PERSPECTIVE ON FOREST BIODIVERSITY INDICATORS FOR PROTECTED AREAS: A COMPARISON OF TURKISH AND SWEDISH FOREST EXPERT OPINIONS

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Abstract. This paper presents a comparative analysis of expert opinions on forest biodiversity indicators for protected areas, using a questionnaire given to forest experts in Turkey and Sweden. Experts were selected according to whether they had studied or worked in areas related to biodiversity, protected areas and sustainable forest management. A Mann-Whitney U test was used to determine the differences between the opinions of Swedish and Turkish experts regarding the indicators. The experts from both countries considered “endemic species” and “naturalness” as the most important indicators, while “overused species”, “forest distribution and regeneration”, “carrying capacity in terms of important species of area” and “the existence of different conservation status of protected areas” were considered equally as the least important indicators. The most important difference between the two groups was related to the indicators “dead wood” and “hollow trees”, which Swedish experts found more important than their Turkish counterparts. Two other large differences were that the Swedish experts found “litter layer” much more important and Turkish experts instead found “plant species composition” much more important. The differences between the two groups reveal different perspectives regarding the planning and management of protected areas in each respective country.
Keywords: *sustainable forest management, dead wood, hollow trees, Turkey, Sweden*

Introduction

First introduced to the forestry literature in the 1990s, sustainable forest management criteria and indicators have been important tools for measuring the sustainability of forests (Mendoza and Prabhu, 2000; Brang et al., 2002). In 1992, the International Tropical Timber Association (ITTO) was the first to propose such criteria and indicators for tropical forests (ITTO, 1992, 2005). Subsequently, the annual Rio Summit highlights the importance of sustainable forest criteria and indicators, along with monitoring and reporting. (Castañeda et al., 2001; Rametsteiner, 2001; Mcdonald and Lane, 2004; Wolfslehner et al., 2005; Mrozek et al., 2006; Steenberg et al., 2013). Recently, the first step was taken towards the development of criteria and indicators for sustainable forest management for nine regional processes in the world. These processes include: the International Tropical Timber Organization (ITTO), Helsinki Process (MCPFE/Pan-European Process), Montreal Process, Tarapoto Proposal, Dry Zone Africa Process, African Timber Organization Process (ATO), Near East Process,

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Lepaterique Process of Central America and Dry Zone Asia Process (Akyol and Tolunay, 2014).

For these regional processes, seven key levels were identified as an overall framework for sustainable forest management. These levels include: the extent of forest resources, biodiversity, health and vitality of forest ecosystems, protective functions of forests, productive functions of forests, socio-economic functions, and legal, political and institutional framework (Castañeda, 2000; Siry et al., 2005; Purnomo et al., 2005; Grainger, 2012).

Among these levels, biodiversity criteria and indicators have been among the most debated since the Rio Summit. Until recently a great deal of effort has been undertaken to further develop the indicators for this criteria (Kotwal et al., 2008) because biodiversity refers to the dynamism, health, sustainability and energy of an ecosystem and its resilience against any kind of disturbance factor (Gülsoy and Özkan, 2008). In short, biodiversity is one of the fundamental bases for the continuity of life. Moreover, there are crucial challenges for ensuring the sustainability of biodiversity (Hagan and Whitman, 2006). These challenges arise because biodiversity is typically defined as the diversity of life measured at the levels of genes, species and ecosystems and the mutual interactions between these levels (Hagan and Whitman, 2006; Gaston, 1996; Claridge et al., 1997). Genetic structure is the primary component of vitality and is the basis of these levels.

The most important factor for the protection and sustainable use of biodiversity is the need to make a quantitative assessment of biodiversity (Duelli and Obrist, 2003). However, due to various challenges, the most practical approach for assessment is to use indicators related to biodiversity (Hagan and Whitman, 2006; Lindermayer et al., 2000). However, it is also difficult to identify and measure indicators for biodiversity (Heink and Kowarik, 2010) because the variables that can be practically surveyed and quantified are quite limited.

