (very important), followed by work (3.71±3.22), wildlife watching (2.87±2.25), and relaxing into the nature (2.73±2.26). Conversely, the two least important reasons were: hiking/trekking (1.95±1.50) and sport activities (1.56±1.36). Based on the high SD values, it is possible to assert that there were two groups of visitors: the first group was composed of students, researchers and professors who frequent the study site for work or educational reasons; while the second group was composed of hikers from the surrounding towns. Taking into account the socio-demographic characteristics of visitors, it is interesting to emphasize that females assigned a higher importance to relaxing into nature and wildlife watching compared to other genders, while males assigned highest importance to NWFPs collection. Moreover, young visitors (under 30 years old) emphasized the importance of hiking/trekking (average value of 2.00±1.27 for visitors under 20 years old and 2.04±1.47 for visitors between 21-30 years old); while older visitors stressed the relevance of NWFPs collection (average value of 1.82±1.50 for visitors between 31-40 years old and 1.78±1.37 between 41-50 years old). Regarding the city of origin of respondents, the results evidenced that the local visitors from Würzburg city highlighted the importance of the motivations related to sport activities (2.08±1.62) and hiking/trekking (2.13±1.36), while visitors from other German lands or abroad emphasized as the main reason wildlife watching (3.28±1.94). The main reasons of the visit both for the members and non-members of environmental NGOs were educational visit and work (4.18±1.71 and 4.22±1.78 vs. 4.00±1.92 and 3.44±2.14 respectively).

Table 3: Importance of the reasons to visit the University Forest Sailershausen in accordance with the visitors 'opinions (5-point Likert scale – from 1 not important to 5 very important).

Tabelle 3: Gewichtung der Gründe für den Besuch des Universitätswaldes Sailershausen in Übereinstimmung mit den Meinungen der Besucher (5-stufige-Likert-Skala - von 1 nicht wichtig bis 5 sehr wichtig).

Reasons	Mean	SD	Median	Min	Max
Hiking/Trekking	1.95	1.23	1	1.00	5.00
Sport activities	1.56	1.17	1	1.00	5.00
Relaxing into the nature	2.73	1.50	3	1.00	5.00
NWFP collection	1.70	1.17	1	1.00	5.00
Wildlife watching	2.87	1.50	3	1.00	5.00
Educational visit	4.07	1.40	5	1.00	5.00
Work	3.71	1.80	5	1.00	5.00

The results of Principal Component Analysis (PCA) highlighted that visitors who have travelled longer (*i.e.* greater travel distance) visited the UFS almost exclusively for an educational visit. In this group of visitors there were foreign students or students from all-over Germany. Conversely, those who most often frequented the UFS were those who did so for work reasons or to practice sport activities or hiking/trekking. In the first group there were presumably researchers from academia, while the second group probably included residents from the surrounding cities. The results of PCA are shown in Figure 2.

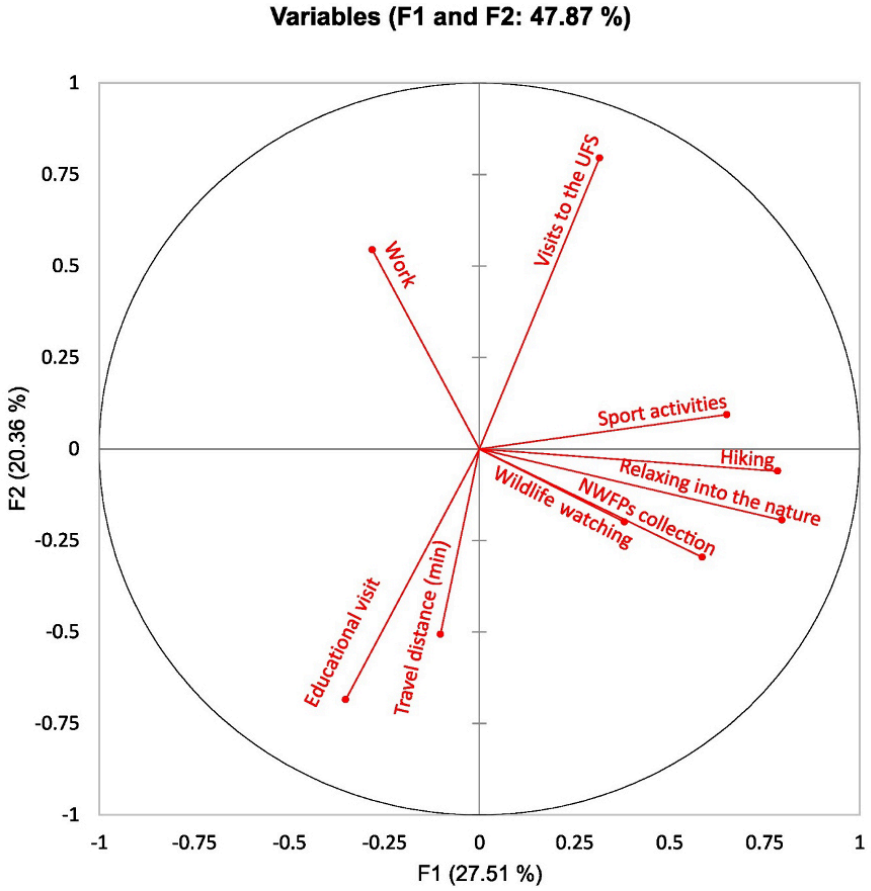


Figure 2: Results of principal component analysis (PCA) considering the frequency of visits, travel distance in minutes between the visitor's home and the site, and the reasons for the visit.

Abbildung 2: Ergebnisse der Hauptkomponentenanalyse (PCA) unter Berücksichtigung der Häufigkeit der Besuche, der Anreisezeit (in Minuten) zwischen dem Wohnort des Besuchers und der Örtlichkeit sowie der Gründe für den Besuch.

