Environmental and Sustainability Indicators 32 (2026) 101576

Contents lists available at ScienceDirect

Environmental and Sustainability Indicators

journal homepage: www.sciencedirect.com/journal/environmental-and-sustainability-indicators

The "Plural Values of Nature" scale: A validated psychometric scale to measure instrumental, intrinsic and relational values

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ARTICLE INFO

Keywords:
Indicators
Values of nature
Plurality
Attitudes
Environmental psychology
Nature restoration

ABSTRACT

Sustainability transformations critically depend on understanding, assessing and monitoring the plural values of nature held across societies. However, while conceptual frameworks increasingly acknowledge a plurality of values, reliable and practical indicators to assess these values remain scarce. We introduce the Plural Values of Nature (PVN) scale, integrating intrinsic, instrumental, and relational values into one multi-dimensional scale. This psychometric scale consists of 11 items and is designed to capture both distinctiveness and overlap of values. Using a seven-step process that includes literature review, expert evaluation, qualitative and cognitive interviews, quantitative pre-testing, pilot testing and final validation, the scale is refined and validated across five European countries using general-public samples (N = 1007). The final 11-item PVN showed a stable three-factor structure and generally good reliability across countries, with comparable factor loadings but not absolute score levels. Analysis shows predictive and incremental validity, adding 6.7–13.3 percentage points of explained variance beyond the RNEP and explaining an additional 5.7–13.6 percentage points in local restoration attitudes and management actions beyond country differences. Based on the development and validation of the PVN, we discuss methodological and conceptual issues and unpack the plurality of values of nature. Descriptive profile analyses further showed that multiple value dimensions commonly co-occur within individuals. As a concise survey-based social indicator, the PVN scale can be used to take stock of the plural values that societies hold regarding the future development of nature, to examine their associations with environmental attitudes, and to monitor value patterns over time within comparable contexts.

1. Introduction

1.1. Background

The world is facing unprecedented environmental challenges, especially related to climate change and biodiversity loss. The Kunming-Montréal Global Biodiversity Framework (GBF) in 2022 has established biodiversity safeguarding targets to be reached in 2030 as well as targets to ensure sustainable use of nature (Hughes and Grumbine, 2023). In addition, the IPBES Transformative Change Assessment has argued for transformative change towards more nature-inclusive societies. Changing human-nature relationships and strengthening nature-positive values is considered an important pathway towards sustainable transformations (IPBES, 2024; Lengieza et al., 2023).

A range of indicators that can measure both biophysical and social aspects of these transformative societal changes are needed. Recent synthesis of the diverse values literature argue that value indicators should not be limited to biophysical or monetary measures, but should also include socio-cultural indicators that capture people–nature relationships and the plurality of ways in which nature matters to people (Pascual et al., 2023). In another strand of literature, looking holistically at social-ecological systems is seen as foundational to understanding connections between the natural environment and people (Colding and Barthel, 2019). However, current biodiversity monitoring and policy practices still rely predominantly on biophysical and, to a lesser extent, monetary indicators. This highlights the need for reliable social

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https://doi.org/10.1016/j.indic.2026.101576
Received 6 June 2026; Received in revised form 18 October 2026; Accepted 19 October 2026
Available online 20 October 2026
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indicators that can assess and monitor plural values of nature across populations and over time. Against this background, this paper introduces the Plural Values of Nature scale - a survey-based psychometric scale capable of measuring the endorsement of plural values of nature within societies.

Support for system-wide transformation depends, in part, on people's perceptions, values and cognition (Patterson et al., 2017). In democratic societies, societal transformation can only succeed if supported by a significant proportion of the general population (Buijs et al., 2025). In addition, views on the value of nature vary within and between socio-demographic groups, communities, cultures, countries and regions (Buijs et al., 2009; Kloek et al., 2017). Indeed, the IPBES Values Assessment (IPBES, 2022) and the IPBES Transformative Change Assessment (IPBES, 2024) argue for the need to explicitly acknowledge and explore the many different values of nature. Incorporating a wide spectrum of values. Furthermore, releasing latent "nature-positive values" is suggested as an important leverage point for sustainable transformations (Horcea-Milcu et al., 2023; IPBES, 2024). Recognition of the plural values of nature allows for the inclusion of diverse groups and worldviews in environmental management (Chan et al., 2016) and addresses the widely acknowledged need to increase sensitivity to justice impacts of sustainable transformations (Bennett et al., 2019). Differences in values can also point at different transition pathways as preferable. Martin et al. (2024) analyse how different transformation pathways (e.g., green economy, earth stewardship and biocultural diversity, nature protection, and degrowth and postgrowth) vary in values prioritized and emphasised, and they argue for a debate around these as needed to address environmental crises. Similarly, for practical decision making, sustainability assessments are also increasingly asking for broadening the scope to provide a more holistic approach (Bond et al., 2025).

This increased focus on the relevance of the plural values of nature, and the extensive theoretical and conceptual developments over the last years in understanding these concepts (IPBES, 2022, 2024), suggests the need for understanding how the plurality of values can be measured and incorporated in inclusive environmental policies. In this paper we engage with this need through developing and testing a psychometric scale that empirically measures the plural values of nature and can function as a survey-based social indicator for assessing and monitoring these values across populations.

1.2. Values of nature

The concept of values is conceptualised in different ways, both within and across fields. Psychology treats values primarily as motivational constructs internal to the individual, as "desirable goals that transcend situations and serve as guiding principles in people's lives in general" (Schwartz, 1992). This relationship with behaviour is for example reflected in the value-attitude-behavior (VAB) cognitive hierarchy model first presented by Homer and Kahle (1988), and extensive research has illustrated the relevance of values for understanding attitudes and behaviours (Steg, 2016).

To understand the richness of people's relationships to non-human nature, the IPBES Value assessment argues for the need to distinguish worldviews, knowledge systems, broad values and specific values. Where broad values are generally considered to be stable, specific values are more changeable over time (IPBES, 2022). Our proposed scale focusses on the specific values of nature. Specific values of nature have been conceptualised into three broad categories - instrumental, intrinsic and relational values (Chan et al., 2016; IPBES, 2022; Muraca, 2011; Pascual et al., 2023). However, decades of philosophical, sociological and psychological explorations of their ontological, epistemological, conceptual, and empirical underpinnings (e.g. Buijs, 2009; Chan et al., 2018; Gould et al., 2024; Himes et al., 2024; Kempton et al., 1995; Lockwood, 1999; Muraca, 2011; Stålhammar and Thorén, 2019) have shown that this categorisation is not without issues. In particular, for psychometric scale development it is important to acknowledge that the three categories are not easily distinguishable or separated. As highlighted in recent scholarship (Himes et al., 2024; Kenter et al., 2019), fuzzy boundaries exist between them, with a high degree of overlap. Moreover, many individuals simultaneously endorse multiple values from each of the categories, as shown in the applied literature (e.g. Uggeldahl et al., 2025). In addition, the ontological and epistemological characteristics of relational values, and whether and how they are ontologically or conceptually different from instrumental and intrinsic values, is still under debate (Gould et al., 2024; James, 2022; Luque-Lora, 2023; Stålhammar and Thorén, 2019).

Instrumental values can be conceptualised as being based on the value that an individual and/or society may derive *from* nature, that is, from animals, plants, ecosystems and natural processes (Himes and Muraca, 2018). Instrumental values are the values of living entities as means to achieve human-defined ends, or to *satisfy human preferences* (Pascual et al., 2017), or the basis of *services* and *benefits* that nature can provide for human beings (See et al., 2020). One important characteristic of instrumental values is that they are transactional, and in principle substitutable, though not always in practice (Himes et al., 2024).

Intrinsic values have been explored extensively in environmental philosophy. Central to the various understandings of the concept are three key elements: i) the *inherent*, non-relational properties of nature and/or natural objects; ii) the value of nature *independent* of human valuation and judgment, and iii) natural entities as bearer of inherent moral value as ends in themselves, and subjects/objects with their own good (O'Neill, 1992). In the IPBES approach, intrinsic value is defined as the " inherent value, that is the value something has independent of any human experience or evaluation. Such a value is viewed as an inherent property of the entity (e.g., an organism) and not ascribed or generated by external valuing agents (such as human beings)" (Pascual et al., 2017: 14). Unlike instrumental values, intrinsic values cannot be substituted.

Relational values as a concept has emerged in the last decade (Chan et al., 2016; Gould et al., 2024). Relational values are values of nature stemming from, often reciprocal, relationships (interactions, responsibilities) between people and nature or among people through, or with regards to, nature (Himes et al., 2024). Importantly, relational values have been suggested as a way to break up the dichotomy of instrumental and intrinsic values. The notion was first articulated in land-use literature by Brown (Brown (1984) as 'relational realm' which is called a value concept, though importantly not as a suggested third value type (Chan et al., 2018). As a value type proper, it was coined in the philosophical literature as part of a new axiological framework by Muraca (2011) and in a broader sustainability science context by Díez et al. (2015) and Chan et al. (2016). The advent of this suggested type of value can be seen as a response to a growing critique of (economic) environmental valuation (e.g. Spash, 2020) and as an effort to move beyond the heavily debated human-nature dichotomy (Himes et al., 2024). It also responds to critiques that instrumental and intrinsic values only capture a narrow spectrum of possible values (R. Gould et al., 2024; Himes et al., 2024).

The concept of relational values is still under debate for various reasons. Some authors argue that relational value is an addition to instrumental and intrinsic value (James, 2022); others that all environmental values are ultimately relational, or at least that relationality is inherent to instrumental and intrinsic values (Luque-Lora, 2023; Norton and Sanbeg, 2021). When the term relational values is used, it aims to capture a more diverse and equitable array of nature's values than intrinsic and instrumental values - meanings and uses. Meanwhile, the meaning and use of the concept itself is still quite diverse, with a recent review of 72 empirical papers reporting 312 unique relational values (Pratson et al., 2023), but also criticising most studies for "not justifying how the relational values they studied aligned with core conceptual elements unique to relational values" (Ibid, p. 9). Notwithstanding this diversity and debate, most conceptualisations converge on a limited number of dimensions of relational values including especially place

attachment, stewardship, indigenous and spiritual practices, kinship, as well as eudemonic values; i.e., living a fulfilling life of care, well-being and reciprocity (Anderson et al., 2022; Chan et al., 2018; Feucht et al., 2023; Himes et al., 2024; Pratson et al., 2023).

1.3. Developing a scale for measuring plural values of nature

The aim of this paper is to develop a psychometrically validated quantitative scale that can serve as a survey-based social indicator for measuring the plurality of values of nature. Here we focus on the Global North, more specifically Europe as a clear spatial boundary in which we seek validity for the scale. Such a scale can be used in quantitative surveys and can contribute to understanding of not only the diversity of values and how they are related, but also how values relate to individual attitudes, motivations and preferences for environmental policies, stewardship or activism (Richardson et al., 2020; Runhaar et al., 2019; Steg, 2016; Taye et al., 2018).

When developing psychometric scales, it is important to already identify its potential use. From a socio-ecological perspective, it is helpful if the scale can be used jointly with ecological and biophysical indicators to inform important trade-offs and management decisions. As shown by Strange et al. (2024), especially relatively simple measures are often used to convey the message for communication and policy making (e.g. species number or hectares to measure ecological value). This trade-off between depth, nuance and brevity is also relevant to social indicators (Ibid.).

A related concern is its relevance and practicality for management. A lack of recognition of local communities' priorities has frequently been raised as a concern, and is linked to the emergence of conflicts (Blondet et al., 2017). For societal transformations to be successful, they require understanding of stakeholders' values and perceptions. Consequently, we aim for a psychometric scale that can capture nuances of people's values in a way that allows for flexible application in on-the-ground conservation practices.

A psychometric scale consists of a set of questionnaire items designed to measure a specific latent construct in a reliable and valid way. Such a scale should consistently produce similar results when used repeatedly under similar conditions, and should accurately measure the latent construct(s) it is intended to measure. Given the overlap and inherent fuzzy boundaries between intrinsic, instrumental and relational values of nature, it can be expected that some items may cross-load across these value types. Such cross-loadings are conceptually coherent with the plural and fuzzy nature of the specific values of nature (Himes et al., 2024). The scale we have developed in this paper is explicitly designed to capture the distinctiveness of these value types whilst accommodating for their overlap and fuzzy boundaries. Nonetheless, there is a fundamental trade-off that has to be considered: While a larger number of items within a scale intended to measure several overlapping latent constructs could potentially better capture differences between the constructs, the number of items has to be balanced against the scale's potential practical use and the need for scale brevity in order to maximize response rate in survey research (Robinson, 2018).