The main strategies developed to protect biodiversity and ensure its sustainability primarily include legal protection and the sustainable management of areas (Svancara et al., 2005). Protected areas that cover almost 12% of the Earth's surface are an important component of global protection strategies (Wells and McShane, 2004; Bajracharya et al., 2005). Although there are a broad spectra of indicators related to sustainable forest management, none of the abovementioned processes adequately describe protected areas (Blicharska et al., 2011; Tolunay and Akyol, 2015). This is because sustainable forest management processes utilize indicators that focus mainly on production forests across the world, which differ from protected areas.

Protected areas are of vital importance for biodiversity, and thus it is necessary to develop appropriate criteria and indicators. For example, one of the objectives of the "Integrated Approach to Management of Forests in Turkey, with Demonstration in High Conservation Value Forests in the Mediterranean Region" project implemented by the United Nations Development Programme is to develop biodiversity indicators in Turkey within the scope of sustainable forest management (UNDP, 2017).

The aim of this study was to evaluate biodiversity indicators that can be used for the sustainable management of protected areas, using opinions from experts. This data is then preliminarily presented for further discussion. From a global point of view, different or similar perspectives to various indicators are to be expected. Factors such as climate, geographical location, biodiversity, development level, and cultural features change the perceptions about and perspectives regarding protected areas in terms of

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nature conservation. To obtain some diverse perspectives, expert views were solicited about the protected areas in Turkey to represent Mediterranean forestry and from Sweden to represent Nordic forestry. We aimed to contribute to the protection and sustainable management of biodiversity in protected areas, which is of great importance at a global scale.

Materials and methods

The main materials of this study were comprised of indicators related to the protection, development and sustainability of biodiversity, which are among the criteria and indicators for sustainable forest management. The primary data was obtained from a survey conducted online in Turkey and Sweden. The secondary data was composed of information obtained from literature analyses and information, and documents and reports from various public entities and organizations (FAO, CIFOR, etc.).

The questionnaire was composed of multiple choice questions using a 4-point Likert scale (not important, less important, important and very important). The questionnaire contained a total of 27 questions divided into two parts. The first part asked about demographic features of the participating experts. The second part asked the experts to assess a set of biodiversity indicators developed from different sustainable forest management studies across the world (*Table 1*).

Table 1. *The set of indicators[1] prepared for the evaluation by the experts*

Indicators	Definition
Plant species composition	The number and composition of plant species per forest types and other wooded area types
Naturalness	The amount of forest types and other wooded area types divided in natural, semi natural or plantation
Forest distribution and regeneration	The rates of natural regeneration and survival of tree species
Sensitive and rare ecosystems	The amount and distribution of sensitive and rare ecosystems
Dead wood	The volume of standing and downed dead wood in different forest types and other wooded area types
Hollow trees	The number of hollow trees and the proportion of the total amount of trees or wood volume
Litter layer	The litter and decaying condition
Genetic resources	The condition of forest genetic resources in the areas managed for seed production, protected areas and other areas
Ecosystem structure	The spatial structure of forest covers in the ecosystem level
Endangered species	The number of endangered forest species according to Red List classification of International Union for Conservation of Nature (IUCN) in relation to total number of forest species. (Threatened, rare, vulnerable, endangered or extinct, mammals, birds other vertebrates or invertebrates)
Endemic species	The population condition of endemic forest species
Overused species	The population condition for overused forest species
Species whose lives depend on protected areas	The number of individuals and population trend for species dependent of protected forests