3.3 Attitudes and preferences towards the University Forest Sailershausen

The results of the second thematic section revealed that for the sample of respondents: flora and fauna conservation was the most important ecosystem service provided by the UFS with a mean of 4.34 (SD=1.19) in a scale from 1 (not important) to 5 (very important), followed by climate change mitigation (3.72±1.24) and timber and bioenergy production (3.53±1.40). Conversely, cultural and historical values were considered the least important ecosystem services provided by the study area (2.85±1.26). Observing data by socio-demographic characteristics, it is interesting to emphasise that the non-parametric Kruskal-Wallis test highlighted statistical significant differences for two ecosystem services: biodiversity (i.e. flora and fauna conservation) (p=0.049) and cultural and historical values (p=0.044). In particular, males assigned lower average values to cultural and historical values and a higher value to the biodiversity, compared to females and others. In addition, people over 40 assigned the highest values to most ecosystem services (*i.e.*, climate change mitigation, water provision, cultural and historical values), while younger people emphasized the importance of biodiversity more than other age classes. Regarding the level of education, the test findings evidenced statistically significant differences for biodiversity (p=0.011) and climate change mitigation (p=0.018). In particular, visitors with an elementary school degree assigned a lower importance to these two ecosystem services compared to the other three groups. Finally, it is interesting to highlight that visitors with higher incomes assigned greater importance to timber and bioenergy production, recreation, and climate change mitigation compared to those with the lowest incomes, which assigned greater importance to biodiversity conservation. The non-parametric Mann-Whitney test showed statistically significant differences between local and non-local visitors only for timber and bioenergy production (p<0.0001), highlighting that foreign visitors assigned higher importance to this ecosystem service compared to local visitors. The outcomes of the test revealed statistically significant differences between members and non-members of environmental NGOs only for biodiversity (p=0.011). Contrary to what was expected, non-members assigned a higher importance to biodiversity than members of environmental NGOs. The importance of ecosystem services by socio-demographic characteristics of respondents are presented in Table 1 of the Annex 2.

Regarding the visitors' perception towards deadwood in forest landscapes, the results highlighted that the preferred image of the UFS was the one represented in Photo 3 with a mean value of 4.05 (SD=1.10) in a scale from 1 (very ugly aesthetic landscape) to 5 (very nice aesthetic landscape), followed by Photo 2 (3.88±1.02) and Photo 1 (3.48±1.32). The non-parametric Kruskal-Wallis test showed statistically significant differences among the visitors' preferences towards the three photos (p=0.006). Therefore, the sample of visitors gave a preference to forest landscapes with the presence (high and medium) of deadwood rather than those without deadwood (Figure 3). Considering the socio-demographic characteristics of respondents (see Table 2 of the Annex 2), the results showed that females prefer Photo 1 and Photo 2, characterized

by the almost total absence or low quantity of deadwood, while males assigned a higher value to Photo 3, characterized by a high deadwood amount. However, the non-parametric Kruskal-Wallis test showed statistically significant differences only for the Photo 1 (p=0.004). Observing the data by age, the results did not show a clear trend, as young people (less than 21 years old) assigned the highest values to both Photo 1 and Photo 3, while people over 40 gave a preference for Photo 2. Also for the level of education no statistically significant differences resulted, with a slight preference of people with high school degree for the photos without or with low amount of deadwood (Photo 1 and 2), and of people with middle school degree for the photo with high amount of deadwood (Photo 3). With regard to the city of origin, the findings revealed that for all three photos local people assigned a lower preference compared to people from other parts of Germany or foreigners. The non-parametric Mann-Whitney test confirmed the absence of statistically significant differences between these two groups of respondents. As expected, people who were not members of environmental NGOs assigned a higher preference to Photo 1 compared to the members (mean value 3.61 vs. 3.35), while members of environmental NGOs assigned higher preferences to Photo 2 (3.92 vs. 3.84) and Photo 3 (4.23 vs. 3.68). However, the non-parametric Mann-Whitney test showed no statistically significant differences between the two groups for all three photos. Taking into account the income of the respondents, the results evidenced that people with a higher income assigned a preference for the photos with a low and high amount of deadwood (Photo 2 and 3) compared to the other categories, while people with a lower income emphasized the aesthetic value of forest landscape without deadwood (Photo 1). However, the non-parametric Kruskal-Wallis test showed no statistically significant differences for all three photos. Finally, the findings revealed that the majority of respondents highlighted the positive roles of deadwood in forest landscapes for fauna conservation (31.7% of total responses), for flora conservation (23.0%), and for soil fertilization (20.8%). Conversely, only a minority of respondents emphasized the negative role of deadwood in forests related to: the risk of forest fires (4.2%), the risk of harmful insects (5.1%), or aesthetic appreciation (2.0%). Overall, these results showed that visitors perceived deadwood in forests more positively than negatively from an aesthetic-visual point of view and functions performed.

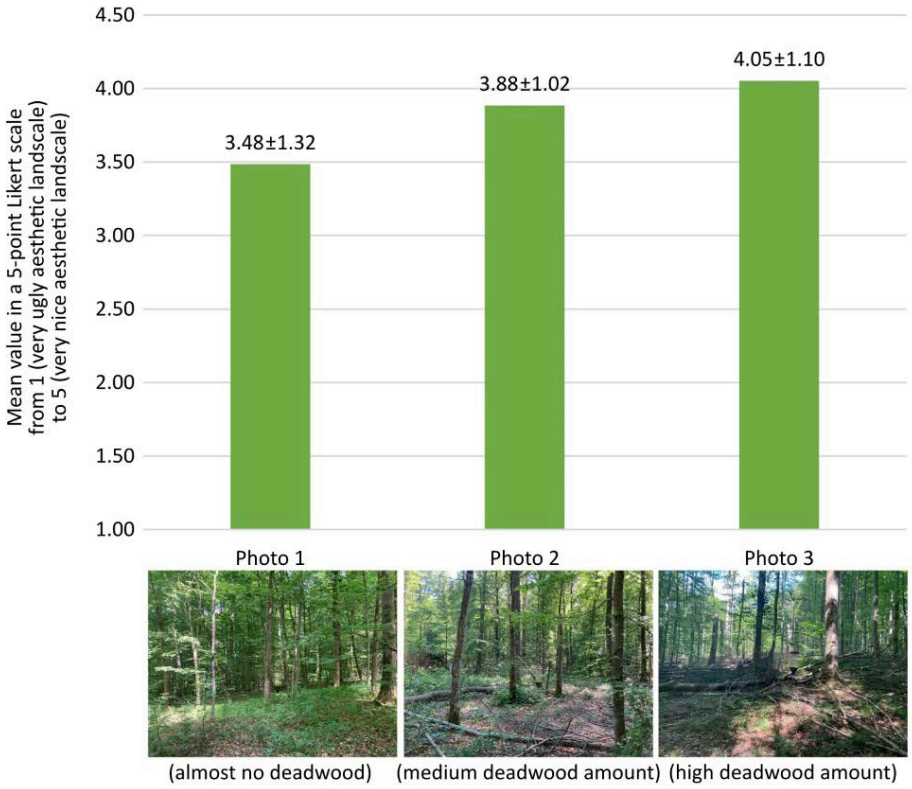


Figure 3: Visitors' perception (mean±standard deviation) towards deadwood in forest landscapes (5-point Likert scale – from 1 very ugly aesthetic landscape to 5 very nice aesthetic landscape).