A valid psychometric scale to measure the plurality of values of nature must respond to several criteria. Based on methodological literature on psychometric scales (G. O. Boateng et al., 2018; Hair et al., 2019; Robinson, 2018), conceptual considerations of the plurality of values of nature with potential fuzzy boundaries (Himes et al., 2024; Pascual et al., 2023) and pragmatic limitations to the length of a scale to be used in real-life empirical research (Stern et al., 1998), we suggest four distinct criteria: First, a psychometric scale by definition must be validated conceptually, empirically, and statistically with representative samples of the general public (Boateng et al., 2018). Second, in order to understand the plurality of values, the potential conceptual overlap between values as well as potential empirical co-occurrence of multiple values, the scale should measure all three values simultaneously. Third, as the three values potentially co-occur, and have fuzzy boundaries, their empirical distinction may vary across countries and/or specific cultures. Therefore, the geographical scope of the scale must be clear, and its factor structure, reliability, and measurement equivalence should be evaluated cross-nationally. Fourth and last, the scale must be useable for real-life research, most notable for surveys of diverse publics. Consequently, the number of items must be limited to allow sufficient space for other concepts to be measures in surveys, such as attitudes, beliefs, behaviours, nature experiences etc. (Stern et al., 1998). Obviously, this last point involves some trade-offs with the other criteria – as will also be clear in the proposed scale and feature as an aspect in the discussion.

To develop indicators of the values of nature people and societies endorse, as well as the relative endorsement of a specific value relative to other values, it is important to develop scales that measure the different values simultaneously (IPBES, 2022; Lengieza et al., 2023; Raymond et al., 2023). In recent years, various item batteries and scales have been developed to measure relational values as a single concept, or in combination with other values (e.g. Feucht et al., 2023; Klain et al., 2017; Lengieza et al., 2023; Lengieza et al., 2025; Lou et al., 2025; Post, 2026; Saito et al., 2021; See et al., 2020). These item batteries and scales differ significantly in length, conceptual focus, theoretical strength, and validation procedures. Not all have rigorous psychometric examinations (Mrotek et al., 2019; Klain et al., 2017) or are based on student samples (Feucht et al., 2023); other scales focus only (Post, 2026; Saito et al., 2021) or predominantly on relational values, with only rather minimal operationalisation of other values (See et al., 2020).

In addition, several well established and cross-culturally validates scales which attend to human-nature relationships already exist, such as the revised New Ecological Paradigm scale (RNEP; (Dunlap et al., 2000), the Connectedness to Nature scale (Mayer and Frantz, 2004), and the Environmental Concerns scale (Schultz, 2001). These scales do not explicitly target values of nature, but rather related constructs such as environmental concern and connection with nature. Assessing whether a new plural values scale can explain additional variation in environmental attitudes alongside such established measures is therefore an important component of its validation.

Recently, two comprehensive scales that measure instrumental, intrinsic and relational values of nature simultaneously have also been developed and validated (Lengieza et al., 2023; Lou et al., 2025), next to a scale that has only been validated with student samples (Feucht et al., 2023). Both Lengieza et al., 2023a,b; Lou et al., 2025 are formally validated in cross-cultural studies, using item batteries consisting of 24 (Lengieza et al., 2023) and 18 items (Lou et al., 2025). These scales differ significantly in the conceptualisation of values, most notably of relational values. Where Lou et al. (2025) has much focus on kinship and emotional connectedness with nature, with one item related to the spiritual values of nature, Lengieza et al. (2023) puts more focus on place attachment, community identity and traditions. Meanwhile, neither include items related to fulfilment and well-being through living a good and meaningful life (eudaimonia), a key element of relational values according to several authors (Himes et al., 2024; IPBES, 2022; Van den et al., 2018). Our scale contributes to this suite of available scales while adding some distinct features, which we introduce below.

In the next section, we will introduce and validate the “Plural Values of Nature (PVN) scale”. We evaluate its dimensional structure, reliability, convergent and discriminant validity, measurement invariance across countries, incremental validity relative to the RNEP, and predictive validity regarding attitudes towards ecological restoration. The scale integrates all three values described above as different dimensions within one psychometric instrument. To optimize the scales usability and potential for inclusion within larger questionnaires (Stern et al., 1998), we aim for a condensed scale.

2. Materials and methods

We developed the Plural Values of Nature (PVN) scale, following

recommended development and validation practices as outlined by Hair et al. (2019) and Boateng et al. (2018), via seven steps (Fig. 1). Table S1 in the supplementary material provides the formulation of all items at each step and the changes made between them. Fig. 3 provides the formulation of the items in the final scale. We developed PVN simultaneously within multiple (European) countries and related cultural settings, and subsequently validated the scale in multiple countries, which required additional considerations regarding the scale validation and statistical analysis. Thus, special attention was given to existing guidelines for cross-cultural scale adaptations during the development and validation of the scale.

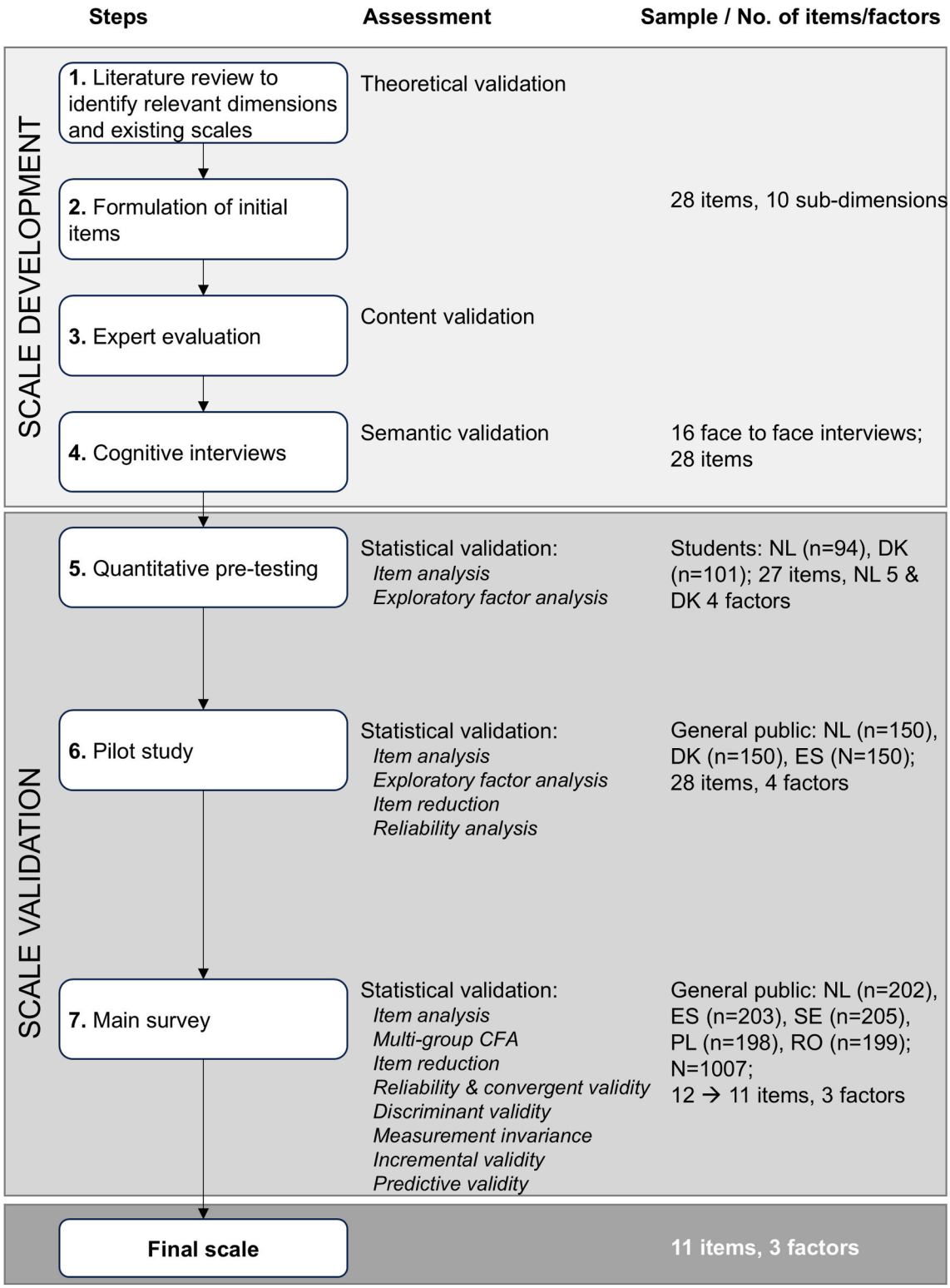


Fig. 1. Methodological overview of PVN scale development and validation process. The figure shows the chronological steps taken for scale development and validation including assessment procedures, used samples, numbers of items and retained factors. CFA refers to confirmatory factor analysis.

2.1. Instrument development

An extensive narrative literature review was carried out to identify existing related scales and explore relevant subdimensions that should be considered within each value type. For instrumental values, we drew from previous conceptualisations of ecosystem services (ESS) and Nature's Contributions to People (NCP), differentiating between three subdimensions of instrumental values: *material, non-material,* and *regulating contributions* to people (Fig. 2) (Diaz et al., 2018). For intrinsic values, we build on existing conceptualisations that distinguish (at least) two subdimensions: *nature as an end in itself* and the recognition that nature has *value beyond human benefit* (Himes et al., 2024). The conceptualisation of relational values proved to be the most difficult, as this relatively new concept is still in development, and is conceptually quite rich, complex, and culturally diverse (Gould et al., 2024; Himes et al., 2024; Klain et al., 2017; Pascual et al., 2023). Due to the conceptual

	Subdimensions	References	Example formulations used for inspiration
INSTRUMENTAL	**1.** Material contributions	Diaz et al., 2018; Feucht et al., 2023; Himes et al., 2024	Nature has a benefit in that it provides food, water, raw materials, etc. for humans (Feucht et al., 2023)
	2. Immaterial contributions	Diaz et al., 2018; Feucht et al., 2023; Himes et al., 2024	This green space is a good venue for recreational activity (See et al., 2020)
	3. Regulating contributions	Diaz et al., 2018; Feucht et al., 2023; Himes et al., 2024	This green space can mitigate climate change (See et al., 2020).
RELATIONAL	**4.** Place attachment and identity	Chan et al., 2016; Klain et al., 2017; Andersen et al., 2022; Lan et al., 2022; Saito et al., 2022; Pratson et al., 2023; Feucht et al., 2023; Himes et al., 2024	There are landscapes that say something about who we are as a community, a people (Klain et al., 2017)
	5. Fulfilment and well-being	See et al., 2020; Andersen et al., 2022; Saito et al., 2022; Himes et al., 2024	My care for this land fulfils me, helps me lead a good life (Saito et al., 2022)
	6. Spirituality	Lliso et al., 2021; Andersen et al., 2022; Pratson et al., 2022; Lan et al., 2022	Nature has a religious, sacred or spiritual value to me (Lliso et al., 2021)
	7. Care	Chan et al., 2016; Andersen et al., 2022; Saito et al., 2022; Pratson et al., 2023; Himes et al., 2024	Caring for all lifeforms and physical forms is a moral necessity (Saito et al., 2022)
	8. Kinship	Klain et al., 2017; Pratson et al., 2023; Feucht et al., 2023	Humans are a part of nature and nature is a part of us (Lliso et al., 2021)
INTRINSIC	**9.** Nature as an end in itself	Feucht et al., 2023; Himes et al., 2024	Just by virtue of its existence, nature already has value (Feucht et al., 2023)
	10. Value beyond human benefits	Himes et al., 2024	Inherent moral value of natural beings (right to exist) (Himes et al., 2024)

Fig. 2. Overview of the values and their subdimensions, including references and examples from previous studies used as inspiration for the PVN scale.

complexity of relational values, their as-yet-undecided conceptual boundaries, and their potential overlap with especially instrumental values (Himes et al., 2024), we decided to first identify subdimensions for relational values from the IPBES Value Assessment, which differentiates between *place attachment and identity*; *fulfilment and well-being* (eudemonia); *spirituality*; and *care* (as stewardship responsibility) (IPBES, 2022). Based on other reviews of relational values (Feucht et al., 2023; Pratson et al., 2023), we added the notion of *kinship* with nonhuman entities as a fifth subdimension. We then mapped items from existing scales for relational values (Feucht et al., 2023; Klain et al., 2017) onto these subdimensions, and formulated some new items alongside these. Together with the three subdimensions for instrumental values and two subdimensions for intrinsic values this resulted in a final set of ten subdimensions which were used as the basis for formulating the scale (Fig. 2).

