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Practitioner disagreement over primeval forest management: Insights from a Policy Delphi process

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ABSTRACT

Understanding how conservation practitioners conceptualize nature conservation and interventions is critical for the effective implementation of conservation policy. Divergent understanding of conservation priorities and goals, as well as rival rationales for interventions can either hinder or enhance decision-making processes.

In this study, we examined differences in preferences and their justifications among conservation practitioners regarding interventions in the Białowieża Forest, one of Europe's best-preserved lowland temperate old-growth forests and an emblem of wildness, which has been the subject of recurring disputes and conflicts. Using the Policy Delphi technique, we identified areas of disagreement regarding various conservation interventions and explored the reasoning behind these differences. We found that disagreement among practitioners was most apparent in relation to interventions addressing national and local safety, recreational use of the area, and active conservation measures. These disagreements were rooted in two distinct foundations: clearly articulated and competing conservation preferences, and, alternatively, widespread uncertainty and ambiguity regarding the expected ecological outcomes of specific interventions. Notably, the scope of disagreement extended well beyond issues previously highlighted in public debates.

Our findings demonstrate that structured deliberative approaches such as the Policy Delphi technique can support conservation decision-making in revealing and acknowledging differences in assumptions and preferences among policy actors. By providing anonymity and a non-confrontational setting, the process facilitates knowledge exchange and reduces power asymmetries among participants. We argue that acknowledging and understanding areas of disagreement among conservation practitioners is essential for fostering transparent and constructive debate, as well as for achieving ecologically sound and adaptive conservation practices.

1. Introduction

The way people conceptualize the role of humans in nature conservation and consequently which actions they prefer over others, is a key factor influencing policy implementation. International initiatives such as the Kunming–Montreal Global Biodiversity Framework (Mendez Angarita et al., 2025) or the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES, 2022; Pascual et al., 2023) attempt to reflect diverse worldviews in science, policy, and practice. Calls for improving conservation decision-making by balancing power in conservation practice (Shackleton et al., 2023) or making it more inclusive (Murali et al., 2025) recognize the need to understand the underlying values and assumptions of actors involved in conservation.

Personal spheres, such as worldview or conception of nature, are seen as an important part, a leverage point of transformative change towards a more sustainable world (Otero et al., 2025). Ambiguous conceptualization, unclear terms and lack of common definitions in discussing the priorities for nature conservation may lead to barriers that recur across contexts (Alberts et al., 2024; Shackleton et al., 2023). Conflicts about conservation are often underpinned or co-occur with differences in values, worldviews, beliefs or knowledge validation (Blicharska et al., 2020; Hakkarainen et al., 2020; Murali et al., 2025; Redpath et al., 2015). They may also be a result of differences in understanding and implying the very concepts of nature conservation and wildlife management (Hasselman, 2017; Rist et al., 2012; Williams and Brown, 2014).

Forest management and conservation are two spheres often plagued by conflict across the world (Ihemezie et al., 2021; Pascual et al., 2023). Forest management affects biodiversity outcomes, governance effectiveness, and climate mitigation at local to global scales (Hörl et al.,

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2020; Spathelf et al., 2018). Unresolved disputes or lack of will to listen to other positions can precipitate habitat loss, undermine conservation initiatives and actions, and may spread the conflict to other sectors or political levels (Fernández-Manjarrés et al., 2021). Conflicts over forests may also reflect more general processes of negotiation over the manner and extent of human use of natural resources, as well as on the purpose and methods of forest management, including openness to the concept of adaptive management (Mola-Yudego and Gritten, 2010; Niemelä et al., 2005; Nousiainen and Mola-Yudego, 2022; Pecurul-Botines et al., 2025; Sousa-Silva et al., 2018).

The European strategies adopted under the European Green Deal, i.e. the EU Biodiversity Strategy 2030 and the EU Forest Strategy 2030, acknowledge the role of forests in mitigating climate change and biodiversity loss (Fulvio et al., 2025; Hermoso et al., 2022). The EU aims not only "to increase the quantity, quality and resilience of its forests", but also recognizes the value of natural forest expansion and "spontaneous forest regrowth through natural succession is the main force driving the increase of forested areas in the EU, mostly associated with the abandonment of agriculture and rural areas" (European Commission, 2019, 2021). Although ambitious and timely, these goals may be in opposition to domestic forest management policies, which might put more emphasis on the role of forests in local and national economies (Beland Lindahl et al., 2023; Walton, 2024). In the sphere of competing interests and interpretations, personal preferences of people involved in implementing forest policies acquire a particular relevance for decision-making. An analysis of forest conflicts in Europe (Nousiainen and Mola-Yudego, 2022) suggested the main sources of disagreements are connected with the management of the forests and extending of protected areas in forests or establishing new ones, particularly when seen as limiting the use of the forest by local communities, management of the peri-urban forests and recreational use of forests. These conflicts are caused by various perceptions of what and whose forests are, how they should be managed and for whom. While the fact that values are embedded in the language of environmental quality is to some extent acknowledged (Hull et al., 2003), the multiplicity and ambiguity of visions and preferences of people involved in environmental management still seem to require attention (Niemelä et al., 2005; Pecurul-Botines et al., 2025; Sousa-Silva et al., 2018).

Here we describe a study focused on the practitioners' preferences and opinions related to conservation, management and preservation of wildness of the Białowieża Forest (BF) – one of Europe's least transformed forest complexes or one of the best-preserved lowland temperate forest in Europe (Jaroszewicz et al., 2019; Szwagrzyk, 2016). Ahead of further discussion on the conservation and management of the area, there is a fundamental issue about its characteristics. The BF is being called and defined as primary or primeval forest (due to the ecological structure of the forest, ancient tree cohorts, and minimal historic disturbance), or an old-growth (as it has developed all key old-growth characteristics, structurally and functionally), or a relic of ancient habitat, a reference area, a symbol of the long-gone lowland temperate European forests, incorporating all the previous characteristics (European Commission, J.R.C., 2021; Jaroszewicz et al., 2019; Sabatini et al., 2018). It is also referred to as a symbol or reference to 'wild nature' or 'wildness' in Poland (in prep.). The BF has been a subject of a long-lasting conflict over the management priorities and solutions that manifested mostly in disputes about timber harvesting or beetle outbreak mitigation (Bieńkowska et al., 2019; Blicharska and Van Herzele, 2015; Jokinen et al., 2016; Niedziałkowski et al., 2014). More recently the BF has also been an area of intensive militarization and humanitarian crisis (Jaroszewicz et al., 2021; Nowak et al., 2024, 2025a).

We intended to explore how policy practitioners conceptualize and interpret the notion of wildness in the Białowieża Forest, and how they prioritize different human interventions in the area. In particular, our aim was to identify areas of disagreement regarding the proposed management interventions for the BF. Given the long-term conflict involving all potential respondents in this study, we adopted a non-confrontational process, using the Policy Delphi methodology, which allowed us to profit from the process and explore plurality of views, ideas and perspectives and their rationale while minimizing preconception or bias stemming from the public debates.