Abbildung 3: Wahrnehmung der Besucher (Mittelwert±Standardabweichung) hinsichtlich dem Totholz in Waldlandschaften (5-stufige Likert-Skala – von 1 sehr unästhetische Landschaft bis 5 sehr schöne ästhetische Landschaft).

4 Discussion

4.1 Visitors' characteristics

First of all, the results showed that visitors of the UFS are mainly represented by young people (under 30 years old) characterized by no or low income under € 15,000 (66.1%), principally coming from Würzburg or other cities in Bavaria (86.4%). Besides, the PCA results highlighted that the sample is divided into three main groups based on visit frequency, travel distance, and reasons for visit:

i) visitors who come from far away for the first time to the site for educational visit reasons;
ii) visitors who come from nearby and regularly frequent the site for work reasons;
iii) visitors who come from nearby and often frequent the site for sporting or hiking reasons.

Presumably the first group includes foreign and non-foreign students, while the second group includes university researchers and technicians, while the third group includes inhabitants of the surrounding cities. The visitors of the sample declared that they generally frequent the forests every day (20.2%) or at least once a week (57.0%), while the "occasional" visitors to the UFS (*i.e.*, at least once a month and at least once a year) are 22.8% of the total. In international literature, Jarský *et al.* (2022) estimated that 70.5% of the Czech people went to the forest at least once a month in 2020 and 56.7% in 2019, while the number of people who could not visit the forest was 7.8% in 2020 and 12.8% in 2019. In a study conducted in Slovenia, Torkan and Krašovec (2019) showed that the majority of respondents visit forests weekly (approximately 28% of the total) or several times a week (approximately 26% of the total), while about 24% of respondents rarely visit forests. In addition, the results revealed that males showed a higher preference for sites with high deadwood amount. This result is confirmed by other studies, such as that of Tyrväinen *et al.* (2003), who found that males tend to approve the presence of dead trees and deadwood on the ground more easily than females, and that of Paletto *et al.* (2022), who identified a greater preference for deadwood by males due to a higher knowledge of the issue. Therefore, the sample of this study is comparable with what is reported by other studies in the literature. Regarding the reasons for visiting the UFS, the third group of visitors is the one most in line with the European literature which highlights hiking and relaxing in the nature as main reasons (Paletto *et al.*, 2017; Langmaier *et al.*, 2023). However, it is important to emphasize that the reasons for visits are strictly connected to the type of forest, proximity to urban areas, and the internal characteristics of a site.

4.2 Importance of forests' ecosystem services

Secondly, the sample of respondents emphasized the importance of supporting and regulating ecosystem services (*i.e.*, flora and fauna conservation and climate change mitigation) provided by UFS compared to the other categories of ecosystem services. This result confirms what has been reported by other studies conducted in other European forests. In particular, numerous studies focus on the systematic collection of data in large protected areas (Lupp *et al.*, 2016), where the value of forest ecosystem services is usually recognized by visitors. For example, in Sweden, Nikodinoska *et al.* (2015) found that the supporting services (habitat and species diversity, net primary production, and soil formation) are the most important ecosystem services provided by Abisko National Park in accordance with the visitors' opinions. Pastorella *et al.* (2016a) highlighted that in accordance with people's opinions the most import-

ant ecosystem services provided by Calabrian forests in southern Italy are biodiversity conservation, followed by landscape conservation and air quality improvement. However, in the literature there are few studies that investigate the perception of users of forest ecosystem services provided by unprotected areas, as has been done in this study. For example, in Italy, De Meo *et al.* (2011) and Paletto *et al.* (2014) highlighted the importance of regulating services (*i.e.* natural hazards protection) and cultural services (*i.e.* recreation and landscape aesthetic) provided by forests in accordance with the stakeholders' opinions. In a study conducted in Slovakia, Dobšinská and Sarvašová (2016) underlined that for the general public the two most important ecosystem services provided by Slovakian forests are recreation (approximately 80% of respondents) and non-wood forest products (12.2%). In Ireland, Howley *et al.* (2011) found that the role of forests to ensure a broad variety of plants and animals is the most important for society, while the role of forests in climate change mitigation through carbon dioxide (CO_2) sequestration has been found to be the most important ecosystem service in Germany (Lupp *et al.*, 2016) and Austria (Ranacher *et al.*, 2017). For an exhaustive and up-to-date meta-analysis of the social perception of ecosystem services provided by forests in Europe see Ranacher *et al*. (2020).

4.3 Perception of deadwood

Thirdly, the results of the present study highlighted that the visitors of the UFS have a positive perception of deadwood in forests, both from an aesthetic-visual point of view and the functionality in the ecosystem. In fact, 43.6% consider the photo of the site with a high amount of deadwood as very pleasant and 21.4% pleasant, while 29.9% and 40.2% consider the photo with a medium amount of deadwood very pleasant or pleasant respectively. Conversely, the photo of the UFS without deadwood is considered the least aesthetically pleasing. In addition, the respondents emphasized the positive roles (*e.g.*, for fauna and flora conservation and soil fertilization) of deadwood in forests more than the negative ones (*e.g.,* for the risk of forest fires, the risk of harmful insects, the aesthetic appreciation). In international literature, some studies have investigated people's preferences and perception towards deadwood in forests. In a study conducted in Italy, Paletto *et al.* (2022) revealed that for the majority of respondents standing dead trees and lying deadwood have neither a positive or a negative effect on forest landscape (52.2% and 34.1% respectively), while a minority was recorded who believe that standing dead trees and lying deadwood have a positive effect on forest landscape (7.5% and 23.0% respectively). Findings from southern Sweden, suggested that deadwood played a pivotal role in shaping a negative attitude towards forests as reported by Golivets (2011). However, it is worth noting that in the opinions of respondents the presence of lying deadwood did not significantly diminish the overall aesthetic value of forest stands in this context. Further exploring Swedish citizens' perspectives, Bakhtiari *et al.* (2014) demonstrated that leaving deadwood in forests was generally accepted as a means of preserving ecosystem