An initial set of items related to these 10 subdimensions was produced by both drawing items from pre-existing scales (Feucht et al., 2023; Klain et al., 2017) and formulating some new items alongside these. This initial formulation of items was then validated in an online workshop with all coauthors as well as in 16 cognitive interviews with people not professionally engaged in conservation or research in the Netherlands and Denmark (Fig. 1). We then pilot tested 28-items using samples of the general public from Denmark, Spain and the Netherlands, with the aim of further refining and shortening the item set. This resulted in a set of 12 items which were then used in the main study, and finally an eventual 11 items following results from this main study (Fig. 3). Based on the pilot study, the question stem for the final scale was adapted to: "*Listed below are statements on different aspects that could be important when thinking of nature in the future. Please indicate how much of a priority you feel each aspect should have in* [respondent's country of residence] *in the future.*" Responses to each item were given on a 7-point scale ranging from 1 (*not a priority at all*) to 7 (*the highest priority*), with 4 indicating a *moderate priority*. A full description of all steps, and changes in formulations between each step, can be found in the Supplementary Text S1 and Table S1.

As highlighted in recent scholarship (Himes et al., 2024; Kenter et al.,

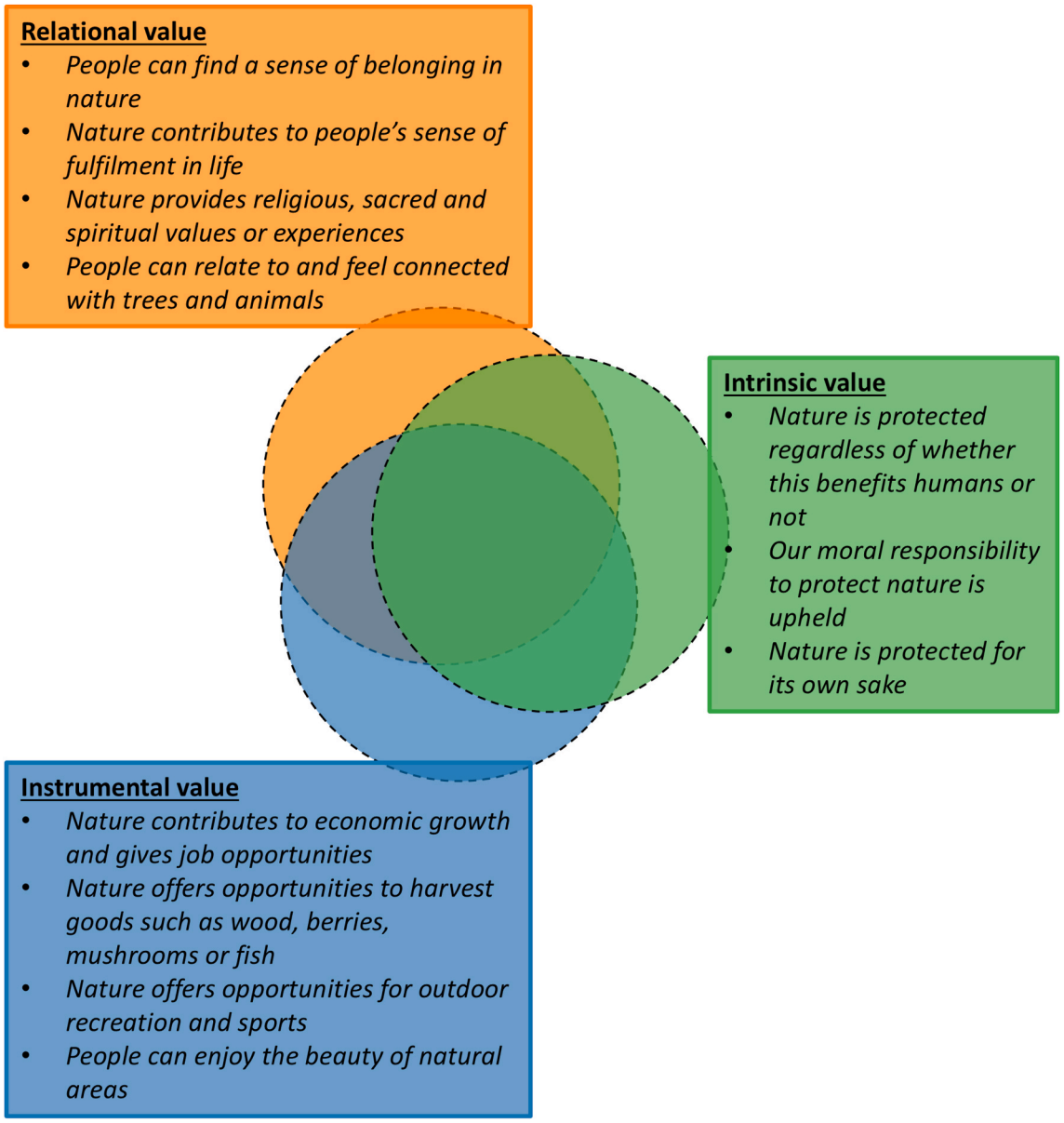


Fig. 3. Final items of the Plural Values of Nature (PVN) scale, all linked to the stem of the question: "Listed below are statements on different aspects that could be important when thinking of nature in the future. Please indicate how much of a priority you feel each aspect should have in [respondent's country of residence] in the future?"

2019) and in the Introduction, the three value dimensions and their respective subdimensions are not mutually exclusive but rather overlap with fuzzy boundaries. We therefore expected that some items might display cross-loadings across factors, reflecting the fact that many people endorse multiple value types simultaneously while only a minority endorse values from only one of the three value types. In addition, individual items may load on different (sub)dimensions. Our validation procedure outlined below enabled us to explicitly explore this in the results and reflect on this in the discussion.

2.2. Data collection

Statistical scale validation was carried out with three independent data collections, each containing samples from multiple countries (Fig. 1). First, an online questionnaire was administered with a convenience sample of university students from the Netherlands and Denmark, some of whom were international students ($n = 94$ & $n = 101$). After further revisions of the scale (see Results section and Table S1–S3), a pilot study was conducted by a professional polling agency, with an online questionnaire targeting a representative sample of the general public in the Netherlands, Spain and Denmark ($n = 3$ x 150) (Table S4). After final iterations of the scale (see results section, Table S1, S5-S8), including a back-translation of the survey to check for translation inconsistencies, it was administered in October 2024 by a professional polling agency as part of a larger online questionnaire on restoration and rewilding. To limit any potential bias related to the aim of the survey, we positioned the items for our PVN scale at the beginning of the questionnaire. The sample consisted of 1007 respondents from the general public in the Netherlands ($n = 202$), Spain ($n = 203$), Sweden ($n = 205$), Poland ($n = 198$), and Romania ($n = 199$; Table S9). The five countries were selected pragmatically to provide geographical variation across northern, southern, western and eastern Europe, while also ensuring sufficient language expertise within the core research team and close collaborators to support translation and validation of the survey instrument. The selection was intended to provide diverse European test contexts rather than to constitute a statistically representative sample of European cultures. The studies were conducted according to ethical guidelines, including informed consent. The ethics approval for the study was given by the Wageningen Research Ethics Committee for nonmedical studies involving human subjects (WUR-REC-2024-112).

2.3. Data analysis

For the statistical validation of the scale, a range of common scale reliability and validity analysis (Hair et al., 2019) were performed for each of the development steps and samples (Fig. 1). Country samples were treated separately in the pretesting and pilot study to support the cross-cultural adaptation and development of the scale. All data analyses was performed in *R* and statistical significance was set at $p < 0.05$. Confirmatory factor analyses (CFA) were estimated using the lavaan package in R (v0.6-7; Rosseel, 2012).

Across all data collections, we evaluated the performance of individual items using basic descriptive statistics, including mean values, standard deviations (SD), skewness, kurtosis, and response range to assess the clarity of the items and response options and to check for potential ceiling or floor effects (mean values > 6.5 or < 1.5). To assess the dimensional structure of the scale, exploratory factor analyses (EFA) using principal axis factoring with direct oblimin rotation were conducted during the pretesting and pilot stages to guide item refinement. The theoretically derived three-factor structure was subsequently tested using multi-group CFA in the independent final validation sample (Fig. 1). Factor loadings $\geq$0.40 were considered substantively relevant, and items loading ≥ 0.40 on more than one factor were considered cross-loading. Because the final survey data did not meet multivariate normality assumptions, CFA models were estimated using robust maximum likelihood (MLR). Model fit was evaluated using the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR).

The reliability of the factors obtained was assessed using Cronbach's alpha. Convergent validity was evaluated using Average Variance Extracted (AVE), with values of approximately 0.50 or higher indicating that a factor explained at least half of the variance in its indicators. We also assessed discriminant validity, that is, whether the three value dimensions were empirically distinguished from one another. Discriminant validity was evaluated using the Fornell–Larcker criterion, which compares the square root of the AVE for each factor with the correlations between factors. When inter-factor correlations exceed the square root of AVE, this suggests that dimensions are not fully distinct (Hair et al., 2019). Given our conceptualisation of instrumental, intrinsic, and relational values as overlapping rather than mutually exclusive dimensions, we anticipated that issues of discriminant validity might arise. We therefore interpreted these statistics alongside the overall factor structure and model fit rather than requiring complete empirical separation between the dimensions. A detailed description of the statistical data analysis in each validation step and for each country, including configurations used, tests for appropriateness, and analysis steps can be found in the Supplementary Text S2.

Measurement invariance of the final scale across countries was assessed sequentially at the configural, metric and scalar levels using multi-group CFA. Changes in model fit between increasingly constrained models were evaluated using robust fit indices and scaled chi-square difference tests; detailed procedures and evaluation criteria are provided in Supplementary Text S2 and Table S11.

Besides the Plural Values of Nature scale, the final survey also contained an abbreviated version of the Revised New Ecological Paradigm (RNEP) scale as a measure of general environmental worldview (Dunlap et al., 2000). In addition, three broader restoration attitudes were assessed both at the national level (changes occurring within a respondent's country) and at the local level (changes occurring within an area close to where the respondent lives): (1) “making landscapes easier for wildlife to move through”, (2) “reducing the influence that humans have on nature”, and (3) “restoring natural processes and dynamics”. Finally, the survey included attitudes towards more specific management actions, including “reducing the number of roads and tracks for vehicles”, “changing timber-production forests to more natural unmanaged forests”, and “encouraging natural predation by animals such as wolves or lynx”.

To assess incremental validity, we compared the explanatory contribution of the three PVN dimensions with that of the abbreviated Revised New Ecological Paradigm (RNEP) scale (Dunlap et al., 2000) across the three broad national level restoration attitudes. Eight RNEP items were included in the survey; one item with a weak one-factor loading was excluded, resulting in a seven-item composite (Supplementary Test S2). Negatively worded items were reverse-coded before then calculating a mean composite score. Higher scores indicate stronger endorsement of an ecological worldview. The complete item wording and descriptive and reliability information are provided in Table S12. Mean composite scores were also calculated for each PVN dimension, reflecting the intended application of the PVN as a directly scoreable survey indicator. For each attitude, we compared linear regression models containing a) country and RNEP, b) country and the three PVN dimensions, and c) a combined model containing country, RNEP and the three PVN dimensions. Incremental validity was evaluated from the change in explained variance (ΔR^2) when PVN was added to the RNEP model, with the reverse comparison used to assess the additional contribution of RNEP beyond PVN. The statistical significance of changes in explained variance was evaluated using nested-model *F* tests. Variance inflation factors (VIFs) were inspected to assess multicollinearity. To examine whether this incremental contribution was consistent across national samples, the same model comparisons were additionally estimated separately within each country.

Predictive validity was further assessed using the three local-level broader restoration attitudes and attitudes towards the three concrete management actions. Each outcome was analysed in a separate linear regression model, with the three PVN composite scores entered simultaneously as predictors and country included as a fixed effect. Predictive validity was evaluated using standardized regression coefficients, total explained variance (R^2), and the additional variance explained by the PVN dimensions beyond country differences (ΔR^2), calculated relative to a model containing country alone. Again, the statistical significance of the PVN block was assessed using nested-model *F* tests and VIFs were inspected to assess multicollinearity. Again, to examine the consistency of these associations across national samples, the same models were additionally estimated separately for each country.

