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Developing an Environmental Impact Assessment Methodology for Disc Golf Courses

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Abstract

The demand for outdoor recreational activities is rising. Therefore, it is important to pay more attention to their environmental impact and sustainability. However, there is a lack of methodology for measuring the impact of novel recreational activities, such as disc golf. This research aimed to address the existing environmental problems with disc golf in Estonia and elaborate on the methodology for assessing the environmental impact of disc golf courses and using it as a teaching tool for rising environmental awareness of the students. Based on existing research, the environmental impact assessment methodology for disc golf areas was developed and tested. The developed methodology is relevant for discovering negative impacts and for minimizing them. It could be used as an assessment tool for service providers and destination managers. Using the methodology as practical exercise proved to be an effective tool for rising the student's environmental awareness.

Keywords: Carrying capacity, disc golf, environmental impact assessment, higher education, methodology development, sustainability.

Introduction

Sustainable Development of Recreational and Tourism Services in the Natural Environment

Population growth, demographic changes, urbanization, and higher incomes have changed people's leisure and vacation needs, and increased the demand for recreational activities in the natural environment (Willibald et al., 2019). The development of tourism in the natural environment is seen as an opportunity to stimulate entrepreneurship in rural areas, raise the standard of living of local inhabitants, develop infrastructure and promote the appreciation for and preservation of the local culture and environment (Leung et al., 2018).

For continued success, sustainable destination development is essential (Shafiee et al., 2019), which considers the current and future needs of visitors, the community, economy sectors, and the environment (Tyrväinen et al., 2014). Sustainable tourism and destination are characterized by the optimal use of resources and responsible management, which requires, among other things, an assessment of economic, social and environmental impacts and the carrying capacity of the destination (James, 2018; Shafiee et al., 2019). Nowadays, sustainability approaches are also crucial in education (Cotterell et al., 2019) for preparing students to become leaders in different fields of the tourism industry (Kim & Jeong, 2018). One of the most convenient ways of teaching about environmental and sustainability issues is using active/participatory learning methods (Pipere, 2019) and they are successful and meaningful, if really implemented outdoors in real nature environment (Ameli, 2022).

The demand for outdoor recreation opportunities has steadily increased in recent decades (Woods et al., 2020; McGinlay et al., 2020), because recreation, especially outdoor activities, have a positive impact on people physically, mentally and socially (Pigram & Jenkins, 2006; Thomsen et al., 2018; Mansfield, 2021), reducing disease risks and making people more capable (World Health Organization, 2018; Lackey et al., 2019). While participating in recreational activities in the natural environment, people can feel connectedness to nature and escape from urban environments (Celestino & Pereira, 2012). Moreover, spending free time in nature has been reported to increase a positive relationship to nature (West, 2010). However, this awareness needs to be facilitated by associations and federations; for instance, the International Orienteering Federation (2015) has issued a Code of Conduct in which awareness is one of the topics. As the awareness of people involved in the sport grows, they choose an environmentally friendly way of conduct where possible and are thus likely to contribute to the sustainability of wildlife (Yska, 1997). Therefore, it is important that part of tourism education is also environmental education, which teaches us how to understand and appreciate natural resources (Leung et al., 2018).

Provision and Impact of Recreational Activities in the Natural Environment

Numerous new activities (e.g., mountain biking, geocaching, disc golf) are coming forth alongside traditional recreational activities (e.g., hiking, cycling, Nordic walking) (Leung et al., 2013). Disc golf is an emerging activity worldwide with millions of players – when in 2008, there were 2,748 disc golf courses around the world, then by 2018, there were 8,364 courses (PDGA a; PDGA, b; Woods et al., 2020).

Greater interest also promotes the establishment of objects of interest and the provision of activities in nature (McGinlay et al., 2020; Winter et al., 2020). However, the increase in the demand and supply for outdoor recreational activities (Woods et al., 2020) also has a negative impact on the environment (McCullough et al., 2018), which is expressed in the trampling of vegetation (Hurt et al., 2009), introduction of alien species (Marion et al., 2016), damage to trees, soil erosion, deterioration of water quality (Trendafilova & Waller, 2011; Gutzwiller et al., 2017), disturbance of wildlife activity (Schirpke et al., 2018), biodiversity and habitat loss (Willibald et al., 2019), and an increase in the amount of waste (Leung et al., 2013).

The environmental problems associated with recreational activities mostly arise from unprofessional planning and a high visitor burden on sites (Trendafilova & Waller,

2011; Leung et al., 2013; McGinlay et al., 2020). In addition, detailed visitor data, which are often not available, are also needed for assessing the impact of recreational activities (Sinclair et al., 2020). Sustainable provision of tourism services in the natural environment requires the evaluation and recognition of resources (Leung et al., 2018), and destination protection (Newsome et al., 2013).

To avoid problems, it is important to pay more attention to the sustainability of recreational activities by increasing awareness of sustainable development, learning about disc golf player profiles, their behavior, the social and ecological impact of the activities, and potential solutions (e.g., area expansion, course demarcation, raising awareness among visitors, people flow management, continuous area monitoring and maintenance) (Clark, 2005; Marzano & Dandy, 2012; Ingver, 2013; Newsome et al., 2013; James, 2018; Mansfield, 2021; Woods et al., 2020). There are several data from different regions confirming that disc golf players represent the younger generation, for example, mainly 26–36-year olds in Finland (Alasalmi & Apiainen, 2013), 30–50-year olds in the USA (Siniscalchi, 2004; Oldakowski & McEwen, 2013) and 24–35-year olds in Canada (Haley, 2002), indicating that playing disc golf often starts in upper secondary school or university.

Universities have a significant part in providing knowledge and skills concerning sustainability (Cotterell et al., 2019) and responsibility issues, which is not only limited to a small "expert" group assessing the environment, but rather should be the required mindset of all tourism stakeholders (Barber et al., 2011). However, integration of sustainability approaches into courses can be difficult. Practical, real-life problem-solving assignments, case studies, hands-on experience, active participation and discussions about important issues in courses (such as tourism planning, impact evaluation, destination and service development) and different methods offer better understanding and management skills of hospitality businesses (Barber et al., 2011; Pousson & Myers, 2018; Tuononen et al., 2019).

Research and Methods on the Impact of Disc Golf as a Recreational Activity

Environmental impact studies of recreational activities were started already in 1920 (Hurt et al., 2009), but the examination of relevant sites and assessment of visitor impacts increased in 1980–1990 (Cole and Wright, 2004). This, in turn, raised the importance of recreation ecology, that is, the research on ecological changes in the man-made environment (Monz et al., 2013; Marion et al., 2016).

The impact of recreational activities on the environment can be investigated by applying qualitative or quantitative methods using an assessment guide, which must consider the specifics of a particular activity and site characteristics (Hurt et al., 2009). The quantitative method is considered more reliable in recreation ecology because it is more accurate and allows reducing the interpretations of the researcher's perceptions (Trendafilova & Waller, 2011).

Research and methods on the impact of recreational activities have been compiled in primary tourist areas in North and South America, Australia, New Zealand, Africa, Antarctica and the Arctic where natural environments require more attention and systemic management (Hurt et al., 2009). The most common activities for measuring the impact are walking or cycling on different surfaces (Monz et al., 2013).

The environmental impact of playing disc golf has also been previously studied and assessed. Trendafilova and Waller (2011) evaluated the negative environmental impact of playing disc golf using three indicators – soil erosion, soil compaction, and vegetation density – by collecting data from a disc golf course and beside the disc golf course. As a result of the study, vegetation degradation, soil erosion and damage to trees (especially near the holes) were identified, and as a solution, it was proposed to apply mulch to problem areas and to rotate the holes or reconstruct the course (Clark, 2005; Trendafilova & Waller, 2011).