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Species whose distribution area is declining and habitat loss	The size of declining species distribution area and the existence and status of forest habitat losses within protected areas
Major distribution areas and population status of the species	The size of distribution area and population status for forest species
Carrying capacity in terms of important species of area	The carrying capacity for important species of protected areas
Water resources and wetland	The quality of water resources and wetlands in forests (Number and area)
Damaged areas	The size and proportion of forest areas damaged by various processes and factors (Pests, disease, fire and flood)
Human use of protected areas	The size and proportion of human uses of land within protected areas (Residential areas, agricultural areas, such as roads, etc.)
Effects of other sectors	The effect on forest from other sectors (Mining, agriculture, livestock, energy and infrastructure etc.)
Existence of contaminants around protected areas	The number, size and type of pollutants around protected forest areas
Differentiated conservation status within protected areas	The existence of areas with different conservation status within the protected forest area (Status, size, cause etc.)
Other issues important for sustainable management	-The availability and capacity of an institutional structure for the management and existence of functional legislation -The existence of economic policy framework and financial instruments -The educational and informational opportunities for implementation of the policy framework -the strengthening of knowledge about endangered species (inventory or research) -The management plans

[1]This set is based on the biodiversity indicators used in International Tropical Timber Organization (ITTO), Helsinki Process (MCPFE/Pan-European Process), Montreal Process, Tarapoto Proposal, Dry Zone Africa Process, African Timber Organization Process (ATO), Near East Process, Lepaterique Process of Central America, Dry Zone Asia Process, Center for International Forestry Research (CIFOR) processes at global level (FAO, 1996, 1997, 2003, 2004, 2010; CIFOR, 1999; ITTO, 2003, 2005; CCFM, 2004; MCPFE, 2006; MPCI, 2017)

In this study, the expert group consisted of specialists from universities and research institutions, experts at ministries of agriculture, forestry and environment related to protected areas, and NGO representatives in both Turkey and Sweden. Experts were selected according to whether they had studied or worked in areas related to biodiversity, protected areas and sustainable forest management. The interest areas and biographies of the experts were reviewed on their web sites.

Three-hundred participants who were assumed to be related to the subject were asked to participate in the study. The survey was submitted to Turkish and Swedish experts simultaneously between September and December 2016. The web link for the questionnaire was sent to Turkish and Swedish experts via email. During the survey, three reminders were given once a month. Ultimately, 122 experts from Turkey and 112 experts from Sweden participated in the survey. Therefore, the response rate was quite high (81.3% for Turkish, 74.6% for Swedish experts), and we assumed that this rate was rather satisfactory (Nulty, 2008). The profile characteristics of the experts participating in the study are demonstrated in *Table 2*. One third of the experts in the study were women and the proportion of women was higher in the Swedish group. The Swedish

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group had a slightly lower average age than the Turkish group. Nearly 70% of the experts belonged to universities and research institutes. There was a higher proportion of experts from universities and research institutes in the Turkish group. The Swedish group had a higher proportion of experts from governmental institutions, but a lower proportion from NGOs.

Statistical analyses were conducted using Statistical Package Program (SPSS 20.0) and the results were evaluated at a significance level of 5%. Cronbach's alpha coefficient was calculated as 0.856, and was greater than 0.8; thus, the scale had high statistical reliability. The data obtained from the questionnaire had a non-parametrical distribution (Kolmogorov-Smirnov test, $p < 0.05$); therefore, a Mann-Whitney U test (Nachar, 2008) was used to determine the differences between the opinions of Swedish and Turkish experts regarding the indicators. According to the average of the responses given by the experts, the indicators were ranked starting from indicators that were considered the most important

Table 2. *Profile characteristics of experts*

Characteristics	Turkey		Sweden		Total	
	f	*%*	*f*	*%*	*f*	*%*
Gender						
Female	34	27.9	46	41.1	80	34.2
Male	88	72.1	66	58.9	154	65.8
Age						
20-30	10	8.2	24	21.4	34	14.5
31-40	43	35.2	23	20.5	66	28.2
41-50	41	33.6	40	35.7	81	34.6
51-60	24	19.7	21	18.8	45	19.3
60<	4	3.3	4	3.6	8	3.4
Affiliation/Working Institution						
University	62	50.8	63	56.3	125	53.4
Research Institute	29	23.8	6	5.4	35	15.0
Agriculture, forest and environment ministries	16	13.1	25	22.3	41	17.5
Non-governmental organization (NGO)	9	7.4	3	2.7	12	5.1
Other	6	4.9	15	13.4	21	9.0

Results

Opinions of experts for biodiversity indicators related to forest species

The opinions about the importance of endangered and endemic species as indicators between the Turkish and Swedish experts did not significantly differ (*Table 3*). In other words, the experts in both groups found these indicators equally important (*Fig. 1*).