Policy Delphi was developed to explore policy issues among informed advocates and referees (Manley, 2013; Turoff, 1970). It allows opposing views from a heterogeneous group to be expressed and explored through a multi-round dialogue. It acknowledges the existence of different perspectives as a given, rather than viewing them as a source of conflict. It enables participants to present their own arguments without feeling the need to confront others. The Policy Delphi aims to generate ideas, to uncover and evaluate policy alternatives, through structured, critical collective debate among a panel of experts (Franklin and Hart, 2007; Moore et al., 2009). It is intended to bring forward options and alternatives and to establish pro and con arguments for differing positions, thus variation of views and difference in opinions and argumentations are considered valuable and enriching (de Loë et al., 2016). Such an approach contrasts with the more widely recognized and applied classical Delphi approach aiming at reaching consensus among a homogeneous group. Like the classical Delphi process, the Policy Delphi is iterative (multi-round) and anonymous (Linstone and Turoff, 2002; Turoff, 2002).

In this paper, we present part of the results we obtained through the Policy Delphi study among people (who we call practitioners) involved in BF management or dispute.

The aim of this paper was (1) to identify the interventions that generate the greatest disagreement among practitioners, and (2) to explore the arguments for and against these interventions expressed by practitioners involved in Białowieża Forest management. Equally, we aimed to examine the Policy Delphi process as a meritocratic, non-confrontational, and non-adversarial tool that enables a structured, multi-round dialogue focused on the substantive merits of arguments among policymakers, managers, and conservation authorities.

2. Methods

2.1. Study object: the Białowieża Forest

The BF is an excellent case to investigate the complexities connected with managing forests in a close-to-natural state. It is a transboundary Polish-Belarussian forest complex (Fig. 1) covering around 1500 km^2 with substantial parts of close-to-primeval European lowland oak-lime-hornbeam forest and a diverse community of flora and fauna (Jaroszewicz et al., 2019). Because of its relatively natural character, it has been designated as a UNESCO World Heritage Site and a Natura 2000 site and is used as a benchmark for scientific research in forestry and biology. The Polish part of the BF spans 630 km^2 and includes Białowieża National Park (BNP, 105 km^2) most of which is a strictly protected area. Beyond BNP, the remaining parts of the forest are managed by the public forest agency the State Forests Holding (SFH) and are subjected to varying levels of protection, including nature reserves and managed forests. The Polish part of the BF has been an object of long-term social conflict over management priorities of the area involving State Forest Holding, local communities, environmental NGOs and scientists of various fields (Blicharska et al., 2020; Niedziałkowski et al., 2014, 2012). The conflict mainly concerns the issue of whether Białowieża Forest should be managed for sustainable yield by State Forest Holding or be protected by an ultimately enlarged BNP. The most vehement stage of the conflict took place between 2016 and 2018 when the Polish government authorized SFH to carry out large scale logging to combat a bark beetle outbreak. This was opposed by environmentalists from NGOs and academia according to whom these actions were not necessary and violated the Habitats Directive. The activists staged protests and blockades to halt logging operations. In April 2018, the Court of Justice of the European Union ruled that Poland violated EU law and

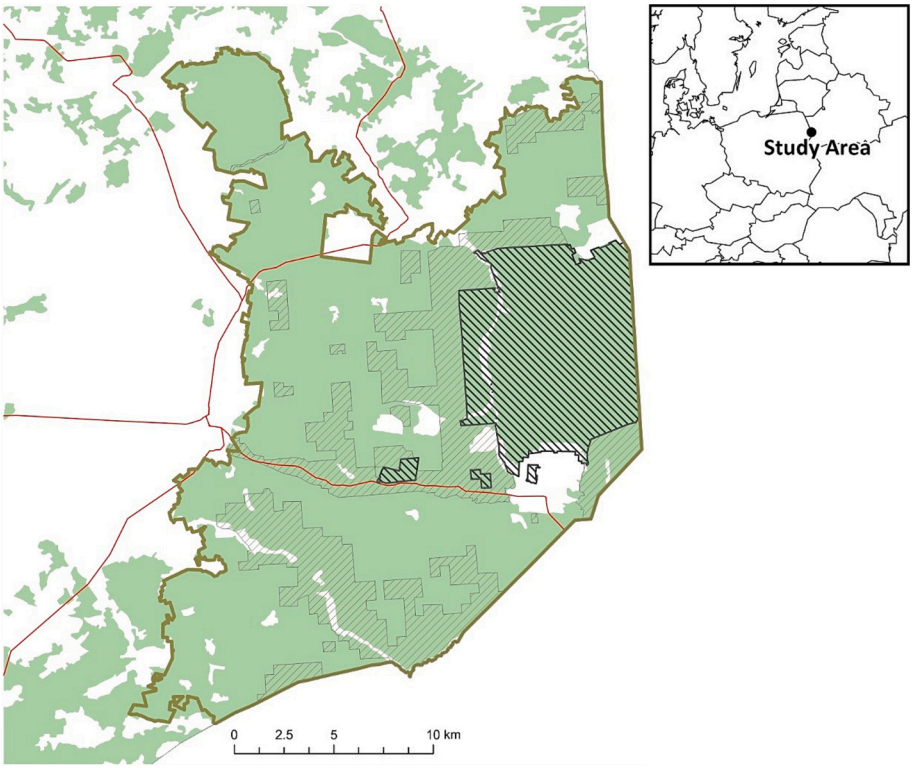

Fig. 1. Map of the study area. Białowieża Forest (marked in green) is located on the Polish-Belarussian border. Hatched area indicate the Białowieża National Park. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

ordered the halting of large-scale logging (Jaroszewicz et al., 2019). Since the ruling of the Court of Justice of the European Union, practically no commercial logging has occurred in the Białowieża Forest.

Currently, the rules of managing the UNESCO World Heritage Site have been developed, which again involves heated discussions between proponents of different management strategies. The discussions around BF have also been impacted by militarization of the area initially associated with a humanitarian crisis on the Polish-Belarusian border in 2021 and exacerbated by Russia's invasion of Ukraine in 2022 (Jaroszewicz et al., 2021; Nowak et al., 2024, 2025a, 2025b).

2.2. Policy Delphi study design

2.2.1. Participants

Following the original idea of Policy Delphi (Turoff, 1970) and its evaluation (de Loë et al., 2016), a purposefully chosen group of 32 persons professionally involved in the conservation of BF, either directly (i.e. working specifically in the BF related area and issues) or indirectly (working on the problems of forest or wildlife ecology, natural resources management, nature conservation), were invited to the study. A total of 19 people (12 men and seven women) agreed to take part in the Policy Delphi study and completed all three surveys. This is an adequate sample as a recommended number of respondents ranges from ten to fifty (Linstone and Turoff, 2002; Turoff, 2002). Yet, the sample size is a factor to bear in mind when interpreting the data. For a modest fee, respondents were contracted to participate in the study. Participants were all professionals in their fields, with specific formal background related to nature conservation and natural resource management, and at the time of the study, employed in institutions related to nature conservation or natural resources management. The group included: 2 national administration representatives, 2 national park officers, 2 representatives of State Forest Holding and forest management administration, 10 scientists representing various fields (ecology, botany, zoology, conservation biology, environmental economy, natural resource management, forestry and forest ecology), 2 NGO representatives, and 1 journalist specializing in nature conservation issues. All of the respondents have been actively engaged in the public and scientific debate about BF at various times over the last two decades, some of them were directly and actively involved in the Białowieża Forest World Heritage Site Management Plan (Polish part) preparation, some participated in the consultation process.