Two approaches – biophysical indicators and media coverage – were used to measure the environmental impact of disc golf in the framework of a methodology and research compiled in the USA in 2013 which considered the specifics of the sport. Based on the studied biophysical indicators, the condition of the soil (slope, amount and conditions of tree seedlings, and tree saplings, extent of bare soil, tree root exposure, and soil compaction) and trees (tree species, height, diameter, clearly visible gouges to the bark, height to the lowest live branch from the ground, horizontal and vertical extent of bark damage and its intensity) were assessed (Leung, 2013; Leung et al., 2013).

The results of the study showed a marked deterioration from the tee area to the middle part of the course and a lower trampling load in the immediate vicinity of the courses, which can be explained by the constant trampling load on and not around the courses. To mitigate the environmental impacts, protective material was recommended to be placed around the trees or on their stems along the courses (Leung, 2013; Leung et al., 2013). In addition, various sources suggest using less vulnerable objects (e.g., larger stones/rocks or artificial objects) as obstacles instead of trees (Clark, 2005) and establishing disc golf areas in abandoned places (e.g., industrial areas and buildings) where there is no direct contact with the natural environment (Ingver, 2013).

The media study was conducted on the basis of 112 published articles covering the impact of disc golf on the environment, social life, economy and health. It appeared that the majority of the articles did not adopt a specific stance, but introduced readers to disc golf as a recreational activity. It was observed that at first, articles with a positive or neutral attitude appeared, but later also articles with negative content emerged. The social and economic benefits were most noted as the impact of disc golf and, to a lesser extent, the environmental impact (damage to trees and the soil) (Leung et al., 2013).

Disc Golf Courses in Estonia – A Case Study

Similarly, to the rest of the world, the popularity of disc golf in Estonia has increased year by year. According to the World Flying Disc Federation, as at 2019, Estonia is the third-ranking disc golf country in the world (PDGA, a; Rotmeister, 2019; WFDF, 2020) with 70 disc golf parks and 149 courses reported in spring 2020 (WEB, e).

During the period of 2012–2019, there were at least ten cases in the mainstream media about disc golf courses. Problems emerged five days to five years after opening a course, but mostly in a 1–2 year time period (Karjus, 2015; Ojasaar, 2018; Vedru, 2018; Roosna, 2019). The problems are mainly recorded by local inhabitants or environmentalists, addressing damage to trees and the ground. In two cases there were conflicts with other users of the area. In all these cases, the areas were closed and/or moved to

other localities. In public discussions, the main conclusions were that disc golf courses had been established by enthusiasts, sometimes together with local authorities, but there had been no impact assessment or estimation of environmental or social carrying capacity, which led to problems very soon (Karjus, 2015; Kask, 2017; Ojasaar, 2018; Vedru, 2018).

In Estonia, due to the increasing demand and the number of visitors in nature sites, recreational carrying capacity has been studied by assessing the impacts of trampling on bog landscape, nature reserves, forest paths and forest areas, and the impact of recreation on recreational areas in state forests (Hurt et al., 2009; Roose et al., 2011). In addition, the assessment methodology developed for the Nordic countries "Visitor Monitoring in Nature Areas" by Kajala et al. (2007) is used in Estonia, which applies the transect method with measurement areas of 1 m^2 sample plots where damage to the vegetation and soil, and waste rates are assessed (Hurt et al., 2009). This methodology is designed primarily for recreational areas and hiking trails and does not consider the characteristics of other recreational activities. The first attempt to assess the impact of disc golf on vegetation and the ground surface was described in 2016 by Ingver (2016), but the methodology did not follow national and international standards.

Methodology

Our research aimed to elaborate on the proper methodology for disc golf courses for assessing the impact of the sport on the ground surface, ground vegetation and higher vegetation like shrubs and trees, to be a simple and reliable tool for disc golf course managers and planners. We also aimed the methodology to be a suitable teaching and learning tool for universities and upper secondary schools for education about sustainable development.

Several recreation ecology studies and methodologies were analyzed to find proper characteristics for disc golf courses. Different approaches (Hurt et al., 2009; Trendafilova & Waller, 2011; Leung et al., 2013; Ingver, 2016) were considered, and based on these the impact assessment methodology for disc golf areas was developed. According to the methodology, a worksheet for fieldwork was elaborated (Figure 1).

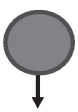
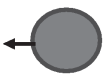
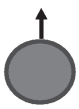
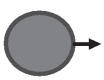
The methodology was tested in two disc golf parks on four courses in Pärnu County, southwestern Estonia in March–April 2020 (Table 1). Three courses were in Jõulumäe Health and Sports Centre, which had been well-used since 2010, and one course established in 2014 was near a school in the small town of Kilingi-Nõmme. Both sites had similar vegetation conditions, laying on dry pine forests on sandy soils. The tested courses at Jõulumäe had to meet the following criteria: all courses had to be of different age, different difficulty level, and have trees growing beside the course. As there were only Scots pines at Jõulumäe, the course in Kilingi-Nõmme was added to the selection as there were also Norway spruces, common oaks and silver birches along the course (WEB, a, b, c, d).

Figure 1

Fieldwork Spreadsheet for Measuring the Impact of Disc Golf on the Ground, Vegetation and Trees in the Disc Golf Course, Running on the Tee-Hole Centerline and Around the Hole in a 10 m Radius Area

	Vegetation disturbance level					
Plot	1	2	3	4	5	6
0						
1						
2						
3						
4						
5						
Litter type						
Amount						

	Tree disturbance level							
Plot	0	1.1	1.2	1.3	2.1	2.2	2.3	3
0-2 m								
2-4 m								
4-6 m								
6-8 m								
8-10 m								

Course no:		Vegetation disturbance level					
Direction from hole	**Plot**	1	2	3	4	5	6
	0-2 m						
	2-4 m						
	4-6 m						
	6-8 m						
	8-10 m						
	0-2 m						
	2-4 m						
	4-6 m						
	6-8 m						
	8-10 m						
	0-2 m						
	2-4 m						
	4-6 m						
	6-8 m						
	8-10 m						
	0-2 m						
	2-4 m						
	4-6 m						
	6-8 m						
	8-10 m						
Overall estimation around hole	314 m^2						

Tree disturbance level around the hole							
0	1.1	1.2	1.3	2.1	2.2	2.3	3

Note: The descriptions for tree and vegetation disturbance level are provided in Table 2. The disturbance level is estimated in the percentage scale.

Table 1

Description of Disc Golf Impact Assessment Testing Areas in March–April 2020, Pärnu County, Estonia (WEB, a, b, c, d, e)

	Jõulumäe disc golf park	Kilingi-Nõmme disc golf park
Location	Leina village, Häädemeeste municipality, Pärnu County 58°13'24.8"N 24°30'55.2"E	Kilingi-Nõmme town, Saarde municipality, Pärnu County 58°09'06.8"N 24°57'05.1"E
Name of the course, difficulty, year of establishment	Yellow course (18 baskets, par 64) – difficulty AAA (2004) Red course (18 baskets, par 62) – difficulty AA (2010) Blue course (9 baskets, par 30) – difficulty B (2017)	KN (9 baskets, par 27) – difficulty B (2014)
Exploitation	In the overall Estonian disc golf rating (*Disc Golf Metrix*) 6th place	In the overall Estonian disc golf rating (*Disc Golf Metrix*) 48th place
Habitat	Dry pine forest on sand dunes	Dry pine forest on sandy loam

To understand the descriptive power of the methodology, the data collected during testing were analyzed using the Analysis of Variance Single Factor test (ANOVA). The statistical analyses were carried out with SPSS 26.0 software. The Analysis of Variance Single Factor test looks for differences between at least two statistically significant groups. When a significant difference is indicated, the Bonferroni test for pairwise comparison is used to identify the groups.

