



Urban forest usage and perception of ecosystem services – A comparison between teenagers and adults

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ABSTRACT

Urban forests provide multiple ecosystem services for a range of user groups. However, teenagers are commonly underrepresented in studies about forest recreation and cultural ecosystem services. This paper examines teenagers' forest use and perception of ecosystem services compared to adult populations. We used an online panel survey to elicit motives for forest visits, frequency of visits, forest activities and constraints for visitation, and what ecosystem services participants expect from forests more generally. We then elicited perceived cultural ecosystem services of different forests by showing participants photographs of forest inventory plots for which we had detailed measures of physical forest characteristics to statistically assess the influence of forest characteristics and other parameters on perceived cultural ecosystem services. Results show that teenagers visit forests less often and also differ from adults in their preferences and activities, their motives for forest visits and reasons for not visiting forests. Teenagers exhibit more social and active forms of forest use, whereas adults use forests in more contemplative ways. Perception of cultural ecosystem services on forest photos was influenced by individual factors such as motives for forest visits, preferences, importance of forest during childhood and socio-demographic factors. Environment- and forest-related factors such as forest type, stand structure and single elements such as root plates and stumps had an influence on ecosystem service perception. We conclude that teenagers have different needs than adults concerning the provision of cultural ecosystem services from forests and therefore should be considered as a user group of its own in the management of recreational forests.

1. Introduction

In today's increasingly urbanised societies, natural and semi-natural ecosystems provide important ecosystem services (ES) contributing to the quality of life, human health and well-being (Andersson et al., 2015; Fisher et al., 2009; Haines-Young and Potschin, 2010; Summers et al., 2012). One of the most widely used definitions is based on the Millennium Ecosystem Assessment, which defines four types of ecosystem services: provisioning, regulating, supporting and cultural (MEA, 2005). Supporting services such as nutrient cycling maintain the conditions for life on earth and form the basis for all other services, whereas provisioning services encompass the provisioning of, for instance, food, timber and fuel, and regulating services include, for example, climate regulation, prevention of natural disasters and habitat provision (MEA, 2005). Cultural services (CES) differ to some extent from other

categories of ES, because they normally require actual contact with the ecosystem by the individual for the benefits to materialise (Hegetschweiler et al., 2017; Plieninger et al., 2013; Ståhlhammar and Pedersen, 2017; Wartmann and Purves, 2018). According to Haines-Young and Potschin (2013) CES are considered mostly final ecosystem services, which influence human well-being directly. Cultural ecosystem services include recreational, aesthetic, inspirational and spiritual benefits, cultural heritage, the provision of sites for education and research and evoking a sense of place (Daniel et al., 2012; Milcu et al., 2013). Although the focus of ecosystem service assessments has commonly been on services considered beneficial for human well-being, ecosystem services can also be harmful to human well-being, and have been coined 'ecosystem disservices' (von Döhren and Haase, 2015).

With regard to the different ecosystems, especially forests in the vicinity of cities and other residential areas have been shown to be

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important green spaces for the urban population (Bell et al., 2009; Pearlmutter et al., 2017). Such forests have even been found to be the most important suppliers for many cultural ecosystem services, including recreation (both physical and psychological), aesthetic enjoyment, and providing a connection to nature (Dobbs et al., 2014; Jaligot et al., 2019). However, urban forests can also be associated with ecological ecosystem disservices, which include allergic reactions to pollen, trees hazardous to human health due to their toxicity, or damage to people and infrastructure from falling branches or trees (Dobbs et al., 2014; Speak et al., 2018; Vaz et al., 2017). Integrated assessments of urban green spaces are therefore a key to examine both services and disservices to human-wellbeing (Dobbs et al., 2014; Vaz et al., 2017).

However, in comparison to ecosystem service assessments for agricultural areas or rural forest areas e.g. Ruijs et al. (2013), urban green areas have received less attention (see review by Dobbs et al. (2014)), but have recently become more of a focus in ecosystem service research (Chen et al., 2020; Dade et al., 2020; Kabisch et al., 2021; Majekodunmi et al., 2020; Rall et al., 2017; Speak et al., 2018; Tian et al., 2020). Within urban ES research, a lack of information on the socio-cultural perception of urban green spaces has been identified (Rall et al., 2017). Particularly, Andersson et al. (2015) have called for more research identifying CES that are *experienced* in the urban context, and for assessments to go beyond identifying the potential for ecosystem service delivery. The assessment of experienced CES requires integrating social science assessments that allow considering the complex relations between people and ecosystem services, which reflects previous calls to better integrate CES into ES research more generally (Chan et al., 2012).

1.1. Socio-cultural perceptions of ecosystem services

The perception of CES has been found to depend on various factors. Age, level of education, gender, urbanity of place of residence, membership in environmental organisations and frequency of visits to nature influence the perception of CES (Jaligot et al., 2019; Martin-Lopez et al., 2012; Plieninger et al., 2013; Riechers et al., 2018). Furthermore, motives for recreation and general preferences regarding the physical environment may influence perception of ES in urban green spaces (Buchel and Frantzeskaki, 2015). In a literature review on perception of CES, both physical forest measures such as stand structure and individual socio-demographic characteristics and forest preferences were found to influence perception of CES (Hegetschweiler et al., 2017).

However, despite studies showing an influence of age on CES perceptions, not all age groups are equally represented in such studies, with youth and the elderly typically being underrepresented (Buchel and Frantzeskaki, 2015). An increasing focus on youth has been highlighted as particularly important in a life-course approach to planning and managing urban green spaces (Douglas et al., 2017), with studies having shown that people who were physically active in their late teens are more likely to stay physically active as adults (Gardsjord et al., 2013). Managing urban green spaces and forests so that they are capable of providing multiple ecosystem services for a range of different user groups therefore requires more information on typically under-represented groups for evidence-based decision-making. We thus take this as a starting point for our study on adolescents' perceptions of urban forests as compared to adult populations. In the following, we review existing literature on adolescent's forest visit behaviour and their relationship to forests and nature more generally.