2.2.2. Survey and research process

The whole research process consisted of three rounds of online surveys sent between May and June 2024 in about three weeks intervals (the questionnaires used for the three-round Policy Delphi process are presented as Supplementary material 1). We used a Google Form tool to generate questionnaires for the three rounds. Each time respondents had 11 or 12 days to answer the survey questions. Participants were provided with extensive information on the aims of the study, rules and ethical standards, as well as technical issues concerning the online form. Before Rounds 2 and 3 a summing up of the results from the previous round and all the answers for open questions were presented to the respondents (Fig. 2). A report from Round 1 was sent together with the invitation to Round 2, while results from Round 2 were incorporated in the online form for Round 3. The respondents were anonymous to each other before, during and after the process.

Each survey started with questions on the wildness of Białowieża Forest (its characteristics and state) as wildness was an overriding concept of reference for the whole study. In this paper however, we focus on practitioners' preferences towards various interventions already undertaken or planned/postulated to be implemented in the BF (including both, protected area and forests managed by the State Forest Holding). Respondents were asked to assess the interventions on two scales - importance (relevance), and desirability (Turoff, 1970). We used 4-point scales, i.e. from ‘definitely unimportant’, through ‘rather unimportant’, ‘rather important’, to ‘definitely important’ (for importance) and from ‘definitely undesirable’, through ‘rather undesirable’, ‘rather

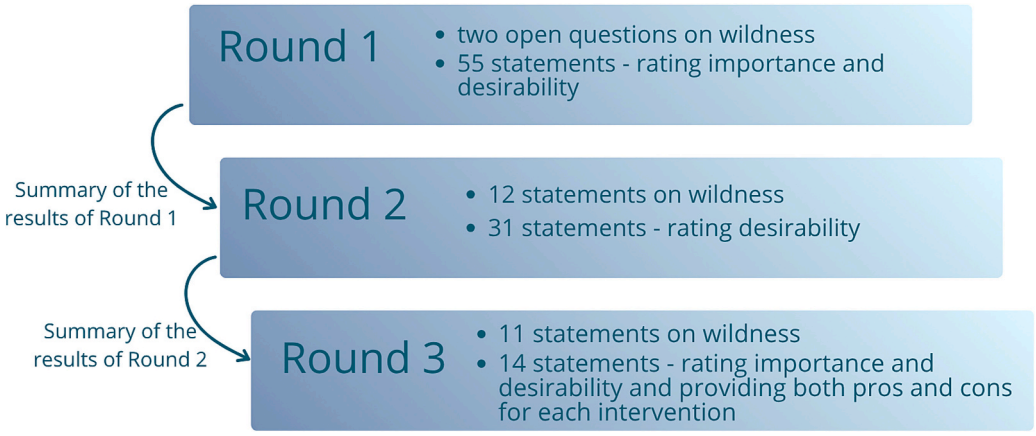

Fig. 2. Visualization of the Policy Delphi research process in the study.

desirable', to 'definitely desirable' (for desirability).

The initial 55 statements introducing various interventions were formulated based on the extensive documentation on BF conservation, in particular on the proposal for the Management Plan for the Białowieża Forest World Heritage Site (Polish part) (IOŚ, 2024). That document defines directions and actions to be undertaken in order to "ensure effective protection and management of the Site, enabling the preservation for present and future generations of a globally unique forest ecosystem, intact ecological processes and the biodiversity created through them". Based on that we developed the statements for the questionnaire. Although some statements may seem to overlap or be repetitive, they represented various forms or levels of intervention. Those statements included the management of invasive species (for ex. "removal of invasive alien species (IAS) of plants", "trapping and euthanizing of IAS", "trapping of IAS and placing them in animal shelters", "IAS trapping and castration, sterilization, release of trapped individuals") or the issue of supplementary feeding (for ex. "feeding and baiting of wild animals", "prohibition of feeding of any animal species", "management of the European bison population, inter alia, through feeding", "prohibition of feeding of any animal species, except European bison"). It may also seem that most of the proposed interventions were related to hands-on strategies, yet as pointed above, they were inspired by the Białowieża Forest World Heritage Site Management Plan (Polish part) (IOŚ, 2024). The document clearly defines the zones, where a given intervention could be carried out. There is only one zone, the strict protection zone (zone 1), that is excluded from any activities and is subject only to the forces of nature. The only permitted activities there are non-invasive scientific research, nature and environmental monitoring, and education, all of which must take place within a strictly defined area. Yet, some measures and activities related to national defense and limited fire safety measures may also be permitted. For other zones active and hands-on management approach is proposed (at the time of this study realization, the Białowieża Forest World Heritage Site Management Plan (Polish part) was being prepared and consulted, having the status of a draft. The document was sent by the Polish Ministry of Climate and Environment on 5th of December 2025 to UNESCO, which started the procedure of assessment. Thus the document, although comprehensive, detailed, and prepared in the participatory process, is not legally binding and not adopted, neither nationally nor internationally).

2.2.3. Analyses

We investigated the data using both quantitative and qualitative approaches. Frequencies and means with standard deviations were calculated for all the answers collected in Rounds 1, 2 and 3 and were the basis for identifying the statements for which respondents disagreed the most.

Out of 55 statements from Round 1, for the Round 2 we selected 26 statements, for which the disagreement (expressed by SDs) was the highest. Additionally, the phrasing of some statements was modified, as a result of the comments from Round 1, so there were 5 new statements in Round 2 (see Table 1). As we noticed that respondents struggled to differentiate the scales of importance and desirability (see Results and Discussion), we decided to narrow the Round 2 questions to the aspects of how desirable was it to take the given actions for the Białowieża Forest wildness.

In Round 3 the survey consisted of 14 statements describing interventions of the highest discrepancy in respondents' ratings in Round 2. Respondents were once again asked to review and rate the interventions' importance (priority) and to rate their preference (whether the action was desirable or undesirable) in the context of preserving the wildness of the BF. For the Round 3, we decided to ask respondents to provide arguments that supported their position as well as the opposing one for each of the 14 statements.