The measured values for vegetation disturbance for each measured plot were calculated as follows: 1 * (%) + 2 * (%) + 3 * (%) + 4 * (%) + 5 * (%) + 6 * (%) to form an index for the plot. For example, Index = 1 * (0 %) + 2 * (0 %) + 3 * (0 %) + 4 * (0 %) + 5 * (90 %) + 6 * (10 %) = 5.1. The damage to trees is summarized for disturbance levels 1.1 … 1.3 and 2.1 … 2.3.

For testing the methodology effectiveness as a teaching tool for sustainability issues, we made use of a Mandatory Interdisciplinary Project-Based Course (6 ECTS) for Tallinn University (TLU) students in 2021. Alongside tens of other topics, the authors proposed a project under the name "Outdoor Recreationist Footprint in Nature", which included several topics of measuring recreational carrying capacity, including disc-golf. No prior knowledge in recreation, ecology, environmental sciences or other fields was required. General outcomes of the course included the ability to relate skills and knowledge from personal academic field of studies to the project topic, to acquire new knowledge and skills from the topic to be related and applied in personal academic field, to apply project work and teamwork principles, to analyze to project process and results, and personal responsibility in performing the project, critically. In addition to the measurement process, analyses of the data and stated results, students had to submit self-reflection on perceived learning outcomes. Sample: In 2021 spring semester and fall semester in total 47 project participants represented the following academic fields: recreation (12), physical education (9), pre-school education (4), organization behavior (4), social work (3), Asian studies (1), journalism (2), vocational education (3), health sciences (3), urban management

(2), political science (1), logistics (1), business administration (2). There were 17 male and 30 female students. Participants were coded P1–P47. Students visited in small groups of 2–3 students in total nine different disc golf parks, freely chosen. In each park, students had to measure at least two tracks per student. The results of the track assessment are not presented in this paper, but qualitative data from written forms of self-reflections are analyzed. Texts were coded within categories, and the self-reflection form was structured.

Results

Method Validation

The elaborated disc golf environmental impact assessment methodology, based on a synthesis of different research, as well as the assessment scales were adequate to describe all disturbances occurring on test areas. The disturbances to the ground surface, vegetation and trees were assessed (Table 2, Figure 1). The scale for disturbance levels on the ground surface and vegetation is mainly based on the methodology of Hurt et al. (2009), but the scale for estimating the disturbance levels of trees and bushes was a synthesis of the authors and tested and verified during fieldwork. The methodology allows efficiently, with little time and effort, estimating the ecological situation of the disc golf courses and does not require deep knowledge of natural sciences.

Table 2

The Elaborated Methodology for Measuring the Disc Golf Impact on the Ground Surface, Vegetation and Trees, Compiled by Methodologies of Hurt et al. (2009), Trendafilova & Waller (2011), Leung et al. (2013), Ingver (2016)

Disturbance levels of trees	
Measurement description	The measurements of tree damage are made on the same area as vegetation measurements. On the path (transect) from the tee area to the basket, following the center of the path, select the first spot 10 m from the tee area and next spots after each 30 meters. Measure the 10 m line (transect) starting from the path (0 m) to one of the sides of the path. Mark the 2 m, 4 m, 6 m, 8 m and 10 m line on the transect. Measure the 5 m area to both sides of the transect as a measuring area. The total area for measuring the trees is 100 m^2. Mark all trees in the worksheet, according to the distance from the center and following the scale.
Scale for tree disturbance estimation	0 No visually identifiable damage on tree trunk or branches, healthy tree 1.1 The tree has some light bark injuries 1.2 The tree has many light bark injuries 1.3 The tree is covered all over with light bark injuries 2.1 The tree has some deep bark injuries and resin or sap is visible 2.2 The tree has many deep bark injuries and some branches are broken, resin or sap is visible 2.3 The tree is covered all over with deep bark injuries, branches are broken and resin or sap is visible 3 The tree is dead

See next page for continuation of table

Continuation of Table 2

Disturbance levels of the ground surface and vegetation	
Measurement description	On the path (transect) from the tee area to the basket, following the center of the path, select the first spot 10 m from the tee area and next spots after each 30 meters. Measure the 10 m line (transect) starting from the path (0 m) to one of the sides of the path. Mark 1 x 1 m quadrats (plots) on 2 m, 4 m, 6 m, 8 m and 10 m on the transect. Estimate the condition of the vegetation and ground surface for each plot following the scale. Give a % value for each scale category.
Scale for ground surface and vegetation disturbance estimation (by Hurt et al., 2009)	1 No traces of recreational use 2 The vegetation/moss layer is present, but compared to neighboring areas, the coverage has declined and species composition may be changed. Damaged plants occur. Vegetation height is lower. The ground surface is covered with debris, leaves, needles, branches and bark litter. 3 The vegetation is minimal (single plants). Visible direct vegetation damage, existing plants are bent or broken, the moss layer is inverted, etc. The ground surface is covered with debris, leaves, needles, branches and bark litter. Forest mould is present. 4 The vegetation is missing (including mosses). The forest mould layer is worn thin or is partially present or missing. The mineral soil is covered by debris. 5 The vegetation and forest mould layer are missing. Debris is minimal. The mineral soil is exposed, may be thickened, but has not lost the initial structure. 6 The mineral soil is exposed and has lost its initial structure and is eroding. The vegetation, debris and forest mould layer are all missing.
Litter, vandalism	
Measurement description	Litter is counted all along the course. Litter is categorized separately as plastic, metal and glass items, including small items like cigarette butts, bottle caps, chewing gum, etc. Small paper and wooden items (ecologically decomposing) are not considered as litter. All vandalism acts on tee areas and basket areas are described separately.

Estimation of the Vegetation and Ground Surface Disturbance

The older the course was, the more severe were the disturbances on the vegetation and ground surface (Table 3, Figure 2). The oldest, the yellow course had the mean damage level of 4.6, which was significantly higher than for the other courses ($p < .001$). The distance from the center of the tee-hole centerline describes well the load of the trampling and tree damage, as the damage on the trees are most frequent near the centerline and trampling damage follow the same pattern (Table 3, Figure 2).

Table 3

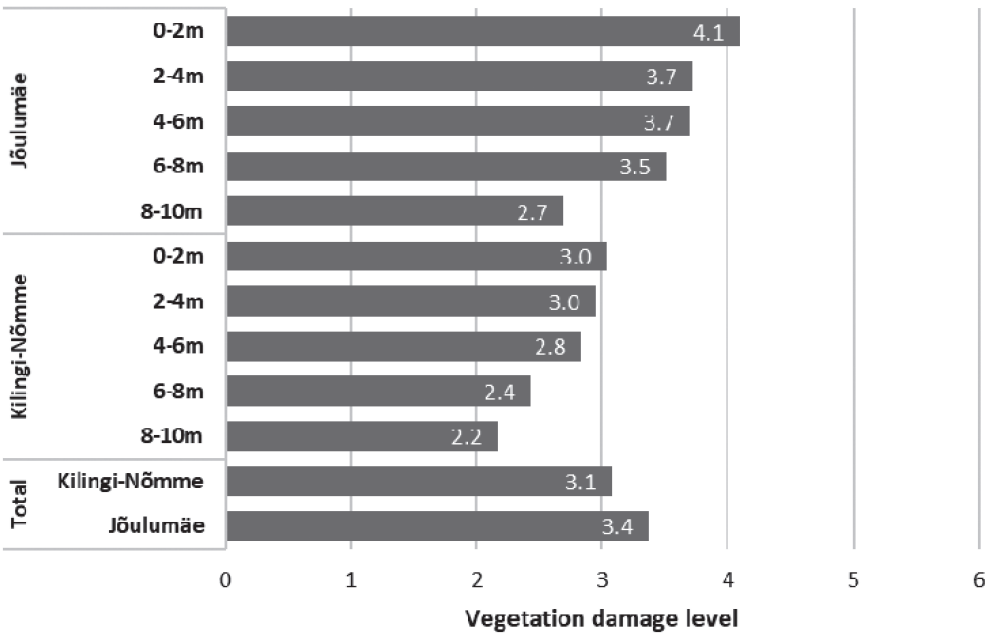
The Vegetation and Ground Surface Disturbance on the Tested Disc Golf Courses and on Different Distances from the Tree-Hole Centerline

