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ORIGINAL PAPER

Conservation of disappearing cultural landscape's biodiversity: are people in Belarus willing to pay for wet grassland restoration?

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Abstract Abandonment of traditional farming practices, such as hay-making and pasturing, has resulted in rapid loss of open wet grassland habitats in Europe. The globally threatened Aquatic Warbler (*Acrocephalus paludicola* L.) is a bird species that occurs almost exclusively in open fen mires, which have virtually disappeared in Western Europe, but still persist locally in Eastern Europe. Focusing on the world's most important breeding site for Aquatic Warbler, the Zvaniec fen mire in Belarus, we estimated Belarusian citizens' willingness-to-pay for adequate conservation management of this fen mire and its focal species the Aquatic Warbler. Results from a discrete choice experiment indicated that Belarusian citizens were willing to pay for appropriate conservation programmes of the Zvaniec fen mire. Scything and mechanical mowing were preferred compared to controlled burning, and especially over herbicide treatment of encroaching shrubs. Conservation management was preferred over legal protection of wetland areas without management. Respondents considered such passive conservation to be insufficient to maintain open fen mire habitat and gave a higher priority to active conservation management programmes. These preferences are consistent with evidence-based knowledge about what is effective conservation management for the Aquatic Warbler. Given the gradual disappearance of Europe's traditional cultural landscapes, we discuss the challenge to fund the maintenance of this biocultural biodiversity legacy.

Keywords Aquatic warbler · Open fen mires · Active conservation management · Willingness-to-pay · Discrete choice experiment

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Introduction

Intensification of agriculture and forestry, and expansion of transport infrastructure have drastically intensified land management in Western Europe (e.g. Angelstam et al. 2004, 2017; Donald et al. 2006).

This has led to alteration, fragmentation and loss of a wide range of habitats (Fahrig 2003), which cause decline in biological diversity. Both natural wetlands and wet grasslands of cultural origin in Western Europe are good examples of this process (Thorup 2005; Schekkerman et al. 2008; Roodbergen et al. 2011; Manton 2016; Manton and Angelstam 2018). For long time farming practices based on grazing and hay-making thus provided habitats for a range of bird species (Thorup 1998; Manton 2016). However, due to intensified land management practices and subsequent conversion and loss of habitat, wader bird populations have declined over the past four decades (International Wader Study Group 2003; Ottvall and Smith 2006). Additionally, modification of traditional farming practices, drainage and altered hydrological regimes, climate change, and increased predators pressure have been put forward as factors contributing to the decline in wetland bird populations (Gill et al. 2007; Isaksson et al. 2007; Schekkerman et al. 2008; Teunissen et al. 2008; Roodbergen et al. 2011; Manton 2016).

The decline of the Aquatic Warbler (*Acrocephalus paludicola* L.) is another example of this process. This is a globally endangered species, which occurs exclusively in open fen mires under traditional use (Kloskowski and Krogulec 1999; Tanneberger et al. 2008; Briedis and Keiss 2016) and is currently almost extinct in Western and Central Europe (BirdLife 2008). Fen mires were used for hay-making, embedded in low intensity farming in the context of traditional village systems combining animal husbandry, plant crops and use of low-productive or poorly accessible sites (dry meadows, heathlands, wetlands) for grazing and hay-making (Byalova 2012; Elbakidze and Angelstam 2007). The decline of this species was caused by the massive draining of wetlands for intensive agricultural use, especially after WWII (Briedis and Keiss 2016; Tanneberger et al. 2008). Despite international efforts to save the Aquatic Warbler, the population is still decreasing, and the range is shrinking. It has not been registered in Latvia since 2003 or in Germany since 2009 (Tanneberger et al. 2008). In Lithuania it has only one small breeding population (Bačelytė and Preikša 2016), but still occurs regularly in several areas in Poland (Tomiałojć and Stawarczyk 2003; Żmihorski et al. 2016). Continued habitat loss remains a significant threat for the species' survival.

However, in landscapes where traditional land management is still practiced, wet meadows and fen ecosystems are better maintained (Thorup 1998; Illyés et al. 2008). Regions located in the periphery of economic development, i.e. further away from markets of Western Europe (Gunst 1989), are more likely to contain intact biodiversity because of lower levels of land management transformation (Angelstam et al. 2013). The lowlands across the Belarus-Ukraine border in the western part of Dnieper River Basin known as the transboundary Paleśsie region (Kułak and Chmielewski 2010) hosts the largest and best-preserved fen mire landscape in Europe. This includes the Pripyat-Stokhid-Prostyr, Mid-Prypiać and Almany Mires Ramsar wetland sites, together with the downstream Turaŭ meadows in Belarus, which host large wetland bird populations and are crucial resting areas during migration (Verkuil et al. 2012).

These areas with suitable habitat for Aquatic Warbler are currently threatened by two different processes. First, intensification of agriculture (e.g., massive amelioration, peat soil erosion, introduction of monocultures and chemical treatment of crops) leads to substantial habitat transformation and degradation of wetland biodiversity. Second, complete abandonment of the traditional agricultural practices (e.g., hay-mowing and small-scale pastures as prerequisites for animal husbandry for rural livelihoods) implies shrinking of the semi-natural open fen habitats. These two processes occur simultaneously, affecting different patches of wetlands.