naturalness. A study in Japan by Kovács *et al.* (2020) used a photograph evaluation approach to assess visitors' perceptions of naturally occurring deadwood compared to cut wood. Interestingly, Japanese visitors associated photos of naturally occurring deadwood with aesthetic and spiritual values, highlighting the influence of cultural and social contexts on perceptions. Conversely, deadwood stemming from silvicultural interventions was often negatively perceived by Japanese citizens. Additionally, the perception of deadwood is intertwined with its decomposition rate (Nielsen *et al.*, 2012; Rathmann *et al.*, 2020). In particular, Rathmann et al. (2020) observed a gradient in perception from negatively evaluated fresh and beginning decomposition stages to positively valued advanced and high decomposition stages. In a comparative case study between Italy and Bosnia & Herzegovina, Pastorella *et al*. (2016b) observed that Bosnian respondents have a more positive perception of dead wood in forests than Italian respondents. Finally, Sacher *et al*. (2022) summarized the results concerning people's preferences towards deadwood in forests by 35 studies conducted from the mid-1980s to 2021. Those authors also showed different results depending on the context (stand characteristics and location) and target group.

In summary, we can assert that the UFS is a forest area with very peculiar characteristics that make the results of this study not exportable to other contexts. Firstly, the visitor target is made up of a high number of students, academics and researchers who visit the site for work and educational reasons. This target group has a higher level of knowledge on forest ecology and management than the common visitors. Presumably this is one of the reasons for the high aesthetic and functional value assigned to the presence of deadwood and SHSs in the UFS. Furthermore, the ecosystem services provided by the UFS are of high importance in the eyes of visitors due to its location within agricultural land for crop production. In this highly anthropized context, the UFS has a key role in providing microhabitats for wildlife and improving air and water quality as was also recognized by the sample of visitors.

5 Conclusions

The conservation of biodiversity in production forests is a key theme in the coming years that the scientific community is starting to investigate from several perspectives (*e.g.*, ecological, economic, social). The present study provided preliminary data on the social perception for biodiversity conservation in a broadleaved mixed forest located in a matrix of production forest. In this context, biodiversity conservation through the creation of a network of SHSs and interventions aimed at the creation of tree microhabitats and deadwood is of key importance. To date, international literature has marginally investigated the social acceptance of biodiversity conservation in production forests, focusing mainly on protected areas. The main advantage of this study was to investigate a site different from the typical areas involved in socio-economic studies on biodiversity (*i.e.*, national and regional parks, Natura 2000 sites, and

other protected areas). Therefore, the main findings obtained – although preliminary – are a starting point for a future debate on the analysis of social acceptance and the involvement of visitors in biodiversity conservation in production forests. In fact, the study allowed to test the methodology for the forests located near large cities where timber production is the primary goal of management. On the other hand, the main weakness of the study is the particularity of the visitors' sample, which cannot be considered representative of German forest visitors for the presence of a relevant group of specialized users: young people with greater knowledge and awareness on environmental issues but low income. This weakness is due to the greater difficulty in intercepting individual visitors and obtaining their willingness to be involved in the survey. Future studies will be undertaken on forests with different site and stand characteristics and to target visitors in order to highlight which variables most affect social preferences and individual willingness to pay for biodiversity conservation in production forests.

Acknowledgments

The present study was carried out in the context of the LIFE SPAN "Saproxylic Habitat Network: planning and management for European forests" (LIFE19 NAT/IT/000104) project aimed to identify possible sustainable forest management strategies capable of integrating nature conservation measures in production forests.

References

Aerts R. (2013). Old trees: extraction, conservation can coexist. Science 339: 904–904.

Aseres S.A., Sira R.K. (2020). Estimating visitors' willingness to pay for a conservation fund: sustainable financing approach in protected areas in Ethiopia. Heliyon 6(8): e04500.

Aznar-Sánchez J.A., Belmonte-Ureña L.J., López-Serrano M.J., Velasco-Muñoz J.F. (2018). Forest ecosystem services: An analysis of worldwide research. Forests 9: 453.

Bakhtiari F., Jacobsen J.B., Strange N., Helles F. (2014). Revealing lay people's perceptions of forest biodiversity value components and their application in valuation method. Global Ecology and Conservation 1: 27-42. https://doi.org/10.1016/j.gecco.2014.07.003

Bhat M.Y., Sofi A.A. (2021). Willingness to pay for biodiversity conservation in Dachigam National Park, India. Journal for Nature Conservation 62: 126022.

Boisvert V., Vivien F.-D. (2005). The convention on biological diversity: A conventionalist approach. Ecological Economics 53: 461-472.

Boncina A. (2011). Conceptual approaches to integrate nature conservation into forest management: A Central European perspective. International Forestry Review, 13, 13–22.

Carrière S.M., Rodary E., Méral P., Serpantié G., Boisvert V., Kull C.A., Lestrelin G., Lhoutellier L., Moizo B., Smektala G., Vandevelde J.-C. (2013). Rio+20, biodiversity marginalized. Conservation Letters 6(1): 6-11.

D'Amato D., Rekola M., Li N., Toppinen A. (2016). Monetary valuation of forest ecosystem services in China: A literature review and identification of future research needs. Ecological Economics 121: 75-84.

De Meo I., Cantiani M.G., Ferretti F., Paletto A. (2011). Stakeholders' perception as support for forest landscape planning. International Journal of Ecology 1: 1–8.

De Meo I., Cantiani M.G., Ferretti F., Paletto A. (2018). Qualitative Assessment of Forest Ecosystem Services: The Stakeholders' Point of View in Support of Landscape Planning. Forests 9: 465.

Dobšinská Z., Sarvašová Z. (2016). Perceptions of forest owners and the general public on the role of forests in Slovakia. Acta Silvatica & Lignaria Hungarica, 12: 23–33.

