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Perceived importance of ecosystem services in the Białowieża Forest for local communities – Does proximity matter?

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ABSTRACT

Effective protection of biodiversity in areas of high conservation value requires trade-offs between local use of natural resources and conservation restrictions. The compromise is often difficult to reach, which causes conflicts over the management priorities of existing and potential protected areas. Ecosystem services (ES) perspective offers a promising avenue for diagnosing and reconciling contrasting interests concerning the use of benefits from ecosystems. We examined how the spatial proximity to the Białowieża Forest (BF), a European biodiversity hotspot, affects the perceived use of ES by local communities. We performed a survey among 719 respondents from 35 villages situated within BF and in its vicinity. We found that both the declared use of ES and the perceived influence of ES on household's economy was declining with the distance from BF with particularly high differences between areas not further than 3 km from BF and areas located 3-15 km from BF. Different zones varied in terms of benefits from tourism and costs connected with a potential limited access to ES due to conservation. Broadening the perspective, we argue that the trade-offs linked to ES may vary depending on the location in relation to the protected area and that local communities should not be treated as a homogenous group when considering benefits from the forest. Awareness of common patterns of ES use over space and local specificity may enhance effective management of even highly contested conservation areas.

1. Introduction

The Millennium Ecosystem Assessment (MA), published in 2005, asserted that services provided by ecosystems (i.e. Ecosystem Services; MA, 2005; Ehrlich and Ehrlich, 1991) support human well-being. MA delineated four different categories of ecosystem services (ES); supporting ES (e.g. soil formation or pollination), provisioning ES (e.g. food production or provision of medicinal resources), regulating ES (e.g. carbon sequestration or purification of water) and cultural ES (e.g. recreational experiences or spiritual values). Introduction of ES thereby provided a novel perspective on the use and management of landscapes ranging from those that are almost pristine (e.g. Pederson et al., 2006; Nahuelhual et al., 2007; Nikodinoska et al., 2015) to those that are highly altered by humans (e.g. Bolund and Hunhammar, 1999; Jim and Chen, 2009; Haase et al., 2014). Although ES concept is contested since it may be viewed as promoting exploitative human-nature relationship and possibly being in conflict with biodiversity conservation objectives (Schröter et al., 2014), it is undoubtedly providing an important tool for quantifying the status of human-nature relationship (e.g. Costanza et al., 2014).

The assessment of ES has become standard instrument in land use management and policies (e.g. Zhao et al., 2004; Metzger et al., 2006). There is an understanding that ES should be assessed and effectively managed to avoid their deterioration (e.g. Maes et al., 2018). The scale of particular assessments of ES delivery ranges from very local (e.g. Tratalos et al., 2007; Liu et al., 2009) through regional and continental (e.g. Eigenbrod et al., 2009; Kienast et al., 2009; Fagerholm et al., 2016) to global (Turner et al., 2007; Costanza et al., 2014). The assessment of ES often involves their economic valuation based on monetary values (Kareiva et al., 2011). However, the assessment may also be performed using non-monetary indicators (e.g. Dasgupta, 2001; Feld et al., 2009; Dobbs et al., 2011). The assessment and management of different types of ES entail a number of issues linked to social, temporal and spatial dimensions of their supply, flow and demand (Burkhard et al., 2014; Martín-López et al., 2014; Blicharska et al., 2017).

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The use of mapping and spatially explicit analyses in assessments of ES are vital instruments for decision makers, enabling them to identify which areas are particularly important in terms of supply and demand of ES (Martinez-Harms and Balvanera, 2012). The resulting maps may also be useful in assessing spatial synergies and trade-offs among different ES, as well as for aligning multiple goals existing in a particular area (Naidoo et al., 2008; Anderson et al., 2009; Maes et al., 2012). The degree of use of ES depends on many different factors including the spatial proximity of the source ecosystem (e.g. Hartter, 2010; Darrel Jenerette et al., 2011; Bagstad et al., 2014; Burkhard et al., 2014).

The assessment and management of ES in conservation areas is particularly challenging because local human needs, especially concerning provisioning ES, must be considered along with the main objective of such areas, namely the maintenance of biodiversity which demands generally low intensity of land-use (e.g. Schneiders et al., 2012). Therefore, studying ES and their use concurrently with biodiversity conservation issues is a necessary step to finding pragmatic solutions, acknowledging possible trade-offs (Palomo et al., 2013), and proposing adequate policy responses, such as payments for ecosystem services (Bishop and Pagiola, 2012). In the case of national parks that border intensively used and densely populated areas, the above issue may be particularly visible and may negatively affect both biodiversity and local livelihoods (e.g. Dressler et al., 2013).

Among different types of ecosystems, forests deliver an especially large quantity of provisioning, regulating, supporting and cultural ES (MA, 2005; Ninan and Inoue, 2013). Furthermore, more diverse forest stands deliver higher levels of multiple ES (Gamfeldt et al., 2013). Not surprisingly, primary forests located in conservation areas potentially offer particularly ample set of ES (firewood, fruits and berries, medical plants, wildlife, amenity values etc.) both for local communities and for tourists (e.g. Straede and Treue, 2006; Hein, 2011; Niedziałkowski et al., 2014). However, the use of ES from forests in conservation areas should be balanced with biodiversity conservation as an overruling management goal. This situation may lead to land-use conflicts concerning the use of ES (e.g. Wang et al., 2006).