Nevertheless, smaller patches of fen habitats still remain relatively intact. Adequate conservation management measures of Paleśsie's wetlands are therefore crucial to preserve these remaining sites in a favourable state (BirdLife 2008). Maintaining this cultural landscape biodiversity requires sustaining traditional types of fen management. However, maintaining management systems that support cultural landscape is a major challenge, which requires collaboration of private, public and civic sectors (Crumley et al. 2018). A key aspect is the extent to which citizens are willing to pay for conservation management that emulates traditional land use practices of biodiversity, particularly if they are neither necessary for securing local livelihoods, nor a part of economically viable agriculture. Coping with this complex challenge is not only a matter of wetland ecology and management, but also policy and economics, which requires

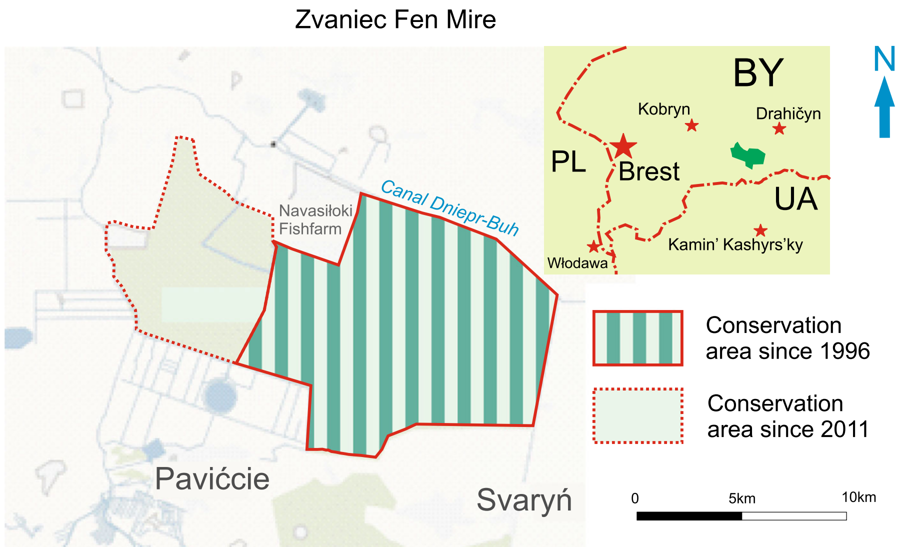

Fig. 1 Study site location map

interdisciplinary exchange of information between environmental managers, pure and applied scientists, and with an international perspective on conservation.

The aim of this study is to estimate Belarusian citizens' willingness-to-pay (WTP) for conservation management of wet fen grassland habitats to sustain populations of the globally threatened Aquatic Warbler in Belarus. This study therefore integrates three topics: ecology, conservation management and economic valuation. We selected the Zvaniec fen mire in the Paleśsie lowland region in southern Belarus as case study area. Then we defined four different alternative biodiversity conservation management approaches for the Zvaniec fen mire. Finally, we estimated citizens' marginal WTP for biodiversity conservation. According to our knowledge this is one of the first non-market valuation studies of environmental goods conducted in Belarus, an East-European country in transition, and which plays an important role in supporting the European continent's biodiversity (Edman et al. 2011; Otto et al. 2011).

Methodology

Case study area and country-specific context

The case study area was the Zvaniec fen located in the Paleśsie region in South-Western Belarus, near the Ukrainian border (52°03′N, 24°51′E, Fig. 1).

Belarus enjoys a quite developed state-governed system of biodiversity conservation comprising Environmental Protection Act, Nature Protection Act, Nature Protected Areas Act, and other legislation as well as strategic documents aimed at biodiversity conservation and sustainable development. Additionally, Belarus is a Party to the major international agreements regulating spatial protection of wetlands biodiversity and key species. Various forms of Nature protected areas of Belarus currently total 1789.7 million ha constituting 8.7% of the country's area (Anonymous 2017). Unlike in many Western European countries (e.g., Angelstam et al. 2011; Peters and von Ungern 2017; Joosten et al. 2017) spatial extension of nature protected areas is facilitated by the absolute predominance of the state-owned land. However, a centralised system of land use and governance of natural resources may lead to ambiguous outcomes since biodiversity conservation may collide with other state policies; in particular where/when economic development goals are being achieved at the expense of biodiversity (Anonymous 2014; Chikalov and Kaskevich 2013).

As one of Europe's biggest intact open fen mires, Zvaniec has been a wetland of international importance (Kazulin et al. 2005). The total surface area of

[1] Only 60% of the mire was formally protected when constructing the survey. The Zvaniec reserve was finally expanded in the beginning of 2011 and currently covers whole the fen mire.

this fen mire is 16,500 ha, of which 10,500 ha were protected as a state nature reserve (*zakaźnik*).[1] As a result of centuries of traditional hay-mowing for grass and reed biomass to support local cattle farming, a unique semi-natural ecosystem developed. It provides habitat for many bird species, including the globally threatened Aquatic Warbler for which the Zvaniec mire is the world's largest breeding site and supports about a quarter of the global population. Additionally, several other rare bird species including Great Snipe (*Gallinago media*), Corncrake (*Crex crex*), and Greater Spotted Eagle (*Aquila clanga*) breed there (Kazulin et al. 2005).

The Zvaniec fen mire remained relatively intact until the 1970s when drainage measures were undertaken. Hydrological changes, combined with cessation of low intensity agricultural use in the 1990s, caused rapid overgrowing of open fen mires with dense reed, shrubs and trees (viz. willows *Salix* spp. and black alder *Alnus glutinosa*). This resulted in an on-going decline of fen habitat quality and area. The population of the Aquatic Warbler declined as a result of encroaching shrub and vegetation succession (see Table 1), which ultimately increases the risk of local extinction.