Duncker P.S., Raulund-Rasmussen K., Gundersen P., Katzensteiner K., De Jong J., Ravn H.P., Smith M., Eckmüllner O., Spiecker H. (2012). How Forest Management affects Ecosystem Services, including Timber Production and Economic Return: Synergies and Trade-Offs. Ecology and Society, 17, 1-17.

EC (2020). EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Brussels, 20.5.2020 COM(2020) 380 final.

Faith D.P., Walker P.A., Ive J.R., Belbin L. (1996). Integrating conservation and forestry production: exploring trade-offs between biodiversity and production in regional land-use assessment. Forest Ecology and Management 85: 251-260.

Garcia S., Harou P., Montagné C., Stenger A. (2011). Valuing forest biodiversity through a national survey in France: A dichotomous choice contingent valuation. Int. j. biodivers. sci. ecosyst. serv. 7(2), 84–97. https://doi.org/10.1080/21513732.2011.628338

Golivets M. (2011). Aesthetic Values of Forest Landscapes. MSc Thesis, Swedish University of Agricultural Sciences 60, Alnarp, Sweden.

Harrison P.A. (2014). Linkages between biodiversity attributes and ecosystem services: a systematic review. Ecosystem Services 9: 191-203.

Herkenrath P. (2002). The implementation of the Convention on Biological Diversity – A non-government perspective ten years on. RECIEL 11(1), Blackwell Publishers Ltd.

Hermoso V., Carvalho S.B., Giakoumi S., Goldsborough D., Katsanevakis S., Leontiou S., Markantonatou V., Rumes B., Vogiatzakis I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: Opportunities and challenges on the path towards biodiversity recovery. Environmental Science & Policy 127: 263-271.

Howley P., Ryan M., Donoghue C. O. (2011). Forestry in Ireland: An examination of individuals' preferences and attitudes towards the non-market benefits of forests. Irish Geography 44(2-3): 291–302. https://doi.org/10.1080/00750778.2011.6

Jarský V., Palátová P., Riedl M., Zahradník D., Rinn R., Hochmalová M. (2022). Forest Attendance in the Times of COVID-19—A Case Study on the Example of the Czech Republic. International Journal of Environmental Research and Public Health 19(5), 2529. https://doi.org/10.3390/ijerph19052529

König A., Dahl S.-A., Windisch W. (2023). Energy intake and nutritional balance of roe deer (Capreolus capreolus) in special Bavarian landscapes in southern Germany. Animal Production Science 63: 1648-1663.

Kovács B., Uchiyama Y., Miyake Y., Penker M., Kohsaka R. (2020). An explorative analysis of landscape value perceptions of naturally dead and cut wood: a case study of visitors to Kaisho Forest, Aichi, Japan. Journal of Forest Research 25(5): 291-298. https://doi.org/10.1080/13416979.2020.1773619

Kruse L., Erefur C., Westin J., Ersson B. T., Pommerening A. (2023). Towards a benchmark of national training requirements for continuous cover forestry (CCF) in Sweden. Trees, Forests and People 12: 100391. https://doi.org/10.1016/j.tfp.2023.100391

Lachat T., Bütler R. (2008). Îlots de sénescence et arbres-habitat pour augmenter la biodiversité en forêt. La Forêt 6: 20-21.

Langmaier M., Hochbichler E., Payrhuber A. (2023). Importance of tree species composition and forest structure on recreational use – a case study for mountain forests in Upper Styria. Austrian Journal of Forest Science 4: 249-278. https://doi.org/10.53203/fs.2304.2

Liquete C., Cid N., Lanzanova D., Grizzetti B., Reynaud A. (2016). Perspectives on the link between ecosystem services and biodiversity: The assessment of the nursery function. Ecological Indicators 63: 249-257.

Lupp G., Förster B., Kantelberg V., Markmann T., Naumann J., Honert C., Koch M., Pauleit S. (2016). Assessing the recreation value of urban woodland using the ecosystem service approach in two forests in the Munich metropolitan region. Sustainability 8(11): 1156. https://doi.org/10.3390/su8111156

Mace G.M., Cramer W., Dìaz S., Faith D.P., Larigauderie A., Le Prestre P., Palmer M., Perrings C., Scholes R.J., Walpole M., Walther B.A., Watson J.E.M., Mooney H.A. (2010). Biodiversity targets after 2010. Current Opinion in Environmental Sustainability 2: 3-8.

Martín-López B., Montes C., Benayas J. (2007). The non-economic motives behind the willingness to pay for biodiversity conservation. Biological Conservation 139: 67-82. https://doi.org/10.1016/j.biocon.2007.06.005

Mason F., Zapponi L. (2015). The forest biodiversity artery: towards forest management for saproxylic conservation. iForest 9: 205-216. https://doi.org/10.3832/ifor1657-008

Mason F., Di Salvatore U., Zapponi L., Cantiani P., De Cinti B., Ferretti F. (2016). Îlots de senescence in the ManFor C.BD sites. Italian Journal of Agronomy, 11, 135-140.

MEA (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Müller J., Mitesser O., Cadotte M.W., van der Plas F., Mori A.S., Ammer C., Chao A., Scherer-Lorenzen M., Baldrian P., Bässler C., Biedermann P., Cesarz S., Claßen A., Delory B.M., Feldhaar H., Fichtner A., Hothorn T., Kuenzer C., Peters M.K., Pierick K., Schmitt T., Schuldt B., Seidel D., Six D., Steffan-Dewenter I., Thorn S., von Oheimb G., Wegmann M., Weisser W.W., Eisenhauer N. (2022). Enhancing the structural diversity between forest patches—A concept and real-world experiment to study biodiversity, multifunctionality and forest resilience across spatial scales. Global Change Biology, 29, 1437–1450. https://doi.org/10.1111/gcb.16564

Müller J., Scherer-Lorenzen M., Ammer C., Eisenhauer N., Seidel D., Schuldt B., Biedermann P., Schmitt T., Kuenzer C., Wegmann M., Cesarz S., Peters M., Feldhaar H., Steffan-Dewenter I., Claßen A., Bässler C., von Oheimb G., Fichtner A., Thorn S., Weisser W. (2021). BETA-FOR: Enhancing the structural diversity between patches for improving multidiversity and multifunctionality in production forests. Proposal for the first phase (2022-2026) of the DFG Research Unit FOR 5375/1.