To illustrate and better understand the plurality of values, we drew inspiration from the Nature-Futures Framework (Kim et al., 2023) and analysed whether people had high endorsement of multiple value types simultaneously. We classified respondents according to a simple typology consisting of all possible combinations of the three value dimensions. For example, if people had high endorsement of both instrumental and relational values, they were assigned to the "Instrumental & Relational" value profile. This classification was based on respondents' scores on the composite scales, as these reflect the priority given to the different value types. Rather than deriving cut-offs from the empirical distribution of each sample, we used a common scale-based threshold of ≥5 to indicate high priority (given the 7-point response scale, where 4 corresponds to "moderate priority" and 7 to "highest priority"). This provides a transparent and reproducible classification that can be applied consistently across samples and studies. Respondents were subsequently assigned into one of eight possible value profiles (Intrinsic; Instrumental; Relational; Intrinsic & Instrumental; Intrinsic & Relational; Instrumental & Relational; Intrinsic & Relational & Instrumental; Indifferent). Mean restoration attitude scores were also plotted across the resulting profiles to descriptively explore how attitude patterns varied across different combinations of highly prioritized values.

3. Results

After the qualitative pretesting as described in the methods section, we refined and validated the scale in three subsequent quantitative steps: 1) a pre-testing with university students, 2) a pilot survey in three European countries, and 3) a final survey sent to the general public in five European countries. The aim of these steps was to reduce the number of items by focusing the scale on the best performing items and to validate the final scale for its adequacy to measure the three values simultaneously. Here, we focus on the results of the final validation test. We will only briefly summarize the results from the pretesting and pilot studies (see Supplementary Text S3 for extensive description of these results) before reporting in-depth results from the final validation study.

3.1. Quantitative pre-testing and pilot study

Data analysis of the quantitative pretest (n = 94 & n = 101; see Table S2) revealed a strong ceiling effect (mean scores above 6.5 on a 7-point scale) for some of the items (Table S2). Given that most of the students were enrolled in nature conservation-related programs, we decided not to adjust the items as we expected that mean values may be more moderate within more diverse samples. Both samples performed well within the EFA and the identified factor structures generally supported the theoretically expected three-dimensional structure of the scale. In the Danish sample, the three value dimensions emerged as clearly distinct. In contrast, in the Dutch student sample, the item on 'care' loaded on the intrinsic values dimension, and the two items related to 'fulfilment and well-being' subdimension showed loadings on the instrumental values (Table S3). This points to potential overlaps between relational and intrinsic as well as between relational and instrumental values. Based on the findings of pretesting and additional theoretical reasoning within the research team, a total of eight items were edited in order to improve their clarity and understandability for respondents (Table S1).

The pilot study (n = 3 x 150; see Table S4) did not show a strong ceiling effect for any of the items in either sample. Overall, the sample showed statistical adequacy in performing an EFA and the initially retained solution for the complete data set explained 62% of the variation (see Table S6). However, some items, most notably items from the Regulating Benefits subdimension within the instrumental value and the Care subdimension within the relational value caused issues with low variability (e.g. 80% of respondents choosing the two highest response options and/or loaded on a factor associated to one of the other values (Table S5 and S6). The reduction in items resulted in the 'Regulating Benefits' and the 'Care' subdimension no longer had any related items in the scale and were therefore removed.

We then performed an additional EFA for each country separately (Table S7), which consistently retained four-factor solutions explaining 64-69% of the variation. The additional factors did not constitute a consistent fourth value dimension across countries but primarily reflected separation of subdimensions and overlap between instrumental and relational items. While the general three-dimensional structure was visible, several cross-loadings highlighted the fuzzy boundaries between values and that these might differ across cultural settings. In the Danish sample, the three dimensions again emerged relatively clearly, though one factor contained two of the items from immaterial contributions subdimension together with items from several of the relational values subdimensions. In the Dutch sample, overlaps were more pronounced with one of the factors containing items from all three value dimensions, while the other three factors contained only items from one of the value dimensions. The Spanish sample showed also some cross loadings between items from the instrumental and relational dimension, while intrinsic values build separate factors. Despite the cross loadings, the theoretically expected three value dimensions, remained visible across the country-specific solutions, while the fourth factor in some countries primarily reflected separation of subdimensions and overlap between instrumental and relational items. Based on the collective findings and analysis of the quantitative pre-testing and pilot study, we selected 12 of the pilot study items (see items in bold in Table S7). Grouping the retained items according to our theoretical three-dimensional model into instrumental, relational, and intrinsic values showed acceptable internal consistency for all three dimensions across countries Cronbach alpha>0.70); Table S8). See Supplementary Text S3 for an extensive description of the results. In the hope of increasing the variability in answers, we decided to slightly change the question stem and focus on the priority of values: "*Listed below are statements on different aspects that could be important when thinking of nature in the future. Please indicate how much of a priority you feel each aspect should have in [your country] in the future*" (Table S1), with a matching 7-point answer scale ranging from 1 (*not a priority at all*) to 7 (*the highest priority*), with 4 indicating a *moderate priority*.

3.2. Main survey

The main survey no longer showed strong ceiling effects (Table S10). However, multivariate normality was not achieved, therefore a robust estimator was used within the CFA. The initial 12-item model showed acceptable fit (robust CFI = 0.958, robust TLI = 0.946, robust RMSEA = 0.067, 90% CI [0.055, 0.078], SRMR = 0.050).

To make the scale more concise and to balance the representation of the three value dimensions, we decided to reduce the number of items representing immaterial contributions. On the basis of content and theoretical considerations, we decided to remove the item on mental well-being. The resulting 11-item scale retained a comparable good fit within the multi-group CFA (robust CFI = 0.958, robust TLI = 0.944, robust RMSEA = 0.069, 90% CI [0.057, 0.081], SRMR = 0.049) and acceptable factor loadings across all countries (Table 1). Measurement

Table 1
Final Plural Values of Nature scale. Overview of the 11 items included in the final scale. Values are standardized factor loadings from the configural multi-group CFA for each of the five country samples. Cronbach's alpha (α) and Average Variance Extracted (AVE) are reported as measures of scale reliability and convergent validity. The last three rows show the standardised correlations between the three latent value dimensions estimated in the same model.

Value dimension	Sweden (n = 205)	Spain (n = 203)	Romania (n = 199)	Poland (n = 198)	Netherlands (n = 202)
Instrumental	**α = 0.827 AVE = .562**	**α = 0.755 AVE = .444**	**α = 0.651 AVE = .375**	**α = 0.766 AVE = .452**	**α = 0.711 AVE = .361**
Nature contributes to economic growth and gives job opportunities	0.636	0.597	0.594	0.531	0.511
Nature offers opportunities to harvest goods, such as wood, berries, mushrooms, or fish	0.718	0.505	0.461	0.476	0.531
Nature offers opportunities for outdoor recreation and sports	0.785	0.708	0.651	0.775	0.538
People can enjoy the beauty of natural areas	0.845	0.815	0.714	0.836	0.783
Relational	**α = 0.817 AVE = .566**	**α = 0.772 AVE = .490**	**α = 0.822 AVE = .581**	**α = 0.768 AVE = .529**	**α = 0.798 AVE = .523**
People can find a sense of belonging in nature	0.843	0.716	0.817	0.847	0.823
Nature contributes to people's sense of fulfilment in life	0.838	0.840	0.820	0.832	0.792
Nature provides religious, sacred and spiritual values or experiences	0.558	0.532	0.654	0.420	0.529
People can relate to and feel connected with trees and animals	0.733	0.677	0.746	0.727	0.711
Intrinsic	**α = .839 AVE = .636**	**α = .859 AVE = .673**	**α = .760 AVE = .533**	**α = .773 AVE = .534**	**α = .820 AVE = .602**
Nature is protected regardless of whether this benefits humans or not	0.830	0.781	0.791	0.701	0.776
Our moral responsibility to protect nature is upheld	0.798	0.811	0.764	0.737	0.788
Nature is protected for its own sake	0.764	0.866	0.625	0.754	0.764
Correlation Instrumental x Relational	0.895	0.772	0.852	0.867	0.850
Correlation Instrumental x Intrinsic	0.628	0.833	0.607	0.888	0.769
Correlation Relational x Intrinsic	0.677	0.637	0.719	0.793	0.757

invariance was subsequently assessed for the final 11-item model across the five countries. Configural and metric invariance were established, while full scalar invariance was not supported (Table S11). This indicates that the factor structure and factor loadings are comparable across countries, while direct comparisons of absolute scale means should be interpreted with caution.

Concerning scale reliability, the results show acceptable to good internal consistency (Cronbach's alpha > 0.7) for the three values in all countries, with the exception of *the instrumental value* in Romania (Table 1). Convergent validity was more variable. AVE exceeded the recommended threshold of 0.50 for *intrinsic values* in all countries and for *relational values* in four of the five countries, but fell below 0.50 for *instrumental values* in Spain, Romania, Poland and the Netherlands. This likely reflects, at least partly, the breadth of the *instrumental values*, whose items intentionally capture different subdimensions.

3.2.1. Conceptual overlap between values

CFA revealed high correlations ($r > 0.85$) between some of the three values (Table 1). Based on follow-up assessment of the Fornell-Larcker criterion, it was confirmed that discriminant validity was particularly limited between *instrumental and relational values.* The correlation between these dimensions exceeded the square root of their respective AVEs in all five countries. Additional overlap between instrumental and intrinsic values occurred in some countries, most notably Poland, where the correlation reached 0.888. These findings indicate that the three dimensions are not fully empirically distinct, consistent with our theoretical expectation that instrumental, relational and intrinsic values have fuzzy boundaries and may overlap in practice. At the same time, the three-factor structure showed acceptable model fit and metric invariance across countries. Dimension-specific associations should therefore be interpreted as effects conditional on the substantial covariance among the three value dimensions. Nevertheless, the consistent three-factor structure supports retaining instrumental, relational and intrinsic values as three analytically distinct values.

3.2.2. Incremental validity

Incremental validity was assessed by comparing the explanatory contribution of the three PVN dimensions with the abbreviated RNEP scale (see Supplementary Material) across three national level restoration attitudes, while controlling for country differences (Table 2). PVN explained more variance than RNEP alone across all three outcomes. Adding the three PVN dimensions to models containing RNEP significantly increased explained variance R^2 by 6.7 percentage points for facilitating wildlife movement, 9.7 percentage points for reducing human influence on nature, and 13.3 percentage points for restoring natural processes (all $p < 0.001$). In comparison, adding RNEP to models containing the three PVN dimensions increased explained variance by 1.1–4.0 percentage points. Multicollinearity among the predictors was low (VIF = 1.16–2.07). Full estimates from the combined models, including standardized coefficients for RNEP and each PVN dimension and their unique contributions to explained variance, are provided in Table S13. Examination of the combined models showed that RNEP retained a unique association with all three attitudes, while much of the additional explanatory contribution of PVN was shared across its three dimensions rather than attributable to a single value dimension (Table S13). Country-specific models showed that the PVN dimensions contributed additional explanatory variance beyond the RNEP for all three national level attitudes in each of the five countries ($\Delta R^2 = 0.047–0.267$, all $p < 0.05$; Table S14). Country-specific analyses showed substantial variation in the explanatory power of the PVN dimensions across countries. For example, the PVN dimensions explained 37.5% of the variance in attitudes towards reducing human influence in Sweden, compared with 4.9% in Romania; the corresponding incremental contributions beyond RNEP were 26.7% and 4.7%, respectively (Table S14).

3.2.3. Predictive validity

Predictive validity of our scale was further assessed using three broader local level restoration attitudes and attitudes towards three concrete management actions (Table 3). Across all six outcomes, the three PVN dimensions significantly increased explained variance beyond country differences ($\Delta R^2 = 0.057–0.136$, all $p < 0.001$). *Relational and intrinsic values* were positively associated with all six restoration attitudes and actions, whereas *instrumental* values showed little association with the broader attitude towards facilitating wildlife movement and restoring natural processes, but negative associations with reducing human influence on nature and with each of the three concrete management actions (Table 3). The strongest additional

Table 2
Incremental validity of the Plural Values of Nature scale relative to the abbreviated Revised New Ecological Paradigm scale. Models predict three broad national level restoration attitudes and include country as a fixed effect (N = 1007). ΔR^2 PVN beyond RNEP represents the increase in explained variance when the three PVN dimensions are added to a model containing RNEP; ΔR^2 RNEP beyond PVN represents the reverse comparison.