These changes are consistent with the process of abandonment of agriculturally unproductive and unfavourable areas, which took place across Central and Eastern Europe in the end of 20th century (Joosten and Clarke 2002; Bragg and Lindsay 2003). Cattle farming had become economically unattractive, and currently neither agricultural cooperatives nor individual farmers are interested in harvesting hay in Zvaniec fen, mostly because of the low accessibility of the area and the associated high costs. In addition, improvement in the local trade and social services reduced the need to raise cattle for self-subsistence of the local population with a high proportion of retired and elderly people. At the same time, the Zvaniec fen does not suffer any direct development pressure. The drainage systems in the surroundings and an inflow of the nutrients from the nearby crop fields pose some threats for the fen habitats as well, as these may speed up encroachment of reeds and shrubs.

Valuation of wetlands and wet grasslands

Efforts to conserve wet grassland ecosystems may be motivated by the recognition of their ecological, social and economic values. Wetlands are one of the world's most productive ecosystems with high biological diversity (Kuik et al. 2009). Therefore, considerable literature focuses on various natural and technical aspects of wetland conservation management that belongs to the domain of ecological and landscape sciences (e.g. Malmström et al. 2009; Groeneveld et al. 2007; Van den Bergh et al. 2005; Marjokorpi and Otsamo 2006; Swab et al. 2008; Burlakova et al. 2009; Comín et al. 2001).

Additionally, however, social system dimensions need to be understood for implementation of biodiversity conservation policy. The concept of ecosystem services emerged in the late 1970s (Daily 1997) for the utilitarian framing of ecosystem goods, functions and values as services (Gómez-Baggethun et al. 2010); besides it offers the opportunity for employing different valuation techniques. This is crucial when addressing problem of their restoration and conservation from an interdisciplinary perspective (e.g. Teal and Peterson 2005; Nielsen-Pincus and Moseley 2013; Brancalion et al. 2014; Turner 2005; Hansson et al. 2012).

The need to accurately quantify benefits arising from ecosystem services (Aronson et al. 2010; Boerema et al. 2017), to incorporate them into decision-making process and to raise awareness of policymakers entails increasing number of studies with this goal within natural and landscape sciences. However, also economic values of wetlands ecosystems are important (e.g. Brancalion et al. 2014; Hansson et al. 2012; Robbins and Daniels 2012; Holl and Howarth 2000; Schultz et al. 2012). Wetland restoration and conservation has become a widely chosen topic of valuation exercises within the domain of environmental and resource economics (see Gren and Söderqvist 1994; Heimlich et al. 1998; Brander et al. 2006; Ghermandi et al. 2007; Wattage and Mardle 2008; Azmi et al. 2009; He et al. 2015). Despite the fact that primary valuation case studies are time and resource intensive, appropriate publications have become quite numerous. For example, a meta-analyses of wetland valuations studies made by Kuik et al. (2009) covered 264 independent observations of economic values for temperate climate zone wetlands, mainly from the US and Europe (see e.g. Barbier et al. 1997 for summary of the applicable valuation techniques). Whilst some of the valuation methods employ a revealed preferences approach relying upon the real

Table 1 Estimated population size of the Aquatic Warbler at the Zvaniec Fen Mire: results of annual field counts as reported by APB—BirdLife Belarus (2009)

Years	1995–2005	2006	2009	2010	2011	2013
AW vocalising males	3000–6000	4223–5159	2896–5798	2254–4428	2033–6974	2049–4459

No monitoring data were available for years 2007–2008 and 2012

choices made by economic agents in the markets, stated preferences valuation methods are survey based (Mitchel and Carson 1989) and derive economic values from the hypothetical markets. The latter approach is the only one consistent with the theory of economics to estimate non-use value—the component of total economic value, arising from the fact of very existence of the natural good (Krutilla 1967), which is likely to be substantial in case of semi-intact wetlands.

Discrete choice experiments (DCE) follow stated preferences valuation approach. They are conducted to estimate people's WTP for the various wetland sites (e.g. Morrison et al. 1999; Carlsson et al. 2003; Birol et al. 2006; Birol and Cox 2007; Weber and Stewart 2009; Luisetti et al. 2011; Johnston et al. 2011; Laurie et al. 2013; Westerberg et al. 2010; Giergiczny et al. 2012; Hess and Giergiczny 2015; Dahmardeh and Shahraki 2014; Yimenu and Nandeeswara Rao 2015; He et al. 2016). Rather than to state their WTP directly, respondents in DCE are asked to make their choices over a set of discrete alternatives, described by various attributes including a monetary bid. Such a setting allows to estimate monetary value not only for the entire natural good under consideration, but also to decompose its value into a set of values of particular attributes which can be compared to each other in order to determine socially optimal conservation management programme in accordance with the people's preferences.

Construction of the DCE scenario

A conservation management programme could prevent or mitigate undesirable changes in the Zvaniec fen mire. An effective method to prevent the overgrowing of fen mires is low-intensity mowing (single swath every few years, late in the vegetation season) under unchanged or improved hydrological conditions with stable high water levels (Wheeler and Shaw 1995; Joosten and Clarke 2002). Regular mowing and removal of biomass are prioritised as essential management methods by the International Action Plans for the conservation of the globally endangered the Aquatic Warbler in order to prevent deterioration of open fen mires and to stop the loss of their unique biodiversity (BirdLife 2008; Bragg and Lindsay 2003). An annual biomass harvesting on 1500–2000 ha of Zvaniec fens in alternating locations, would result in each location being mown every few years. This scheme is expected to effectively slow down shrub encroachment and subsequent woodland succession. Four different management options were proposed as alternatives in the choice experiment, namely scything, mechanical mowing, controlled burning and herbicide treatment.

Manual Scything is considered the most culturally authentic but practically abandoned technique of biomass harvesting. It conserves a characteristic sedge tussock structure of vegetation (Middleton et al. 2006a, b), which enhances breeding success by providing food and cover for the Aquatic Warbler.