1.2. Adolescents' perception of forests and nature

It has been repeatedly shown that forest perception, forest visit behaviour and perception of ecosystem services change with age (Eriksson et al., 2012; Hegetschweiler et al., 2020; Martin-Lopez et al., 2012; Plieninger et al., 2013). Adolescents or teenagers around the age of 14–18 years remain under researched, with relatively little known about the relationship of teenagers to forest. Previous empirical studies

showed that forest seems to play a minor role in the lives of most teenagers, and their forest visit frequency is lower than that of adults (Dobré and Granet, 2007; Oppliger et al., 2019). It has been postulated that teenagers use forests mainly when seeking freedom from the control of adults, for smoking and drinking, etc. (Bell et al., 2003). This view is partly modified by studies showing that although getting away from adult control can be a motive for forest visits, teenagers also seek nature and tranquillity, as well as using the forest as a place to meet friends (Ensinger et al., 2013; Oppliger et al., 2019).

Adolescents may also not constitute a homogeneous group, and several differences within this group have been observed. For instance, adolescents' perceptions and uses of forests may differ geographically from global to local scales. For example, adolescents surveyed across 4 different parts within the area of Zurich, Switzerland reported different forest visitation frequencies, with the authors stating that the higher the social status of a residential area and the fewer foreign residents, the higher the likelihood that the pupils had visited forests (Seeland et al., 2009).

Moreover, gender differences in outdoor space use were observed, where male adolescents spent more time outdoors than female adolescents (Hewitt et al., 2020). The presence of informal publicly accessible sport infrastructure was found to have a positive effect on adolescents' activity, but research suggests competitive sport infrastructure may become dominated by boys (Limstrand and Rehrer, 2008), whereas girls use other infrastructure such as miniparks, walking paths, and tracks (Cohen et al., 2006).

And finally, we may observe differentiation within the age group of adolescents, where for example, older adolescents showed more concern and awareness about landscape change than younger ones (Hewitt et al., 2020).

Despite emerging research on adolescents' perception and uses of natural areas and urban green spaces, there is a dearth of research that focusses specifically on adolescents' use of forests and perception of ecosystem services in comparison to adult populations. This study aims to contribute to addressing this research gap through a focus on the following research questions:

- RQ1. Do teenagers' forest visit frequency, motives for visitation and preferred forest activities differ from those of adults?
- RQ2. Which ecosystem services do teenagers and adults expect from urban forests?
- RQ3. What social factors and forest characteristics influence teenagers' and adults' perceptions of cultural ecosystem services?

2. Material and methods

2.1. Data collection

We conducted a nation-wide online survey in 2016 using the Swiss internet panel of the market research institute Bilendi (<https://www.bilendi.ch>). A pre-test was used to further improve the questionnaire and pre-test data were checked for consistency. The link to the final online questionnaire was sent to members of the panel in the three languages German, French and Italian until given quotas regarding language, age, gender and level of education were filled. Quotas were based on census data of the Swiss population from the Swiss Federal Office of Statistics. A comparison between the quotas and Swiss census data is provided in the [supplementary materials](#) of Hegetschweiler et al. (2020). The questionnaire was completed by 1090 respondents aged 14–65 years, among them 199 teenagers aged 14–18 years. Small incentives were given for participation (see <https://meinungsplatz.ch/home> and <https://appadvice.com/app/meinungsplatz-ch/1474603505> for rates paid). The 89 respondents who had taken < 8 min to complete the entire questionnaire were removed, resulting in 1001 respondents.

Based on the Swiss sociocultural forest monitoring WaMos

(Hegetschweiler et al., 2022a; Hunziker et al., 2012) and literature we compiled a survey containing items about how often the respondents went to the forest, about their motives for visiting the forest, reasons against forest visits (constraints) and activities in the forest, as well as CES expected from forests in general, and an elicitation of perceived CES using forest photos. In the following, we describe the survey in more detail. The full questionnaires in German, French and Italian are available online at: https://www.envidat.ch/dataset/wml_bilderstudie (Hegetschweiler et al., 2019).

2.1.1. Survey questions on forest visitation frequency, motives for visiting, constraints for visiting and forest activities

The survey questions were taken from the Swiss socio-cultural forest monitoring (Hegetschweiler et al., 2022a; Hunziker et al., 2012) and extended with more teenager-specific questions from the literature (Bell et al., 2003; Mäkinen and Tyrväinen, 2008), as shown in Table 1 (author translations from original questionnaire languages German, French and Italian).

2.1.2. Survey questions on general forest preferences and forest infrastructure preference

Participants were also asked about their own inherent forest preferences in forests close to their home (Hegetschweiler et al., 2020) and preferences concerning recreational infrastructure (Table 2).

2.1.3. Survey questions on expectations about ecosystem services in urban forests

In addition, participants were asked about their expectations concerning seven cultural and 14 ecological ecosystem services in urban forests, i.e. in forests close to towns and residential areas according to the Millennium Ecosystem Assessment (MEA, 2005). Services were described in a vernacular way that was deemed understandable for a general public (Table 3).

2.1.4. Survey questions on perceived CES from forest pictures

In addition, respondents of the online questionnaire were shown six randomly selected forest photos out of a pool of 50 and asked which cultural ecosystem services they spontaneously associated with the forest depicted on the photo on a scale from 1 (do not agree) to 5 (fully agree) (Fig. 1; Fig. 2; Table 4).

The photos had originally been taken for documentation of sample plots in the Swiss National Forest Inventory NFI. The full set of photos is available on the NFI-website (LFI, 2019). The forests on the photos were characterised by a set of parameters based on the NFI field survey manual (Keller, 2013). Parameters included cover of ground vegetation, shrub layer and berry bushes, stand structure, stage of stand development, geomorphological objects, lying and standing dead wood, root plates, signs of logging, presence of moss, ivy and ferns and all visible infrastructure such as footpaths, fences and high-voltage lines, which have been described and evaluated in a previous study (Hegetschweiler et al., 2020). This enabled us to examine the influence of forest characteristics on CES perception. The questionnaire concluded with socio-demographic questions, environmental attitude and some questions concerning the role of the forest during the respondent's childhood.

2.2. Data analysis

We used descriptive statistics and exploratory factor analysis to determine factors of visitation motives, constraints against visiting forests, general forest preferences and preferences for infrastructure. In all factor analyses, we chose promax rotation to allow for correlations between the resulting factors, as social constructs are rarely completely uncorrelated (Field, 2009). In the following we describe the analyses in more detail.

Table 1
Survey questions on forest visitation, constraints and activities.