Plot number and distance from the tee-hole centerline	The name of the course				Mean + SD of the plots
	Yellow ± SD (n = 18)	Red ± SD (n = 48)	KN ± SD (n = 18)	Blue ± SD (N = 12)	
1 (0–2m) (n = 16)	4.48 ± 1.30	3.89 ± 1.01	3.03 ± 0.06	4.30 ± 1.56	3.9^{a} ± 1.05
2 (2–4m) (n = 16)	4.27 ± 1.39	3.71 ± 0.94	2.95 ± 0.06	2.95 ± 0.07	3.6^{ab} ± 0.96
3 (4–6m) (n = 16)	4.20 ± 1.59	3.79 ± 0.64	2.83 ± 0.31	2.63 ± 0.53	3.5^{ab} ± 0.94
4 (6–8m) (n = 16)	4.35 ± 1.41	3.29 ± 0.71	2.43 ± 0.42	3.15 ± 1.34	3.3^{ab} ± 1.01
5 (8–10m) (n = 16)	4.13 ± 1.98	2.45 ± 0.56	2.17 ± 0.31	1.50 ± 0.71	2.6^{b} ± 1.18
Mean + SD of the course	4.57^{a} ± 1.36	3.16^{b} ± 1.29	3.08^{b} ± 0.98	2.42^{b} ± 1.57	

Note: For the disturbance scale see Table 2. The ANOVA p-value for plot means is 0.001* and for the means of the courses is 0.000. [a], [ab], and [b] mark the statistically significant differences by the Bonferroni test, significance level 0.001. (SD – Standard Deviation)

Figure 2

The Comparison of Jõulumäe and Kilingi-Nõmme Disc Golf Parks' Vegetation Situation by Means



Note: The 0–2 … 8–10 m describes the distance from the tee-hole centerline. At Jõulumäe the data includes data of red, yellow and blue courses, in Kilingi-Nõmme one course. For the disturbance scale see Table 2.

The disturbance of trees is distinguished by eight levels (Table 4) and on the red course 2 hole routes are included in the analysis. The pattern of the damage severity follows the age of the course; the older the course is, the more severe the damage (Table 4). The blue course is outlined with a high number of dead trees, which is due to the thick young forest and high light competition combined with disc golf disturbances (Table 4, Figure 3).

To simplify the data, the damage of level 1 and level 2 can be summarized and presented together as light bark damage and severe bark damage, respectively (Figure 3). The yellow course, as the oldest, shows a high rate of severely damaged trees.

Table 4

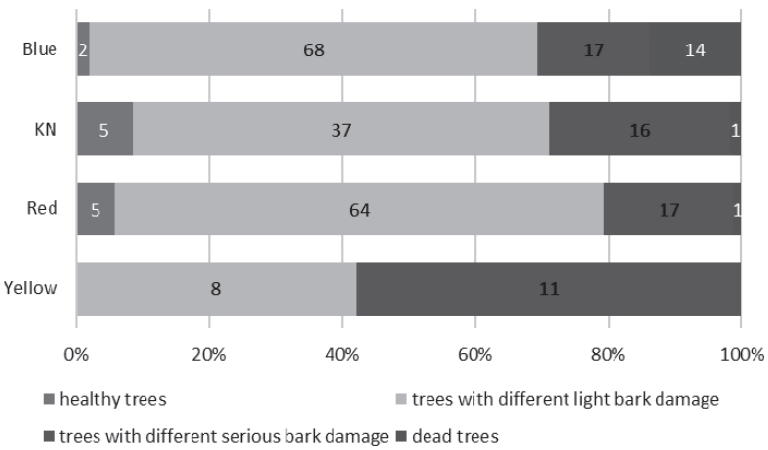
The Disturbance of Trees on Tested Disc Golf Courses Along the Tee-Hole Centerline, Summarized

Disturbance level	Yellow		Red, hole 4		Red, hole 10		KN		Blue	
	No of trees	%	No of trees	%	No of trees	%	No of trees	%	No of trees	%
0	0	0	3	8	2	4	5	8	2	2
1.1	1	5	21	57	25	50	17	29	31	31
1.2	6	32	7	19	10	20	16	27	37	37
1.3	1	5	0	0	1	2	4	7	0	0
2.1	4	21	4	11	5	10	5	8	10	10
2.2	3	16	0	0	5	10	4	7	5	5
2.3	4	21	1	3	2	4	7	12	2	2
3	0	0	1	3	0	0	1	2	14	14
Total	19	100	37	100	50	100	59	100	101	100

Note: For disturbance levels see Table 2.

Figure 3

The Disturbance of Trees on Tested Disc Golf Courses Along the Tee-Hole Centerline, with Level 1 and Level 2 Summarized



Note: For disturbance levels see also Table 2. For the red course, two routes are summarized.

Disturbances Around the Hole in the Put Range

The worksheet for fieldwork also enables measuring the impact of disc golf on the ground, vegetation and trees in the disc golf course around the hole in a 10 m radius area or put area. The methodology of summarizing the data is the same as for the route from the tee-hole centerline. The damage on the vegetation and surface was the most serious from the direction of the tee area where the vegetation was lost and the mineral soil, being exposed and eroding, lost its structure. The least severe damage was on the back side of the hole where most of the vegetation was usually damaged but the ground was still covered with debris and forest mould was present. The damage on the left side was more serious than on the right side (Table 5). The surface around the hole was the most damaged, the vegetation and forest mould missing and mineral soil exposed (Table 5).

Table 5

Vegetation Damage Around the Hole Areas in 10 m Range (Put Range)

Measurement direction	Average ± SD	ANOVA p-value	Measurement distance from hole	Average ± SD	ANOVA p-value
			0-2m (n = 20)	4.93^{a} ± 0.74	
↓ (n = 25)	5.31^{a} ± 0.46		2-4m (n = 20)	4.52^{a} ± 1.32	
← (n = 25)	4.24^{ab} ± 1.45	0.000	4-6m (n = 20)	3.85^{a} ± 1.77	0.0245
↑ (n = 24)	2.99^{c} ± 1.73		6-8m (n = 20)	3.63^{a} ± 1.74	
→ (n = 25)	3.86^{b} ± 1.53		8-10m (n = 19)	3.59^{a} ± 1.84	

Note: The directions are from the tee-hole centerline. All holes are summarized. Differences in the same area between the measurement direction and distance were detected with the ANOVA test.

The average disturbance level for the holes on different courses can be calculated from the study plots (Table 6). Establishing plots takes time and effort and if the put range is marked, the damage level could be evaluated by an experienced researcher as an overall estimation. We checked the differences between measured and calculated averages (Table 6) and only for the severely damaged yellow course the calculated and estimated averages were close values.