Mechanical Mowing Because it seems difficult in practice to re-introduce traditional scything on a large scale, a mowing machinery that achieves similar effect as scything has been developed and tested in neighbouring areas in Poland (Lachmann et al. 2010). Such equipment allows implementing large-scale mowing without considerable damage to the soft peat soils and micro-relief of fen mires, even if this is questioned by some other recent studies (Kotowski et al. 2013). Mechanical mowing normally takes place in two annual rounds. However, neither scything, nor mowing or scrub removal should be carried out during the Aquatic Warbler breeding season from early March until late July. However, the biomass harvested in late summer/autumn (August–September) and in winter has little value as fodder. This biomass can potentially be used locally as bio-fuel, if processed with the appropriate briquetting technology (Tanneberger and

Wichtmann 2011). However, this requires certain technical and organisational preconditions on the ground, which are currently not fulfilled in case of Zvaniec.

Controlled Burning of dry biomass in winter is a low-cost management option. However, this has negative consequences as it may result in increased nutrient availability due to fertilisation with ash and topsoil peat mineralisation, which accelerate vegetation succession and scrub encroachment (Schmidt et al. 2000). In addition, burning is detrimental to overwintering invertebrates that provide food for the Aquatic Warbler (Tanneberger et al. 2008), which dwell in standing vegetation, tussocks and in the soil.

In the case of *the Chemical Treatment* of shrubs with herbicides, it is not clear if this option could contribute to the sustainable conservation of the fens. Nevertheless, herbicides are likely to be effective for controlling shrub encroachment at least for a short time (Klimkowska et al. 2010; Teal and Peterson 2005), but their application will entail negative effects on aquatic and semi-aquatic invertebrates (Crompton 2007), which are the main diet of the Aquatic Warbler.

Also, some other factors that are important for the effective conservation of this site were introduced in the DCE, including the necessity of the annual mowing of part of the area and the extent of the enlargement of the nature reserve. Whilst the former factor corresponds to the concept of active conservation, the latter is in line with the idea of passive conservation (e.g., Carey 2003). Whereas active conservation targets particular populations, species or habitats, passive conservation favours maintenance of natural processes within ecosystems. Other things being equal, either a larger protected area or a larger managed area would be expected to improve the state of the open fen mire habitat. However, both factors imply social costs which might be more obvious to the general public than the corresponding benefits as, unlike the majority of the biodiversity-linked benefits, the costs of conservation actions can be calculated using market prices. While old-growth forests need passive conservation in a large area allowing natural disturbance regimes to operate (Angelstam and Kuuluvainen 2004), cultural grasslands require active management (Manton and Angelstam 2018). The comparison of people's marginal WTP for one additional spatial unit of active conservation vs. one additional spatial unit of passive conservation of wetland ecosystems is necessary to account for people's preferences towards a particular conservation approach. Thus, three more attributes were included into the DCE besides the management option itself, i.e. (a) the surface that has to be annually subjected to active conservation management, (b) the enlargement of the nature reserve area, and (c) the cost. All the above listed attributes (variables) and corresponding levels (values) used in the DCE (see Table 2) were also agreed in consultations with policy makers and conservation experts during focus groups.

Experimental design and survey administering

The final version of the questionnaire was tested in a pilot study of 50 respondents. The payment vehicle used in the survey was an obligatory annual payment that all adult Belarusian residents would have to make to a fund exclusively dedicated to the conservation of the Zvaniec wetland's focal species.

Each respondent faced sixteen choice situations, every one consisting of the status quo alternative with no additional conservation program and no extra payment required, and three programme alternatives. The choice-sets were prepared following the optimal-orthogonal-in-the-difference design (OOD).[2]

Following the best–worst (BW) approach, each respondent was asked to select the most preferred alternative out of four, the least preferred alternative out of three, and the most preferred alternative of the remaining two, effectively providing a full ranking of all four alternatives in every choice task.

The questionnaire consisted of four parts. The first part examined respondent's general attitude towards biodiversity and conservation issues. The second part described the ecological importance of stopping the succession of trees and bushes at the open fen mire and introduced possible policy options. As the conservation of the Zvaniec mire is important for saving the Aquatic Warbler, this bird being the sites' flagship

[2] In addition to maintaining orthogonality in OOD design attributes common across alternatives never take the same level in a given choice situation so respondents are forced to trade on all attributes in the experiment, whilst the orthogonality of the design ensures that the independent influence which each attribute has upon choice can be determined (Street and Burgess 2007). The other advantage of OOD over D-efficient designs is that they do not require the prior knowledge of preference parameters.

Table 2 Attributes and levels used in the Choice Experiment

Attribute	Description	Levels
Method of removing shrubs	Four different methods contemplated by the reserve management team BAU* = none	(1) Manual Scything (2) Mechanical mowing (3) Controlled burning of the dry biomass in winter (4) Chemical treatment with herbicides
Managed area	Annual area over which the shrubs would be removed (ha/year) BAU = 0	(1) 1000 (2) 2000 (3) 3000 (4) 4000
Enlarging conservation area	Enlarging the size of the reserve from the current 10,500 ha BAU = 0	(1) + 0 ha (2) + 2000 ha (3) + 4000 ha (4) + 6000 ha
Cost	Annual cost per person (USD'2010 prices)** BAU = 0	(1) 1.75 USD (2) 10.53 USD (3) 19.30 USD (4) 28.07 USD

*BAU: Business-as-Usual

**At the time of the survey 1 USD was approximately equal to 2850 BYR at the internal market, so the original attribute levels stated in the questionnaire were BYR 5000; 30,000; 55,000 and 80,000 respectively

species, maps with its current spatial distribution, breeding sites and illustrative photos were presented to the respondents. The third part introduced the choice tasks themselves. Each respondent faced sixteen successive choice-sets presented on computer screen as colour tables. An example of a choice card is presented in Fig. 2. The fourth part contained debriefing questions and collected socio-economic data, including gender, age, location, education, household characteristics, and income.