Question	Answer	Source
Do you go to the forest regularly? If so, how often?	Never; less than once a month; 1–3 times a month; 1–2 times a week; 3–7 times a week	Hegetschweiler et al. (2022a); Hunziker et al. (2012)
In spring, summer and autumn. In winter.		
What do you do when you are in the forest? (multiple answers possible)	walking (without dog); hiking; walking / hiking with dog / walking dog; jogging; Nordic walking; cycling; biking; picnicking / barbecuing; horse riding meeting friends	Hegetschweiler et al. (2022a); Hunziker et al. (2012)
	making a fire; playing with children; mushroom/berry picking; orienteering, geocaching	Bell et al. (2003); Mäkinen and Tyrväinen (2008) Based on authors' observation of forest use in Switzerland
Why do you go to the forest? (5-point Likert scale)	I want to do something for my health; I want to enjoy the peace and quiet.; I am looking for joy/fun; I want to spend time with my family; I want to experience nature	Hegetschweiler et al. (2022a); Hunziker et al. (2012)
	To meet up with my boyfriend/girlfriend; to smoke / drink / smoke pot; to have sex; to use drugs	Bell et al. (2003); Mäkinen and Tyrväinen (2008)
	To be unobserved in my activities / in activities with my friends	Reasons provided by teenagers during interviews at fire places in the forest at night (author, unpublished) Bell et al. (2003)
The following points are reasons for me not to visit the forest: (5-point Likert-scale)	It's boring in the forest.; My leisure activities outside the forest are using up all my time.; My friends don't go into the forest; There are strange people hanging around in the forest, so I prefer to stay away. I get hay fever in the forest; I am afraid of getting lost in the forest; I am afraid of being attacked; I am afraid of poisonous plants or that my children eat poisonous plants.; I am afraid of diseases transmitted by animals (e.g. fox tapeworm, bird flu).; I am afraid of accidents (falling down, a branch falling on my head).; I don't like the loneliness in the forest. The nearest forest is too far away for me to spend my free time there.; I am afraid of dogs running loose in the forest.; There are too many mosquitoes and other insects in the forest, I don't like to go there.; I don't go into the forest because of the ticks.	Lyytimäki and Sipilä (2009) Reasons provided by forest visitors (author, unpublished)

2.2.1. Analysis of forest visitation frequency, motives for visiting, constraints for visiting and activities

We analysed forest visitation frequencies between adults and teenagers with descriptive statistics to report on mean visitation frequencies and compared the two groups using a *t*-test for parametric data using a significance level of $\alpha = 0.05$ and adjusted for multiple comparisons

Table 2
Survey items for inherent forest preferences and recreational infrastructure.

Question	Answer	Source
What do you generally like about forests, what don't you like? (5-point Likert scale)	If it has almost only conifers.; If it has almost only deciduous trees.; If it has conifers and deciduous trees.; If it has many different types of trees.; If it has many bushes and shrubs.; If it has many clearings in the forest.; If the forest is rather dense and dark.; If there are branches and piles of branches on the ground.; If it has fallen trees; If it has standing, dead trees; If it has boulders or rocky areas; If it has depressions and ditches	Hegetschweiler et al. (2022a); Hunziker et al. (2012)
	If it has slopes to climb; If it has trees to climb; If it has trails; If it has tree trunks to sit on; If it has predominantly large trees with thick trunks; If it has a mixture of thick and thin trunks; If there is ivy growing on the trees; If there is a lot of moss on the ground and on the trees; If the forest floor is covered with plants	Newly developed items based on significant predictors (forest characteristics) in Hegetschweiler et al. (2017)
There are various infrastructures in the forest. Which ones do you like, which ones bother you? (5-point Likert scale)	Parking spaces at the edge of the forest; woodchip jogging trail [German "Finnenbahn"], fitnesstrail [German "vitaparcours"] or running tracks; Bike trails; Raised hide [for hunting, German: "Hochsitz"]; Fireplaces; Playgrounds; Forest huts or shelters; Benches; Litter bins; Robidog (bin for dog faeces); Toilets; Information boards; Wayside crosses and other spiritual symbols; Fences (pasture fences, protective fences)	Infrastructure as stated in Hunziker et al. (2012) or in Hersperger et al. (2012)

using the Bonferroni correction.

We conducted exploratory factor analyses to analyse visitation motives and constraints against visiting forests.

Motives for visiting forest were reduced to the following three underlying factors (based on Hegetschweiler et al. (2020), Appendix 1):

- *Freedom* (to smoke and drink, to consume drugs, to be unobserved in one's activities, to have sex, to be able to listen to loud music and make a noise)
- *Social reasons* (to meet friends, to meet one's girl-/boy-friend, to spend time with one's family, to have fun)
- *Contemplative reasons* (tranquillity, enjoy nature, health reasons)

Constraints against visiting the forest were reduced to the following three factors (Appendix 2; Hegetschweiler et al., 2020, see also Oppliger et al. (2019)):

Table 3
Survey questions on cultural ecosystem services expected from forests.

Question	Options	Source
Forests have large benefits for us humans. This also applies to the so-called urban forests near cities and settlements. What do you expect from urban forests? (5-point Likert-scale: I don't expect at all, I rather don't expect, Undecided, I rather expect, I expect a lot; I cannot judge)	<i>Cultural ecosystem services</i> I expect to be able to relax well in the forest. I expect a forest to contribute to the beauty of the landscape. I expect a forest to be a spiritual place. I expect the forest to contribute to the preservation of our cultural heritage. I expect the forest to provide a site for education and research. I expect the forest to inspire us humans, e.g. for folklore, art, architecture, advertising. I expect the forest to give me a sense of belonging.	Developed for this survey based on MEA (2005)
	<i>Supporting services</i> I expect the forest to contribute to soil formation. I expect the forest to help maintain the nutrient cycle. I expect the forest to contribute to the conservation of genetic diversity.	Developed for this survey based on MEA (2005)
	<i>Provisioning services</i> I expect the forest to provide a habitat for animals that are available to us humans as food after hunting (e.g. game). I expect the forest to provide building material for us in the form of wood. I expect the forest to provide firewood for us.	Developed for this survey based on MEA (2005)
	<i>Regulating services</i> I expect the forest to store CO ₂ and thus counteract climate change. I expect the forest to compensate for extreme temperatures in summer. I expect the forest to prevent flooding and other natural disasters (e.g. avalanches). I expect the forest to maintain our water quality (purify water by seeping into the ground). I expect the forest to help maintain air quality (filtering air pollution and fine particles). I expect compostable waste to be broken down in the forest. I expect the forest to provide habitat for pollinators (e.g. wild bees) of our agricultural crops (e.g. apple trees). I expect the forest to provide habitat for animals and plants.	Developed for this survey based on MEA (2005)

- *Disgust* (fear of diseases transmitted by animals, fear of poisonous plants, dislike of mosquitoes and other insects, fear of ticks, hay fever)
- *Fear* (fear of being assaulted, getting lost, being alone, of having an accident, of meeting weird people, of dogs)



Was fällt Ihnen zu diesem Bild spontan ein?