Nielsen A.B., Heyman E., Richnau G. (2012). Liked, disliked and unseen forest attributes: relation to modes of viewing and cognitive constructs. Journal of Environmental Management 113: 456–466. https://doi.org/10.1016/j.jenvman.2012.10.014

Nikodinoska N., Paletto A., Franzese P.P., Jonasson C. (2015): Valuation of ecosystem services in protected areas: The case of the Abisko National Park (Sweden). Journal of Environmental Accounting and Management, 3: 355–369.

Ohtani S. (2022). How is People's Awareness of "Biodiversity" Measured? Using Sentiment Analysis and LDA Topic Modeling in the Twitter Discourse Space from 2010 to 2020. SN Computer Science 3: 371.

Paletto A., Guerrini S., De Meo I. (2017). Exploring visitors' perceptions of silvicultural treatments to increase the destination attractiveness of peri-urban forests: A case study in Tuscany Region (Italy). Urban Forestry & Urban Greening 27: 314-323.

Paletto A., Balest J., De Meo I., Giacovelli G., Grilli G. (2014). Perceived influence and real power of stakeholders in forest management: A case study in Italy. In: Schiberna E., Stark M. (eds): Adaptation in Forest Management Under Changing Framework Conditions. Sopron, Foundation for Sustainable Forest Management: 163–175.

Paletto A., Becagli C., De Meo I. (2022). Aesthetic preferences for deadwood in forest landscape: A case study in Italy. Journal of Environmental Management 311: 114829. https://doi.org/10.1016/j.jenvman.2022.114829

Paletto A., De Meo I., Cantiani M.G., Maino F. (2013). Social Perceptions and Forest Management Strategies in an Italian Alpine Community. Mountain Research and Development, 33(2):152-160.

Pastorella F., Avdagić A., Čabaravdić A., Mraković A., Osmanović M., Paletto A. (2016b). Tourists' perception of deadwood in mountain forests. Annals of Forest Research. 59: 311-326. https://doi.org/10.15287/afr.2016.482

Pastorella F., Giacovelli G., Maesano M., Paletto A., Vivona S., Veltri A., Pellicone G., Scarascia Mugnozza G. (2016a). Social perception of forest multifunctionality in southern Italy: The case of Calabria Region. Journal of Forest Science 62(8): 366-379. https://doi.org/10.17221/45/2016-JFS

Ranacher L., Stern T., Schwarzbauer P. (2017). Do wood products protect the climate? Public perception of the forest based sector's contribution to climate change mitigation. Austrian Journal of Forest Science (3): 281–298.

Ranacher L., Sedmik A., Schwarzbauer P. (2020). Public perceptions of forestry and the forest-based bioeconomy in the European Union. Knowledge to Action 3, Joensuu: European Forest Institute. https://doi.org/10.36333/k2a03

Rathmann J., Sacher P., Volkmann N., Mayer M. (2020). Using the visitor-employed photography method to analyse deadwood perceptions of forest visitors: a case study from Bavarian Forest National Park, Germany. European Journal of Forest Research. 139(3): 431–442. https://doi.org/10.1007/s10342-020-01260-0

Rose O., Callot H. (2007). Redécouverte de Phloeostichus denticollis Redtenbacher, 1842 dans le massif des Vosges (France) (Coleoptera Phloeostichidae). L'Entomologiste 63: 129-133.

Sacher P., Meyerhoff J., Mayer M. (2022). Evidence of the association between deadwood and forest recreational site choices. For. Pol. Econ. 135, 102638. https://doi.org/10.1016/j.forpol.2021.102638

Sagoff M. (2008). On the economic value of ecosystem services. Environ. Values 17(2), 239–257. https://doi.org/10.3197/096327108X303873

Tyrväinen L., Silvennoinen H., Kolehmainen O. (2003). Can ecological and aesthetic values be combined in urban forest management? Urban For. Urban Green. 1, 135–149. https://doi.org/https://doi.org/10.1078/1618-8667-00014

Thu Le T.H., Lee D.K., Kim Y.S., Lee Y. (2016). Public preferences for biodiversity conservation in Vietnam's Tam Dao National Park. Forest Science and Technology 12: 144-152. https://doi.org/10.1080/21580103.2016.1141717

Torkan G., Krašovec U. 2019. Students' attitudes toward forest ecosystem services, knowledge about ecology, and direct experience with forests. Ecosystem Services 37, 100916. https://doi.org/10.1016/j.ecoser.2019.100916

Zapponi L., Minari E., Longo L., Toni I., Mason F., Campanaro A. (2014). The Habitat-Trees experiment: using exotic tree species as new microhabitats for the native fauna. iForest 8: 464-470. https://doi.org/10.3832/ifor1281-007

Annex 1

QUESTIONNAIRE

The questionnaire has been realized in the framework of the LIFE SPAN project aimed at integrating the conservation of saproxylic biodiversity (dead wood-associated species, which altogether constitute at least 30% of forest biodiversity) in forest management. The LIFE SPAN project is implemented in two study areas: one in Italy and one in Germany. The University Forest Sailershausen is one of the areas of intervention of the Project and the present survey aims to collect information from visitors to improve its usability.
The data collected will be processed anonymously and solely for monitoring the results of the Project.

Your support is precious to us and for this we thank you for your cooperation.

The data collected will be used exclusively for research and non-managed purposes, in aggregate and anonymous form, in compliance with the European Privacy Regulation (Reg. EU No. 679/2016, GDPR).
By continuing to complete the questionnaire, you consent to the use of the data for the research purposes described above.

Section 1 - Recreational use of the University Forest Sailershausen

The University Forest Sailershausen is located between Schweinfurt and Haßfurt in the northern of Bavaria. The University Forest Sailershausen covers an area of 2,176 ha of which 750 ha are part of the Natura 2000 area "Wässernachtal". It is dominated by beach- oak forests (80%), as well as extensively managed hay meadows (19%) and inland water bodies (1%). A smaller part of the forest in the South is part of the FFH and SPA area "Mainaue between Eltmann and Haßfurt", mainly with focus on migrating birds along the river Main. The land is owned by the University of Würzburg.