The questionnaire was administered face-to-face on a sample of the Belarusian population. Interviews were conducted in respondents' houses in January 2010. The sample covered the area of Minsk (the capital of Belarus), regional and district centres, as well as rural areas situated in different parts of the country, thus covering all of its regions. Questionnaires were randomly assigned to individuals in the course of the random door-to-door round, with the socio-economics controlled to be consistent with those of the Belarusian population. A total of 270 complete interviews were conducted and 206 valid questionnaires were used in the subsequent econometric analysis. Descriptive statistics of the sample are presented in Table 3.

Econometric modelling

In a DCE exercise, individuals are asked to identify their preferred choice i among a given set of J alternatives. The data analysis follows the Random Utility Model (RUM) (McFadden 1974). Under RUM, it is assumed that the observed choice from an individual n is the one she expects to provide her with the highest utility. Her utility function, U_{ni}, can be decomposed into a systematic part, V_{ni}, and a stochastic part, ε_{ni}. The probability P_{ni} that the decision maker n chooses alternative i instead of another alternative j of the choice set is $P_{ni} = \Pr(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \forall j \neq i)$. If ε_{nj} is assumed to be an independently and identically distributed extreme value type I (Train 2003), this probability has a closed form multinomial logit (MNL) expression,

$$P_{ni} = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} \tag{1}$$

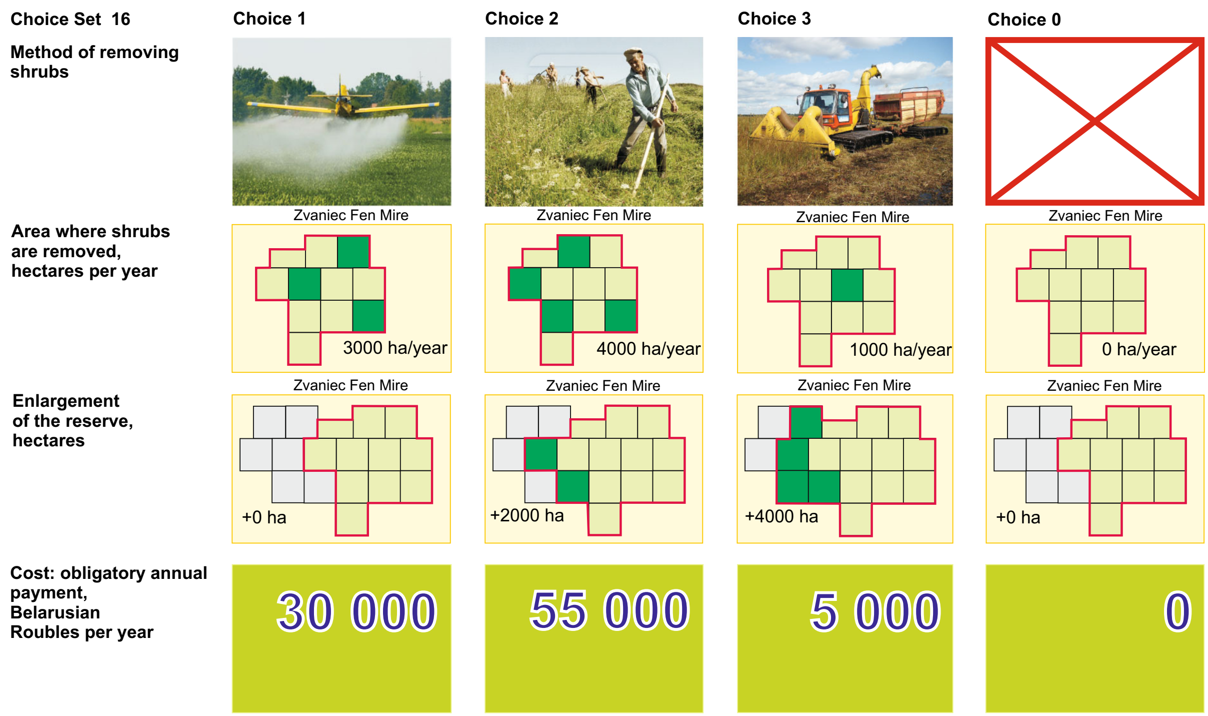

Fig. 2 Example of a choice card used

Table 3 Descriptive statistics of the sample of 206 respondents

Variable	Min	Max	Mean	SD
Age	18	72	45.7	15.5
Years at school	6	17	11.7	2.4
Share of women	0	1	0.46	0.50
Average monthly income (USD*)	43.2	1269.4	259.5	181.3
Share of respondents who have heard of Aquatic Warbler	0	1	0.37	0.48

*At the time of the survey 1 USD was approximately equal to 2850 BYR at the internal market, so the average monthly income denominated in Belarusian roubles was BYR 739,644

where x is a vector of variables and β is a vector of parameters.

In our exercises, respondents instead of a standard best choice, were using the Best–Worst elicitation format (BW). We assumed that respondents reveal their rank-order (i.e. preference order) in accordance with the RUM model. We can then associate the best available alternative with the highest level of utility and the worst with the lowest level of utility. The rank of the other alternatives should also be coherent with the underlying utility levels. The respondent is assumed to select the alternative she prefers most, and if that is not available she would select the second-best option, etc. Information on the most preferred alternative alone is sufficient to estimate preference parameters. More efficient estimates, i.e. that with lower standard errors, could be obtained when information on lower ranked alternatives is used in addition; such efficiency gains are particularly relevant when the data are scarce. However, the question of real relevance in this context is whether the preferences that drive responses in such full elicitation approaches are the same as those from the standard-stated choice methods.