	Trifft zu	Trifft eher zu	Weder noch	Trifft eher nicht zu	Trifft nicht zu
Ich denke, dass ich mich in diesem Wald gut erholen kann.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dieser Wald ist einfach schön.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dieser Wald ist für mich ein spiritueller Ort.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dieser Wald gehört zu unserem kulturellen Erbe.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dieser Wald bietet eine Stätte für Bildung und Forschung.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dieser Wald ist eine Quelle der Inspiration, z.B. für Folklore, Kunst, Symbole, Architektur, Werbung).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich fühle mich innerlich mit diesem Wald verbunden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

[weiter](#)

Fig. 1. Screenshot of online photo survey to elicit CES of forests (in German).

- *Uninteresting* (full leisure time, boredom, friends don't visit forest, too far away)

2.2.2. Analysis of general forest preferences and preferences for infrastructure

Based on the exploratory factor analysis, *general forest preferences* were reduced to the following factors (Appendix 3; Hegetschweiler et al., 2020):

- *Preference for wilderness* (lying and standing dead trees, woody debris, rocks and rocky terrain, dark and dense forest)
- *Preference for a high vegetation cover* (presence of moss, presence of ivy, high ground vegetation cover)

- *Preference for diverse forest* (high diversity of tree species, mixed forest, i.e. deciduous and coniferous trees, a lot of shrubs and young trees, forest clearings, mixture of large and thin tree trunks)
- *Preference for an adventurous forest* (informal trails, trees suitable for climbing, big trees with large trunks)
- *Preference for monoculture* (only coniferous trees or only deciduous trees)

Preferences for infrastructure were reduced to the following three factors (Appendix 4):

- *Infrastructure for social experiences* (benches, huts and shelters, tree trunks to sit, BBQ-sites, playgrounds; see also Frick et al. (2018))



Fig. 2. Selection of forest photographs shown to participants to elicit perceived CES (Source: NFI/WSL).

Table 4
Survey questions on CES perceived from forests photos.

Question	Answer	Source
What do you associate with the forests shown in the following pictures?	I think that I can relax well in this forest. This forest is simply beautiful. This forest is a spiritual place for me. This forest is part of our cultural heritage. This forest provides a place for education and research. This forest is a source of inspiration, e.g. for folklore, art, symbols, architecture, advertising. I feel innerly connected to this forest.	Developed for this survey based on MEA (2005)

- *Infrastructure for sports* (running trails, fitness trails, mountain bike trails)
- *Infrastructure for cleanliness* (bin for dog’s faeces, rubbish bin, toilets)

2.2.3. Analysis of expectations about cultural ecosystem services

Expectations of cultural ecosystem services were reduced to two factors, which, except for education and research, coincided well with

the classification used by Haines-Young and Potschin (2013); Appendix 5:

- *Spiritual and cultural interactions* (inspiration, sense of place, education and research, cultural heritage, spiritual service)
- *Physical and experiential interactions* (aesthetics, recreation)

We used independent-samples *t*-tests and χ^2 -tests to test for differences between teenagers and adults in how they perceived ecosystem services and disservices of urban forests. In total, 15 *t*-tests and 15 χ^2 -tests were conducted. Considering the high number of tests, the Bonferroni correction (Dunn, 1961) was applied to adapt the significance level to $p = 0.05/30 = 0.002$.

2.2.4. Analysing perceived CES from forest pictures

The factors influencing perception of cultural ecosystem services provided by the forests on the photos were modelled using ordered logit models. These models are suited to the analysis of data for which the dependent variable takes values from a set of discrete and ordered values, where this ordinal relationship is of more importance than the actual value of the dependent variable. More specifically, these models represent the probability that any of the levels in the dependent variable is chosen, given the value of a latent variable. The only assumption is that higher values of the latent variable increase the probability of a high value of the dependent variable. In particular, the form of that

relationship (e.g. linear) does not need to be specified by the researcher.

In other words, these regression-based models map a latent preference scale to a discrete ordered observed outcome (Greene, 2014). The aim was to determine which person-related and which forest-related factors influenced perceptions of cultural ecosystem services (see research question 3). Therefore, all parameters characterising the forests on the photos were included as forest-related factors the respondents actually saw. Person-related factors consisted of socio-demographics, parameters related to environmental attitudes, the importance of forest during childhood and motive, constraint and preference factors resulting from the factor analysis. These were necessary to test if heterogeneities between different person groups exist. As we lacked a clear hypothesis about which would be the key influencing factors, all factors were used to examine their influence on the probability of choosing a certain level of agreement on the cultural ecosystem services provided by the forest displayed on the photos. Two separate models were estimated grouping the ordered responses into perceptions of *Spiritual and cultural interactions* and *Physical and experiential interactions* according to the findings of the factor analyses. The sample was further split into two subsamples to examine the difference in the perceptions of teenagers and adults. In total four different models were estimated. Statistical analysis was conducted using IBM SPSS Version 24 (SPSS, 2016). Estimation of the ordered logit model was carried out using the Apollo software package, Version 0.1.0 (Hess and Palma, 2019a, b) in R, Version 4.0.2 (R Core Team, 2020).

3. Results

3.1. Forest visitation frequency

To understand perceptions of forest ecosystem services, we first need insight concerning respondents' forest usage. Fig. 3 shows teenagers' and adults' forest visit frequency during the summer (spring, summer, autumn) and the winter season. A higher percentage of adults compared to teenagers visits the forest 1–2 times a week or almost daily, whereas a higher percentage of teenagers visits the forest only 1–3 times a month or less than once a month. In terms of number of forest visits per year, teenagers visit the forest significantly less often than adults (mean visits teenagers: 44 times per year, SE = 4.35; mean visits adults: 69 times per year, SE = 3.90, $t = -3.092$, $df = 970$, $p = 0.002$ *).