Table 6

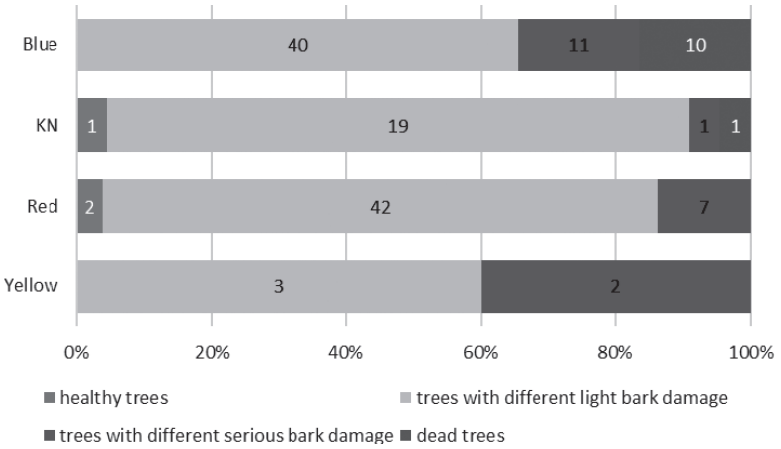
The Comparison of the Average Damage Level of the Put Area Around the Hole, Based on Measurements and Visual Estimation

	Yellow	Red 4	Red 10	KN	Blue
Average damage level of the put area around the hole, based on measurements	5.65 ± 0.54	3.54 ± 1.71	3.89 ± 0.96	3.49 ± 1.45	4.07 ± 1.92
Average damage level of the put area around the hole, based on visual estimation	5.66	4.05	4.48	3.07	3.75

Note: Average damage level of the put area around the hole, based on measurements, is presented with SD.

Figure 4

The Disturbance of Trees on Tested Disc Golf Courses in the Put Area Around the Hole, with Level 1 and Level 2 Summarized



Note: For disturbance levels see also Table 2. For red course, the two holes are summarized.

The tree damage around the hole in the put area follows the same pattern as for the routes from the tee area to the hole, showing the most severe damage around the yellow hole (Figure 4). There was no litter registered in any of the courses at Jõulumäe while there was some in Kilingi-Nõmme. Empty bottles, chips packages and small paper wraps were near the course although there were litter bins around.

Students' Learning Experience

Majority of students stated their personal interest in nature and/or doing outdoor sports/activities (walking, hiking, biking), and/or just wandering and enjoying being in the nature as one of the reasons the project topic addressed them. The other reasons: the topic is concurrent with the field of study, relates to previous insights about environmental awareness, wish to increase one's awareness on the topic. For few also the possibility to do some school work experientially and outdoors was a reason to join. The more personal interest, the more increased personal engagement and openness. Majority also mentioned the willingness to "get a bigger picture" and to do something good for natural environment, to give personal effort in sustainability project and be part of a bigger project. For some making a difference was important "/…/ being a "pioneer" as there have not many evaluation projects like that done for long time and our little research can be input for future" (P31, social work) "/…/ to feel that I have given an effort in research, to explore impact on natural environment of different events and so popular disc golf opportunities provided in Estonian nature, because I do see when we play disc golf what kind of "footprint" we leave behind by playing on regular bases" (P42, urban studies).

Participating in such a course expanded knowledge, understanding and experiences ("opened my eyes") in carrying capacity of outdoor recreation (as individual and as

outdoor provider) field. "/…/ helped to get wider perspective, open my eyes and get more deep in natural world, to see problematic aspects resultant on outdoor recreation, to see from very important perspective" (P 3, recreation). In addition, additional knowledge in natural sciences was gained "/…/ learned about some species that I had seen, but had no idea what it was" (P4, recreation) and ability to notice natural environment in more detail. "Participating in the project enlarged my silmaringi, to notice around me the impact and results of outdoor recreational activities" (P33, Asian studies). The value of the practical measuring activities showed real results, and it made students reason and discuss: "Earlier I thought that it is just wonderful that people are outdoors, are physically active, enjoy fresh air, but now I realize and can consider the negative aspects of it" (P40, health sciences). Moreover, the discussion on compromise between nature protection and visiting natural environment for recreational purposes was enriching, opened eyes to see the surrounding in more sustainable way. It is surprises people, how much of waste is still on disc golf parks, nature trails: "People can carry on trails and their outdoor session much stuff, but weird that they cannot carry it after using the content, and just drop it on the ground" (P 17, physical education).

More specifically, students expanded knowledge on disc golf as outdoor activity and its environmental impacts, organization of recreational activities and events in natural areas addressing the sustainability aspect "As I am recreational disc golf player myself, it made me think, is it really necessary to establish parks in areas densely populated with trees. If we build parks, then trees should be definitely well protected" (P14, physical education). It has been realized that disc golf is popular and the environmental impacts are more noticeable than it has been realized before. "It is extremely sad what is going on disc golf parks, not only surface is damaged but also trees" (P27, organizational behavior). "I was so surprised seeing barely living trees, I would have never guessed it is all because of disc golf" (P10, recreation). Participants of the course have become more attentive about environmental impacts in their daily recreational surroundings, due to the new knowledge and skills to evaluate it. "I spend much time outdoors, /…/ to my surprise, I started to look around in my regular outdoor activities in much different way" (P1, recreation). "Daily we do not pay attention unless we start deeply focusing (süvenema)" (P23, pre-school education). Within such insight it can be generalized that participants of the course showed interest in the condition of natural environment in the future. One aspect is related to their own behavior, the belief to be more attentive and careful while being outdoors and/or being engaged in some outdoor activity, and to be more sustainable doing so. The experience has given confidence in feeling environmentally aware enough to pay others' attention to sustainability issues. "/…/share my knowledge to people I know, so that outdoor activities for physical health could be continued long as our benefit" (P44, political sciences). Even more, most of participants find acquired skills and knowledge applicable in real life one or the other way. Either the experience has given rich insights on purposeful teamwork to be transferred in work environment, or transfer the sustainability principles and environmental awareness in communicating with different target groups: "/…/ in the kinder garden to tell and show how our physical activities leave a footprint in nature" (P25, pre-school education). "/…/ as outdoor provider and instructor, be more sustainable and be an example to my clients" (P7, recreation). On top, few insights also considered the topic to be so important that it should be: "/…/brought in higher priority in society and get more media coverage" (P44, political science).

Despite the methodology at first seemed to be complicated (in theory), the practical work with methods and getting engaged in variety of measuring activities gave confidence that was applicable without specific academic knowledge. Some suggestions to improve methodology for someone who has no background of environmental or natural sciences has been forwarded: a) species and items in nature more specifically opened and described (känd, palk, betoon…); b) more specific time schedule for repetitive measuring; c) add other observational aspects like detect and cover sustainable methods used to protect area; d) more specific guidelines on how to position and take photos; e) evaluation scale to be more specific to different terrain types; f) IT program solution in data collection and analysis. The project course received positive feedback due to well-structured experiential course design on teaching the methodology, especially in such a short time the project had. Support by competent and energetic project leaders is important in learning and applying new methodology. "The participation experiments were especially interesting – felt like the science was being born under my own eyes, being able to see and do at once" (P38, vocational education). Not only experiential approach but also theoretical part (scientific articles, guidelines) was valued: "I read several suggested articles that expanded my perception and understanding about the topic" (P47, business administration). To keep up the motivation of the students, project leaders and mentors need to share their inner motivation to be engaged in the field and teaching, and learning themselves.

Discussion

Outdoor activities are the trend (Leung et al., 2013; Willibald et al., 2019; Woods et al., 2020) and the Covid-19 pandemic has increased the need for outdoor activities even more (McGinlay et al., 2020). Thus, the negative impact of recreational activities is rising and the need for sustainable development gets more attention. James (2018), Shafiee et al. (2019) and Tyrväinen et al. (2014) point out that sustainable development assumes a strategic and long-term approach that implies understanding the meaning of responsibility, awareness of impact factors and assessment of economic, social and ecological impacts resulting in maximum benefit and minimum damage, especially in nature-based destinations.

For understanding the impact of recreational and tourism activities on nature, there are specific measuring methods (Hurt et al., 2009) widely implemented in America (Clark, 2005; Monz et al., 2013; Trendafilova & Waller, 2011). However, there is a lack of methodology for measuring the impact of novel recreational activities involving specific devices, such as disc golf, which take under consideration the specifics of the place. The assessment methodology that is used in America may be needed to adjust for Europe due to differences in measurement systems, environment, etc.