The evaluated level of importance for the other five species indicators (*Table 3*) was statistically different ($p < 0.05$) between the two groups. For all of these indicators, the level of importance given by Turkish experts was higher than that of Swedish experts (according to 4-point Likert scale) (*Fig. 1*). The least important species indicator in the evaluation was "overused species". It was also the indicator where the evaluation differed most between the groups. In total, 47% of Swedish experts found this indicator

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not and less important, while only 9% of the Turkish experts found this indicator less important.

Table 3. *Mann-Whitney U test results for the importance of forest species indicators*

Indicators	M-Whitney U	Wilcoxon W	Z	p
Endangered species	6325.000	12653.000	-1.798	0.072
Endemic species	6623.000	12951.000	-0.853	0.393
Overused species	4085.000	10413.000	-5.721	**0.000**
Species whose lives depend on protected areas	5889.500	12217.500	-2.494	**0.013**
Species whose distribution area is declining and habitat loss	5924.000	12252.000	-2.328	**0.020**
Major distribution areas and population status of the species	5985.000	12313.000	-2.059	**0.039**
Carrying capacity in terms of important species of area	5123.500	11451.500	-3.720	**0.000**

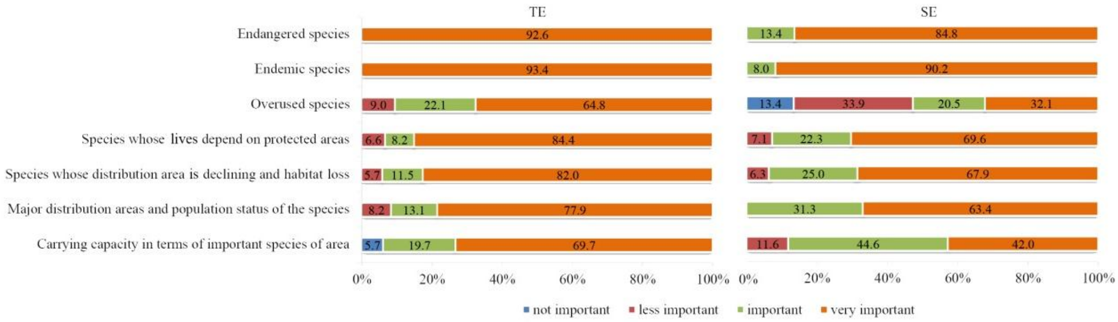

Figure 1. *Differences in given level of importance for the forest species indicators. (Turkish experts: TE, Swedish experts: SE, n_{TE} = 122, n_{SE} = 112, only values > 5%)*

Opinions of experts for indicators related to conservation of natural heritage, genetic resources and some forest structures

Genetic diversity refers to the diversity of genetic material and is assessed as the genetic difference in a specific species, population, variety, subspecies or race. The Turkish and Swedish experts found the indicators for genetic resources very important (*Fig. 2*), and there were no statistically significant differences found between the two groups (*Table 4*).