Dependent variable (National level attitude)	R^2 RNEP	R^2 PVN	R^2 PVN + RNEP	ΔR^2 PVN beyond RNEP	p	ΔR^2 RNEP beyond PVN	p
Making landscapes easier for wildlife to move through	0.125	0.180	0.192	0.067	<0.001	0.011	<0.001
Reducing the influence that humans have on nature	0.155	0.213	0.253	0.097	<0.001	0.040	<0.001
Restoring natural processes and dynamics	0.109	0.221	0.241	0.133	<0.001	0.020	<0.001

Note: Reported R^2 values are total R^2 including the country fixed effects. ΔR^2 values represent the additional variance explained when the indicated predictor set is added to the alternative model. p values are based on nested-model F tests comparing the respective reduced and full models.

Table 3
Predictive validity of the Plural Values of Nature scale across local restoration principles and concrete management actions. Summary of the linear regression models, testing the relationship between the three value dimensions (independent variables: intrinsic, relational, instrumental) and support for three broader local level restoration attitudes and attitudes towards three concrete management actions (dependent variables) across five countries (N = 1007). All models include country as a fixed effect. Values shown are standardized regression coefficients (β), total explained variance (R^2), and the additional variance explained by the three PVN dimensions beyond country differences (ΔR^2). Significance Levels: *p < 0.05, **p < 0.01, ***p < 0.001.

Dependent variable	β Instrumental	β Relational	β Intrinsic	R^2 full model	ΔR^2 PVN beyond country	p for PVN block
Broader restoration attitudes						
Making the landscape easier for wildlife to move through	**.015**	**.152*****	**.148*****	0.126	0.071	<0.001
Reducing the influence that humans have on nature in the area	**−.145*****	**.204*****	**.222*****	0.124	0.086	<0.001
Restoring natural processes and dynamics	**.029**	**.094***	**.302*****	0.166	0.136	<0.001
Specific restoration actions						
Reducing the number of roads and/or tracks for vehicles	**−.179*****	**.182*****	**.197*****	0.073	0.062	<0.001
Changing timber-production forests to more natural unmanaged forests	**−.141****	**.203*****	**.224*****	0.107	0.087	<0.001
Encouraging natural predation by animals such as wolves or lynx	**−.189*****	**.203*****	**.166*****	0.157	0.057	<0.001

explanatory contribution of the PVN dimensions was observed for restoring natural processes and dynamics in the local area ($\Delta R^2 = 0.136$). Country-specific analyses indicated broadly positive associations of relational and intrinsic values with restoration attitudes, while associations with instrumental values were more variable across countries and tended to become negative for several concrete management interventions (All country-specific estimates are presented in Table S15).

3.3. Plurality of values across study countries

To explore how different values co-occur within individuals, we classified respondents according to all possible combinations of the three PVN dimensions. We used a common threshold of ≥5 to indicate high priority, anchored in the meaning of the 7-point response scale, where 4 represents *moderate priority* and 7 *the highest priority*. Using the same scale-based threshold rather than sample-specific cut-offs provides a transparent and reproducible way of describing value combinations across samples and future applications of the PVN. Fig. 4 illustrates the large cooccurrence of the different values across societies, showing that the majority of residents (61.1- 85.4%) in all countries place a high priority on more than one value type simultaneously. There are, however, differences in the plurality of values (i.e. the prominence of the different value profiles) across the included countries (Fig. 4, Table S17).

Individuals expressing a high priority for all three value dimensions simultaneously is the most common profile in all countries, with the relative share spanning from 29.1% in the Netherlands to 67.3% in Romania, reflecting a strong pattern of plural value endorsement. The next most common profile in all countries is the combination of intrinsic and instrumental values, ranging from 32.5% in Spain to 10.1% in Romania. The profiles combining relational with intrinsic and relational with instrumental values are generally less common, with the highest share in The Netherland where 8.9% of respondents simultaneously endorsed relational and intrinsic values. Similarly rare are the 'pure' profiles meaning segments of respondent that only prioritise one of the value dimensions. While 14.8% of Dutch respondents prioritized only intrinsic values and 10.6% of Swedish respondents prioritized purely instrumental values, respondents prioritizing relational values alone were missing in three out of the five countries. Even in Romania & Poland, they comprised only 0.5-1.0% of the population. Because full scalar invariance was not established, country-specific profile distributions are presented descriptively and should not be interpreted as precise cross-country differences in absolute value levels. Nevertheless, these patterns show that high prioritisation of multiple value dimensions is common across all five samples, whereas profiles in which only one dimension exceeds the high priority threshold are less frequent.

To further explore the descriptive usefulness of these value profiles, we plotted mean support for the three national level restoration attitudes across the profiles in the pooled sample (Fig. 5). Several patterns are visible. Respondents expressing no priority for any value (i.e. 'Indifferent') generally show the lowest support for restoration actions. In contrast, people prioritizing intrinsic values occur towards the higher end of the support scale. Importantly, profiles with plural combinations of values (e.g., intrinsic & relational, or all three together) tended to show relatively high support. These descriptive patterns suggest that particular combinations of highly prioritized values may be relevant for understanding restoration support and provide a basis for more explicit tests of interactions between value dimensions in future research.

4. Discussion

The presented Plural Value of Nature (PVN) scale is a new psychometric scale and survey-based social indicator of people's values of nature, that can differentiate between relational, intrinsic, and instrumental values. The scale recognises several things: the plurality of values held across societies; that individuals can endorse values of nature related to the intrinsic, instrumental and relational value types simultaneously; and that values may be prioritized differently between people and within and between countries, leading to potential differences in nature-related preferences, attitudes, and behaviours.

Cross-national validation studies in five countries ($n = 1007$) show internal consistency and reliability of the scale. The scale showed predictive validity across a range of restoration attitudes and management actions, with the three PVN dimensions explaining an additional 5.7–13.6 percentage points of variance beyond country differences and explaining up to 37.5% of variability in attitudes towards ecological

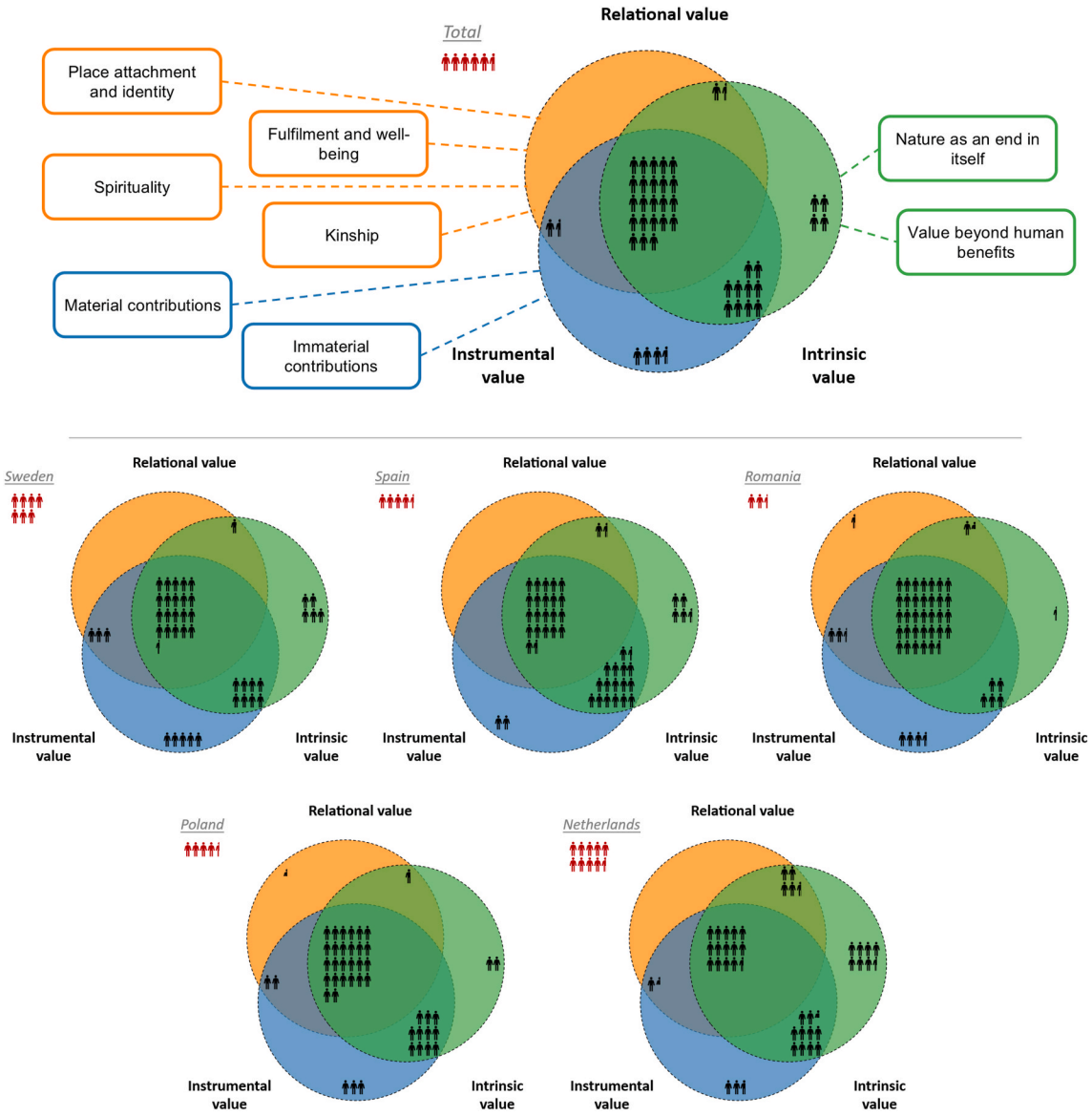


Fig. 4. Exploration of plurality of values. *Persons indicate the prominence of the different value* **profiles** *across the five countries, whereby one person represents 2% of the total population. The red persons outside the circles are those that were classified as none, meaning that they do not express high priority for any of the three values. Figure on top shows average for all five countries (and includes the subdimensions of each value). Figures below represent the five countries separately. (Figure inspired by the Nature Futures Framework;* IPBES, 2024*).*

restoration in a specific country (Table S14). Relational and intrinsic values showed consistently positive effect on restoration attitudes, whereas the effect of instrumental values were mostly negative or not significant. The scale also showed incremental validity relative to the often-used Revised New Ecological Paradigm (RNEP; Dunlap et al., 2000), contributing an additional 6.7–13.3 percentage points of explained variance across the three national level restoration attitudes. These results confirm the validity and practical value of the scale, and its usefulness across different national contexts within Europe.

The profile analysis further illustrates that the majority of respondents in all countries prioritise more than one value type, with the combination of high intrinsic, instrumental and relational values being the single most common profile in each country (Fig. 4, Table S17). This supports recent calls to recognize not only instrumental and intrinsic values but also relational values of nature (Andersen et al., 2022; Chan et al., 2016). These results can be seen as empirical support for treating values of nature as plural and potentially co-occurring rather than as mutually exclusive orientations. Profiles combining multiple values, particularly those including intrinsic values, tended to show relatively high support for restoration, whereas respondents who did not view any of the three value dimensions as being a high priority generally showed lower support for restoration (Fig. 5). These exploratory patterns also suggest that particular combinations of values may be relevant for understanding restoration support and provide a basis for future research examining whether and how the different values interact.

4.1. Plurality of values and scale development challenges

In developing a scale for measuring the values of nature, it is important to reflect on epistemological and ontological discussions regarding the nature of the three values (Kenter et al., 2019), most notably of relational values (Gould et al., 2024; Stålhammar and Thorén, 2019), and on the potential fuzzy boundaries between these values (Himes et al., 2024; Kenter et al., 2019).