To explore the reasons and argumentation for the diverging positions of the participants, and to interpret the answers to the open questions we applied a qualitative approach. We analyzed the respondents' explanations to disentangle their rationale for or against a given intervention through hybrid coding (inductive, data-driven used in the 1st round of coding and deductive, basing on selected categories in the 2nd round of coding) (Proudfoot, 2023). For the 1st round of coding we looked for the themes emerging from the respondents' answers regarding their arguments for and against interventions affecting the wildness of the BF. This allowed us to create three categories based on different perspectives: arguments reflecting a "nature perspective" (taking into account the value of nature and its context), "human perspective" (expressing the values and issues that concern people), or "uncertainty" (expressing uncertainty, relativism and context dependency). We then applied these categories in the 2nd round of coding. This coding had a deductive character and was focused on better understanding the distribution of each argumentation among the interventions. We also identified and coded all statements straightforwardly pointing out lack of arguments for or against a given intervention. The coding was conducted in MAXQDA.

3. Results

3.1. A misunderstanding of the terms "importance" and "desirability" - an unobvious challenge

As aforementioned in the Methods section, respondents had difficulties with the terms "importance" and "desirability". While "importance" was used for prioritization of a person's judgment about the impact, priority or consequence of a given intervention, "desirability"

Table 1
Preferences of respondents (based on "desirability" question "Please rate on a 4-point scale from '1: definitely undesirable', '2: rather undesirable', '3: rather desirable', to 4: 'definitely desirable' how desirable (appropriate, benefitting) is it to take the following actions to conserve the wildlife of the Białowieża Forest?") regarding 62 interventions affecting wild nature in BF in the three rounds of Policy Delphi. Interventions are ordered from the most to least preferred. The averages are presented on a color scale, with dark blue representing the lowest score (unwanted interventions) and dark green representing the highest score (most wanted interventions). For each statement a standard deviations (SD; in yellow color scale) is given. *Statements 56–60 were added in the Round 2, statements 61–62 were added in the Round 3.

		ROUND 1		ROUND 2		ROUND 3	
		average	SD	average	SD	average	SD
1	Restoration of ecological corridors with neighboring protected areas (e.g., areas included in the Natura 2000 network) in the Forest.	3,7895	0,4189				
2	Conducting scientific research and monitoring of species and habitats	3,7895	0,4189				
3	Maintaining programs to support farmers suffering losses due to the protection of populations of wisent (European bison) or other protected species	3,737	0,452				
4	Restoration of disappearing wetland habitats	3,6842	0,7493				
5	Removal of invasive alien species (IAS) of plants	3,6316	0,7609				
6	Territorial brand promotion ("Białowieża Forest UNESCO site" or Białowieża Forest)	3,6316	0,684				
7	Leaving deadwood in the forest	3,5263	0,9643	3,8421	0,3746		
8	Participation of the public (local communities, NGOs or others) in the development, implementation and monitoring of conservation measures in the Forest	3,5263	0,6118				
9	Slowing river flow and reducing surface runoff by installing proper infrastructure using natural materials (e.g., woody debris)	3,4737	0,7723				
10	Enlargement of the strict reserve	3,4737	0,6967				
11	Buyout of land by the State Treasury	3,3684	0,7609				
12	Culling/shooting of IAS	3,2632	0,9335	2,6842	1,0569	2,7895	1,0842
13	Incorporating the entire area of the Białowieża Forest into a national park	3,2105	0,9177	3,1579	1,1673		
14	Restricting tourist traffic by limiting number of visitors in selected strictly protected areas	3,1579	0,8342	3,1053	0,6578		
15	Subsidies for private land owners (within the Białowieża Forest or in bordering areas)	3,1053	0,8093	3,0526	0,705		
16	Maintaining the passability of the main roads to ensure fire safety in areas adjacent to the strictly protected part of the Białowieża Forest	3,0526	0,8481	2,5263	0,9643		
17	Trapping and euthanizing of IAS	3	0,9428	2,8421	1,1673	2,9474	1,026
18	Transition from the use of solid fuels in heating to renewable energy sources (solar and wind farms)	3	0,8165				
19	Mowing and de-scrubbing of meadows in river valleys	2,8421	0,8342	2,8947	0,8093	2,7368	0,8719
20	Tree pruning in the vicinity of tourist attractions (e.g. Palace Park)	2,8421	0,6882				
21	Hiking trail marking	2,7895	0,855	2,5263	0,9048		
22	Harvesting of undergrowth by local communities	2,7895	0,6306				
23	Low-intensity grazing in selected forest and grassland habitats	2,7368	1,0457	2,3684	0,8951	2,2632	1,0457
24	Species reintroduction	2,7368	0,9335	2,3684	0,9551		
25	Maintaining the passability of the main roads and trails in the strictly protected areas to ensure fire safety and the safety of people in the Park	2,6842	1,2496	2,2105	1,0317	2	0,9428
26	Trapping of IAS and placing them in animal shelters	2,6842	1,0029	2,7895	0,9763		
27	Mowing and de-pruning /de-scrubbing of mid-forest meadows and former timber depots areas	2,5789	1,0174	2,5789	0,7685		
28	Investment and construction activities in communities neighboring the Białowieża Forest	2,4737	0,8412	2,3684	0,684		
29	Construction of tourist infrastructure (viewing terraces, shelters, picnic areas)	2,3684	0,8307	2,0526	0,9113	2	0,8819
30	Collection of firewood by local communities	2,3158	0,8201				
31	Construction of structures to strengthen the state border (fence, wall, Border Guard locations)	2,2632	1,1945	1,7895	1,2283	1,7895	1,1822
32	IAS trapping and castration, sterilization, release of trapped individuals (catch neuter release)	2,2632	1,0457	1,8421	0,8983		
33	Deploying pheromone traps	2,2632	0,8719				
34	Controlled burning of selected parts of the forest	2,2105	1,0317	2,2105	1,0842	2,3158	0,8852
35	Lethal control of protected species if appropriate permissions are issued	2,2105	1,0317	2	1,0541		
36	Carrying out maintenance, modernization and construction of new retention reservoirs and water facilities	2,0526	1,0788	1,9474	1,026	2,1579	1,1673
37	Planting native trees	1,9474	1,026	1,8421	1,0679	1,7368	0,9912
38	Desludging of selected river sections	1,8947	0,8753	1,8421	0,9582		
39	Harvesting timber for construction by local communities	1,8421	0,8342				
40	Laying out of gravel roads	1,8421	0,7647				
41	Shooting of game species (hunting)	1,7368	0,8719	1,5789	0,8377		
42	Sanitary cuts in the forests	1,7368	0,8719				
43	Maintenance treatments (e.g., mowing) in planted areas	1,6842	0,8852	1,8947	1,197		
44	Fencing of newly planted areas	1,6316	0,684				
45	Timber harvesting	1,5263	0,6967				
46	Construction of fences and barriers along roads	1,4737	0,7723				
47	Construction of new or repair of existing drainage ditches	1,4211	0,7685				
48	Removal/chipping of felled trees	1,4211	0,6925	1,3158	0,671		
49	Feeding and baiting of wild animals	1,4211	0,607				
50	Land buyout by private owners	1,4211	0,5073				
51	Construction or maintenance of timber skidding roads	1,3684	0,684				
52	Construction of asphalt roads	1,3158	0,4776				
53	Introduction of species new to the Białowieża Forest area	1,1579	0,3746				
54	Application of herbicides in planted areas	1,1053	0,3153				
55	Floodplain drainage	1,0526	0,2294				
56	Protection of wild pollinators by, inter alia, leaving (not cutting) hollow trees and leaving (not removing) dead trees in varying degrees of decay			3,5789	0,5073		
57	Abandonment of hunting in the Białowieża Forest			2,9474	1,2236	3,3684	1,0116
58	Cessation of feeding of any animal species			2,8947	1,0485		
59	Abandonment of any human activity in the area of Białowieża Forest			2,6842	0,8852	3	1,1055
60	Placing honeybee apiaries on the territory of the Forest			1,7368	0,8057		
61	Management of the bison population, inter alia, through feeding					2,1053	0,8753
62	Prohibition of feeding of any animal species					3,2632	0,8719