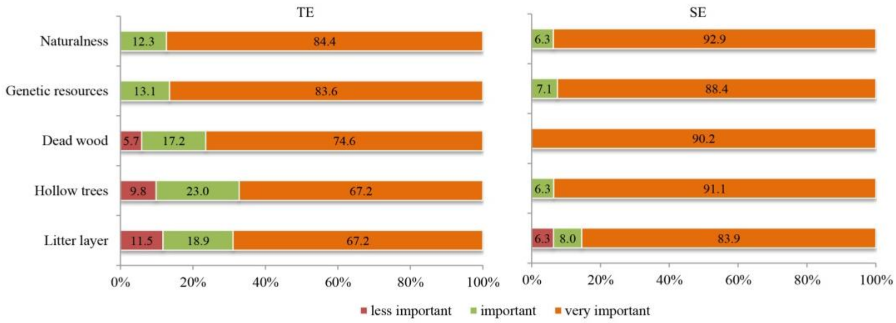

Figure 2. *Differences in given level of importance for the conservation of natural heritage, genetic resources and some forest structures indicators (n_{TE} = 122, n_{SE} = 112, only values > 5%)*

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Turkish experts found the indicators for dead wood and hollow trees less important than their Swedish counterparts (*Fig. 2*). The opinion about the importance of the dead wood and hollow trees indicator differed significantly between Turkish and Swedish experts (*Table 4*). Similarly, the "naturalness" indicator was found more important by the Swedish experts (*Fig. 2*). Another significant difference was that the Swedish experts found litter layer more important than did Turkish experts.

Table 4. *Mann-Whitney U test results for the importance of conservation of natural heritage, genetic resources and some important structures in forests indicators*

Indicators	M-Whitney U	Wilcoxon W	Z	p
Naturalness	6249.500	13752.500	-2.033	**0.042**
Genetic resources	6528.500	14031.500	-0.971	0.332
Dead wood	5801.000	13304.000	-2.984	**0.003**
Hollow trees	5202.000	12705.000	-4.411	**0.000**
Litter layer	5720.500	13223.500	-2.843	**0.004**

Opinions of experts for biodiversity indicators related to ecosystem

Regarding biodiversity indicators related to ecosystem, there were different opinions between the two expert groups for "plant species composition" and "forest distribution and regeneration" (*Fig. 3*). These indicators were found relatively more important by the Turkish experts and were statistically different (*Table 5*).

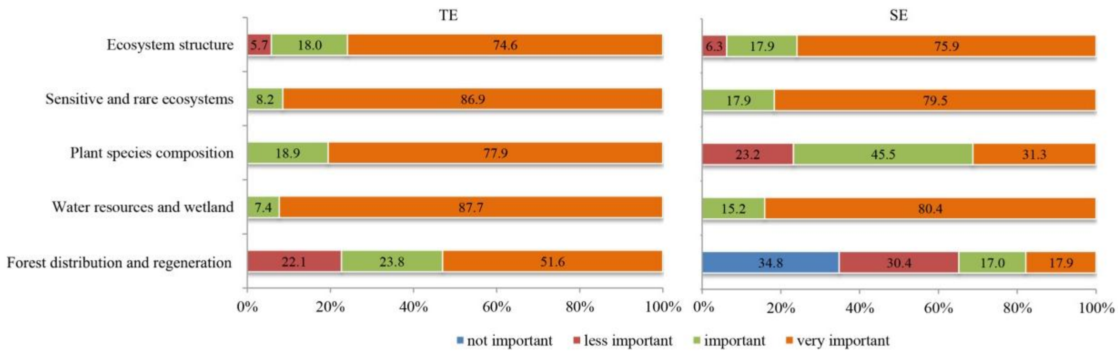

Figure 3. *Differences in given level of importance for ecosystem indicators (n_{TE} = 122, n_{SE} = 112, only values > 5%)*

Table 5. *Mann-Whitney U test results for the importance of ecosystems indicators*

Indicators	M-Whitney U	Wilcoxon W	Z	P
Ecosystem structure	6723.000	14226.000	-0.279	0.780
Sensitive and rare ecosystems	6374.500	12702.500	-1.366	0.172
Plant species composition	3450.000	9778.000	-7.333	**0.000**
Water resources and wetland	6358.500	12686.500	-1.444	0.149
Forest distribution and regeneration	3275.000	9603.000	-7.156	**0.000**

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Turkish and Swedish experts found “sensitive and rare ecosystems” and “ecosystem structure” indicators equally important. The “plant species composition” indicator was found less important by the Swedish experts (*Fig. 3*).