Instrumental and intrinsic values are well established in literature, whereas the conceptual debate on relational values, and its relationship

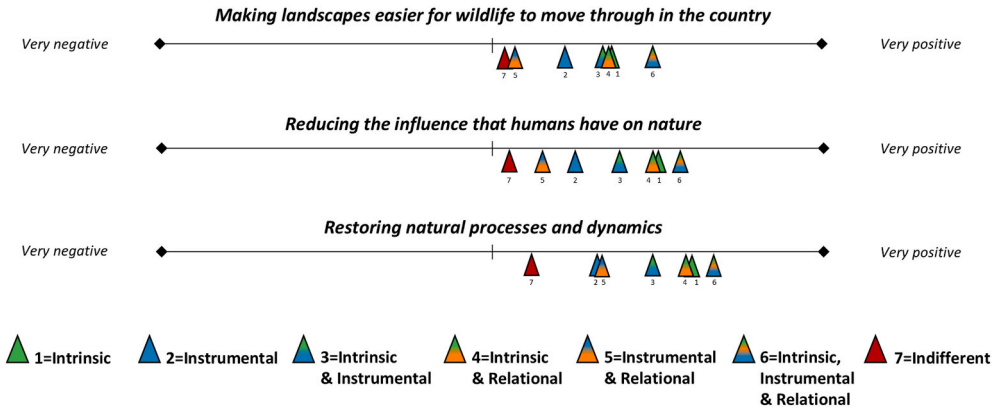


Fig. 5. Mean support for three national level restoration attitudes across value profiles. *Respondents were asked: "How would you feel about the following changes to how land and nature are managed in [country]?" The lines represent the 7-point response scale (left end point = very negative, right endpoint = very positive), on which the value profiles are placed according to their mean score across the total sample. Note that due to the small number of participants* classified in the relational-only profile, *this type was not plotted for the attitude scales.*

to the two other value types, is ongoing (Ibid.). This conceptual challenge was reflected in the process of conceptualising and operationalising relational values for our scale. Statistical validation of the scale showed empirical evidence that fuzzy boundaries do indeed exist between the values. Most notably, our results show that especially the instrumental and relational dimensions are closely related and not fully distinct. Difficulty in delineating between relational and instrumental values was a persistent issue, from the initial pre-testing to the final scale. The final validation suggested that the dimensions can be distinguished sufficiently for measurement purposes while retaining substantial conceptual and empirical overlap. This partial overlap and fuzzy boundary found empirically were not unexpected, as in theory relational values are described as "anthropocentric yet non-instrumental", and thus closely related to, or overlap with, at least a subsection of instrumental values (Himes and Muraca, 2018). We also encountered overlaps such as this when designing the scale. For example, only after a thorough review of the classifications of beauty or spirituality in the literature into different value types (or into two or three types simultaneously) (e.g. Anderson et al., 2022; Gould et al., 2024; Himes et al., 2024; James, 2019), and after internal discussions and cognitive interviews, we decided to conceptualize the spiritual component of nature as a relational value and the beauty of nature as an instrumental value and tried to formulate the items in line with this (partial) conceptualisation (see also Table S1 for these changes throughout the process). While confirmatory factor analysis confirmed most respondents indeed interpreted these items as relational and instrumental values respectively, analysis also showed that at the national level the items sometimes also scored on other value types. In addition, in several countries, the item on berry picking - conceptualised as an instrumental value by the researchers - also loaded on to the factor related to relational values. This again is an example of conceptual overlap, where in some targeted countries (e.g. Denmark) berry picking is also a culturally significant practice for relating to nature and thus is not only valued for the instrumental value of the berries themselves.

Furthermore, instrumental items reflecting Nonmaterial Contributions to People (NCP's) - or cultural ecosystem services in ESS terminology - showed loadings on both the relational and instrumental value factor. Consequently, approaches to operationalise instrumental values through the concept of ecosystem services may need to be reconsidered in light of the more recent debate on relational values (e.g. Plieninger et al., 2013). In general, as highlighted by literature on relational values, Nature's Contributions to People, or ecosystem services should not be considered as one-directional contributions, but as multi-directional relationships between humans and nonhuman nature, where the relationship itself holds value and contributes to nature and people alike (Himes et al., 2024; West et al., 2018).

Rather than compromising the scale's utility, the fuzzy boundaries and overlap between value types reflect a substantive empirical reality. Splitting intrinsic, instrumental, and relational items into three independent scales would not resolve this overlap, since it would not reflect how respondents relate to these values. In fact, it would more likely prevent the overlap from being measured and reported at all. A combined scale, by contrast, is what allows the extent of covariance between values to be assessed directly. Obviously, developing a combined scale means compressing meaning, reducing complexity – and, not least, risking validity. While the reduction of complexity in this scale may limit its potential use for in-depth analysis of each individual value, its utility should be seen in relation to its practical use – as one of the criteria we set up for the scale development – and so, as Stern et al. (1998) argue in their seminal paper, it is crucial to develop a brief 'inventory' of values that is suitable for use in survey research, as longer instruments are simply impractical – not least in relation to challenges of survey fatigue (Jeong et al., 2023). Based on experience with e.g. the 15-item NEP-scale (Dunlap et al., 2000), we argue an 11-item scale is a feasible length to add to question batteries in environmental research.

Over the last years, two other psychometrically validated scales have been developed to measure all three values of nature simultaneously (Lengieza et al., 2023; Lou et al., 2025). In the current state of early development of such scales and related to the ongoing ontological and epistemological debates about relational values, this in our view should be considered a strength and a healthy development towards maturation of the field. Each of the scales have shown incremental validity over well-established scales, such as Schultz's (2000) Environmental Concern measures; in (Lengieza et al., 2023a,b), Biospheric values (Stern and Dietz, 1994; in Lou et al., 2025), and in the present study the PVN relative to the Revised New Ecological Paradigm (Dunlap et al., 2000) explaining additional variance in restoration attitudes beyond this established measure of general ecological worldview. Meanwhile, as described in the introduction, each of the scales differ in focus, conceptualisation of the values – most notably of relational values –, size, and policy-orientation. For example, in conceptualising relational values, the PVN explicitly builds on the conceptualisation of these values into subdimensions as suggested by IPBES (2022) and Himes et al. (2024), including the subdimension of eudemonia. In addition, while the other scales include more items, enabling them to develop a more nuanced understanding of values, with only 11 items the PVN scale is more condensed, enabling easier uptake as a plug-in in other more policy-oriented research. Another methodological strength of the PVN is the explicit assessment of measurement invariance across countries, which provides evidence on whether the same latent structure is being

measured across national samples and clarifies the conditions under which cross-country comparisons are appropriate. Configural and metric invariance supported a common three-factor structure and comparable factor loadings across the five countries, while the lack of full scalar invariance cautions against direct comparisons of absolute scale scores between countries. Measurement invariance has also been assessed in more recent cross-cultural validations of other plural values scales (Lengieza et al., 2025; Lou et al., 2025), highlighting its importance as a criterion for evaluating whether plural-values scales function comparably across cultural settings. We suggest future research may focus on explicitly comparing these emerging scales (PVN, Lengieza et al., 2025; Lou et al., 2025) for identifying their relative strengths and weaknesses related to their specific purposes and use, and to further strengthen the scales and contribute to further advancement in the field of measuring plural values of nature.

4.2. Potential limitations

Several potential limitations of PVN should be discussed. First, quantitatively measuring values of nature is a challenging task. The measurement of relational values is especially challenging, not only because of epistemological and conceptual differences between different schools of thought, but also because they relate to a wide variety of relationships – both relationships between people and nature and nature-meditated relationships between people and people (Chan et al., 2016; Gould et al., 2024; Rawluk et al., 2019). Meanwhile, we agree with Schultz and Martin-Ortega (2018), who argue that exploring both quantitative and qualitative approaches to the understanding of relational values is helpful for our understanding of values – and, we would add, of the plurality of values. In addition, developing quantitative approaches to understanding the plurality of values of nature not only expands the evidence base for the relevance of acknowledging diverse values in society but can also help contribute to a better understanding of potential overlaps and divergence between values. Finally, it may contribute to the political legitimacy of environmental decision-making, where numbers and statistics may have more discursive power than more qualitative and interpretive approaches (Schulz and Martin-Ortega, 2018).

Secondly, to maximize the usefulness of the scale for transformative practices and transformative science, we choose to focus on 'future nature' when asking about values of nature. Here, one can ask what the respondents will perceive - how far into the future will that be? This did not arise as a matter of ambiguity or concern during the scale validation process. Again, as time spans differ in terms of changes in nature (e.g., a forest can take more than 100 years to fully develop, whilst changes in meadows or moors can be considerable after ten or twenty years), applying a restricted time length could again act as too much of a restriction. Obviously, it still opens the question of what period respondents had in mind when answering the survey. If a specific time length is in question, the scale can be adapted to be used in such a manner.

Thirdly, the three intrinsic-value items in the final scale all refer explicitly to protecting nature. This wording is conceptually consistent with expressions of intrinsic values, particularly where protection is explicitly framed as being motivated independently of any potential human benefits, or ‘for its own sake’(e.g. See et al., 2020). This may create some semantic proximity to particular conservation or restoration outcomes and should be considered when interpreting dimension-specific associations. However, statistical analysis showed that intrinsic values were also positively associated with broader restoration attitudes and specific management actions that did not use protection-related wording, suggesting that shared terminology alone is unlikely to account for the observed relationships. Meanwhile, this relationship to protection may introduce variance related to conservation motivation that is not equally present in the instrumental and relational items. We therefore caution against interpreting differences in the relative predictive strength of the three PVN dimensions as clean estimates of their unique importance. Future research could test alternative intrinsic value formulations that separate intrinsic valuation more explicitly from protection-oriented wording.

Lastly, the scale has been developed within a European context. Europe has a diversity of cultures, but also commonalities. Values and culture are intertwined, and we therefore found the within-Europe context sufficient to show some diversity but also acknowledging that many cultural aspects are likely not included. Although configural and metric invariance were supported across the five countries, full scalar invariance was not. This supports comparison of factor structure and associations across these samples but cautions against interpreting differences in absolute PVN scores as substantive cross-country differences. Whether the PVN will work in other contexts, or need adjustments is thus an open question, which we leave for future studies.

4.3. The PVN as a survey-based indicator of plural values

We consider PVN as a survey-based social indicator that can help to take stock of the current values that societies have regarding the future development of nature, and that could be used as a monitoring tool to observe potential shifts in societal values of nature over time. The establishment of configural and metric invariance supports the use of the PVN for cross-national analyses of value structures and their associations with other variables (e.g. relevance in explaining support for conservation), although the lack of full scalar invariance means that differences in absolute country mean scores should be interpreted cautiously. In this sense, the PVN can be understood as a survey-based social indicator of current plural values of nature. It captures a societal condition that is increasingly recognised as relevant for biodiversity governance and sustainability transformations: the extent to which different publics prioritise instrumental, intrinsic, and relational values of nature (Pascual et al., 2023). As such, the PVN complements biophysical indicators by providing a concise measure of the values that may shape public support for conservation, restoration, and nature-positive transformation pathways. In this way, it may also help to incorporate more social aspects in social-ecological modelling efforts.

We discussed that the PVN showed meaningful predictive associations with attitudes towards ecological restoration and added explanatory value beyond the RNEP. Based on this predictive and incremental validity, the PVN could also be used to explore people's preferences for future developments impacting nature, including approaches for transformative change. Using the PVN in transformative dialogues and processes could contribute to the inclusiveness of these processes. Here, the link to the Nature Futures Framework can be relevant, an approach to develop scenarios for what is stated as nature-positive futures (Pereira et al., 2020), recognising the diversity and - more recently - the plurality of values of nature (Durán et al., 2023). In situations where qualitative approaches may not be possible (such as the number of stakeholders being too high, or trust and engagement with stakeholders being too low), using the PVN in surveys may help to facilitate more inclusive and just transformation process.

One other potential use of the scale is to understand better the connection between plural values of nature, and preferences for environmental actions or policies. However, surveys to understand environmental valuation or attitudes are already long, and brevity of additional questions is therefore crucial. Here the condensed nature of the PVN scale has an advantage – given that it still captures the plurality of values within and between populations. Similar usage could be to link the plurality of values to analyses of preferences for different concrete environmental changes, which may help to better understand such preferences. Thus, use of the PVN scale may help to facilitate design of policies that are both socially acceptable and inclusive of the diverse values for nature.

5. Conclusions

Our aspiration for this research was to develop a concise, validated measure of the co-occurrence of multiple values of nature: the Plural Values of Nature (PVN) scale. By providing a repeatable survey-based measure, the PVN can function as a social indicator for monitoring plural values of nature across populations and over time. This indicator function is especially relevant in contexts where biodiversity and restoration policies require not only ecological monitoring, but also an understanding of the societal values that shape support, contestation and implementation.

Such quantification can be used to increase our understanding of the plural values of nature and link it to elicited attitudes towards environmental management initiatives across stakeholder groups and different population segments. Based on the strong predictive power, we expect that the scale can contribute to our understanding of attitudes towards preservation, conservation and restoration of nature. We also hope that its use can facilitate more inclusive dialogues for effective and just transformative change, by sensitising change efforts to the plural values of nature held by diverse communities and informing the design of related policies.

The scale is simple and short so that it can be of practical use in surveys linked to other research questions being raised, where survey length and fatigue are common concerns. We have shown that the PVN has a stable three-factor structure and comparable factor loadings across five European countries. We have found that the scale, despite its chosen simplicity, is able to identify intrinsic, relational and instrumental values for nature held by the general public. We find some overlap between the value categories, reflecting the inherent fuzziness in the definition and specification of these values. We acknowledge that the brevity of the scale comes at a cost – missing nuances both across the plurality of value types as a collection and within individual value types. We encourage future research to elaborate further on these potential limitations and explore the use of the scale beyond the European context.