was planned to rate how preferable, acceptable, or desirable a policy option is (de Loë et al., 2016; Steinert, 2009). Participants of our study, while commenting on rating the importance of the 55 statements in the Round 1, explained their choices through references (in almost every comment) to positive or negative impacts or implications of the given intervention, which suggested the confusion about "importance" and "desirability". The respondents noted in their comments, among others:

> "*this action has positive or negative impact on the part of the BF that is covered by managed forests. For example, the use of herbicides may have a significant negative impact, while planting native tree species may have a significant positive impact.*"

or

> "*I am unable to assess the impact of individual measures here. Most of them are definitely important, but some are harmful and others are positive.*"

or

> "*The significance for nature can be either negative (actions harmful to nature) or positive (actions beneficial to nature), although sometimes the effect can be twofold. For example, leaving dead wood has a significant impact on nature, but this action can be considered both significantly positive (naturalness of the forest, saprophyte habitats) and negative (risk of large-scale fire and, as a result, destruction of part of the natural habitats).*"

We interpreted these comments as indication of difficulties in separating the category of 'importance' itself from the direction of influence of a given action. For those reasons, we decided to narrow the Round 2 questions to aspects of how desirable (effective, benefitting) was it to take the given actions for the conservation of Białowieża Forest wildness.

However, to explore this issue more, in Round 3 we decided to ask again about the two scales, but asking firstly about desirability and only then about importance of each intervention. We assess this sequence as easier for respondents as it allowed for giving more intuitive ('I want this action or I don't want this action in the BF') response first and only then reflect consciously on the importance (relevance) of each action. However, the results from Round 3 also suggest that the statements selected were in vast majority important for BF wildness, as illustrated in Fig. 3.

3.2. Areas of dissent over conservation interventions in the Białowieża Forest

Based on respondents' preferences towards the proposed list of interventions, we identified those for which the areas of disagreement were the greatest. Overall, we distinguished three main areas of disagreement: (1) safety of the local inhabitants (fire safety within the area of the Forest) or general society (national safety related to the Polish-Belarussian border and current geopolitical situation in Europe), (2) recreational use of the Białowieża Forest (for hunting, investments or tourism development) and (3) conservation interventions (animal IAS management, habitat restoration including water reservoirs and rivers, management measures such as planting trees, species reintroduction, feeding animals including European bison, controlled burning of restricted areas, etc.).

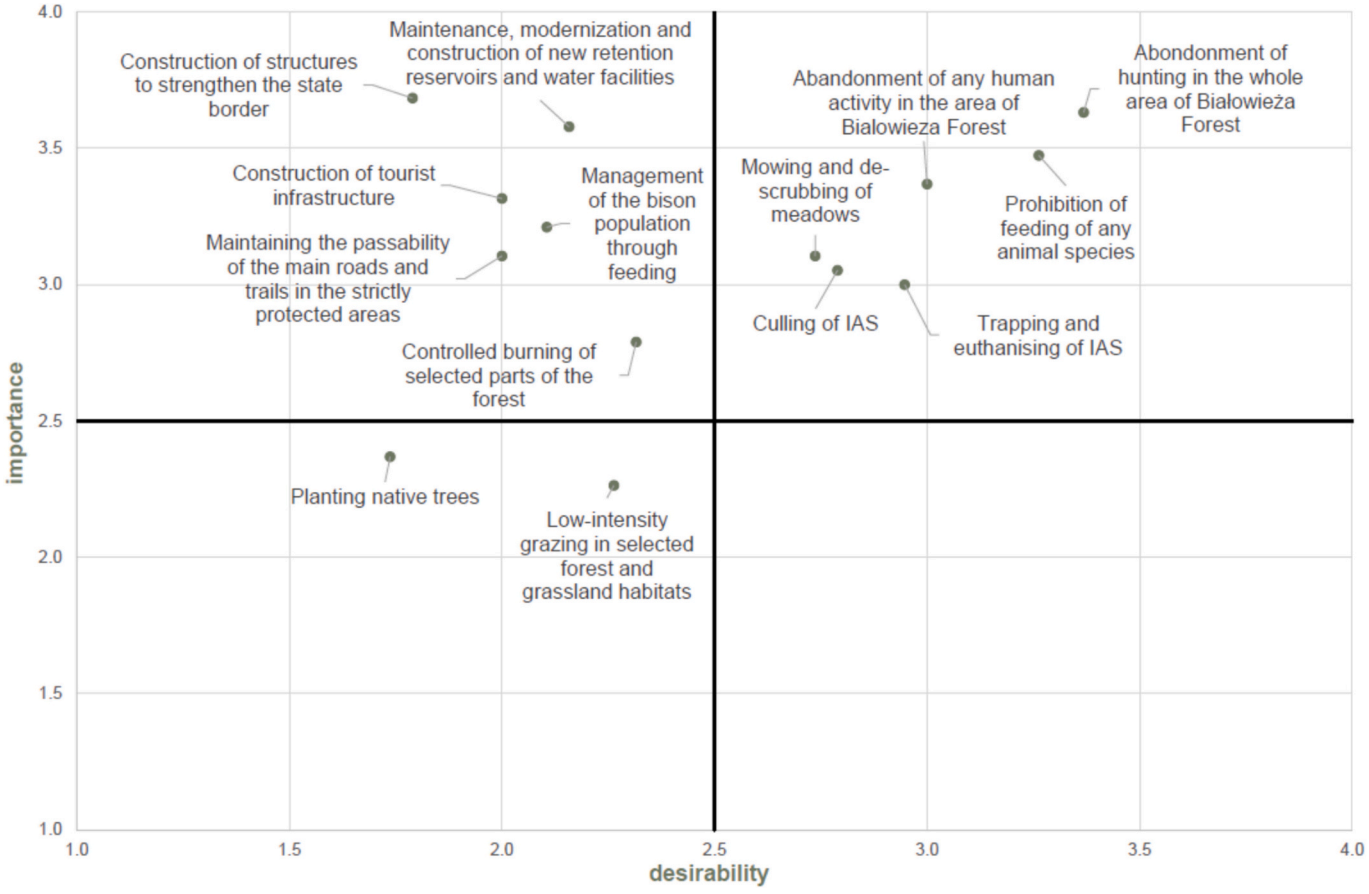

Fig. 3. A scatterplot of mean values on scales of desirability and importance for 14 statements assessed in Round 3. Desirability was assessed on a scale from "1: definitely undesirable", "2: rather undesirable", "3: rather desirable", to 4: "definitely desirable" and importance on a scale from "1: definitely unimportant", "2: rather unimportant", "3: rather important", to "4: definitely important". Bold lines indicate the center of each scale. Some descriptions have been shortened for the sake of readability of the figure.