A common practice amongst analysts is to pool all BW stages and estimate a joint model whilst only accounting for potential heteroskedasticity, i.e. scale differences, across the stages. However, early work by Hausman and Ruud (1987) and Ben-Akiva et al. (1991), already provides warnings about the stability of preference structures when using the traditional ranking approach where the full preference order is obtained through a sequence of 'best' questions. Despite these findings, many researchers estimate joint models using all ranks (either coming from standard ranking or BW) without testing preference stability across ranks. In most applications of the BW elicitation format, this is justified by the belief that BW tasks are superior to the standard ranking approach as they take advantage of a person's propensity to respond more consistently to extreme options (Flynn et al. 2007; Marley 2010). Moreover, these researchers also claim that by moving the focus away from middle ranked alternatives, the BW approach potentially circumvents the stability issues observed in the ranking approach. However, this advantage of BW over ranking in terms of preference stability is rarely tested. Giergiczny et al. (2017), showed in their recent study that BW and traditional ranking reveal exactly the same inconsistencies and that BW does not solve any problems which were identified for ranking.

In this study we tested a joint model hypothesis against stage-specific models in the way described by Giergiczny et al. (2017). Using the exploded logit formula,

$$\boldsymbol{Pr}(\boldsymbol{C} > B > D > A) = \frac{\exp\left(\boldsymbol{\mu}_1 \boldsymbol{\beta}' \boldsymbol{X}_{\boldsymbol{C}}\right)}{\sum_{\boldsymbol{j}=\boldsymbol{A},\boldsymbol{B},\boldsymbol{C},\boldsymbol{D}} \exp\left(\boldsymbol{\mu}_1 \boldsymbol{\beta}' \boldsymbol{X}_{\boldsymbol{j}}\right)} \cdot \frac{\exp\left(\boldsymbol{\mu}_2 \boldsymbol{\beta}' \boldsymbol{X}_{\boldsymbol{B}}\right)}{\sum_{\boldsymbol{j}=\boldsymbol{A},\boldsymbol{B},\boldsymbol{D}} \exp\left(\boldsymbol{\mu}_2 \boldsymbol{\beta}' \boldsymbol{X}_{\boldsymbol{j}}\right)} \cdot \frac{\exp\left(\boldsymbol{\mu}_3 \boldsymbol{\beta}' \boldsymbol{X}_{\boldsymbol{D}}\right)}{\sum_{\boldsymbol{j}=\boldsymbol{A},\boldsymbol{D}} \exp\left(\boldsymbol{\mu}_3 \boldsymbol{\beta}' \boldsymbol{X}_{\boldsymbol{j}}\right)} \quad (2)$$

where β represent preference parameters and μ represent scale parameters, we estimated models in which the following assumptions were made: Model (I) β and μ are constant across all stages, Model (II) μ varies across all stages and β's are constant, and finally Model (III) β parameters are stage specific. Model I imply that both preference parameters and scale estimates are constant across the stages. If this is true, then all stages of BW could be pooled, and more efficient estimates would be obtained. Model II implies that the only differences in estimates across the stages are in scale estimates. This would mean that after controlling for scale differences, all stages of BW could be pooled, and more efficient preference estimates would be obtained, and finally, Model III implies that both preference and scale estimates vary across the stages, so the data for each stage should be estimated independently.

Model specification I is nested within model specifications II-III. Similarly, model specification II is nested in model specification III. A Likelihood Ratio (LR) test can be performed to test whether model specification I, II or III provides a better fit to the observed choices. When model specification III is supported by the LR-test, complete stability of utility parameters across the stages is rejected and only the model on best choice data should be estimated.

After rejecting the hypothesis of a joint model, the data on best choices were analysed using MNL and more advanced mixed logit model (MMNL) (McFadden 1974; Train 2003), which is any model whose choice probabilities take the form

$$P_{ni} = \int \frac{e^{\beta_n' x_{ni}}}{\sum_j e^{\beta_n' x_{nj}}} \phi(\beta|b, \Omega) d\beta, \quad (3)$$

where $\frac{e^{\beta_n' x_{ni}}}{\sum_j e^{\beta_n' x_{nj}}}$ is a standard logit formula, $\phi(\beta|b, \Omega)$ is the density of the random coefficients with mean b and covariance Ω. Thus, the logit expression can be treated as a special mixed logit case with β being fixed. Limitation of the standard MNL which represent only the systematic taste variation, but not random taste variations is relaxed by assuming a mixing distribution that is not degenerated at fixed parameters. In the MMNL model, we accounted for the panel structure of the data and systematic taste variation.

The utility function for both MNL and MMNL models includes four effects-coded variables associated with the shrub removal method (*Manual Scything*, *Mechanical Mowing*, *Controlled Burning* and *Chemical Treatment*), the three continuous variables: *Managed Area*, *Enlarging Conservation Area*, *Cost* and a dummy variable *SQ* denoting status quo alternative. A linear in attributes specification of the utility functions was used on the basis of preliminary analyses that did not reveal any consistent and significant nonlinearity in response with the data at hand.

For the MMNL model, all the non-monetary attributes were assumed to follow normal distribution, while the cost coefficient was assumed to follow log-normal distribution.[3] Since the integral in equation [3] cannot be evaluated analytically the probabilities have to be simulated; in each run 500 random draws were generated.