CRediT authorship contribution statement

Arjen E. Buijs: Writing – original draft, Conceptualization, Methodology, Resources. **Sabrina Dressel:** Methodology, Formal analysis, Writing – original draft, Visualization. **Jette B. Jacobsen:** Writing – original draft, Methodology, Conceptualization. **Tim M. de Kruiff:** Writing – review & editing, Conceptualization, Resources. **Laura C. Quintero-Uribe:** Writing – review & editing, Conceptualization, Resources. **Angus Monro Smith:** Writing – review & editing, Data curation, Resources. **Christian Gamborg:** Writing – original draft, Conceptualization, Resources.

Ethical approval

Research has been done according to ethical standards for human subject research, including formal approval of the study by the appropriate institutional ethics commission. Ethics committee: WUR Research Ethics Commission for review of nonmedical studies with human subjects (WUR-REC) APPROVAL NUMBER: 2024-112 FORM OF CONSENT: written consent.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, the author(s) used ChatGPT for language refinement of author-provided text, including grammar, sentence structure, clarity, and readability. The tool was not used to generate original scientific content, analyse data, or draw conclusions. After using this tool, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the published article.

Declaration of competing interest

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

Acknowledgements

This manuscript and the underlying research received financial support from the European Union's Horizon Europe research and innovation program under grant agreement 101081251 (wildE). Views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.indic.2026.101576.

Data availability

We intend to archive our data in the Data Station for Social Sciences and Humanities (DANS) upon acceptance.

References

Andersen, G., Fløttum, K., Carbou, G., Gjesdal, A.M., 2022. People's conceptions and valuations of nature in the context of climate change [Article] Environ. Values 31 (4), 397–420. https://doi.org/10.3197/096327121X16328186623850.

Anderson, C.B., Athayde, S., Raymond, C.M., Vatn, A., Arias, P., Gould, R.K., Kenter, J., Muraca, B., Sachdeva, S., Samakov, A., Zent, E., Lenzi, D., Murali, R., Balvanera, P., Pascual, U., Christie, M., Baptiste, B., González-Jiménez, D., 2022. Chapter 2: conceptualizing the diverse values of nature and their contributions to people. In: Balvanera, P., Pascual, U., Christie, M., Baptiste, B., González-Jiménez, D. (Eds.), Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat. https://doi.org/10.5281/zenodo.6493134.

Bennett, N.J., Blythe, J., Cisneros-Montemayor, A.M., Singh, G.G., Sumaila, U.R., 2019. Just transformations to sustainability [Review] Sustainability 11 (14), 3881. https://doi.org/10.3390/su11143881.

Blondet, M., de Koning, J., Borrass, L., Ferranti, F., Geitzenauer, M., Weiss, G., Turnhout, E., Winkel, G., 2017. Participation in the implementation of Natura 2000: a comparative study of six EU member states. Land Use Policy 66, 346–355. https://doi.org/10.1016/j.landusepol.2017.04.004.

Boateng, G., Neilands, T., Frongillo, E., Melgar-Quinonez, H., Young, S., 2018. Best practices for developing and validating scales for health, social, and behavioral research: a primer. Front. Public Health 6, 149. https://doi.org/10.3389/fpubh.2018.00149.

Boateng, G.O., Neilands, T.B., Frongillo, E.A., Melgar-Quiñonez, H.R., Young, S.L., 2018. Best practices for developing and validating scales for health, social, and behavioral research: a primer [Review] Front. Public Health 6. https://doi.org/10.3389/fpubh.2018.00149.

Bond, A., Morrison-Saunders, A., Sinclair, A.J., 2025. Sustainability assessment: the state of the art in 2026. Impact Assess. Proj. Apprais. 1–11. https://doi.org/10.1080/14615517.2025.2593204.

Brown, T.C., 1984. The concept of value in resource allocation. Land Econ. 60 (3), 231–246. https://doi.org/10.2307/3146184.

Buijs, A., Hoogstra-Klein, M., de Boer, T., Dressel, S., Langers, F., 2025. Evidence for increasing public support for nature conservation: a 15-year longitudinal analysis of nature conservation attitudes in the Netherlands. Biol. Conserv. 308. https://doi.org/10.1016/j.biocon.2025.111239.

Buijs, A.E., 2009. Lay people's images of nature: frameworks of values, beliefs and value orientations. Soc. Nat. Resour. 22 (5), 417–432.

Buijs, A.E., Elands, B.H.M., Langers, F., 2009. No wilderness for immigrants: cultural differences in images of nature and landscape preferences. Landsc. Urban Plann. 91 (3), 113–123. https://doi.org/10.1016/j.landurbplan.2008.12.003.

Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G.W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., Turner, N., 2016. Why protect nature? Rethinking values and the environment. Proc. Natl. Acad. Sci. USA 113 (6), 1462–1465. https://doi.org/10.1073/pnas.1525002113.

Chan, K.M.A., Gould, R.K., Pascual, U., 2018. Editorial overview: relational values: what are they, and what's the fuss about? Curr. Opin. Environ. Sustain. 35, A1–A7. https://doi.org/10.1016/j.cosust.2018.11.003.
Colding, J., Barthel, S., 2019. Exploring the social-ecological systems discourse 20 years later. Ecol. Soc. 24 (1). https://doi.org/10.5751/es-10598-240102.
Diaz, S., Pascual, U., Stenseke, M., Martin-Lopez, B., Watson, R.T., Molnar, Z., Hill, R., Chan, K.M.A., Baste, I.A., Brauman, K.A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P.W., van Oudenhoven, A.P.E., van der Plaat, F., Schroter, M., Lavorel, S., Shirayama, Y., 2018. Assessing nature's contributions to people. Science 359 (6373), 270–272. https://doi.org/10.1126/science.aap8826.
Díez, M.A., Etxano, I., Garmendia, E., 2015. Evaluating participatory processes in conservation policy and governance: Lessons from a Natura 2000 pilot case study. Environ. Pol. Gov. https://doi.org/10.1002/eet.1667.
Dunlap, R.E., Van Liere, K.D., Mertig, A.G., Jones, R.E., 2000. Measuring endorsement of the new ecological paradigm: a revised NEP scale. J. Soc. Issues 56 (3), 425–442 sfx.library.wur.nl:9003/sfx_local?sid=SP%3APSYI;id=pmid%3A;id=doi%3A10.1111%2F0022-4537.00176;issn=0022-4537;isbn=;volume=56;issue=3;spage=425;pages=425-442;date=2000;title=Journal%20of%20Social%20Issues;atitle=Measuring%20endorsement%20of%20the%20new%20ecological%20paradigm%3A%20A%20revised%20NEP%20scale.;aulast=Dunlap;pid=%3CAN%3E2001-14019-004%3C%2FAN%3E%3CAU%3EDunlap%2C%20Riley%20E%3BVan%20Liere%2C%20Kent%20D%3BMertig%2C%20Angela%20G%3BEmmet%20Jones%2C%20Robert%3C%2FAU%3E%3CDT%3EJournal%3BPeer%20Reviewed%20Journal%3BEmpirical%20Study%3C%2FDT%3E.
Durán, A.P., Kuiper, J.J., Aguiar, A.P.D., Cheung, W.W.L., Diaw, M.C., Halouani, G., Hashimoto, S., Gasalla, M.A., Peterson, G.D., Schoolenberg, M.A., Abbasov, R., Acosta, L.A., Armenteras, D., Davila, F., Denboba, M.A., Harrison, P.A., Harhash, K. A., Karlsson-Vinkhuyzen, S., Kim, H.J., Pereira, L.M., 2023. Bringing the Nature Futures Framework to life: creating a set of illustrative narratives of nature futures. Sustain. Sci. https://doi.org/10.1007/s11625-023-01316-1 [Article].
Feucht, V., Dierkes, P.W., Kleespies, M.W., 2023. The different values of nature: a comparison between university students' perceptions of nature's instrumental, intrinsic and relational values. Sustain. Sci. 18 (5), 2391–2403. https://doi.org/10.1007/s11625-023-01371-8.
Gould, Muraca B., Himes, A., Hackenburg, D., 2024. Biodiversity and relational values. In: Encyclopedia of Biodiversity, pp. 8–17. https://doi.org/10.1016/b978-0-12-822562-2.00091-8.
Gould, R., Himes, A., Anderson, L.M., Arias Arévalo, P., Chapman, M., Lenzi, D., Muraca, B., Tadaki, M., 2024. Building on Spash's critiques of monetary valuation to suggest ways forward for relational values research. Environ. Values 33 (2), 139–162.
Hair, J.F., Gabriel, M.L.D.S., da Silva, D., Braga Junior, S., 2019. Development and validation of attitudes measurement scales: fundamental and practical aspects. RAUSP Manag. J. 54 (4), 490–507. https://doi.org/10.1108/RAUSP-05-2019-0098.
Himes, A., Muraca, B., 2018. Relational values: the key to pluralistic valuation of ecosystem services. Curr. Opin. Environ. Sustain. 35, 1–7. https://doi.org/10.1016/j.cosust.2018.09.005.
Himes, A., Muraca, B., Anderson, C.B., Athayde, S., Beery, T., Cantu-Fernandez, M., Gonzalez-Jimenez, D., Gould, R.K., Hejnowicz, A.P., Kenter, J., Lenzi, D., Murali, R., Pascual, U., Raymond, C., Ring, A., Russo, K., Samakov, A., Stalhammar, S., Thoren, H., Zent, E., 2024. Why nature matters: a systematic review of intrinsic, instrumental, and relational values. Bioscience 74 (1), 25–43. https://doi.org/10.1093/biosci/biad109.
Homer, P.M., Kahle, L.R., 1988. A structural equation test of the value-attitude-behavior hierarchy. J. Personality Soc. Psychol. 54 (4), 638.
Horcea-Milcu, A.I., Koessler, A.K., Martin, A., Rode, J., Moreno Soares, T., 2023. Modes of mobilizing values for sustainability transformation [Review] Curr. Opin. Environ. Sustain. 64, 101357. https://doi.org/10.1016/j.cosust.2023.101357.
Hughes, A.C., Grumbine, R.E., 2023. The Kunming-Montreal Global Biodiversity Framework: what it does and does not do, and how to improve it. Front. Environ. Sci. 11. https://doi.org/10.3389/fenvs.2023.1281536.
IPBES, 2022. The Methodological Assessment Report on the Diverse Values and Valuation of Nature.
IPBES, 2024. Thematic Assessment Report on the Underlying Causes of Biodiversity Loss and the Determinants of Transformative Change and Options for Achieving the 2050 Vision for Biodiversity.
James, S.P., 2019. Natural meanings and cultural values [Article] Environ. Ethics 41 (1), 3–16. https://doi.org/10.5840/enviroethics20194112.
James, S.P., 2022. Against relational value. Harv. Rev. Philos. 29, 45–54.
Jeong, D., Aggarwal, S., Robinson, J., Kumar, N., Spearot, A., Park, D.S., 2023. Exhaustive or exhausting? Evidence on respondent fatigue in long surveys [Article] J. Dev. Econ. 161, 102992. https://doi.org/10.1016/j.jdeveco.2022.102992.
Kempton, W., Boster, J.S., Hartley, J.A., 1995. Environmental Values in American Culture. MIT Press.
Kenter, J.O., Raymond, C.M., van Riper, C.J., Azzopardi, E., Brear, M.R., Calcagni, F., Christie, I., Christie, M., Fordham, A., Gould, R.K., Ives, C.D., Hejnowicz, A.P., Gunton, R., Andra-Ioana, H.-M., Kendal, D., Kronenberg, J., Massenberg, J.R., Seb, O.C., Ravenscroft, N., Thankappan, S., 2019. Loving the mess: navigating diversity and conflict in social values for sustainability. Sustain. Sci. 14 (5), 1439–1461. https://doi.org/10.1007/s11625-019-00726-4.
Kim, H., Peterson, G.D., Cheung, W.W.L., Ferrier, S., Alkemade, R., Arneth, A., Kuiper, J. J., Okayasu, S., Pereira, L., Acosta, L.A., Chaplin-Kramer, R., den Belder, E., Eddy, T. D., Johnson, J.A., Karlsson-Vinkhuyzen, S., Kok, M.T.J., Leadley, P., Leclère, D., Lundquist, C.J., Pereira, H.M., 2023. Towards a better future for biodiversity and people: modelling nature futures. Glob. Environ. Change 82. https://doi.org/10.1016/j.gloenvcha.2023.102681.
Klain, S.C., Olmsted, P., Chan, K.M.A., Satterfield, T., 2017. Relational values resonate broadly and differently than intrinsic or instrumental values, or the New Ecological Paradigm. PLoS One 12 (8), e0183962. https://doi.org/10.1371/journal.pone.0183962.
Kloek, M.E., Buijs, A.E., Boersema, J.J., Schouten, M.G.C., 2017. Beyond ethnic stereotypes – identities and outdoor recreation among immigrants and nonimmigrants in the Netherlands. Leisure Sci. 39 (1), 59–78. https://doi.org/10.1080/01490400.2016.1151843.
Lengieza, M.L., Aviste, R., Richardson, M., 2023a. The human–nature relationship as a tangible target for pro-environmental behaviour—guidance from interpersonal relationships. Sustainability 15 (16). https://doi.org/10.3390/su151612175.
Lengieza, M.L., Aviste, R., Swim, J.K., 2023b. Nature as community: an overlooked predictor of pro-environmental intentions. J. Environ. Psychol. 91. https://doi.org/10.1016/j.jenvp.2023.102127.
Lengieza, M.L., Swim, J.K., DeCoster, J., Guerriero, J.G., Saito, O., Le Coent, P., Sella, L., Chien, H., Hérivaux, C., Rota, F.S., Ragazzi, E., 2025. A five-culture validation of the environmental value-bases scale: a measure of instrumental, intrinsic, and relational environmental values. Sustainability 17 (22). https://doi.org/10.3390/su172210102.
Lockwood, M., 1999. Humans valuing nature: synthesising insights from philosophy, psychology and economics. Environ. Values 8 (3), 381. http://www.swetswise.com/link/access?db?issn=0963-2719&vol=00008&iss=00003&year=1999&page=381&ft=1.
Lou, X., Mei, D., Li, L.M.W., 2025. Development and validation of a scale measuring intrinsic, relational, and instrumental environmental values. J. Environ. Psychol. 106. https://doi.org/10.1016/j.jenvp.2025.102744.
Luque-Lora, R., 2023. The trouble with relational values. Environ. Values 32 (4), 411–431. https://doi.org/10.3197/096327122x16611552268681.
Martin, A., Gomez-Baggethun, E., Quaas, M., Rozzi, R., Tauro, A., Faith, D.P., Kumar, R., O'Farrell, P., Pascual, U., 2024. Plural values of nature help to understand contested pathways to sustainability. One Earth 7 (5), 806–819. https://doi.org/10.1016/j.oneear.2024.04.003.
Mayer, F.S., Frantz, C.M., 2004. The connectedness to nature scale: a measure of individuals' feeling in community with nature. J. Environ. Psychol. 24 (4), 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001.
Mrotek, A., Anderson, C.B., Valenzuela, A.E.J., Manak, L., Weber, A., Van Aert, P., Malizia, M., Nielsen, E.A., 2019. An evaluation of local, national and international perceptions of benefits and threats to nature in Tierra del Fuego National Park (Patagonia, Argentina). Environ. Conserv. 46 (4), 326–333. https://doi.org/10.1017/s0376892919000250.
Muraca, B., 2011. The map of moral significance: a new axiological matrix for environmental ethics. Environ. Values 20 (3), 375–396.
Norton, B., Sanbeg, D., 2021. Relational values: a unifying idea in environmental ethics and evaluation? Environ. Values 30 (6), 695–714.
O'Neill, J., 1992. The varieties of intrinsic value. The Monist 75 (2), 119–137.
Pascual, U., Balvanera, P., Anderson, C.B., Chaplin-Kramer, R., Christie, M., González-Jiménez, D., Martin, A., Raymond, C.M., Termansen, M., Vatn, A., Athayde, S., Baptiste, B., Barton, D.N., Jacobs, S., Kelemen, E., Kumar, R., Lazos, E., Mwampamba, T.H., Nakangu, B., Zent, E., 2023. Diverse values of nature for sustainability. Nature. https://doi.org/10.1038/s41586-023-06406-9.
Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R.T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S.M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y.S., Amankwah, E., Asah, S.T., Yagi, N., 2017. Valuing nature's contributions to people: the IPBES approach. Curr. Opin. Environ. Sustain. 26–27, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006.
Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., Barau, A., 2017. Exploring the governance and politics of transformations towards sustainability. Environ. Innov. Soc. Transit. 24, 1–16. https://doi.org/10.1016/J.EIST.2016.09.001.
Pereira, L.M., Davies, K.K., den Belder, E., Ferrier, S., Karlsson-Vinkhuyzen, S., Kim, H., Kuiper, J.J., Okayasu, S., Palomo, M.G., Pereira, H.M., Peterson, G., Sathyapalan, J., Schoolenberg, M., Alkemade, R., Carvalho Ribeiro, S., Greenaway, A., Hauck, J., King, N., Lazarova, T., Lundquist, C.J., 2020. Developing multiscale and integrative nature–people scenarios using the nature futures framework. People Nat. 2 (4), 1172–1195. https://doi.org/10.1002/pan3.10146.
Plieninger, T., Dijks, S., Oteros-Rozas, E., Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. Land Use Policy 33, 118–129. https://doi.org/10.1016/j.landusepol.2012.12.013.
Post, K.M., 2026. Developing a novel instrument to assess human–nature relational values. People Nat. 8 (6), 1901–1915. https://doi.org/10.1002/pan3.70330.
Pratson, D.F., Adams, N., Gould, R.K., 2023. Relational values of nature in empirical research: a systematic review. People Nat. 5 (5), 1464–1479. https://doi.org/10.1002/pan3.10512.
Rawluk, A., Ford, R., Anderson, N., Williams, K., 2019. Exploring multiple dimensions of values and valuing: a conceptual framework for mapping and translating values for social-ecological research and practice [Article] Sustain. Sci. 14 (5), 1187–1200. https://doi.org/10.1007/s11625-018-0639-1.
Raymond, C.M., Anderson, C.B., Athayde, S., Vatn, A., Amin, A.M., Arias-Arévalo, P., Christie, M., Cantú-Fernández, M., Gould, R.K., Himes, A., Kenter, J.O., Lenzi, D., Muraca, B., Murali, R., O'Connor, S., Pascual, U., Sachdeva, S., Samakov, A., Zent, E., 2023. An inclusive typology of values for navigating transformations towards a just and sustainable future. Curr. Opin. Environ. Sustain. 64. https://doi.org/10.1016/j.cosust.2023.101301.
Richardson, Passmore, H.A., Barbett, L., Lumber, R., Thomas, R., Hunt, A., Fish, R., 2020. The green care code: how nature connectedness and simple activities help explain