Opinions of experts for biodiversity indicators related to conservation status and external factors

There were no statistically significant differences between the opinions of the Turkish and Swedish experts regarding the importance of forest biodiversity indicators regarding conservation status and external factors (*Table 6*), and most of the experts deemed these indicators as “important” or “very important” (*Fig. 4*).

Table 6. *Mann-Whitney U test results for the importance of conservation status and external factors indicators*

Indicators	M-Whitney U	Wilcoxon W	Z	p
Existence of contaminants around protected areas	6467.500	12795.500	-1.057	0.290
Differentiated conservation status within protected areas	6226.500	12554.500	-1.341	0.180
Effects of other sectors	6788.500	14291.500	-0.110	0.913
Human use of protected areas	6392.500	12720.500	-1.009	0.313
Damaged areas	6650.000	14153.000	-0.450	0.653
Other issues important for sustainable management	6794.500	14297.500	-0.107	0.915

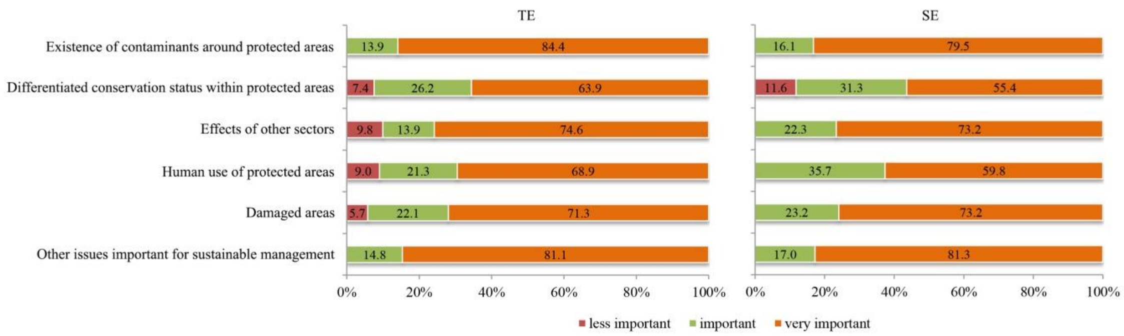

Figure 4. *Differences in given level of importance for forest biodiversity indicators related to conservation status and forest structure (n_{TE} = 122, n_{SE} = 112, only values > 5%)*

Ranking for forest biodiversity indicators

Table 7 presents the ranking of the scores and opinions of the experts for each indicator from the highest score to the lowest according to averages. The averages are calculated from the responses given on a 4-point Likert scale (not important = 1, less important = 2, important = 3 and very important = 4). Accordingly, the top five and last five indicators in the table are indicated with a grey colour. *Table 7* shows that only the indicator “forest distribution and regeneration” out of the 23 indicators had an average value of 2.74. The average value of the remaining 22 indicators was above 3. In general, this indicates that the experts found the indicators appropriate for the study.

The average values of the responses given by the Swedish and Turkish experts regarding the importance level of the indicators reveal that “endemic species” and

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"naturalness" were placed at the top amongst all indicators. This means that experts from both groups found endemic species and naturalness indicators equally important. The indicators for which there were the largest differences in opinion between the Swedish and Turkish experts included "dead wood" and "hollow trees". These indicators were ranked third and fourth, respectively, by Swedish experts, while Turkish experts ranked them fourteenth and eighteenth, respectively. The two indicators where both Turkish and Swedish experts gave the lowest rank and found equally less important were "overused species" and "forest distribution and regeneration". Additionally, "carrying capacity in terms of important species of area" and "the existence of different conservation status of protected areas" were found equally less important (*Table 7*).