As a final step, we calculated the WTPs from the model estimates. WTPs were calculated as marginal rates of substitution of non-monetary attributes of the good under consideration for the monetary attribute; in other words, WTP for non-monetary attribute *a* was calculated as negative ratio of partial derivative of the utility function with respect to the variable *a* to the partial derivative of the utility function with respect to the monetary variable *Cost*.

$$WTP_a = -\frac{\partial U/\partial a}{\partial U/\partial Cost} \qquad (4)$$

The values were calculated for each person in the data, taking into account the socio-demographic interactions, and hence we also obtained heterogeneity in the MNL model.

Results

Preference stability

We start the result section with testing the hypothesis of the stability of utility parameters in the repeated BW experiment. As discussed in the previous section, we estimated three Models I, II and III. The test results are presented in Table 4. The LR-test shows that model specification II, in which we control for scale heterogeneity, fits significantly better than model specification I and, more importantly, model specification III significantly outperforms model specifications I and II. This result suggests that only controlling for differences in scale parameters is insufficient and that wrongfully assuming parameter stability across stages may lead to incorrect inferences. Hence, the warnings of previous research on pooling responses from repeated best surveys are confirmed and extend to pooling responses across the stages from the repeated BW format. Our results in this regard are fully consistent with findings reported in Giergiczny et al. (2017), who confirmed the same pattern concerning the four independent datasets collected in different context (marketing, transportation and non-market valuation).

Best choice results

The modelling results are given in Table 5 as two sets of estimated model parameters—for MNL and MMNL. Besides the model coefficients which represent marginal utility, respondents derived from the corresponding attribute, MMNL parameters include estimates of standard deviations of the random parameters' distribution, assumed in the model, being a general measure of the preferences' heterogeneity in case of appropriate attribute.

The signs of the coefficients with main effects are consistent with a priori expectations. The estimates for *SQ* parameter are negative, indicating that respondents generally would like some conservation management programme to be implemented. The negative coefficient with the *Cost* indicates that the respondents are on average price-sensitive which is consistent with the economic theory. The positive and statistically significant coefficients for *Managed Area* and *Enlarging Protection Area* imply that conservation programmes associated with larger area of removing shrubs and the enlargement of the existing reserve are more likely to be chosen. Positive and statistically significant coefficients for *Manual Scything* and *Mechanical Mowing* indicate that people, on average, associate positive utility with these two methods, whereas *Controlled Burning* and *Chemical Treatment* with herbicides contribute, on average, negatively to their utility.

The signs and significance of interaction terms are consistent with a priori expectations. The coefficient by *Cost-Income* ratio is negative indicating that respondents with a higher income have lower price sensitivity, i.e. their WTP for the conservation

[3] Assuming log-normal distribution for *Cost* restricts all respondents to have negative coefficients by Cost. In addition, log-normal cost allows for random taste variation in price sensitivity and guarantees WTP to have finite moments (Daly et al. 2012). However, assuming a log-normal distribution for cost is not a standard approach. Most authors in the field of environmental valuation assume cost to be fixed as this prevents mean WTP values from 'exploding'. We question this practice; detailed discussion on this topic is presented in Giergiczny et al. (2012).

Table 4 Log-likelihood ratio test

LL for model specification			LR—test between model specifications					
I (df = 7)	II (df = 9)	III (df = 21)	I versus II	p value	I versus III	p value	II versus III	p value
− 9206.89	− 8935.37	− 8712.76	271.52	0.00	494.13	0.00	445.42	0.00

Table 5 Discrete choice modelling results

	MNL		MMNL	
	Coeff.	t-rate	Coeff.	t-rate
Main effects				
Manual scything	0.4996	13.68	0.7272	8.40
Mechanical moving	0.2908	7.15	0.5763	7.30
Controlled burning	− 0.1867	− 4.56	− 0.1537	− 2.66
Managed area	0.2814	12.04	0.4625	8.99
Enlarging conservation area	0.076	6.68	0.1234	6.46
Cost	− 0.0146	− 12.54	− 4.1050	− 21.62
SQ	− 0.4162	− 4.68	− 1.3619	− 10.04
Socio-demographics effects				
Cost/income	− 0.0443	− 10.23	− 0.0140	− 1.59
University * enlarging conservation area	0.0749	2.63	0.1903	3.60
User * managed area	0.1942	7.24	0.1790	4.05
User * enlarging conservation area	0.2848	6.42	0.3141	3.07
Standard deviations of random parameters				
Manual scything			1.02	15.24
Mechanical moving			0.85	9.42
Controlled burning			0.35	4.01
Managed area			0.56	12.31
Enlarging conservation area			0.14	5.63
Cost			1.99	13.31
Log-likelihood function	− 3570.4		− 2756.8	
Number of parameters	11		28	

programme is higher, other factors being equal. Other interactions with socio-demographics also implied behaviourally plausible results. Respondents with a university degree derive a higher marginal utility associated with enlarging the reserve. Users, i.e. respondents who declared visiting the wetland in the past have a higher marginal utility for the *Managed Area* and *Enlarging Conservation Area* attributes.

By using the MMNL model, we obtained an improvement in log-likelihood by 813.6 units compared with the MNL model, which means a significant improvement of the model fit (p = 0.99). Similarly, the means of the normally distributed parameters are all statistically significant, and the standard deviations of the random parameters were all statistically significant at the 99 per cent confidence interval, indicating substantial taste heterogeneity among respondents which clearly shows that the MMNL model gives significantly better fit to the data than the MNL model. The five normally distributed random coefficients have relatively high standard deviations with coefficients of variation ranging from 1.21 to 2.27.[4] The mean and standard deviation of underlying log-normal

[4] The coefficient of variation (CV) is defined as the ratio of the standard deviation to the mean. It shows the extent of variability in relation to the mean of the population.

distribution for the *Cost* coefficient were also highly significant.