One of the internationally renowned areas where conservation and use of natural resources (i.e. ES), have been subject to long-term debate is the Polish part of the Białowieża Forest (BF). The largest part of BF (> 80%) is managed by the State Forests Holding (SFH) with a focus on commercial timber production and to some degree on biodiversity conservation, while the rest is designated as the Białowieża National Park (BNP). For several decades conservation biologists and environmental activists have criticized the forest management of SFH for compromising natural qualities of BF (e.g. Wesołowski, 2005; Czeszczewik et al., 2015). Conservation biologists and environmental activists have been advocating decreasing harvest levels and strengthening conservation measures, including the enlargement of BNP. However, such management scheme could potentially limit the use of some ES provided by BF (Marris, 2008; Blicharska and Angelstam, 2010; Niedziałkowski et al., 2012; Blicharska and Van Herzele, 2015). These proposals were opposed by local foresters, working for the public forest agency, local authorities, and a large section of the local communities, who saw timber production and processing as crucial branches of the local economy, and apprehended potential restrictions connected with biodiversity conservation (e.g. Franklin, 2002; Niedziałkowski, 2016). They perceived forest management in BF as sustainable and adequately securing BF's exceptional values (Brzeziecki et al., 2017). In 2011, the Ministry of the Environment introduced rigorous restrictions in silvicultural practices, considerably lowering the level of the timber harvest but without the expansion of the BNP. Since 2016, the conflict over the management of BF became particularly severe due to greatly increased logging linked to the removal of spruce trees affected by the spruce bark beetle (*Ips typographus*) infestation (Mikusiński et al., 2018). This new phase of conflict has been central not only in the Polish political debate but also in the development of Poland's relations with the European Union and as such has been debated in leading global media and science journals (e.g. Schiermeier, 2016; Berendt, 2017; Nelsen, 2017; Stokstad, 2017). NGOs and conservation biologists strongly opposed salvage logging and questioned its legality and scientific soundness (Chylarecki and Selva, 2016; SCB, 2016). Eventually, the Court of Justice of the European Union sentenced salvage logging as illegal because it transgressed the Habitats and Birds Directives (CoJEU, 2018).

BF provides a number of ES (Pabian and Jaroszewicz, 2009). These ES are undoubtedly important for local population and broader society and as such strongly influence discussions concerning the future management options for this area, including the proposed enlargement of the national park (Gliński, 2001). Moreover, the multifunctional character of the BF and its ability to provide all important ecosystem services on a sustainable basis has been suggested to be dependent on silviculture (Brzeziecki et al., 2018). Niedziałkowski et al. (2014) examined the conflict around the extension of the park through perceived use of ES. They found that local people were not as dependent on forest resources as often claimed, but that firewood proved a crucial resource for a large part of the local population. However, since that study encompassed large area including settlements with different proximities to BF (up to 10 km), we assume that perceived importance of it in the ES perspective may differ spatially. In particular, we hypothesize that for inhabitants of villages located just next to the BF, the importance of this forest is the highest and gradually decreases with distance for both practical and non-tangible reasons.

We claim that the knowledge on spatial patterning of perceptions concerning the significance of ES may be highly relevant for diagnosing the nature and spatial characteristics of contrasting interests concerning the use of benefits from areas of high conservation value in populated landscapes (Liu et al., 2016). It may also provide a basis for structured, constructive negotiations between stakeholders and developing management strategies reconciling competing uses. Furthermore, it shifts the attention of policy-makers from the binary options of conservation and use to concrete challenges and mechanisms connected with satisfying critical local needs. To facilitate development of tools for eliciting how local communities' perceptions of ES from biodiversity hotspots change with the distance from these areas and to move forward the sometimes languishing discussion around the management of the BF, we assessed how the spatial proximity of BF affected the perceived use of ES among local communities.

We focused on the following research questions: (1) What are the crucial ES identified by local residents living within the forest, at its outskirts, and in some distance from it? (2) Does the perception of ES change with the distance? If so, what are the patterns and which ES are influenced? (3) How do the local people from different areas assess the impact of potential extension of BNP on their use of ES from BF? (4) Does the knowledge of the local communities regarding conservation rules change with the distance from the protected area? For that purpose we used the data from Niedziałkowski et al. (2014) and carried out statistical analyses focusing on identification of spatial patterns. We focused our analysis mostly on provisioning and to some degree on cultural ES (MA, 2005).

2. Material and methods

The Białowieża Forest is the largest remnant of a Central European broad-leaved forest type, the ecosystem that has already nearly vanished, having at present only about 0.2% of its original area in relatively undisturbed condition (Hannah et al., 1995). The forest has been protected since medieval times - initially as a royal hunting reserve (Peterken, 1996; Samojlik, 2010). The forest is characterized by many well-preserved stands with characteristics of typical old-growth forest (e.g. large and old trees, lots of dead-wood). As a whole, it is treated as forest biodiversity hot-spot with virtually complete sets of ungulate species, predators (mammals and birds) and old-growth specialists (e.g. woodpeckers or saproxylic insects) occurring in the temperate forests of