Based on the standard deviations (Table 1), we found that in Round 1 respondents had different views on the desirability of activities, interventions or conservation measures undertaken for (1) maintaining the existing roads and fire safety infrastructure (statements 16, 25), (2) building and fortifying border structures (statement 31), (3) prevention of biological invasions (regarding various methods of IAS elimination) (statements 12, 17, 26, 32), (4) habitat restoration and habitat management measures (statements 7, 19, 23, 24, 27, 33, 35, 36, 37), (5) incorporating the entire area of the BF into a national park (statement 13), and (6) tourism development (statements 14, 21, 29).

In Round 2, respondents referred to the 31 interventions and the biggest disagreement coincided with the themes from Round 1 and also concerned newly added statements on abandonment of hunting, prohibition of feeding of any animal species, enlarging the national park area to the whole Białowieża Forest, and abandonment of any human activity in the area of BF.

Round 3 required respondents' opinions on the 14 interventions or conservation measures and it proved that most of them remained controversial for the study participants, and continued to be areas of disagreement.

We found no statistically significant change in respondents' preferences for the 10 statements that were repeated in the same form across all three rounds (ANOVA, df = 29, F = 12,625, p = 0,299). Also, respondents themselves in general did not declare the changes (when asked at the end of Round 3, only 4 out of 19 declared they changed their preference between the rounds).

While in the Policy Delphi process we looked for disagreement, the result of Round 1 allowed for identification of interventions for which there was a common agreement and separate those from the statements of higher dissent. Respondents were explicit and consistent in expressing their positive views on the restoration of ecological connectivity (statement 1), conducting research and monitoring (statement 2) and maintaining the programs to support local farmers (statement 3). They were also unambiguous towards the most unwanted actions in the BF, namely floodplain drainage, use of herbicides, introduction of new species, construction of asphalt roads (statements from 52 to 55).

3.3. Exploring arguments to understand reasons for differences

While the quantitative analyses identified the most controversial interventions in the BF, the qualitative analysis was oriented at understanding the reasons for the diverging positions of the participants. We explored respondents' argumentations for and against 14 interventions assessed in Round 3 – irrespective of respondents' preference ("desirability"), assessed on a scale from 1 to 4, they were all asked to provide both for and against arguments (see Supplementary material 1 for the exact questions). Inductive coding process allowed us to identify numerous themes repeatedly appearing in respondents' statements. Respondents were able to evaluate, both positively and negatively the consequences of undertaking a given intervention, as well as consider its influence on nature or on people. The coding process revealed three main themes: (1) the impact of human activities or management interventions on habitats, species and ongoing ecological processes in the BF; (2) activities that influence economic development and intensify human-wildlife conflicts, affecting both the safety of the area and the ethical dimension of the intervention, and (3) uncertainty or hesitation

Table 2
Counts of fragments coded with four codes used in coding respondents arguments for and against given interventions.

	nature perspective	human perspective	no arguments	uncertainty, ambiguity
Construction of structures to strengthen the state border_FOR	3	9	3	1
Construction of structures to strengthen the state border_AGAINST	25	2	2	0
Maintaining the passability of the main roads and trails in the strictly protected areas to ensure fire safety and the safety of people in the Park_FOR	1	10	5	0
Maintaining the passability of the main roads and trails in the strictly protected areas to ensure fire safety and the safety of people in the Park_AGAINST	20	1	4	0
Abandonment of hunting in the Białowieża Forest_FOR	17	3	3	0
Abandonment of hunting in the Białowieża Forest_AGAINST	5	6	7	0
Construction of tourist infrastructure_FOR	2	11	2	0
Construction of tourist infrastructure_AGAINST	15	2	0	0
Culling/shooting of IAS_FOR	16	5	1	4
Culling/shooting of IAS_AGAINST	7	4	1	6
Management of the bison population, inter alia, through feeding_FOR	6	10	2	2
Management of the bison population, inter alia, through feeding_AGAINST	15	6	0	3
Prohibition of feeding of any animal species_FOR	7	5	1	3
Prohibition of feeding of any animal species_AGAINST	12	2	4	0
Low-intensity grazing in selected forest and grassland habitats_FOR	10	1	2	4
Low-intensity grazing in selected forest and grassland habitats_AGAINST	13	6	1	2
Planting native trees_FOR	3	1	10	3
Planting native trees_AGAINST	12	0	0	3
Trapping and euthanizing of IAS_FOR	12	8	1	2
Trapping and euthanizing of IAS_AGAINST	8	10	5	2
Controlled burning of selected parts of the forest_FOR	10	1	1	2
Controlled burning of selected parts of the forest_AGAINST	5	3	0	2
Mowing and de-pruning /de-scrubbing_FOR	11	6	0	2
Mowing and de-pruning /de-scrubbing_AGAINST	9	0	0	2
Carrying out maintenance, modernization and construction of new retention reservoirs and water facilities_FOR	3	0	4	3
Carrying out maintenance, modernization and construction of new retention reservoirs and water facilities_AGAINST	9	0	0	2
Abandonment of any human activity in the area of Białowieza Forest_FOR	5	2	2	1
Abandonment of any human activity in the area of Białowieza Forest_AGAINST	4	3	3	1

The cells are colour-coded — darker shades indicate a higher number of counts, while white indicates no counts.

about justifying the given intervention. Deductive coding of arguments for and against each intervention was aimed to look for nature and human perspective in respondents' argumentation as well as to identify all statements pointing out the uncertainty or insolvability of the issue or straightforward stating lack of arguments (Table 2).

Arguments identified as having 'nature perspective' pointed out species, population or ecosystem issues or processes. To mention a few examples: "disrupting natural processes", "interference in the evolutionary processes of a species", "promotes the dispersion of parasites", "habitat fragmentation", "prevents gene flow between populations" were among the coded fragments.

Arguments coded as having 'human perspective' raised issues that were important from the point of view of people and society, such as: "state border protection", "safety considerations for visitors", "tourist traffic management", "increase in costs", "damages to agriculture and forestry", "the most effective and economical method", "conflict mitigation", "limits economic losses". Also, an important part of 'human perspective' arguments were those relating to ethical or moral judgements. Ethical declarations appeared mostly in relation to hunting and culling issues (both in general and targeted at IAS) gathering clear opinions such as: "*culling is the least ethical method*", "*culling and euthanizing are more humane than shooting*", "*eliminating the animal, for example by using firearms, is a better, faster and less stressful option than trapping*", "*killing of animals, even if they are representatives of alien species, raises moral concerns*".