Table 7. *Mean scores and rank for the evaluated forest biodiversity indicators*

Indicators	Turkish experts		Swedish experts		Total	
	Mean	Rank	Mean	Rank	Mean	Rank
Endemic species	3.90	1	3.88	2	3.89	1
Naturalness	3.81	5	3.92	1	3.86	2
Endangered species	3.89	2	3.83	6	3.86	3
Genetic resources	3.80	6	3.83	5	3.81	4
Water resources and wetland	3.83	3	3.76	9	3.79	5
Existence of contaminants around protected areas	3.83	4	3.74	10	3.79	6
Sensitive and rare ecosystems	3.80	7	3.77	8	3.78	7
Other issues important for the sustainable management	3.76	9	3.79	7	3.78	8
Dead wood	3.64	14	3.84	4	3.74	9
Hollow trees	3.57	18	3.88	3	3.72	10
Species whose lives depend on protected areas	3.76	8	3.61	15	3.69	11
Ecosystem structure	3.66	13	3.70	12	3.68	12
Species whose distribution area is declining and habitat loss	3.75	11	3.60	16	3.68	13
Damaged areas	3.64	15	3.70	13	3.67	14
Effects of other sectors	3.61	16	3.69	14	3.65	15
Major distribution areas and population status of the species	3.68	12	3.57	17	3.63	16
Litter layer	3.51	21	3.74	11	3.62	17
Human use of protected areas	3.58	17	3.55	18	3.57	18
Differentiated conservation status within protected areas	3.52	20	3.40	19	3.46	19
Plant species composition	3.75	10	3.08	21	3.43	20
Carrying capacity in terms of important species of area	3.53	19	3.27	20	3.41	21
Overused species	3.48	22	2.71	22	3.11	22
Forest distribution and regeneration	3.25	23	2.18	23	2.74	23

Other indicators with large differences were "plant species composition," as this was ranked tenth by Turkish experts and only twenty-first by Swedish experts. On the contrary, "litter layer" was ranked eleventh by Swedish experts and twenty-first by Turkish experts and was found less important than other indicators. The sometimes-diverging opinions between the groups are interesting, and can be helpful in defining the most important forest

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biodiversity indicators. The dynamic and varying structure of the indicators contribute positively to the identification of the best indicators for a given region.

Discussion

Dead wood and hollow trees represent structures of great importance for biodiversity and ecosystem health in forests. They provide important habitats for many species. Furthermore, they play a crucial role in increasing the resilience of forests and ensuring the continuity of ecological balance. Dead wood is a critical source for forest biodiversity and is commonly used as an indicator for sustainable forest management (Jonsson et al., 2016). Although the importance of dead wood for biodiversity is commonly known, directed strategies for protection of dead wood in forest ecosystems are implemented only in some of the regions across the world (Seibold et al., 2015). The most important difference among indicators is “dead wood” and “hollow trees” according to the experts in this study. Turkish experts found these indicators less important. One reason for this may be because of the common belief in Turkey that the existence of dead wood and hollow trees results in entomological pest species outbreaks (bark beetles, etc.) and may have implications for protected areas, for example by increasing the risk of forest fires. On the contrary, hollow trees have for a long time been known among Swedish foresters and biologists as very important for cavity nesting birds and many saproxylic invertebrates (Ehnström and Waldén, 1986; Nilsson and Baranowski, 1994; Ranius and Jansson, 2000). For Turkish conditions, similar results have been found in recent studies (Jansson and Coskun, 2008; Sama et al., 2011; Bergner et al., 2016), but this knowledge is still new and not commonly acknowledged in Turkish society.