Europe (e.g. Jędrzejewska and Jędrzejewski, 1998; Wesołowski et al., 2006). The iconic symbol of the Białowieża Forest is the European bison (*Bison bonasus*): with over 900 individuals making almost 25% of the total world's population of the species and over 30% of free-living animals. Presently, the Białowieża Forest is divided by the Polish-Belorussian border and encompasses about 1500 km^2 characterized by the long-term continuity of unusually high forest cover (Mikusinska et al., 2014). The Polish part of BF includes the BNP (10,500 ha) and three forest districts (52,600 ha) managed by the State Forests Holding (SFH). Since 2004, the entire area of BF located in Poland has a status of Natura 2000 site, based on both Bird and Habitat Directives. The landscape of the Natura 2000 site (63,148 ha) is characterized by a very high forest cover (93.2%). In the area managed by the SFH (excluding 12,182 ha of nature reserves), wood is harvested, but with substantial restrictions in comparison to other managed forests in Poland. The remaining area consists of meadows and pastures (3.4%), arable land (2.3%), bogs (0.9%) and built-up areas (0.2%). Both land administered by the SFH and BNP is state owned. The land-use in areas neighboring to the Natura 2000 site has a rural character with the dominance of arable fields (40.3%), fragmented forests (31.1%), and meadows and pastures (24%). The land in this rural landscape is owned mostly by farmers (see Fig. 1). BNP has been listed as a UNESCO Word Heritage site since 1979. In 2014, the site was enlarged and at present it essentially covers the entire Białowieża Forest with BPN as its core.

The study was performed in the part of Hajnówka County (Podlaskie Voivodship, Poland) that encompasses BF and its vicinity (Fig. 1). The county covers an area of 1767 km^2 and has 44,146 citizens, of whom 21,131 live in the town of Hajnówka. The average population density is very low at 27.12 person/km^2 (the national average in 2016 was 123 person/km^2) and is decreasing as the county depopulates at the highest rate in the region (Statistical Office in Białystok, 2017). The Hajnówka County represents a relatively high population age, as inhabitants over 65 constitute 27% of the total number of inhabitants, while this number amounts to 19.9% and 20.2% in the region and in Poland respectively (Central Statistical Office, 2017). The Podlaskie region is considered less developed with the second lowest GDP out of all regions in Poland.

Between 29th June 2011 and 16th July 2011, we carried out a questionnaire survey among local communities in the vicinity of the BF. The questionnaire consisted of 19 questions (closed and open-ended) concerning the frequency and purpose of visits to BF, areas most frequently visited, ES utilized, their perceived impact on the household budget, and perceived influence of the potential enlargement of BNP (see Appendix for a complete list of questions). Most of the question concerned provisioning services but some of them also cultural services (e.g. recreation).

We focused on rural communities, i.e. people living in villages, as they are usually more dependent on forest resources and therefore we excluded citizens of the Hajnówka town from our survey. Data concerning the use of ES by the local community was collected in villages located in BF and in the neighboring zones which were defined to investigate how proximity is affecting perceptions (Fig. 1). The villages were chosen using purposive sampling to provide relatively equal geographic distribution around the BF. As there are substantially fewer villages within the forest, we surveyed all except two. Out of 35 villages surveyed, 6 were located within BF (Zone 1), 15 on the outskirts of the BF (up to 3 km from the Natura 2000 border – Zone 2) and 14 were located 3–15 km from the Natura 2000 border (Zone 3) (Fig. 1). Villages in this part of Poland are typically located along roads, with houses built close to each other on narrow strips of land perpendicular to the road, which facilitated door-to-door visits. We used traditional pen-and-paper interviewing methods, carried out by a team of individuals who were trained in interviewing techniques, most of whom were from the region. The interviews were conducted in Polish. We aimed at surveying 15–25 households from each village (depending on its size), but the actual number of respondents hinged on the availability of respondents at their homes and their willingness to participate in the survey. Each was defined as one household, irrespective of the actual number of people living there. The houses in villages were

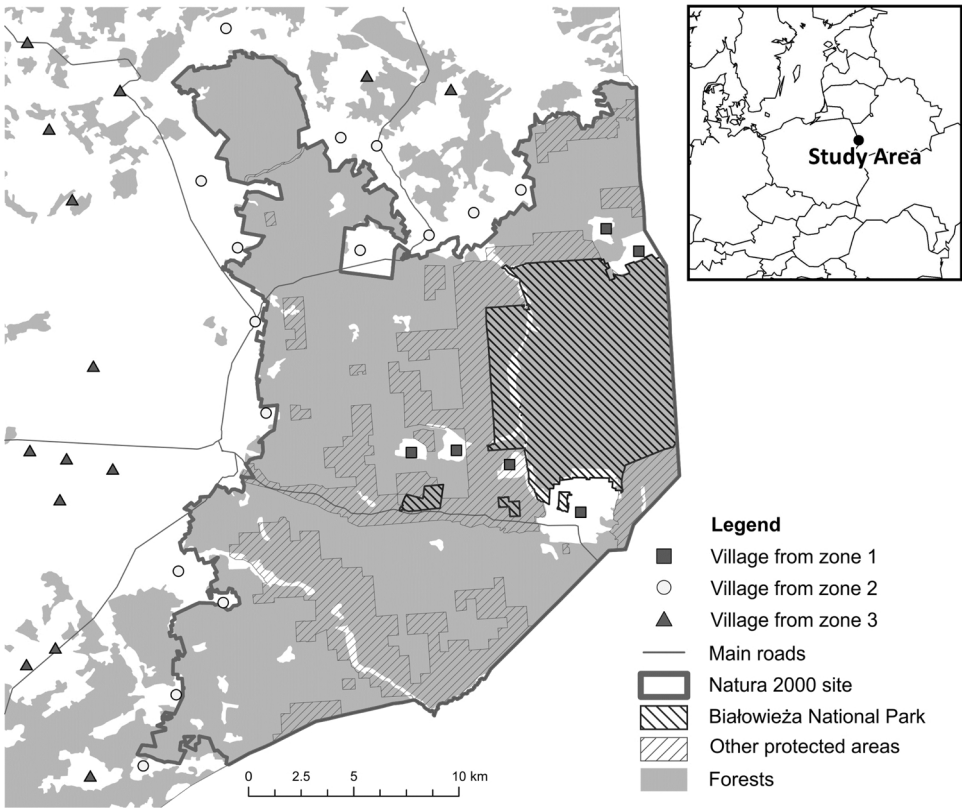

Fig. 1. Study area.

approached one by one, along the road, until the targeted number of surveys were carried out. In larger villages, individual members of the research team started surveying in different parts of the village. The choice of villages and houses were not randomized. In each house, we asked for one adult to answer the questionnaire without suggesting who this should be. We collected 719 responses in total (Zone 1 = 172 respondents; Zone 2 = 224 respondents; Zone 3 = 323 respondents), which amounted to around 4% of the total population of the area. Of the people we approached, 170 refused to be interviewed (19% refusal rate).