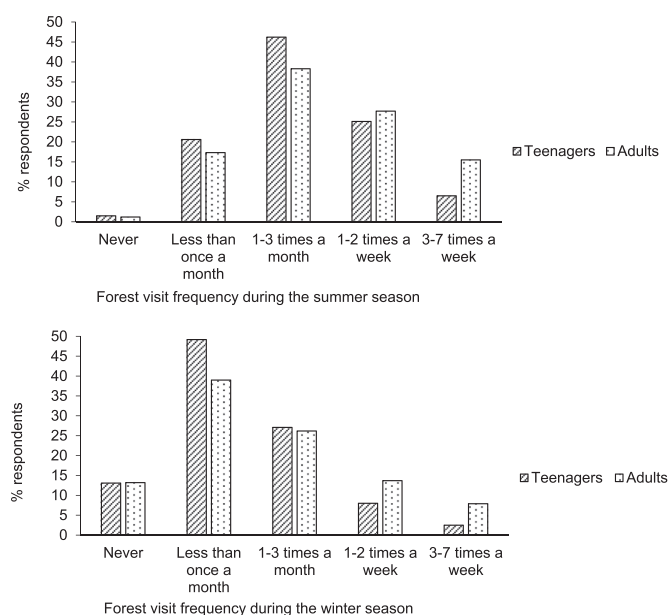


Fig. 3. Forest visit frequency of 199 teenagers and 802 adults during the summer and winter seasons.

3.1.1. Importance of forest during childhood

Forest visits during childhood might also influence respondents' relationship to the forest as teenagers and adults. When asked about the importance of forest during their childhood, 80 % of the teenagers and 88 % of the adults said that the forest had been very or quite important during their childhood. The importance of forest during childhood tended to be higher for today's adults than for today's teenagers, but not significantly ($t = -2.718$, $df = 999$, $p = 0.007$). As expected, more teenagers (16 %) spend time in the forest with a youth group (scouts/guides, nature conservation youth programmes, etc.) than adults (4 %; $t = 6.020$, $df = 999$, $p < 0.001$ *). But even when looking at former membership in an outdoor-oriented youth group, we found a slightly higher percentage of teenagers (44 %) than adults (33 %; $t = 2.726$, $df = 999$, $p = 0.007$). Slightly more teenagers (32 %) attended a forest playgroup, forest crèche or forest kindergarten than adults (26 %), but the difference was not significant ($t = 1.806$, $df = 999$, $p = 0.071$). In addition, more teenagers (64 %) than adults (46 %) had been to the forest regularly with school or kindergarten ($t = 4.474$, $df = 999$, $p < 0.001$ *). In contrast, more adults (79 %) than teenagers (68 %) said that they had enjoyed unorganised, unsupervised play in the forest as children ($t = -3.371$, $df = 999$, $p = 0.001$ *).

3.2. Forest visitation motives, constraints, and activities between adults and teenagers

To answer the question why teenagers visit the forest less often than adults, we compared the motives for and the reasons against forest visits. Teenagers tended to rate the factor *Social Reasons* higher than adults ($t = 3.106$, $df = 986$, $p = 0.002$ *), and the factor *Freedom* marginally higher ($t = 2.489$, $df = 986$, $p = 0.013$), while adults rated *Contemplative Reasons* higher ($t = -7.710$, $df = 986$, $p < 0.001$ *).

A significant difference was also found in the rating of the factors *Disgust* ($t = 6.662$, $df = 999$, $p < 0.001$ *), implying that more teenagers than adults stated that their dislike of mosquitoes and other insects, ticks, diseases transmitted by animals and poisonous plants prevented them from going to the forest. The same applies to the factor *Uninteresting* ($t = 9.348$, $df = 999$, $p < 0.001$ *), which shows that teenagers found the forest boring and too far away more often than adults and spent their leisure time outside the forest, especially if their friends didn't visit the forest either.

This pattern is also reflected when looking at the various activities in the forest (Fig. 4). Going for a walk is the most popular activity for teenagers and adults alike, but the percentage of teenagers going to the forest for social activities such as making a fire at a meeting place ($\chi^2 = 42.167$, $df = 1$, $p < 0.001$ *) and meeting friends ($\chi^2 = 39.519$, $df = 1$, $p < 0.001$ *) is higher than the percentage of adults. Teenagers tend to have a picnic/BBQ more often too ($\chi^2 = 7.705$, $df = 1$, $p = 0.006$). Likewise, the percentage of teenagers doing sports, i.e. jogging ($\chi^2 = 71.268$, $df = 1$, $p < 0.001$ *), cycling ($\chi^2 = 36.160$, $df = 1$, $p < 0.001$ *) and orienteering ($\chi^2 = 65.717$, $df = 1$, $p < 0.001$ *) in the forest is higher than the percentage of adults, only for mountain biking the difference was not significant ($\chi^2 = 3.181$, $df = 1$, $p = 0.074$). On the contrary, the percentage of adults is significantly higher regarding contemplative activities such as going for a walk ($\chi^2 = 9.404$, $df = 1$, $p = 0.002$ *) and picking berries/mushrooms ($\chi^2 = 21.201$, $df = 1$, $p < 0.001$ *). In addition, more adults play with children in the forest than teenagers ($\chi^2 = 10.537$, $df = 1$, $p = 0.001$ *). No significant differences were found for hiking ($\chi^2 = 0.137$, $df = 1$, $p = 0.7$), walking the dog ($\chi^2 = 0.295$, $df = 1$, $p = 0.6$), riding ($\chi^2 = 5.507$, $df = 1$, $p = 0.019$), Nordic Walking ($\chi^2 = 9.101$, $df = 1$, $p = 0.003$) and geocaching ($\chi^2 = 4.156$, $df = 1$, $p = 0.041$).