Some assessed interventions gathered arguments coded as "uncertainty, ambiguity" (Fig. 4). We found this category particularly meaningful because it relates to fundamental considerations of clarity vs. complexity of conservation goals and methods.

Based on the coding we identified two main contexts behind disagreement – there is a number of interventions for which the positions are clear and definite and a group for which there is a lot of doubt, relativism and uncertainty (Fig. 5).

Statements concerning safety (national safety related to the vicinity of the Polish-Belarussian border or fire safety in the BF) as well as those concerning recreational use of the forest in the form of hunting or tourist infrastructure development gathered arguments with a clear division between nature vs. human perspective. The arguments used were mostly unambiguous and clear. These groups of interventions also received clear statements indicating that the respondents had no arguments against opposing positions. We interpret it in a way that respondents were explicit about their preferences and had clear positions concerning these issues.

Statements concerning interventions such as the restoration, preservation and maintenance of species, habitats and ecosystems – generally human actions aimed at the conservation of nature or the management of natural resources – received more diverse arguments from both a human and a natural perspective, as well as more indications of the uncertainty and relativity of the rationale for undertaking each intervention. Several comments indicated context dependency, possible trade-offs and ambiguity for each intervention (see Fig. 4 for examples of arguments). We interpret the opinions and comments of respondents as indicating that disagreement about this group of interventions stems from the ambiguity, hesitation and uncertainty surrounding the effects of conservation interventions on the whole socio-ecological system of the BF, as well as the reluctance and indecisiveness of experts.

4. Discussion

4.1. Divergent preferences among practitioners

Understanding how conservation practitioners conceptualize nature conservation and forms of intervention is important for effective implementation of conservation policy. This aligns with calls for greater consideration of values plurality and diverse conceptions of human-nature relation for improving conservation policy (Chan et al., 2016; Gorddard et al., 2016; Hull et al., 2003; Kenter, 2018; Manfredo et al., 2021; Sandbrook et al., 2011). Seeing people who implement conservation policy at various levels as those co-shaping conservation process is not only reasonable but also necessary. Broadening the idea of expertise is needed to effectively address conservation challenges in rapidly changing circumstances of the Anthropocene, but also by newly acquired knowledge, changing norms and worldviews (Burgman et al., 2011; Clement et al., 2023; Pelai et al., 2021; Wyborn et al., 2021).

We focused here on people involved in debate and decision-making about the Białowieża Forest that for clarity of the text we call practitioners. We see this group as crucial for shaping and implementing conservation policy in relation to the BF. As we presented in our study, preferences towards conservation interventions aimed at the preservation of BF wildness expressed by study participants are, in some areas, divergent. We categorized the interventions about which respondents disagreed into three groups: actions related to safety issues (broad national context or fire safety), recreational use of the forest (tourism, hunting) and active conservation measures aimed at species, habitats and ecosystems restoration. This goes far beyond the conflict around the

- *The risks may outweigh the benefits.*
- *This is not an absolutely necessary measure: the benefits of control and the potential risks must be weighed up.*
- *The question of what is currently the priority.*
- *It is a matter of strategy.*
- *It is a matter of decision.*
- *I would leave this issue to be decided by the scientific community.*
- *Wider use of this method should be preceded by field tests and extensive training at many levels of area management.*
- *It is either wild nature (passive protection) or active protection....*
- *We keep coming back to the question: what do we actually want in the BF, and what is our general concept of nature conservation in Poland? Do we want to prevent any changes (which is rather unlikely), slow down some of the changes (which is classic in Natura 2000), observe changes passively (always? what about IAS?), or use a mixed system at "at one's discretion" (i.e. more or less the chaos that currently exists)?*

Fig. 4. Examples of respondents' quotes coded as "uncertainty, ambiguity".

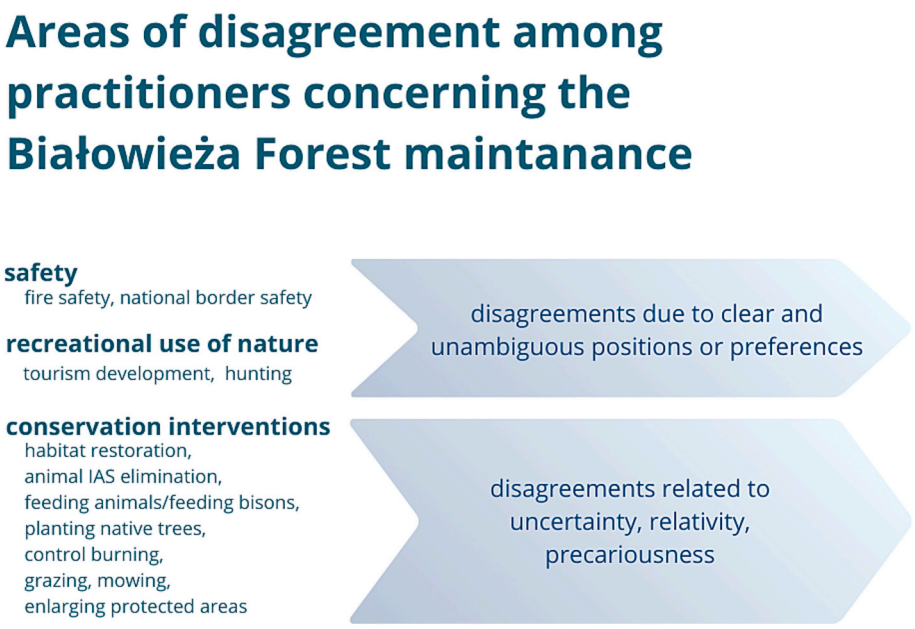

Fig. 5. Graphical summary of results and their interpretations concerning practitioners' disagreement areas and their contexts.

BF management that arose in the mid-2010s, which focused on increased logging as a way of addressing an outbreak of spruce bark beetles (Blicharska et al., 2020) and was an expression of the wide-ranging differences in values and beliefs among various interest groups.

Dilemmas and discursive struggles among conservation professionals have been acknowledged in the context of policy implementation (Steinwall, 2015). Recognition of conceptual diversity among experts, practitioners, generally people involved in implementing nature conservation should be an important aspect of deciding about implementation of particular interventions or policy options (Clement et al., 2023; Hagerman and Satterfield, 2013). As indicated by Hagerman and Satterfield (2013), some policy options are preferred not only based on their assessed ecological influence but also due to experts' feelings or worldviews. A study by Hertog and Turnhout (2018) suggests that practitioners justify their actions by appealing to multiple views of nature and variety of beliefs. Our study illustrates that differences in preferences towards actions related to safety or recreational use of the BF stemmed from clear and unambiguous positions of practitioners.

Another conclusion from our study is that management judgements or conservation preferences for areas of high biocenotic and ecological value, such as the BF, tend to be met with hesitation and caution, even among experts. We identified several conservation interventions, such as feeding wild animals, eliminating animal IAS, controlled burning and planting native trees, as being viewed differently due to uncertainty among respondents, their precautionary stance or perceived relativity of possible conservation outcomes.