Among our respondents, 53.4% were women and 46.6% men. The average age was 59.4 years (minimum 18; maximum 101; median 61). In terms of education, 1.2% of the respondents did not have any formal education, 36.6% of the respondents had primary education (in many cases not completed), 50.2% had vocational or secondary education, and 12.0% had graduated from a university. Only 36.0% of the respondents were vocationally active, while others declared that the main source of their income was a retirement pension (45.5%), a disability pension (11.7%) or welfare (1.3%).

To investigate the influence of spatial location of the households (i.e. in particular zones) on the answers given, we used two non-parametric tests, namely the G-test of goodness-of-fit (also known as the likelihood ratio test for nominal variables) and the Kruskall-Wallis test for differences on a continuous dependent variable by a categorical independent variable (Sokal and Rohlf, 1981). We used the software package SPSS 16.0 for all statistical analyses.

3. Results

The declared frequency of visits to BF was the highest among respondents living in villages within BF (Zone 1), followed by those from the outskirts of BF (Zone 2) and, finally, from Zone 3 (Table 1). The differences in the frequency of visits of the respondents from particular zones were highly significant (G-test, G-value = 183; degrees of freedom (d.f.) = 6; p-value (p) = 0.000; sample size (n) = 672).

In all three zones, tourism/recreation and collection of mushrooms, berries and firewood were the main purposes for visiting BF for about 80% of the respondents (Table 1). However, the collection of mushrooms, berries and brushwood in Zone 2 (49.4%) was much higher in comparison to the other zones (40.1% and 37.0%, in Zones 1 and 3, respectively). The proportions were reversed in the case of tourism/recreation where only 27.8% of respondents in Zone 2 declared these activities as the main reason for visiting BF, while the corresponding figures in the two other zones were over 40%. The main reasons for visiting BF significantly differed between the particular zones (G-test, G = 15.9; d.f. = 6; p = 0.014; n = 713).

The declared use of different ES is presented in Fig. 2. The delivery/production of wood, as well as mushrooms and berries were the most important provisional services for the majority of households in all three zones (between 53.9 and 89.5%). The use of BF for recreation was also indicated as important in all three zones. With very few exceptions, we found a clear gradient in the perceived use and importance of ES, being the highest in Zone 1, intermediate in Zone 2 and the lowest in Zone 3. The exceptions were higher levels of berry and brushwood collection in Zone II in comparison to two other zones. The average number of ES per household followed the same gradient with Figs. 3.5, 2.9 and 2.1 in zones 1, 2 and 3, respectively, and differed significantly between the zones (Kruskal-Wallis Test; d.f. = 2; p = 0 0.000; n = 719).

Table 1
Frequency and purposes of visits to the Białowieża Forest (% of respondents) in the tree zones.

	Zone 1	Zone 2	Zone 3
Frequency of visits to the Białowieża Forest (% of respondents)			
Several times a week	52.4	32.4	5.7
Several times a month	22.0	20.0	13.4
Several times a year	15.2	24.3	33.9
Once a year or less	10.4	23.3	47.0
Purposes of visits in the Białowieża Forest (% of respondents)			
Tourism/recreation	40.7	27.8	42.2
Collecting mushrooms	40.1	49.4	37.0
Work	11.0	11.0	8.9
Other	8.2	11.8	11.9

The wood from BF was used in all three zones mainly as firewood (Fig. 3), with the highest use in Zone 1 (89.0% of respondents), intermediate in Zone 2 (78.1%) and lowest in Zone 3 (60.1%). The differences between zones in the case of other types of wood usage were not pronounced and did not follow any particular pattern. Firewood in Zones 1 and 2 originated primarily from the forest districts located within BF (84.9% and 58.3% of households, respectively) while only 25.9% of wood in Zone 3 originated from these sources (Fig. 3). In contrast, Zone 3 had the highest use of firewood from private forests outside of BF (32.2%), while it was lower in Zone 2 (24.2%) and almost non-existent in Zone 1 (2.4%). The differences between the zones were statistically significant (G-test, G = 204.1; d.f. = 8; p = 0.000; n = 590).

In Zone 1, as much as 30.2% of respondents declared at least one source of tourism-related income of their households, linked to the presence of BF, while the corresponding figures for Zones 2 and 3 were only 8.0% and 9.6%, respectively. In Zone 1, room rental was clearly the most important way of generating tourism-related income (17.4% of respondents), followed by guiding (5.8%) and souvenir manufacturing (4.7%) (Fig. 4). In Zones 2 and 3, selling berries or other non-wood forest products to tourists were indicated as the main source of tourism-related income (5.4% and 7.1% respectively respectively), while in Zone 1 this source of income was indicated only by 4.7% of respondents.