3.3. General forest preferences

As teenagers use the forest as a place to do sports, it is not surprising that their preference for sports infrastructure such as fitness and running

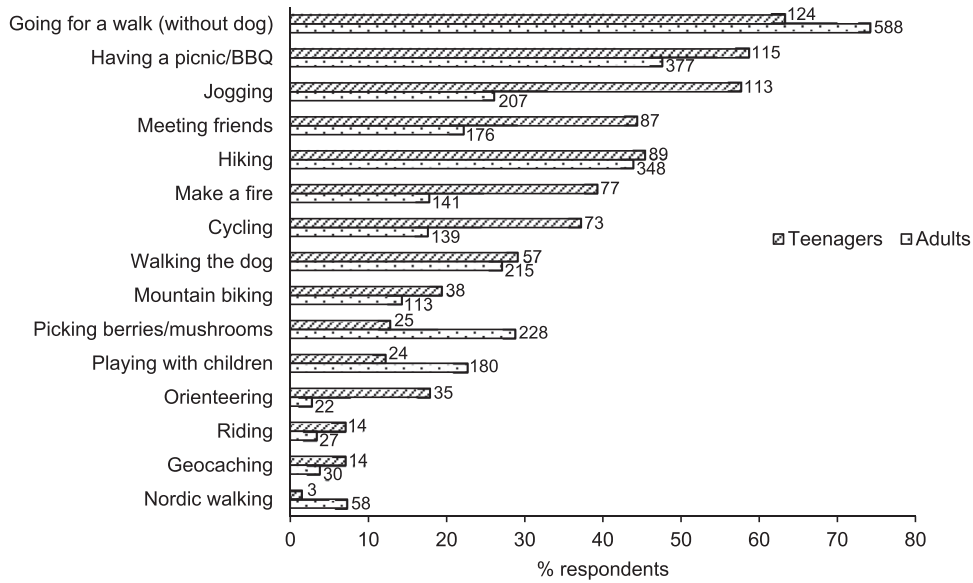


Fig. 4. Activities that 199 teenagers and 802 adults carry out in the forest. Multiple answers were possible.

trails and bike trails is higher than that of adults ($t = 3.412$, $df = 999$, $p < 0.001$ *). Infrastructure for social experiences, e.g. sitting possibilities is appreciated by teenagers and adults alike, as is infrastructure for cleanliness (rubbish bins, toilets, etc.).

3.4. Ecosystem services expectations of urban forests

Fig. 5 shows the ecosystem services that respondents expected from urban forests. Habitat for flora and fauna ranked highest, followed by CO₂-mitigation, aesthetics, air quality regulation and recreation. Other

cultural services such as cultural heritage, spiritual and inspirational services were less expected. The same applies to provisioning services such as fuel or timber provision, which were not expected a lot compared to most regulating services. Teenagers generally had slightly lower expectations of ecosystem services, but displayed the same overall pattern in their expectations as adults (Fig. 5).

3.5. Perception of CES on forest photos

Teenagers generally had fewer influencing factors than adults,

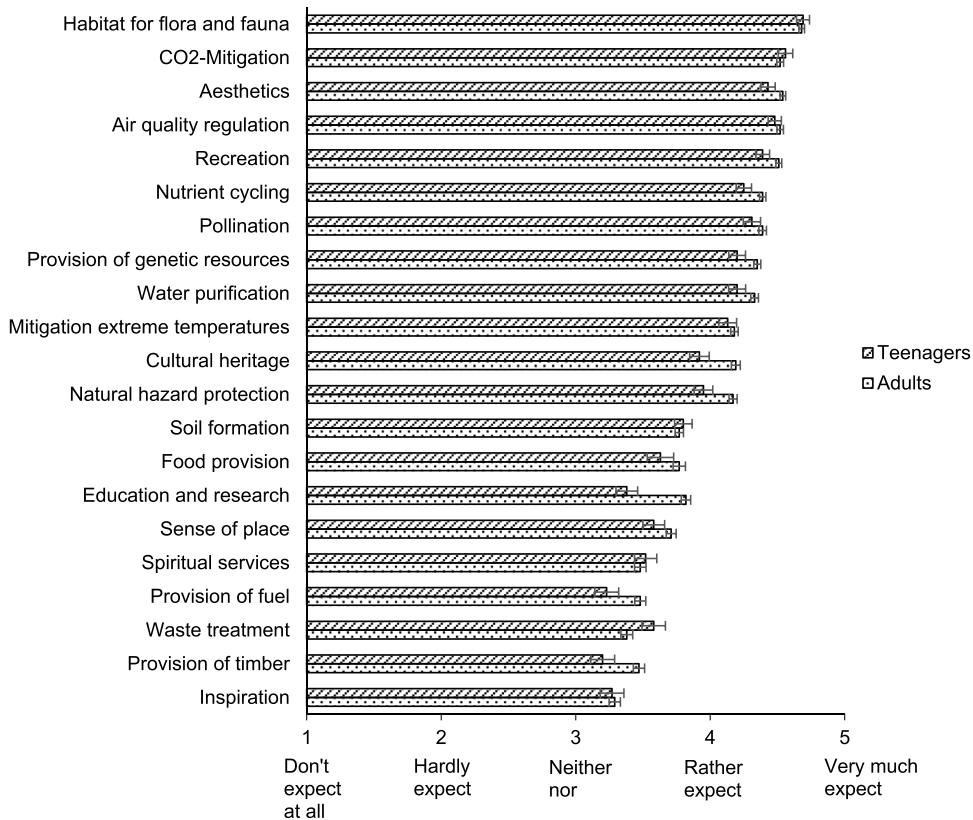


Fig. 5. Expectations of ecosystem services of urban forests. Mean values ± 1 SE of 157 teenagers and 725 adults are shown.

possibly because ecosystem services, especially spiritual and cultural interactions, are less important to teenagers, as shown in Fig. 5. Table 5 shows the factors influencing the perception of cultural ecosystem services of forests shown on photos. The full ordered logit models can be found in Appendices 6 and 7. Sunny conditions on the photos and fully foliated trees had a positive effect on the perception of both spiritual and cultural interactions and physical and experiential interactions. Standing dead trees, signs of logging and ivy on trees had a negative effect on the perception of both groups of CES, block debris and the presence of ferns had a negative effect on physical and experiential interactions for teenagers and on both groups of CES for adults. Furthermore, a high shrub layer cover, the presence of scree, fences and an asphalt path or road lowered the perception of physical and experiential services for teenagers, whereas moss on trees and stones enhanced it. For adults, mixed forests and pure deciduous forests lowered perceptions of CES, implying that perceptions of CES were highest for pure coniferous forests. Stand structures that were multi-layered or all-aged/all-sized had the same negative effect on physical and experiential interactions as a high shrub layer cover for teenagers, possibly because they hinder people from leaving the footpaths. This also applies to the cover of berry bushes, especially when *Rubus* sp. (blackberry) covers large areas. Concerning the stage of stand development, mixed stages enhanced the perception of physical and experiential services, whereas young, medium and old timber lowered spiritual and cultural interactions. Stumps and root plates had a positive effect on both groups of CES, as did tree trunks left at the edge of the road after logging.