Q1.1. How many times did you visit the University Forest Sailershausen in the last 12 months? _____

Q1.2. How long do you remain in the University Forest Sailershausen **today**? (single choice)

- ☐ All day (more than 4 hours)
- ☐ A few hours (2-4 hours)
- ☐ Less than 2 hours

Q1.3. What means of transport did you use to move from your home/holiday accommodation and reach the University Forest Sailershausen today? (single choice)

- ☐ Car
- ☐ Motorbike
- ☐ Public transport
- ☐ Other (indicate_____)

Q1.3.bis. What were the transport costs? _____ €

Q1.4. How long did it take to reach the University Forest Sailershausen from your home/holiday accommodation today? (single choice)

- ☐ Less than 1 hour
- ☐ Between 1 and 2 hours
- ☐ Between 2 and 3 hours
- ☐ Between 3 and 4 hours
- ☐ Between 4 and 5 hours
- ☐ More than 5 hours

Q1.5. How many people visit today the University Forest Sailershausen with you? (single choice)

- ☐ None (I am alone)
- ☐ 1 person
- ☐ 2 persons
- ☐ 3 persons
- ☐ 4 persons
- ☐ 5 persons
- ☐ More than 5 persons

Q1.6. In order to visit the University Forest Sailershausen today, how many days will you stay in an accommodation facility in the area? (single choice)

- ☐ I will not sleep in any accommodation facility
- ☐ 1 night
- ☐ 2 nights
- ☐ 3 nights
- ☐ 4 nights
- ☐ 5 nights
- ☐ More than 5 nights

Q1.6.bis. What was the approximate cost per night per person? _____ €/person/night

Q1.7. Where did you have lunch during today's visit to the University Forest Sailershausen? (single choice)

- ☐ Packed lunch
- ☐ Restaurant/Alpine refuge
- ☐ Other (indicate _____)

Q1.7.bis. What was the approximate cost for lunch per person? _____ €/person

Q1.8. What other types of expenses have you incurred or do you plan to incur today?

Type of expenses	**Amount of expenses**
Equipment rental (e.g. for trekking, mountain bike, horse riding)	_____ €
Guided tours (e.g. environmental guides, hiking guides)	_____ €
Purchase of local food and wine products	_____ €
Purchase of local handicraft products	_____ €

Q1.9. What are the main reasons for your visit to the University Forest Sailershausen?
(from 1=not important to 5=very important)

Reasons	**1**	**2**	**3**	**4**	**5**
Hiking/Trekking					
Sport activities (e.g., mountain biking, running, horse riding)					
Relaxing into the nature					
Non-wood forest products collection (e.g., mushrooms, berries)					
Wildlife watching (e.g., birdwatching)					
Educational visit					
Work					
Other (indicate)					

Section 2 – Attitudes and preferences towards the University Forest Sailershausen

Q2.1. In your opinion what are the importance of the following benefits provided by University Forest Sailershausen?
(from 1=very low importance to 5=very high importance)

Benefits	**1**	**2**	**3**	**4**	**5**
Timber and bioenergy production					
Tourism and recreation opportunity					
Fauna and flora (biodiversity) conservation					
Climate change mitigation					
Provision of clean water					
Protection of cultural and historical values and local identity					
Creation of job opportunities for the local populations					
Other (indicate_____)					

Q2.2. What is your favourite University Forest Sailershausen landscapes from an **aesthetic point of view**? (from 1= very ugly aesthetic landscape to 5= very nice aesthetic landscape)

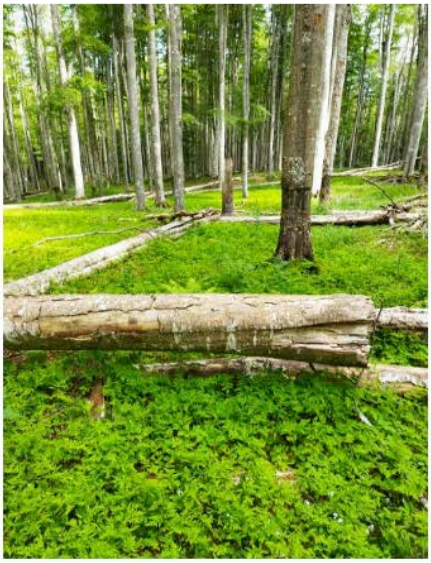
	1	2	3	4	5
Photo 1					
Photo 2					
Photo 3					

Photo 1

Photo 2

Photo 3

Q2.3. In your opinion, is standing (Snag) or ground (Log) deadwood a positive or negative element in forests (as shown in the figure below)? (single choice)



- □ Positive for fauna conservation (e.g., birds, mammals)
- □ Positive for flora conservation
- □ Positive for climate change mitigation
- □ Positive for soil fertilization
- □ Negative for the risk of forest fires
- □ Negative for the risk of harmful insects
- □ Negative for aesthetic deterioration
- □ I don't know

Section 3 - Personal information of respondent

We remind you that the answers to the questions given will be analysed in **aggregate** form and that the questionnaire is received **anonymously**.

Q3.1. Gender

□ Male □ Female □ Other

Q3.2. Age

- □ Less than 20 years old
- □ 21-30 years old
- □ 31-40 years old
- □ 41-50 years old
- □ 51-60 years old
- □ 61-70 years old
- □ More than 70 years old

Q3.3. What is your level of education?

- Elementary school degree
- Technical or middle school degree
- High school degree
- University or post-University degree

Q3.4. What city/town do you live in? _____

Q3.5. Are you a member of any environmental association?

YES NO

Q3.6. What was your individual annual after-tax income in 2022?

- I do not have personal income
- Up to € 14.999
- From € 15.000 and € 29.999
- From € 30.000 and € 44.999
- Over € 45.000

Q3.7 How often do you visit forest areas?

- Every day
- At least once per week
- At least once per month
- At least once per year
- Almost never

THE QUESTIONNAIRE IS FINISHED!

Thank you for your cooperation.

Annex 2

Table 1A: Importance of ecosystem services (mean±SD) provided by the University Forest Sailershausen (UFS) in accordance with the visitors' opinions (5-point Likert scale – from 1 not important to 5 very important). (Bold values indicate the highest value per column).