In response to the question regarding whether the use of BF ES influenced the household's budget, the majority of respondents in all three zones claimed no influence (Table 2). However, there was a gradient along the zones, with decreasing level of perceived (large and small) influence from Zone 1 (42.0%), through Zone 2 (35.4%) to Zone 3 (23.9%). The differences between zones were statistically significant (G-test, G = 21.9; d.f. = 4; p = 0.000; n = 710).

In all three zones, respondents who perceived that BF influenced their household's finances were on average using more types of ES that those who stated no influence (Fig. 5). This difference was particularly pronounced in zones 2 and 3. The relationship between the average number of different types of ES used and frequency of visits in BF followed a similar pattern across all three zones (Fig. 6). Respondents visiting BF at least several times per month used on average more diverse ES than those visiting BF less frequently.

To assess whether the respondents could distinguish BF from other forests nearby, the respondents were asked 1) how far from their household BF was and 2) what share of the BF was included in the BNP. The analysis of the answers revealed that in Zone 1 almost all respondents (98.3%) answered the first question correctly, whereas in Zone 2 and particularly in Zone 3 fewer people gave correct answers (75.9% and 52.8%, respectively). Most of the respondents overestimated the size of the BNP indicating on average that its area amounts to 30.1%, 35.4% and 31.9% of BF in Zones 1, 2, and 3, respectively. In reality, the BNP covers 16.6% of BF. The differences in answers between the zones were statistically significant (G-test, G = 141.8; d.f. = 2; p = 0.000; n = 712 for the first question; Kruskal-Wallis Test; d.f. = 3; p = 0.033; n = 318 for the second).

Finally, in the case of questions about potential problems related to living close to BF, responses from the three zones differed markedly. Significantly more respondents from Zones 1 and 2 perceived some problems related to the vicinity of BF (43.0% and 36.3%, respectively) the those from zone 3 (21.6%) (G-test, G = 27.8; d.f. = 2; p = 0.000; n = 714). The majority of respondents (> 65%) in all three zones

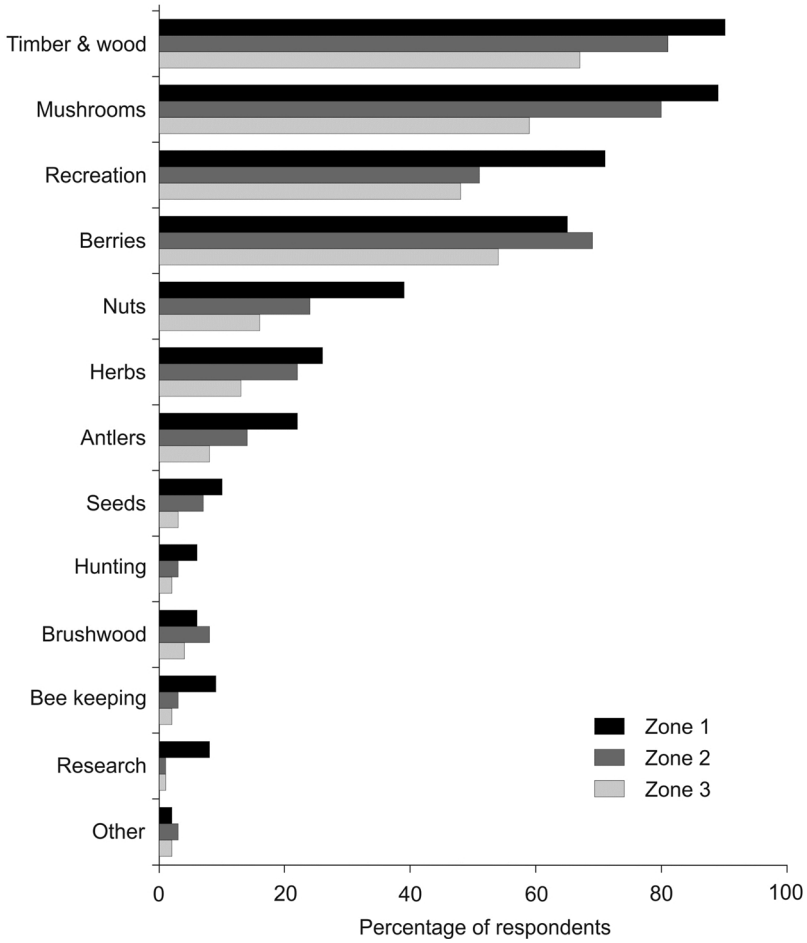

Fig. 2. Use of different ES declared by respondents in the three zones (n = 719).

perceived potential/prospective enlargement of the BNP as something that would negatively affect their way of using ES from BF, whereas possible positive influence was perceived only by a very small fraction of the respondents (Table 2). However, relatively more respondents in Zone III declared no influence (G-test, G = 26.4; d.f. = 4; p = 0.000; n = 712).

4. Discussion

Spatial considerations concerning beneficiaries of ES originating from conservation areas have profound importance for developing successful management strategies for those areas (Naidoo et al., 2008). Moreover, such areas cannot be treated solely in biological terms but as social-ecological systems which involve both natural processes and human activities (Figueroa and Aronson, 2006). The functioning of conservation areas is thereby affected by internal biological processes, the landscape dynamics in the surrounding areas (DeFries et al., 2007; Wade et al., 2011), and by the attitudes and practices of stakeholders, such as local people or visitors (Allendorf et al., 2012; Halkos and Jones, 2012). These attitudes, practices and needs differ spatially, and the goal of this paper was to find out if the perceptions of local communities concerning ES of BF depend on their spatial location in relation to the forest.