Disc golf is an emerging activity worldwide with millions of players, also in Estonia. However, based on previous studies (Trendafilova & Waller, 2011; Leung et al., 2013) if disc golf courses in nature or public spaces are not properly planned or constantly assessed, there can be damage to the natural environment, and conflicts may occur between interest groups. According to PDGA (c), "ideally, a well-balanced course has a mixture of holes that go completely through the woods, partially through woods and mostly in the open". Courses are usually equipped with different safety instructions for preserving the infrastructure and peoples' health but not foreseeing measures for saving trees. An overview of the problematic cases of disc golf in Estonian media published

during the last 10 years revealed that there were ten cases addressed where disc golf courses had caused environmental and social problems. The main causes of the problems were unexpected popularity and too high visitation numbers of a particular disc golf course or the lack of planning skills of such outdoor activity in terms of underestimating the carrying capacity, both ecological and social. This proves an additional need for raising awareness in stakeholders of problems and potential solutions related to disc golf courses.

Based on previous research and methodologies, the environmental impact assessment methodology for disc golf areas was developed. The developed methodology was tested on four disc golf courses in Pärnu County, Estonia, assessing the disturbance of trees, vegetation and the ground. The aim of the testing was to examine the eligibility of the methodology. During the testing, no adjustments were needed for assessing the vegetation, soil and litter. The measurements for tree disturbances needed more differentiation, as the damage was of different coverage and character, which required adjusting in the methodology.

Testing revealed similar results compared to previous studies (Hurt et al. 2009; Trendafilova & Waller, 2011; Gutzwiller et al., 2017; McCullough et al., 2018; Willibald et al., 2019). Fieldwork results indicated that the soil and vegetation cover were degraded on all studied courses, and tree trunks were damaged severely. Thus, it can be stated that the longer the disc golf course is operating, the more severe damage it inevitably endures. When operating for more than 10 years damage to vegetation and trees becomes irreversible, as shown in the case of the yellow course at Jõulumäe. The extensive damage to the yellow course may be explained not only by the age of the course (since 2004) but also by its location on a slight slope and its difficulty level AAA, which means professional players with stronger throws. However, compared to Leung et al. (2013), there were no problems with litter on any of the five courses. Differences in litter issues could originate from the work of disc golf course keepers.

Testing revealed that the impact on the vegetation and soil was far wider than that measured around the holes (put area, 314 m^2). The impact was more extensive and widespread around the holes on slopes while holes on the level ground had less severe and less expanded damage.

Damage to the trees confirmed that the longer the distance from the tee-hole centerline, the less numerous and severe the damage to the trunk and branches. While Clark (2005) has concluded that the rate of damage is not related to the tree species but rather to the age of the tree, as younger trees have thinner barks and are more susceptible to damage. We have found that Scots pines are the best at tolerating damage, while all other species (Norway spruces, common oaks and silver birches) along the course neighboring the Scots pines were damaged very severely. We also cannot confirm Clark's (2005) results about damage mainly to younger trees, as all trees were equally hit, but testing results indicated that younger trees, which were hit, had more severe damage than older neighboring trees.

Based on the testing results, the developed disc golf impact assessment methodology can be used to measure soil degradation and vegetation loss, damage to tree trunks and litter on disc golf courses in Estonia or nearby countries. With a small configuration, it could be also used elsewhere. The best time to do fieldwork is in autumn after the season has ended (Hurt et al., 2009) but it is also convenient in early spring, because there are no leaves on trees that would cover and make it more difficult to recognize and evaluate

the damage to the trees. The measurement of soil and vegetation damage after every 2 meters is important for saving time and effort and for describing the situation. Naturally, more measurements can be done, if found relevant.

The best time for fieldwork is in the morning (at 7–8 AM) without the presence of players or course keepers. It is easier and more convenient to collect data in pairs or groups. It takes 1–1.5 hours to evaluate one operating disc golf course.

While our aim with developing and testing the methodology was not to assess the state of any of the disc golf parks, our preliminary results indicated serious problems with the vegetation, soil and trees on the tested courses. While recommended by PDGA (c) that landscapes with different densities of trees should be favored, we would rather suggest avoiding the establishment of disc golf parks in sites with young tree stands and areas sensitive to trampling, as also recommended by Clark (2005) and Hurt et al. (2009). While establishing new courses, the obstacles could be boulders or artificial objects instead of trees.

Another measure for minimizing environmental impacts is adding mulch (10 cm layer) around the holes, which helps keep the soil fresh and moist and protects it from trampling and erosion (Clark, 2005; Trendafilova & Waller, 2011). When damage to trees and vegetation is not irreversible, it is recommended to change the tee-hole trajectory direction or relocate the holes for mitigating the impact and promoting recovery (Trendafilova & Waller, 2011). Trees should be covered with protective material like net, wire, wood or plastic (Leung et al., 2013). It is also crucial to inform players about the impact of disc golf by installing information boards, introducing the environmental impact originating from recreational activities and thereby influencing their behavior (Marzano & Dandy, 2013).

The developed disc golf impact assessment methodology was tested in TLU courses carried out as active/participatory learning (Pipere, 2019) in real natural environment, which was the most effective way of transforming the learners (Ameli, 2022). This makes studies more practical and encourages students to be active learners as Barber et al. (2011), Pousson and Myers (2018), and Tuononen et al. (2019) consider important in higher education nowadays. The students reflected in their feedback these qualities and also assessed that the methodology was easy to use and understand.

In classical tourism education, the topic of sustainability is rather neglected, but based on Barber et al. (2011), Leung et al. (2018) and Cotterell et al. (2019), it is crucial that today's students from different disciplines, including tourism and hospitality management, acquire knowledge of sustainability concepts in its widest scope and understand the impact of human activity and the relationship between the latter and the environment. Therefore, the developed methodology has been proved to be relevant in tourism, destination, recreation, or nature tourism-based studies as study material for raising awareness of the impact of the ecological carrying capacity and tourist activities on nature areas. The students claim that they have gained the knowledge that helps to develop and maintain recreational activities, services, and areas in a sustainable way in their future work and leisure practices.

The methodology was developed by a tourism management student together with a tutor, and tested by the student. Testing with number of students in the fields revealed that the methodology with a short introduction was easy to understand and use even by students who did not have previous knowledge and skills related to environment studies. Therefore, the methodology could be used by different stakeholders in the future. Service

providers and destination managers can use the methodology to easily assess the condition of their disc golf parks and take proactive measures to mitigate the impact of recreational activities. Universities can use it as a practical tool for outdoor learning about environmental carrying capacity.

Limitations and Implications for Future Research

In future studies, this methodology can be further developed, and the extent can be determined to which the impact of disc golf on the soil and vegetation coverage may reach from the basket area. In addition, the measurement of the disturbance level of woody plants in this methodology can be improved by the addition of a measurement scale for assessing damage to young growths. For example, if young stands are included within the measurement range, the percentage of the approximate disturbance (hit trees) of the entire young stand can be found. Determining the level of disturbance of each tree in a young stand would, according to the author, prove too time-consuming, but such an approach is not excluded.

This study focused on developing and testing the methodology for environmental impact investigation. The social impact was not specifically studied. At the same time, gathering background information on disc golf courses in Estonia in media publications revealed that there were several cases where disc golf courses had caused environmental as well as social problems. Further studies should therefore also focus on determining relevant social issues in order to develop a methodology for exploring the social carrying capacity and to identify the causes and consequences of and solutions to these problems.