Concerning the person-related factors, a preference for high vegetation cover (moss, ivy, ground vegetation), social reasons for visiting forests and a preference for infrastructure for sports enhanced perceptions of CES for both teenagers and adults. Respondents from the French-speaking part of Switzerland were more likely to perceived physical and experiential services on the photos.

Teenagers with a preference for infrastructure for social experiences (benches, fire places, etc.) had lower perceptions of spiritual and cultural services, while those with a preference for infrastructure for cleanliness (rubbish bins, toilets, etc.) perceived these services more, as did teenagers with forest owners in their family. The importance of forest during childhood contributed positively to the perception of physical and experiential interactions. Teenagers who stated they were chronically ill or disabled perceived both groups of CES more strongly.

Adult perception of CES was positively influenced by several forest preferences. Contemplative reasons for forest visits also enhanced perception of CES, while fear of forest lowered it. In contrast to the perception of teenagers, a preference for infrastructure for social experiences had a positive effect on physical and experiential interactions. Age and membership in an environmental organisation positively influenced perception of spiritual and cultural interactions. Female respondents and respondents from the Italian-speaking part of Switzerland perceived both groups of CES higher.

4. Discussion

Given the importance of urban forests and green spaces in delivering ecosystem services for increasingly urbanised societies, integrated ecosystem service assessments are essential. However, despite differences in how ecosystem services may be perceived and used between different age groups, adolescents have so far been under researched. This study focusses on adolescents' perception of ecosystem services and comparing teenagers to adults using Switzerland as a case study example. In the following, we discuss our results with respect to the literature, consider the limitations of this study, and highlight avenues for future research.

Table 5

Results from an ordered logit model showing influencing factors on teenagers' and adults' perception of cultural ecosystem services on forest photographs.

	Teenagers		Adults	
	Spiritual/ cultural interactions	Physical/ experiential interactions	Spiritual/ cultural interactions	Physical/ experiential interactions
Environment- and forest- related factors				
Foliage	+	+	+	+
Sun	+	+	+	+
Mixed coniferous forest			-	-
Mixed deciduous forest				-
Multi-layered stand structure				-
Stand structure all-aged/all- sized			-	-
Stage of stand development: Young, medium or old timber			-	
Stage of stand development: mixed				+
Cover of berry bushes			-	-
Shrub layer cover		-		
Scree		-		
Block debris		-	-	-
Rock				-
Stumps			+	+
Root plates			+	+
Lying dead trees			-	-
Standing dead trees	-	-	-	-
Signs of logging	-	-	-	-
Tree trunks at edge of road			+	+
Ivy on trees	-	-	-	-
Moss on trees and stones		+		
Presence of ferns		-	-	-
Fence		-		
Asphalt path or road		-		
Concrete road			+	
Gravel road			-	-
Person-related factors				
Preference for high vegetation cover	+	+	+	+
Preference for monoculture			+	+
Preference for wilderness			+	+
Preference for diverse forest				+
Social reasons for forest visit	+		+	+
Contemplative reasons for forest visit			+	+
Fear of forest				-
Preference for infrastructure for social experiences	-			+
	+	+	+	

(continued on next page)

Table 5 (continued)

	Teenagers		Adults	
	Spiritual/ cultural interactions	Physical/ experiential interactions	Spiritual/ cultural interactions	Physical/ experiential interactions
Preference for infrastructure for sports	+			
Preference for infrastructure for cleanliness		+		
Forest in childhood important				
Forest owners in the family	+			
Chronic illness/disabilities	+	+		
Female			+	+
Age			+	
Membership in environmental organisation			+	
Language region French-speaking		+		+
Language region Italian-speaking			+	+

4.1. Teenagers visit forests less often and prefer different activities from adults

We found that teenagers visit forests significantly less often than adults, which is in line with previous studies indicating lower forest visitation frequencies by teenagers (Dobré and Granet, 2007; Oppliger et al., 2019). While teenagers rated social factors and seeking freedom higher than adults, contemplative reasons were more pronounced in adults than teenagers. Teenagers stated reasons related to disgust and disinterest in forests significantly higher than adults, which might be linked to a reduced exposure to natural environments in their childhood (Bixler and Floyd, 2016; Milligan and Bingley, 2007). Our results therefore support the notion that teenagers go to forests and other green spaces to meet friends, spend time with their family and to have fun (Mäkinen and Tyrväinen, 2008). The forest also offers teenagers a place where they can listen to loud music and make a noise without disturbing anyone, smoke and drink and generally get away from constantly being watched, which is in line with previous studies (Bell et al., 2003), but of less importance compared to social reasons (Oppliger et al., 2019). However, there is also a lack of interest and disgust from dirt or mosquitoes that is keeping teenagers away from the forest. Adults on the other hand go to the forest to enjoy the peace and quiet, to enjoy nature and for health benefits, which is in line with previous findings (Ensinger et al., 2013; Hunziker et al., 2012).

The most popular activity in forests is walking for both adults and teenagers, but significantly more adults than teenagers indicated going for a walk as a forest activity. Overall, teenagers participated more in social activities such as making a fire, having a BBQ, and meeting friends, as well as for sports such as jogging, or cycling. There were no differences between activities such as mountain biking and Nordic walking, whereas significantly more adults stated contemplative activities than teenagers.

When asking adults and teenagers about their childhood experiences linked to forests, teenagers had more organised activities but less free play in the forest during their childhoods than today's adults. This may be reflective of a general change in outdoor play behaviour more generally for less free play in outdoor spaces (Skar et al., 2016; Valentine and McKendrick, 1997). Nonetheless, the general importance of forest during childhood was still high for most respondents in this study,

although slightly lower for teenagers than for adults. Given our focus on forests, we do not know whether this difference holds for other landscape types as well or is particular to forest areas as places that are used for recreation and relaxation, but can also be experienced as places of fear and insecurity (Skår, 2010).

4.2. Similar expectations of ecosystem services from urban forests by teenagers and adults

Our second research question dealt with expectations of ecosystem services. Teenagers had highly similar overall expectations of ES from urban forests as adults, where for both groups the five most expected services were in decreasing order: habitat for flora and fauna, CO₂-mitigation, aesthetics, air quality regulation and recreation. However, teenagers had slightly lower overall expectations than adults. These rankings are in line with previous studies on ecosystem services where e.g. provision of habitat, air purification and CES, namely recreation, information and scenic landscape were ranked highest (Agbenyega et al., 2009; Martin-Lopez et al., 2012), indicating similar patterns about ecosystem service expectations emerge across studies, at least within European forests.