Given the ecological dynamics, climate changes, political insecurity, new conservation challenges (such as IAS management), these uncertainties or hesitation should not be considered as a weakness, incompetence or incapability, but rather as a space for discussion and a common ground for various societal groups and policy experts. This is yet another reason why the development of management plans and conservation actions should be carried out in an inclusive, deliberative and iterative way.

4.2. Plurality and uncertainty to be acknowledged

Different perceptions, understandings and preferences towards nature conservation are a fact. This should not be considered an unwanted aspect of policy implementation, nor should it be neglected. On the contrary, acknowledgement of diverse beliefs and values, also among people implementing conservation policy, might be seen as a first step towards improving policy processes (Kelemen et al., 2023) or anticipating or mitigating conflicts (Crowley et al., 2017). Adopting a 'multiple evidence base' approach enables these diverse knowledge systems, including indigenous, local, and scientific knowledge systems to be recognized as equal and complementary sources of both, information and knowledge. Acknowledging this would provide a richer picture of social-ecological systems, without requiring one system to be validated by another (Tengö et al., 2014). It is also an element of adaptive management approach, which acknowledges the process of continuous learning and adaptation of measures to changing environmental, political or geopolitical conditions (Allan and Stankey, 2009).

While not everything is and might be defined in legal regulations and not every intervention (or rather its ecological effect) has sound scientific evidence, expert judgements or preferences may play an influential role in certain contexts of policy implementation. Knowing the scope of diverging preferences and their context helps to go beyond illusory conception that legal regulations assure effective conservation. We highlight that differences in practitioners' preferences are likely to influence or even shape policy implementation, especially given the power issues and uncertainty. Indeed, acknowledging and understanding underlying values and assumptions is an important step towards better consideration of power in conservation (Bennett et al., 2017; Shackleton et al., 2023).

While part of the interventions for which we uncovered disagreements among practitioners stems from what Dewulf and Biesbroek (2017) categorized as epistemic uncertainty that might be reduced by providing more information and knowledge through research, another part (called ambiguity) might be mitigated by joint sensemaking and collective knowledge generation (Brugnach and Ingram, 2012). Following Dewulf and Biesbroek (2017), ambiguity relates to different frames for understanding the issue or interpreting actions or processes. In that sense acknowledging and understanding differences in conceptualization and preferences of policy actors is an important insight into reducing uncertainty in policy implementation.

Thus, the solutions proposed by law should be locally adaptable, and subsequently monitored and if needed adjusted to the changing conditions, needs and requirements, taking into account the social-ecological context of the conservation object (Westgate et al., 2013). Our results

might suggest that there is a potential for more openness towards acknowledging or accepting uncertainty as a part of conservation management as respondents highlighted context-specificity and unambiguity of many interventions. Acknowledging the uncertainties or hesitation of foreseen actions was also recognized in the Białowieża Forest World Heritage Site Management Plan (Polish part) that was prepared at the same time as the described study (IOŚ, 2025).

4.3. Policy Delphi as a method for understanding plurality of preferences

Our study illustrates that the Policy Delphi process can play a useful role in conservation policy, and in particular in overcoming decision-making impasses. While its primary aim is to generate a variety of policy solutions, it also aims to expose opposing views. Here, while adhering to the Policy Delphi assumptions, we used this method to recognize and explore the plurality of preferences and arguments related to the conservation of wildness of one of the most valuable forest complexes in Europe, representing ecological dynamics typical for natural lowland primeval forests. By ensuring anonymity and a safe, non-confrontational environment for sharing perspectives, positions and preferences, the process can balance power relations and stimulate substantive debate, particularly in long-term or high-intensity conflicts. We suggest that the Policy Delphi technique could be a valuable element of conflict management, as it can reveal the root causes of conflicts while also facilitating the inclusion of diverse perspectives and knowledge systems (Tengö et al., 2014).

Although we consider the Policy Delphi method as advantageous and promising, we noticed some challenges too. Even well-defined and pretested scales can be challenging and too difficult in an online, self-administered process. Turoff (2002) described four scales to be used in a Policy Delphi process, suggesting use of a maximum of two of them. In case of our study, respondents struggled with the two scales that we asked about, “importance” and “desirability”. In most cases, participants commented on the character of importance of particular actions (if it is positive or negative) even though they were informed about the following set of questions on desirability (where they could rate whether the action was appropriate and benefitting). Many comments suggested that the given intervention is important, yet has positive or negative implications. Those comments indicated misunderstanding of the importance aspect (that was confused with desirability). Adjusting the sequence (first asking about desirability, then importance) and reducing the number of sentences in Round 2 seemed to facilitate the process. Another challenge is assembling a diverse group of respondents with different levels of experience, expertise, roles and power in relation to the analyzed issue. While group heterogeneity is crucial, group size is also a factor to consider. Although our group of respondents was both diverse and dedicated, the pool was still relatively modest.

We succeed to obtain a result suggested by Turoff (2002, p. 83) namely to identify the actions for which the disagreement in judgment stem from uncertainty or from ‘differences among the self-interests’. This kind of results provides important information about the context of disagreement or dispute that might be used to further management processes.

5. Conclusions

The concepts of nature itself and conservation interventions are continuously negotiated within a policy context (Steinwall, 2015). The Policy Delphi proved useful in identifying and exploring a variety of views on interventions in an emblematic and primeval area of BF and therefore might be beneficial for moving forward conservation negotiations. The Policy Delphi process allowed us to acknowledge various standpoints, and its iterative nature encouraged participants to compare their perspectives with those of others without feeling the need to confront them, but rather to recognize and understand. We see both the process and its results as contributing to awareness and reflexivity about plurality of preferences among conservation practitioners.

The plurality of values, beliefs and preferences among people implementing conservation policy, and the inclusion of this plurality in the management processes, are important issues that should be widely acknowledged. Recognizing this diversity is the first step towards more in-depth and constructive deliberation about conservation interventions that could help to reach a consensus or generate new policy solutions (Van Herzele and Aarts, 2019). Treating different preferences as an asset would also help to shift the focus of the conservation debate away from individuals and coalitions who are persistent in their positions (Pietrzyk-Kaszyńska and Olszańska, 2024; Van Herzele et al., 2015), towards the merits of the issue, thereby reducing polarization.

In summary, we emphasize that research within the transdisciplinary field of conservation social science may provide novel tools, methods and solutions for nature conservation (Dietsch et al., 2016). It brings not only science-based knowledge on peoples' beliefs, cultural changes and behaviors, but also shows how the social-ecological systems evolve and change (Berl et al., 2025). It may also improve the ability to react and define the core of the human-wildlife crises and transform them into resolvable challenges (Martin et al., 2024).

CRediT authorship contribution statement

Agata Pietrzyk-Kaszyńska: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Agnieszka Olszańska:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Agata Pietrzyk-Kaszynska reports financial support was provided by National Science Centre, Poland. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2026.111931.

Data availability

Data will be made available on request.

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