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References

Alasalmi, J., & Apiainen, T. (2013). *Development plan for ruka disc golf*. Bachelors' thesis, Kajaani University of Applied Sciences. ihttps://www.theseus.fi/bitstream/handle/10024/69493/Alasalmi_Jaakko_Apiainen_Teemu.pdf?sequence=1&isAllowed=y

Ameli, K. (2022). Where is nature? Where is nature in nature and outdoor learning in higher education? An analysis of nature-based learning in higher education using multispecies ethnography. *Journal of Teacher Education for Sustainability*, *24*(2), 113–128. https://doi.org/10.2478/jtes-2022-0020

Barber, N., Deale, C., & Goodman, R. (2011). Environmental sustainability in the hospitality management curriculum: Perspectives from three groups of stakeholders. *Journal of Hospitality and Tourism Education, 23*(1), 6–17. https://www.tandfonline.com/doi/abs/10.1080/10963758.2011.10696994

Celestino, T., & Pereira, A. (2012). The sport of orienteering: Performance of physically active people who partake in leisure activities but have no experience in this modality. *Cultura Ciencia Deporte*, *7*, 45–52. https://doi.org/10.12800/ccd.v7i19.24

Cole, D., & Wright, V. (2004). Information about wilderness visitors and recreation impacts. *International Journal of Wilderness*, *10*(1), 27–31. https://www.fs.fed.us/rm/pubs_other/rmrs_2004_cole_d002.pdf

Clark, J. R. (2005). *Golden Gate Park Arborist Report*. http://savemclarenpark.org/SMP_docs/GG_arborist_report_2005.pdf

Cotterell, D., Hales, R., Arcodia, C., & Ferreira, J. A. (2019). Overcommitted to tourism and under committed to sustainability: The urgency of teaching "strong sustainability" in tourism courses. *Journal of Sustainable Tourism*, *27*(7), 882–902. https://doi.org/10.1080/09669582.2018.1545777

Gutzwiller, K. J., D'Antonio, A. L., & Monz, C. A. (2017). Wildland recreation disturbance: Broad-scale spatial analysis and management. *Frontiers in Ecology and the Environment*, *15*(9), 517–524. https://doi.org/10.1002/fee.1631

Haley, H. (2002). *Exploring emerging recreation and its planning challenges: The case of disc golf in Calgary*. Master thesis, University of Calgary. http://dx.doi.org/10.11575/PRISM/14663

Hurt, E., Karoles, K., Maran, K., Sepp, K., & Vendla, V. (2009). Koormustaluvuse hindamise metoodika kaitsealadel seoses nende rekreatiivsete kasutamisega [The methodology for assessing carrying capacity in protected areas in relation to recreational use]. Eesti Maaülikool. https://www.vvvs.ee/failid4/Koormustaluvuse%20METOODIKA.pdf

Ingver, A. (2016). *Discgolfi mõju keskkonnale. Discgolfi pargi sobivus maastikku Põltsamaa näitel* [Disc golf impact on the environment. Disc golf course suitability in the environment on the example of Põltsamaa city] Master thesis. https://discgolfiliit.ee/wp-content/uploads/2016/06/Argo_Ingver_Magistrit%c3%b6%c3%b6_Discgolfi_m%c3%b5jud_keskkonnale_elektrooniline.pdf

International Orienteering Federation. (2015). *IOF trail orienteering competition rules 2014*. https://www.orientacnisporty.cz/upload/dokumenty/trail-o/ioftrail-orules2014_20141116115409.pdf

James, V. U. (Ed.). (2018). *Capacity building for sustainable development*. CAB International.

Kajala, L., Almik, A., Dahl, R., Dikšaitė, L., Erkkonen, J., Fredman, P., Jensen, F. Søndergaard, Karoles, K., Sievänen, T., Skov-Petersen, H., Vistad, O. I., & Wallsten, P. (2007). *Visitor monitoring in nature areas – A manual based on experiences from the Nordic and Baltic countries*. Swedish Environmental Protection Agency.

Karjus, J. (2015). Pirital suletakse populaarne discgolfi rada [The disc golf course is closed in Pirita]. https://www.postimees.ee/3308271/pirital-suletakse-populaarne-disc-golfi-rada

Kask, R. (2017). Discgolf Nõmmel – kas säilitada või likvideerida? [Disc golf in Nõmme – To maintain or close]. https://www.postimees.ee/4088507/discgolf-nommel-kas-sailitada-voi-likvideerida

Kim, J. H., & Jeong, M. (2018). Research on hospitality and tourism education: Now and future. *Tourism Management Perspectives*, *25*, 119–122. https://doi.org/10.1016/j.tmp.2017.11.025

Lackey, Q. N., Tysor, D. A., McNay, D. G., Joyner, L., Baker, K. H., & Hodge, C. (2019). Mental health benefits of nature-based recreation: A systematic review. *Annals of Leisure Research*, *21*(5). https://doi.org/10.1080/11745398.2019.1655459

Leung, Y. F., Spenceley, A., Hvenegaard, G., Buckley, R., & Groves, C. (2018). *Tourism and visitor management in protected areas: Guidelines for sustainability*. IUCN. https://doi.org/10.2305/IUCN.CH.2018.PAG.27.en

Leung, Y. F. (2013). *Resource condition assessment and monitoring of disc golf courses. Manual of procedures. Parks, recreation and tourism management*. Raleigh.

Leung, Y. F., Walden-Schreiner, C., Matisoff, C., Naber, M., & Robinson, J. (2013). A two-pronged approach to evaluating environmental concerns of disc golf as emerging recreation in urban natural areas. *Managing Leisure*, *18*(4), 273–285. https://doi.org/10.1080/13606719.2013.809181

Mansfield, L. (2021). Leisure and health – Critical commentary. *Annals of Leisure Research*, *24*(3), 283–294. https://doi.org/10.1080/11745398.2020.1767664

Marion, J. L., Leung, Y. F., Eagleston, H., & Burroughs, K. (2016). A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry*, *114*(3), 352–362. https://doi.org/10.5849/jof.15-498

Marzano, M., & Dandy, N. (2012). *Recreational use of forests and disturbance of wildlife. A literature review*. Forestry Commission. https://cdn.forestresearch.gov.uk/2012/07/fcrp020.pdf

McCullough, B. P., Bergsgrad, N. A., Collins, A., Muhar, A., & Tyrväinen, L. (2018). *The impact of sport and outdoor recreation (Friluftsliv) on the natural environment*. MISTRA. https://www.mistra.org/wp-content/uploads/2018/06/Sport-and-outdoor-recreation-background-paper-2018-1.pdf

McGinlay, J., Gkoumas, V., Holtvoeth, J., Fuertes, R. F. A., Bazhenova, E., Benzoni, A., Botsch, K., Martel, C. C., Sánchez, C. C., Cervera, I., Chaminade, G., Doerstel, J., García, CJ. F., Jones, A., Lammertz, M., Lotman, K., Odar, M., Pastor, T., Ritchie, C., … & Jones, N. (2020). The impact of COVID-19 on the management of European protected areas and policy implications. *Forests*, *11*, 1214. https://doi.org/10.3390/f11111214

Monz, C. A., Pickering, K. M., & Hadwen, W. L. (2013). Recent advances in recreation ecology and the implications of different relationships between recreation use and ecological impacts. *Frontiers in Ecology and the Environment*, *11*(8), 441–446. https://www.jstor.org/stable/43187657

Newsome, D., Moore, S. A., & Dowling, R. K. (2013). *Natural area tourism. Ecology, impacts and management* (2nd ed). Channel View Publications.