We found that proximity to BF had a clear effect on the perceived importance of its provisioning (and to some extent cultural) ES in the studied households. In three zones (within BF, at its outskirts, and within 10 km from its border) people differed regarding their perception of the role ES provided by BF played in their livelihoods. The villages in centrally located Zone 1 had a privileged position both in terms of the access to different forest resources and better developed infrastructure and tourism potential. In this respect, the villages in this zone are typical “gateway communities” that are often better off economically in comparison to other communities in remote rural areas (e.g. Mules, 2005; Wouters, 2011). On the other hand, people in this zone depended most heavily on wood provided by the SFH operating in the managed part of BF. Considering the fact that BNP is not commercially harvested, this dependence on a particular local resource and its supplier may be one of the main reasons why, for the last two decades, the local people have been opposing the proposed enlargement of the BNP (Blicharska and Angelstam, 2010; Niedziałkowski et al., 2012, 2014).

The clear majority of the respondents in Zone 1 (79.4%) confirmed that enlargement of the BNP would negatively affect their use of ES, and were concerned with potential restrictions. At the same time, over 30% of respondents indicated some tourism-related income. This suggests that for some local people it is BF itself rather than BNP that attracts tourists, and that BNP extension would not necessarily increase their benefits from tourism, while potentially compromising access to ES. Although there is a lack of explicit studies on the economic effects of tourism development on Białowieża’s gateway communities, studies performed elsewhere (e.g. Eagles et al., 2000; Mayer, 2014) indicate that benefits from nature tourism in national parks in developed countries outweigh the costs of their existence. The important question is how benefits and costs are distributed (Sandbrook and Adams, 2012) and whether local people associate the benefits with the national park.

Zone 2, located at the outskirts of BF, had different characteristics. The declared use of ES from BF by households located in this zone was slightly less intensive than in Zone 1. However, in comparison to Zone

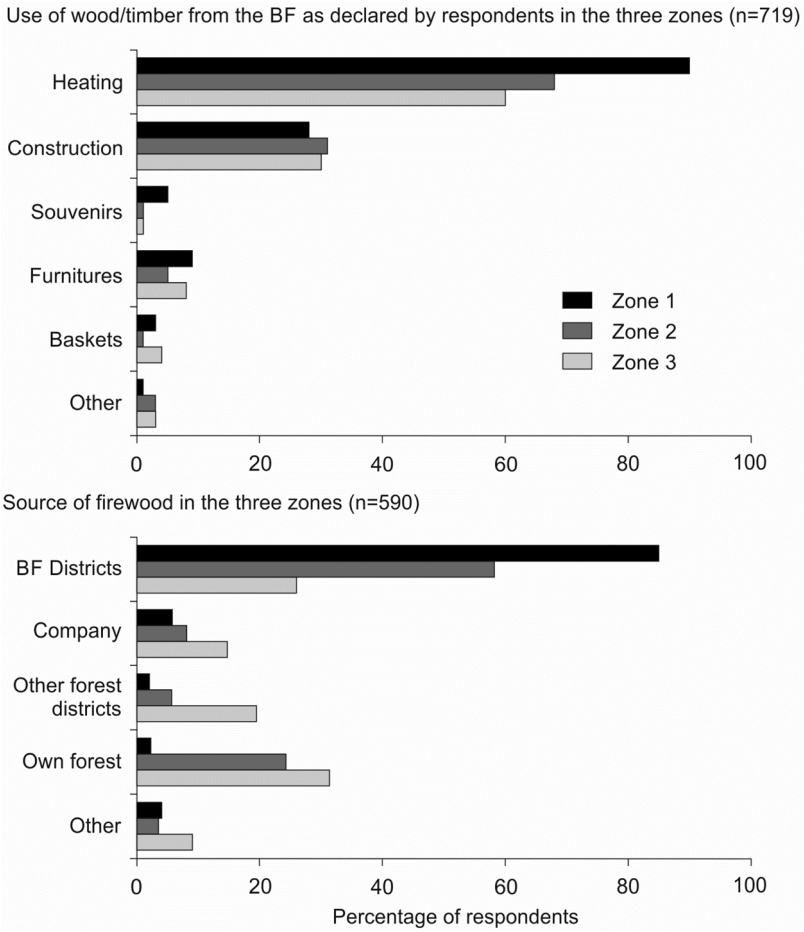

Fig. 3. Use of wood/timber from BF for different purposes as declared by respondents in the three zones (n = 719) and the sources of firewood in the three zones (n = 590).

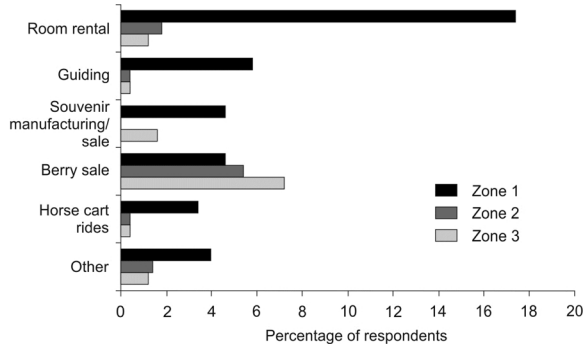

Fig. 4. Declared earning on tourists by the households in the three zones (n = 719).

1, the most striking difference declared was the much lower economic importance of tourism-related activities. This may be explained by the fact that tourist infrastructure (e.g. hotels, lodges, tourist information) in villages at the outskirts of BF is very underdeveloped or non-existent. In respect to several other dimensions we investigated, Zone 2 was more similar to Zone 1 than to Zone 3. The use of forests as a source of firewood and the lesser use of BF for recreation were distinct exceptions.