4.3. Perception of cultural ecosystem services from forest photos

To determine the influence of social factors and forest characteristics on CES perception, we presented respondents with forest images. As in López-Santiago et al. (2014), landscape or forest characteristics respectively and person-related factors influenced associations with CES on photographs. The same images had been used to investigate the effect of forest characteristics on perceived visual attractiveness in Hegetschweiler et al. (2020), making it possible to compare the factors influencing visual attractiveness with the factors influencing the perception of CES.

Sunny conditions and fully foliated trees enhanced the perception of CES in teenagers and adults alike and also contributed positively to the visual attractiveness (Hegetschweiler et al., 2020). Concerning the structure of the forest, multi-layered forests were found visually more attractive than single-layered forests (Hegetschweiler et al., 2020), but had a negative effect on physical and experiential experiences. A multi-layered forest is beautiful to look at, but the shrub layer hinders visitors from leaving the footpaths and thus might limit their recreational experience in the forest. A medium understorey and ground vegetation height has been found to enhance aesthetic experience, although a low understorey is preferred for recreational purposes (Giergiczny et al., 2015; Wang et al., 2017).

The degree of mixture has a similar effect. When asked about their preferences, mixed forests are preferred by the majority of the population (Hunziker et al., 2012). In the present study however, expectations for CES were highest for pure coniferous stands, same as in Baumeister et al. (2020). Dense spruce forests normally lack a shrub layer and are therefore much appreciated for recreational activities, as well as by kindergarten- and school classes. In addition, at least in German-speaking parts, fairy-tales are often associated with coniferous forests, but not with mixed forests (Jenal, 2019), which might explain the negative effect of mixed forests on spiritual and cultural interactions (see also Baumeister et al. (2020)).

Several factors enhanced the perception of CES, but had no influence or even a negative one on visual attractiveness. Stumps and root plates had a positive effect on the perception of CES, but did not explain any variance in visual attractiveness (Hegetschweiler et al., 2020). Similarly, tree trunks placed at the edge of forest roads for transport after logging had a negative effect on visual attractiveness, but contributed positively to the perception of CES in adults. While logs, stumps and root plates are not attractive to look at, they still play a role in forest recreation. They can be used to sit on, and children can climb on them or balance across them. Root plates might also remind people of "fairy-tale forests" and

hereby enhance spiritual and cultural interactions (Jenal, 2019).

4.4. Insights for forest management and planning and further work

The difference in recreational activities and perceptions between teenagers and adults found in this study indicate that these user groups have different needs for and uses of forests. Consequently, assessments about the provisioning of forest recreation services and forest recreation planning can benefit from considering the variation in activities exhibited by different age groups shown in this study. The potential tension arises from teenagers seeking more social and active forms of ecosystem services from forests, whereas adults stated more activities that relate to seeking peace and quiet, which can lead to conflicts of different recreational user groups. Managing forests for conflict resolution requires an understanding of the different user groups and their perspectives (Mann and Absher, 2008), and this study indicates there is a need to include teenagers as a user group with different recreation behaviour and needs.

However, as our sample of teenagers was limited, we did not consider within-group differences between teenagers, such as gender, socio-economic and ethnic backgrounds (Fernandez et al., 2020). We used a simple proxy variable of whether respondents' parents grew up in Switzerland as an indication of first-generation or second-generation migrants, as this variable was shown to influence forest perceptions (Hegetschweiler et al., 2022b). Future work would benefit from sampling more teenagers with different backgrounds to study the differences within this age group in more detail.

And finally, to put results into practice there is a need to consider how to better integrate such perspectives into management practice and planning. Although there is some literature on including children and youth planning processes in urban/built environments (Bridgman, 2004; Wridt, 2010), there is considerably less work on integrating youth in forest management. Some examples include youth involvement in community forestry (Brown, 2021) and integrating First Nation youths in forest management (Robitaille, 2018), with a potential to adapt such approaches into other contexts.

4.5. Limitations

First and foremost, we see the limitation of our sample size of teenagers, which was sufficient with 199 teenagers in our sample for comparing with an adult population of 1001 respondents, but did not allow breaking the teenage sample further down into language areas or socio-economic background. Furthermore, the comparatively small sample size led to larger standard errors in the models for teenagers than for adults, implying that our results for adults are more reliable estimates for the whole adult population than our results for teenagers are for the whole teenage population. Further studies would benefit from increased sample sizes of teenagers to increase reliability and to allow additional variables to be taken into account, but this is associated with higher costs for recruitment on online platforms where teenager quota are challenging to obtain. Therefore, at least for visitation behaviour, other forms of assessment through social media data may be integrated that have higher representation among the younger population, but such data is often lacking detailed information on user's age and therefore also has its limitations in terms of representativeness (Wartmann et al., 2021). Another consideration is how well teenagers can answer questions concerning ecosystem services that are not directly linked to their experiences, which is a critique also raised for adults and the difficulty to grasp the ecosystem service concept, particularly for cultural ecosystem services (Kirchhoff, 2012). The difficulty of assessing cultural ecosystem services relates to much broader debates in the field of ecosystem services (Chan et al., 2012), but during our pre-test we found that teenagers indicated the questions were comprehensible. We do thus not envision that there are significant issues of understanding the questions posed to teenagers in comparison to adults.

5. Conclusion

In this article we investigated differences in forest usage and perception of forest ecosystem services between teenagers and adults. We saw that forest characteristics and person-related factors influenced the perception of ES, among these the importance of forest during childhood and participation in forest play groups. As children's free play in the forest is decreasing and teenagers' forest visit frequency is a lot lower than that of adults, these groups need to be considered in forest management with their specific needs. The results show that forest characteristics contribute differently to the perception of various ES and often also differ from the characteristics contributing to visual attractiveness. In this sense we contribute to basic knowledge for multifunctional forest management considering the usage and perception of multiple ecosystem services not only by adults but by teenagers as well.

CRedit authorship contribution statement

K. Tessa Hegetschweiler: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Visualization, Writing – original draft; **Flurina M. Wartmann:** Writing – original draft, Writing – review & editing. **Ilka Dubernet:** Methodology, Formal analysis, Writing – original draft, Writing review & editing; **Christoph Fischer:** Data Curation; **Marcel Hunziker:** Conceptualization, Supervision, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2022.127624.

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