Ojasaar, R. (2018). Likvideeritavale Nõmme discgolfirajale leiti uus asukoht, lisaks täispikale rajale luuakse ka algajatele rada [New location fount to the Nõmme disc golf course under closure, next to the full course a beginner's course will be created]. *Delfi Sport*. https://sport.delfi.ee/news/varia/muu/likvideeritavale-nomme-discgolfirajale-leiti-uus-asukoht-lisaks-taispikale-rajale-luuakse-ka-algajate-rada?id=83876889

Oldakowski R., Mcewen, J. W. (2013). Diffusion of disc golf in the United States. *Geographical Review*, *103*(3), 355–371. https://doi.org/10.1111/j.1931-0846.2013.00003.x

PDGA (n.d. – a). *PDGA world rankings*. https://www.pdga.com/players/rankings/world

PDGA (n.d. – b.). *A guide to disc golf from the PDGA*. https://www.pdga.com/introduction

PDGA (n.d. – c). *Disc golf course design elements*. https://www.pdga.com/course-development/design-elements

Pigram, J. J., & Jenkins, J. M. (2006). *Outdoor recreation management* (2nd ed). Routledge.

Pipere, A. (2019). Journal of Teacher Education for Sustainability after the UN Decade of Education for Sustainable Development: Exploring for the future. *Journal of Teacher Education for Sustainability*, *21*(1), 5–34. https://doi.org/10.2478/jtes-2019-0002

Roose, A., Sepp, K., Vendla, V., Villoslada, M., Semm, M., Järv, H., Raet, J., Hurt, E., & Veersalu, T. (2011). Kaitsealade külastuskoormuse hindamise juhend: Seiremeetodite arendamine ja rakendamine [The guide for assessing visitor carrying capacity in protected areas: Developing and implementing monitoring methods]. SA Keskkonnainvesteeringute Keskus.

Pousson, J. M., & Myers, K. A. (2018). Ignatian pedagogy as a frame for universal design in college: Meeting learning needs of Generation Z. *Education Sciences*, *8*(4), 193, 1–10. https://doi.org/10.3390/educsci8040193

Roosna, M. (2018). Miks ülipopulaarne disc golf Tallinnasse ära ei mahu? Ka Nõmme park suletakse [Why the extra popular disc golf does not fit in Tallinn? The Nõmme park will also be closed]. *Delfi Sport*. https://sport.delfi.ee/news/varia/muu/miks-ulipopulaarne-disc-golf-tallinnasse-ara-ei-mahu-ka-nomme-park-suletakse?id=83588197

Roosna, M. (2019). See sõda on läinud ajuvabalt koledaks. Nad teevad kõik, et meie spordiala sealt kaoks [This war has become senselessly ugly. They do all to exterminate our sport from there]. *Delfi Sport*. https://sport.delfi.ee/news/varia/muu/see-soda-on-lainud-ajuvabalt-koledaks-nad-teevad-koik-et-meie-spordiala-sealt-kaoks?id=85113579

Rotmeister, R. (2019). Eesti on maailmas 3-s discgolfi riik! [Estonia is the third Discgolf country in the World!] *EDGL*. http://discgolfiliit.ee/eesti-on-maailmas-3-s-discgolfi-riik/

Schirpke, U., Scolozzi, R., Da Re, R., Masiero, M., Pellegrino, D., & Marino, D. (2018). Recreational ecosystem services in protected areas: A survey of visitors to Natura 2000 sites in Italy. *Journal of Outdoor Recreation and Tourism*, *21*, 39–50. https://doi.org/10.1016/j.jort.2018.01.003

Shafiee, S., Hasanzadeh, A., Rajabzadeh Ghatari, A., & Jahanyan, S. (2019). Developing a model for sustainable smart tourism destinations: A systematic review. *Tourism Management Perspectives*, *31*, 287–300. https://doi.org/10.1016/j.tmp.2019.06.002

Sinclair, M., Mayer, M., Woltering, M., & Ghermandi, A. (2020). Using social media to estimate visitor provenance and patterns of recreation in Germany's national parks. *Journal of Environmental Management*, *263*, 1–12. https://doi.org/10.1016/j.jenvman.2020.110418

Siniscalchi, J. M. (2004). *The personal and community benefits of disc golf to rural America (and beyond)*. Master thesis. West Virginia University. https://www.pdga.com/files/documents/BenefitsOfDiscGolf-Siniscalchi.pdf

Thomsen, J. M., Powell, R. B., & Monz, C. (2018). A systematic review of the physical and mental health benefits of wildland recreation. *Journal of Park and Recreation Administration*, *36*, 123–148. https://doi.org/10.18666/JPRA-2018-V36-I1-8095

Tuononen, T., Parpala, A., & Lindblom-Ylänne, S. (2019). Graduates' evaluations of usefulness of university education, and early career success – A longitudinal study of the transition to working life. *Assessment & Evaluation in Higher Education*, *44*, 581–595. https://doi.org/10.1080/02602938.2018.1524000

Trendafilova, S. A., & Waller, S. N. (2011). Assessing the ecological impact due to disc golf. *International Journal of Sport Management, Recreation & Tourism*, *8*, 35–64. https://doi.org/10.5199/ijsmart-1791-874X-8c

Tyrväinen, L., Uusitalo, M., Silvennoinen, H., & Hasu, E. (2014). Towards sustainable growth in nature-based tourism destinations: Clients' views of land use options in Finnish Lapland. *Landscape and Urban Planning*, *122*, 1–15. https://doi.org/10.1016/j.landurbplan.2013.10.003

WEB (n.d. – a). *Discgolfi Rajad. Kilingi-Nõmme discgolfi park* [Disc golf courses. Kilingi-Nõmme disc golf park]. https://www.discgolfirajad.ee/park/kilingi-nomme-discgolfipark/

WEB (n.d. – b). *Discgolfi Rajad. Jõulumäe discgolfi park (Kollane)* [Disc golf courses. Jõulumäe disc golf park (Yellow)]. https://www.discgolfirajad.ee/park/joulumae-discgolfi-park-kollane/

WEB (n.d. – c). *Discgolfi Rajad. Jõulumäe discgolfi park (Punane)* [Disc golf courses. Jõulumäe disc golf park (Red)]. https://www.discgolfirajad.ee/park/joulumae-discgolfi-park-punane/

WEB (n.d. – d). *Discgolfi Rajad. Jõulumäe discgolfi park (Sinine)* [Disc golf courses. Jõulumäe disc golf park (Blue)]. https://www.discgolfirajad.ee/park/joulumae-discgolfi-park-sinine/

WEB (n.d. – e). (2020). *Disc golf metrix. Top 100 players*. https://discgolfmetrix.com/?u=mystat

Vedru, J. (2018). Disc golfi rõõmud ja mured – populaarne ala pahandab loodusesõpru [The joys and worries of disc golf parks. The popular sports annoy nature-lovers]. *ERR Sport*. https://sport.err.ee/876362/discgolfi-roomud-ja-mured-populaarne-ala-pahandab-loodusesopru

West, C. D. (2010). *Connection to nature in park visitors: A look at structured and unstructured recreational activities*. Master thesis. University of Nebraska at Lincoln. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1004&context=natresdiss

WFDF. (2020). *WFDF world rankings*. https://wfdf.sport/2019/10/wfdf-releases-updated-disc-golf-world-rankings/

Willibald, F., van Strien, M. J., Blanco, V., & Gret-Regamey, A. (2019). Predicting outdoor recreation demand on a national scale – The case of Switzerland. *Applied Geography*, *113*, 1–13. https://doi.org/10.1016/j.apgeog.2019.102111

Winter, P., Selin, S., Cerveny, L., & Bricker, K. (2020). Outdoor recreation, nature-based tourism, and sustainability. *Sustainability*, *12*(1), 1–12. https://doi.org/10.3390/su12010081

Woods, J., Cossman, J. S., & Wolf, J. K. (2020). Disparities in disc golf course distribution in the United States. *Managing Sport and Leisure*. https://doi.org/10.1080/23750472.2020.1856711

World Health Organization. (2018). *Global action plan on physical activity 2018–2030: More active people for a healthier world*. https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf?ua=1

Yska, R. (Ed.). (1997). Management of the environmental effects associated with the tourism sector. Office of the Parliamentary Commissioner for the Environment.

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