Zone 3, being the farthest from BF, appears to be the least linked to BF and its ES as almost 80% of respondents in this zone did not see any influence of BF on their household's finances. Also, having direct access to non-designated private and public forests, they were not as dependent on firewood from BF as the respondents from the two other zones.

Table 2
Perceived influence of the ecosystem services provided by the BF on household's budget in the three zones (n = 710) and perceived influence of the BNP enlargement on the use of ES from the BF (n = 712).

	Zone 1	Zone 2	Zone 3
Perceived influence of the BF on household's budget (% of respondents)			
Large influence	16.0	9.9	6.0
Small influence	26.0	25.6	17.9
No influence	58.0	64.6	76.0
Perceived influence of the BNP enlargement on the use of ES of the BF (% of respondents)			
Negative influence	79.4	80.4	66.3
No influence	13.7	16.9	30.2
Positive influence	6.9	2.7	3.5

Nevertheless, a relatively large proportion of households in this zone used BF for recreational purposes, as well as for the collection of wood, mushrooms and berries. Thus, although people in this zone were not dependent on BF resources, they still appreciated some of the benefits the forest provided. Most of them (60%) also negatively perceived potential BNP extension – this corresponds with 60.1% of households in this zone using wood from BF for heating purposes.

Our study demonstrated that local communities are dependent on the provisioning resources originating from BF. Wood for heating proved a critical life-sustaining resource, especially considering the harsh winters in the area. This dependence probably impacts the attitudes toward BNP expansion, which is widely perceived as potentially threatening to the use of ES of BF, which confirms observations indicated in the literature (e.g. Gliński, 2001; Sadowski, 2001;

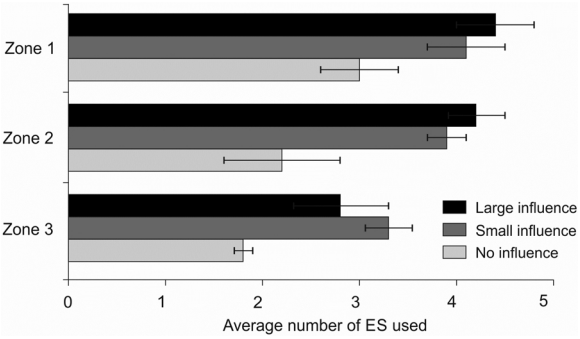

Fig. 5. Average number of ES used by households (+/- SE) in relation to the perceived influence of the BF on household's budget in the three zones (n = 708).

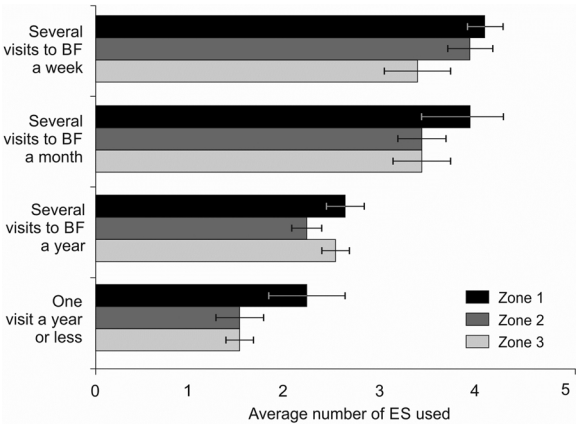

Fig. 6. Number of ES used by households in relation to frequency of visits in BF (n = 672).

Niedziałkowski et al., 2012, 2014).

We acknowledge that our analysis is based on data from 2011 and probably some changes have occurred during the last eight years with respect to people's perception of ES. Although the general pattern of BF management has not been altered significantly (no expansion of BNP and SFH is still in charge of most of the BF), the debate concerning its management strategy has intensified and possibly influenced how people think about its value. Recent restrictions in the use of areas affected by bark beetle could, to some degree, limit collection of wood, mushrooms and berries, as well as recreation (Czeszczewik et al., 2019). These areas provide a slightly different set of ecosystem services now but this change is not large considering the whole BF. The socio-economic conditions for local communities in Hajnówka County have improved since the data was collected (e.g. the rate of unemployment fell from 12.1% in 2010 to 7.9 in 2017, and the average income of municipalities per capita increased by around 40% between 2010 and 2017) (Białystok Statistical Office, 2019). Despite this, the population of the county is still decreasing and aging and the region remains one of the least developed in the EU. Moreover, there were no radical changes in the heating systems used by households in the county except for the gradual replacement of coal-based stoves with biomass, gas and oil stoves. The impact of these processes on the reliance on biomass from BF and on other ES is difficult to assess. Still, we assume that the results of our analysis, although based on data from 2011, provide a reasonable illustration of the general perceptions of local communities concerning use of ES from BF.

The lack of adequate knowledge about the functioning of the national park (Niedziałkowski et al., 2014) may lead to the general perception of its enlargement as linked to numerous restrictions limiting some important traditional use of ES with consequent income losses. The perception of benefits for local stakeholders is one of the key factors influencing attitudes towards protected areas elsewhere as well (Allendorf et al., 2012; Nastran, 2015). Moreover, a general socio-cultural or socio-psychological discomfort with the national park concept is another problem (e.g. Stoll-Kleemann, 2001). Prospective conservation initiatives will need to tackle these issues.