Swedish experts found the “naturalness” indicator more important. This may be because of the opinion in Sweden that a desirable management regime in many protected forest areas is to make them look as “untouched” as possible (Steinwall, 2015). Turkish experts found the indicators for “plant species composition” and “forest distribution and regeneration” more important. One reason for this may be that the question of whether or not silvicultural treatments should be implemented in the protected areas of Turkey is still controversial. This debate exists because the affected areas are impacted to a certain extent by anthropogenic factors that are sometimes from entomological pest species outbreaks and an increased risk of forest fire (Colak, 2001; Alptekin et al., 2010). In Sweden there are lower risks for wild fires, and in some forest habitats wild fires are seen as positive and a part of the natural disturbance regime in the northern taiga forest ecosystem (Drobyshev et al., 2012).

The indicators for “sensitive and rare ecosystems” and “ecosystem structure” are used for monitoring, particularly in protected areas (Akyol and Tolunay, 2014). These ecosystems are jeopardized by the global climate change (Williams et al., 2015). Climate change may have multiple effects such as those related to the dynamics of species within ecosystems and abiotic factors that may have implications for ecosystems, such as forest fire dynamics (Costanza et al., 2016). Turkish and Swedish experts found these indicators equally important. It is also important to monitor “plant species composition” and put this in relation to these effects (Seidl et al., 2014; Pommerening et al., 2016), but in this study the Swedish experts found this less important than Turkish experts.

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Regarding biodiversity indicators related to conservation status and external factor, there were same opinions between the two expert groups and these indicators were found important or very important. Similar to most developing countries, a rigid and conservative approach is dominant in Turkey. This is the reason why local people are usually excluded from the planning and management of protected areas in Turkey. This approach is based on the assumption that a natural resource can be protected by prohibiting or restricting its exploitation as a natural resource by law (Rutagarama and Martin, 2006). This approach leads to a conflict between managers and users from the perspective of objectives set for the protected areas, since the aims of the resource managers are to minimize or prevent the utilization of these resources while users try to increase their utilization of the resources or at least maintain the same level of exploitation (Alkan, 2009; Alicia et al., 2018). Ultimately, rigid and passive protection approaches fail because there is dependence by local people on the natural resources in or around protected areas. This is especially the case in developing countries, where use could not be eliminated and alternative sources of income could not be provided to locals who are already in difficult socioeconomic situations. As such, protection often times exists only on paper (Akyol et al., 2017; Alkan et al., 2009; Alkan and Korkmaz, 2009; Thomas and Middleton, 2003; WWF, 2003; Arias et al., 2000).

Conclusions

It is important to monitor and assess biodiversity and sustainability in protected areas. Suitable indicators for protected areas have not been developed from the perspective of biodiversity and sustainable forest management. This study analysed a set of forest biodiversity indicators developed in international processes and solicited opinions from Turkish and Swedish forest experts to compare and analyse the indicators.

Although the overall ranking order differed, the first nine indicators were ranked the same by both expert groups and the top four indicators in total when adding the two groups together were among top six for both groups. These indicators were: “endemic species”, “naturalness” “endangered species” and “genetic resources”. The indicators with the lowest rankings in total and for both expert groups were “overused species” and “forest distribution and regeneration”.

Indicators with significant importance ranking differences were “dead wood” and “hollow trees”. This has important implications. Recent studies have shown very high biodiversity in old hollow oaks in Turkey, and thus these studies should be expanded to also cover other tree species and dead wood in general in Turkish forests. Naturally it takes time before results from scientific studies gains acceptance in society, and as such differences may be in part due to such a time lag in distributing knowledge.

The results also reveal different perceptions on the importance of such structures amongst people from different biogeographical regions, and hence environmental conditions may result in different perspectives on nature management. The differences should be considered an advantage in the process of developing improved biodiversity indicators as both groups could benefit from each other’s experiences in these matters.

There is a need for further studies to evaluate the measurability of these indicators and to identify indicators that are the most cost-effective and reliable for measurement and quantification. It is also preferable if these indicators can be monitored in a standardized manner to ensure non-biased long-term data regarding indicator dynamics and how they relate to external factors, such as climate change. The set of indicators assessed in this study are a first step in the process of developing appropriate indicators for biodiversity in protected areas. This research provides a solid base and a guideline for the next step in the process.

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