Tabelle 1A: Bedeutung der vom Universitätswald Sailershausen erbrachten Ökosystemleistungen (Mittelwert±Standardabweichung) gemäß der Besuchermeinungen (5-stufige-Likert-Skala – von 1 nicht wichtig bis 5 sehr wichtig). (Fettgedruckte Werte zeigen den höchsten Wert pro Spalte an).

	Timber and bioenergy	Recreation	Biodiversity	Climate change mitigation	Water provision	Cultural and historical values	Job opportunities
Gender							
Male	3.45±1.40	3.02±1.22	4.07±1.09	3.45±1.02	3.32±1.23	2.55±1.17	2.88±1.25
Female	3.56±1.20	2.96±1.13	**4.57±0.72**	3.87±1.11	**3.43±1.13**	3.11±1.11	3.16±1.08
Other	**4.25±0.96**	**3.50±1.29**	4.50±0.58	**4.25±0.50**	2.75±2.06	**3.25±0.50**	**3.50±1.00**
Age							
Less than 21 yr.	3.17±0.76	3.14±1-07	**4.71±0.49**	3.86±0.90	3.00±1.29	3.00±1.16	3.14±1.07
21-30 yr.	3.42±1.27	2.95±1.14	4.35±0.97	3.60±1.11	3.17±1.19	2.63±1.02	3.07±1.13
31-40 yr.	**3.92±1.38**	2.92±1.31	4.17±0.84	3.92±0.79	3.82±0.98	3.17±1.47	**3.50±1.24**
More than 40 yr.	3.57±1.45	**3.43±1.22**	4.29±0.99	**4.00±1.20**	**3.85±1.35**	**3.43±1.22**	2.46±1.27
Level of education							
Elementary degree	**3.56±1.59**	2.44±0.73	3.78±0.97	3.44±1.24	3.22±1.30	2.22±1.20	2.22±0.97
Middle school degree	3.38±1.69	**3.75±1.39**	**4.78±0.44**	**4.44±0.73**	**3.75±1.58**	**3.67±1.12**	3.00±1.20
High school degree	3.37±1.26	2.74±1.20	4.63±0.96	4.11±0.74	3.39±1.04	2.84±1.17	3.00±1.05
University degree	**3.56±1.19**	3.09±1.12	4.24±0.93	3.46±1.11	3.28±1.18	2.77±1.07	**3.19±1.16**
City of origin							
Würzburg city	2.90±1.03	**3.20±1.24**	**4.43±0.90**	**3.87±0.68**	3.10±1.08	2.72±1.16	**3.03±1.05**
Others	**3.84±1.23**	2.96±1.14	4.29±0.91	3.58±1.16	**3.47±1.18**	**2.84±1.11**	2.92±1.18
Environmental NGOs membership							
YES	3.09±1.23	3.05±1.13	4.09±0.75	**3.82±0.91**	**3.48±1.03**	2.50±0.96	**3.00±1.07**
NO	**3.63±1.22**	3.05±1.20	**4.44±0.95**	3.64±1.06	3.27±1.19	**2.91±1.16**	2.95±1.16
Income							
None	3.20±1-06	3.25±1.16	**4.70±0.47**	3.70±0.80	3.10±1.07	2.65±1.18	2.68±0.75
Up to €14,999	3.60±1.23	2.80±1.16	4.36±1.04	3.60±1.08	3.04±1.17	2.64±0.95	3.20±1.19
€ 15,000-29,999	3.09±1.22	3.27±1.19	4.18±0.98	3.55±1.13	**3.90±0.99**	**3.20±1.23**	**3.60±1.35**
€ 30,000-44,999	**3.75±1.60**	3.33±1.07	4.08±1.04	**3.92±0.95**	3.55±1.13	2.69±1.25	2.42±1.24
Over € 45,000	3.33±1.21	**3.67±0.82**	4.17±0.75	3.50±1.23	3.83±0.75	3.00±1.27	2.67±0.82

Table 2A: Visitors' preferences (mean±SD) towards three photos characterized by an increasing gradient of deadwood (5-point Likert scale – from 1 very ugly aesthetic landscape to 5 very nice aesthetic landscape). (Bold values indicate the highest value per column).

Tabelle 2A: Vorlieben der Besucher (Mittelwert±Standardabweichung) für drei Fotos, die sich durch einen zunehmenden Grad an Totholz auszeichnen (5-stufige Likert-Skala – von 1 sehr unästhetische Landschaft bis 5 sehr schöne ästhetische Landschaft). (Fettgedruckte Werte zeigen den höchsten Wert pro Spalte an).

	Photo 1	Photo 2	Photo 3
Gender			
Male	3.14±1.27	3.81±1.03	**4.12±1.14**
Female	**3.89±1.24**	**4.11±0.85**	4.02±1.02
Other	2.50±1.00	2.70±1.71	3.25±1.71
Age			
Less than 21 yr.	**4.14±1.22**	4.00±1.41	**4.57±0.79**
21-30 yr.	3.43±1.30	3.81±1.09	3.94±1.16
31-40 yr.	3.08±1.24	3.92±0.52	4.08±1.00
More than 40 yr.	3.54±1.45	**4.15±0.80**	4.31±1.03
Level of education			
Elementary degree	3.56±1.13	3.89±0.78	3.89±0.93
Middle school degree	3.44±1.42	4.00±1.32	**4.56±0.88**
High school degree	**3.79±1.40**	**4.11±1.10**	4.16±0.96
University degree	3.38±1.29	3.79±0.99	3.95±1.21
City of origin			
Würzburg city	3.31±1.26	3.68±1.19	3.68±1.25
Others	**3.57±1.35**	**3.98±0.92**	**4.23±0.99**
Environmental NGOs membership			
YES	3.35±1.36	**3.92±1.16**	**4.23±1.03**
NO	**3.61±1.30**	3.84±0.98	3.97±1.14
Income			
None	3.42±1.39	3.92±1.13	4.19±1.13
Up to € 14,999	**3.89±1.19**	3.89±1.05	3.93±1.07
€ 15,000-29,999	3.25±0.87	3.92±1.17	4.25±0.97
€ 30,000-44,999	3.06±1.48	3.63±0.96	3.88±1.26
Over € 45,000	3.57±1.40	**4.14±0.69**	**4.29±1.11**