However, recognizing the central role of some ES, we also demonstrated in this study that perceptions of ES vary dependent on the spatial location of communities in relation to BF. Schirpke et al. (2014) indicated that provisioning and cultural ES from a number of Natura 2000 sites in Italy were important mostly for the beneficiaries from outside of the protected area, whereas regulating services benefitted people living within or very close to the protected area. Study performed on the periphery of one national park in Zimbabwe indicated much higher awareness and utilization of provisioning ES in communities located near the park in comparison to communities located further away (Mero Dowo et al., 2018). Based on our results, we recommend that potentially different management approaches and political instruments should be applied in gateway communities in comparison to those located at the outskirts of protected areas.

In the case of BF, we suggest efforts to eliminate misperception concerning present and future possibilities of ES use. These are apparently caused by several different nature conservation designations with diverse management goals, i.e. BNP, SFH, Natura 2000, UNESCO Biosphere Reserve and a World Heritage Site divided to several management zones. All these designations have different spatial extents and levels of protection that are not easy to understand. Moreover, such a confusing situation may be used by different stakeholders to spread potentially dishonest information intended to help them in attaining their own agendas (Jędrzejewska and Jędrzejewski, 2003; Niedziałkowski et al., 2014). Such situation may also hinder effective planning and management of areas valuable for biodiversity, due to potentially unclear responsibilities over their particular components.

When planning for the future of an area that is both important for biodiversity and for the local people, it is particularly important to have clear information on the needs of the local communities in relation to the different areas designated for particular management options. This requires mapping supply- and demand-sides of ES of forests for the purpose of defining the institutional scale at which ES should be managed (García-Nieto et al., 2013). Moreover, as demonstrated in the survey study concerning wetlands in the United States, the attitudes towards conservation and the awareness of ES provision might be dependent both on spatial proximity and on the personal involvement in activities like birdwatching, wildlife viewing, and fishing (Wilkins et al., 2019).

The whole Polish part of BF is included in the Natura 2000 network (Pullin et al., 2009) and is an example of a governance regime crossing scales and governance levels. The implementation of Natura 2000 across Europe, even if based on the same policy documents and guidelines, has to a large extent been affected by the natural conditions, national policies, and nature conservation models of member states and the existing governance settings (Paavola et al., 2009; Sotirov, 2017). Knowledge of the importance of a given Natura 2000 site, such as BF, for the local people is crucial when creating the management plan for this area and should provide a basis for guiding public participation process, preferably using participatory mapping (Brown and Weber, 2011), to identify key areas for ES provisioning and to ensure that sustainable local use is not compromised. Also, it is essential to provide adequate representation of local communities not only from the area being designated but also representing people from adjacent areas. Such public participation processes have been effective in achieving greater acceptance for Natura 2000 policies in several countries, though implications on the actual management practices were mostly rooted in the local historical socio-economic and institutional contexts (Blondet et al., 2017). For the Białowieża Forest, in line with Palomo et al. (2013), we suggest that there is a need for a broader territorial planning

strategy to consider the benefits and impacts of BF.

Despite the fact that current political debate around BF focuses on controversial logging linked to the bark beetle outbreak, the conflict actually results from diverging interests and values concerning use of ES in the management of this biodiversity hotspot (Niedziałkowski et al., 2019). The conflict arises especially over the tension between foresters who value BF as a source of timber for commercial purposes and environmental activists and conservation biologists who value the cultural and ecological features of the least disturbed lowland forest in Europe. Currently, due to multiple designations of the BF and their disparate spatial extents, the legal rules regulating conservation and use are confusing and BF poses a great management challenge for the rational use of ES. This was recognized by both sides of the conflict, who proposed that the entire Polish part of BF be managed by one administrator based on an agreed future vision, although they disagreed who the administrator should be. Such management should recognize and consistently support local use of ES building local trust (Stern, 2008).

Awareness of provisional and cultural ES at the local scale, and common patterns across space and local specificity, as studied in this work, may be helpful in reaching such a goal. It needs to be recognized that locally, certain trade-offs will be necessary due to the use of ES, especially connected with wild foods and recreation, which negatively impact conservation goals (Ziv et al., 2018). Securing future of the remaining intact and near-natural forests like BF is a global challenge clearly expressed by Aichi target 11 on setting aside a minimum of 17% of terrestrial areas (CBD, 2010). In populated areas it requires careful considerations that take into account local livelihoods (Naughton-Treves et al., 2005). The use of ES in assessment of the dependence of local communities on natural resources certainly provides useful framework. However, as demonstrated by our study, such assessment should take into account possible differences in perception of ES linked to spatial proximity to conservation areas of interest.

To translate the results of the study into concrete management recommendation in the BF case, one can advise securing firewood supply (or supporting replacing old wood stoves) for local people in Zone 1 and Zone 2, securing access to provisional ES for the inhabitants at the outskirts of BF, and supporting development of sustainable tourism in Zones 2 and 3 to enable fair distribution of potential benefits from BF and tourism that it attracts, e.g. by creating relevant infrastructure which does not compromise conservation objectives. Such interventions could potentially decrease the level of conflict and increase openness to new conservation initiatives.

5. Conclusion

We found that both the declared use of ES and the perceived influence of ES on household's budget were declining with the distance from BF and possibly with increasing access to resources originating from the outside. We also found that provisioning of wood for heating purposes was the key ES, with local people living within the forest being the most dependent on this resource. At the same time, these people benefited the most from tourism in the area. A clear majority of inhabitants are apprehensive of the enlargement of the national park over the whole BF. We imply that before taking such a decision, the needs of local people in different locations should be recognized in the management plans. In our view, this would ease the tension caused by heated political discussions concerning BF. Finally, we recommend that assessments of ES in larger conservation areas inhabited by people should examine the spatial relations between supply of ES and needs of local communities more often.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.104667.

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