pro-nature conservation behaviours. People Nat. 2 (3), 821–839. https://doi.org/10.1002/pan3.10117.
Robinson, M.A., 2018. Using multi-item psychometric scales for research and practice in human resource management. Hum. Resour. Manag. 57 (3), 739–750. https://doi.org/10.1002/hrm.21852.
Rosseel, Y., 2012. lavaan: An R package for structural equation modeling. J. Stat. Software 48 (2), 1–36. https://doi.org/10.18637/jss.v048.i02.
Runhaar, H., Runhaar, P., Bouwmans, M., Vink, S., Buijs, A., Kleijn, D., 2019. The power of argument: enhancing citizen's valuation of and attitude towards agricultural biodiversity. Int. J. Agric. Sustain. 17 (3), 231–242. https://doi.org/10.1080/14735903.2019.1619966.
Saito, T., Hashimoto, S., Basu, M., 2021. Measuring relational values: do people in Greater Tokyo appreciate place-based nature and general nature differently? Sustain. Sci. 17 (3), 837–848. https://doi.org/10.1007/s11625-020-00898-4.
Schultz, P.W., 2001. The structure of environmental concern: concern for self, other people, and the biosphere. J. Environ. Psychol. 21 (4), 327–339 sfx.library.wur.nl:9003/sfx_local?sid=SP%3APSYI;id=pmid%3A;id=doi%3A10.1006%2Fjevp.2001.0227;issn=0272-4944;isbn=;volume=21;issue=4;spage=327;pages=327-339;date=2001;title=Journal%20of%20Environmental%20Psychology;atitle=The%20structure%20of%20environmental%20concern%3A%20Concern%20for%20self%2C%20other%20people%2C%20and%20the%20biosphere.;aulast=Schultz;pid=%3CAN%3E2002-10149-001%3C%2FAN%3E%3CAU%3ESchultz%2C%20P.%20Wesley%3C%2FAU%3E%3CDT%3EJournal%3BPeer%20Reviewed%20Journal%3BEmpirical%20Study%3C%2FDT%3E.
Schulz, C., Martin-Ortega, J., 2018. Quantifying relational values — why not? Curr. Opin. Environ. Sustain. 35, 15–21. https://doi.org/10.1016/j.cosust.2018.10.015.
Schwartz, S.H., 1992. Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. Adv. Exp. Soc. Psychol. 25, 1–65.
See, S.C., Shaikh, S.F.E.A., Jaung, W., Carrasco, L.R., 2020. Are relational values different in practice to instrumental values? Ecosyst. Serv. 44. https://doi.org/10.1016/j.ecoser.2020.101132.
Spash, C.L., 2020. A tale of three paradigms: realising the revolutionary potential of ecological economics. Ecol. Econ. 169, 106518.
Stålhammar, S., Thorén, H., 2019. Three perspectives on relational values of nature. Sustain. Sci. 14 (5), 1201–1212. https://doi.org/10.1007/s11625-019-00718-4.
Steg, L., 2016. Values, norms, and intrinsic motivation to act proenvironmentally. Annu. Rev. Environ. Resour. 41, 277–292.
Stern, P.C., Dietz, T., 1994. The value basis of environmental concern. J. Soc. Issues 50 (3), 65–84. http://sfx.library.wur.nl:9003/sfx_local?sid=SP%3APSYI;id=pmid%3A;id=;issn=0022-4537;isbn=;volume=50;issue=3;spage=65;pages=65-84;date=1994;title=Journal%20of%20Social%20Issues;atitle=The%20value%20basis%20of%20environmental%20concern.;aulast=Stern;pid=%3CAN%3E1995-23521-001%3C%2FAN%3E%3CAU%3EStern%2C%20Paul%20C%3BDietz%2C%20Thomas%3C%2FAU%3E%3CDT%3EJournal%3BPeer%20Reviewed%20Journal%3BEmpirical%20Study%3C%2FDT%3E.
Stern, P.C., Dietz, T., Guagnano, G.Y., 1998. A brief inventory of values. Educ. Psychol. Meas. 58 (6), 984–1001. http://sfx.library.wur.nl:9003/sfx_local?sid=Elsevier%3AScopus;genre=article;issn=00131644;volume=58;issue=6;spage=984;epage=1001;pages=984-1001;date=1998;title=Educational%20and%20Psychological%20Measurement;atitle=A%20brief%20inventory%20of%20values;aufirst=P.C.;auinit=P.C.;auinit1=P;aulast=Stern;artnum=;_service_type=getFullTxt.
Strange, N., Ermgassen, S.z., Marshall, E., Bull, J.W., Jacobsen, J.B., 2024. Why it matters how biodiversity is measured in environmental valuation studies compared to conservation science. Biol. Conserv. 292. https://doi.org/10.1016/j.biocon.2024.110546.
Taye, F.A., Vedel, S.E., Jacobsen, J.B., 2018. Accounting for environmental attitude to explain variations in willingness to pay for forest ecosystem services using the new environmental paradigm. Journal of Environmental Economics and Policy 7 (4), 420–440. https://doi.org/10.1080/21606544.2018.1467346.
Uggeldahl, K., Olsen, S.B., Lundhede, T., Jacobsen, J.B., 2025. Public perceptions of biodiversity and the value of its conservation. Ecol. Econ. 236. https://doi.org/10.1016/j.ecolecon.2025.108681.
Van den, Born, Arts, B., Admiraal, J., Beringer, A., Knights, P., Molinario, E., Horvat, K. P., Porras-Gomez, C., Smrekar, A., Soethe, N., Vivero-Pol, J.L., Ganzevoort, W., Bonaiuto, M., Knippenberg, L., De Groot, W.T., 2018. The missing pillar: eudemonic values in the justification of nature conservation. J. Environ. Plann. Manag. 61 (5–6), 841–856. https://doi.org/10.1080/09640568.2017.1342612.
West, S., Haider, L.J., Masterson, V., Enqvist, J.P., Svedin, U., Tengö, M., 2018. Stewardship, care and relational values [Review] Curr. Opin. Environ. Sustain. 35, 30–38. https://doi.org/10.1016/j.cosust.2018.10.008.