A strong negative correlation is observed between *Manual Scything* and *Controlled Burning* (Table 6). This high level of correlation made sense as these two methods are very different, so it was likely that respondents who, for example, like scything, dislike burning, and vice versa. A similar pattern holds for *Controlled Burning* vs *Mechanical Mowing*. We also found a relatively high positive correlation between *Managed Area* and *Enlarging Conservation Area*, which seems reasonable as people who were more concerned about the area where shrubs were removed also had a higher preference for increasing the size of the reserve. Indeed, the larger the areas from which the shrubs were removed, the better are the conditions for the rare bird species. Similarly, the larger the reserve is, the better the conservation of the site is, so the high positive correlation between these two random taste coefficients makes sense. Correlation levels for other pairs of coefficients are relatively small.

Since the MMNL model gives significantly a better fit to the data than the MNL model, we focus our attention here on WTP estimates obtained for the MMNL model only, whilst the WTP values for the MNL model are left as the reference level. Looking at WTP estimates (Table 7) we see that WTP for manual removal was 13.43 USD and was valued more highly than mechanical removal (10.65 USD). We also see that burning was valued less negatively (− 2.86 USD) than chemical removal which was perceived as the worst method of management (− 21.24 USD). The WTP for the area of removal and the reserve size were both positive, with the former being about four times as high i.e. 9.60 USD compared 2.28 USD. This indicated that respondents strongly preferred active conservation by restoration management to simply enlarging the reserve. When moving from the MNL model to the MMNL model, the WTP measures increased for the majority of components and substantial levels of heterogeneity were obtained across respondents. This is typically observed when cost is assumed to follow a log-normal distribution (Giergiczny et al. 2012). The ordering of WTP remains the same for the both models.

Table 6 Correlations between normally distributed non-cost coefficients

	β_{ma}	β_{me}	β_{bu}	β_{ar}
β_{me}	− 0.17			
β_{bu}	− 0.82	− 0.41		
β_{ar}	− 0.32	0.20	0.14	
β_{re}	− 0.31	0.07	0.18	0.54

Discussion

Positive environmental preferences do not depend on the natural resource governance system

Our results show that people in Belarus derive positive and significant economic benefits from fen mires conservation. This is in line with the results of valuation studies conducted in West European countries including stated preferences studies (e.g. Birol et al. 2006; Carlsson et al. 2003). This indicates that people's environmental preferences are to a large extent independent of the dominating type of natural resource governance (top-down in Belarus vs. multi-level in the West), the advance of market transformation or the structure of property in the economic system (a high degree of state-owned property in Belarus compared to mostly private property in the West).

This study also indicates that citizens in Belarus are, on average, willing to pay a substantial amount of money for the conservation management of the Zvaniec mire as a habitat for the Aquatic Warbler and other co-occurring endangered species. For instance, the estimated mean WTP for a conservation programme comprising mowing 1,000 ha/year on the Zvaniec fen mire yields an equivalent of 20.25 USD'2010. If extrapolated on the total adult population of Belarusians,[5] this yields annual WTP of more than 8240 USD per hectare of the Zvaniec mire which is close to the upper boundary of results internationally obtained in valuation studies (Wichmann et al. 2016). This result reveals that on average Belarusian citizens are aware of the necessity for investing financially in biodiversity conservation. Among the four alternative management methods, a positive WTP was associated

[5] The country's total population in 2016 was 9,327,329 people, where around 72% of them were adults (https://myfin.by/wiki/term/naselenie-belarusi, accessed 15th February 2018).

Table 7 Willingness-to-pay estimates

	MNL (in USD '2010*)		MMNL (in USD '2010*)	
	Mean	SD	Mean	SD
Manual scything	7.66	1.77	13.43	27.22
Mechanical mowing	4.46	1.03	10.65	22.44
Controlled burning	− 2.86	0.66	− 2.83	8.72
Chemical treatment	− 9.26	2.14	− 21.24	27.78
Managed area (per 1000 ha)	5.10	2.13	9.60	16.16
Enlarging conservation area (per 1000 ha)	1.16	0.27	2.28	3.94

*At the time of the survey 1 USD was approximately equal to 2850 BYR at the internal market

with the hand scything and mechanical mowing options, with scything being the most preferred solution. As this technique is considered to be the most adequate for conservation of fen mire ecosystems, the result confirms that pro-environmental preferences predominate amongst Belarusian citizens.

The mean WTP for the mechanical mowing programme, which is the most likely to be undertaken in practice, was about 40 percent lower than the WTP for scything. In contrast, the WTP values for burning and herbicide application were negative. From the answers to the debriefing questions, we learned that people on average were afraid of using chemicals for the purposes of controlling shrub encroachment. The estimated negative WTP for herbicide treatment was in line with findings of some other studies, emphasising public concern and providing examples of the aversion to the methods by the general public (e.g. Teal and Peterson 2005). As far as the burning option is concerned, its negative evaluation can be explained by a mass-media social campaign against *uncontrolled* vegetation burning in early Spring. This means that the two kinds of vegetation burning could have been mixed up by respondents. Controlled burning management might also be associated with peat fires, which impose safety risks on the local inhabitants and may cause health problems due to smoke pollution. However, undrained fen mires are characterised by peat soil saturated with water (mostly groundwater) and are hence less prone to peat fires.

Interestingly, while low-intensity land use for nature conservation purposes was clearly supported, the option of enlarging the nature reserve was much less popular. In fact, respondents, on average, were willing to pay more than twice as much for increasing the managed area by one hectare compared to enlarging the Zvaniec Nature Reserve by one hectare. Respondents thus considered passive conservation to be insufficient to maintain open fen mire habitat, and they give priority to the conservation management programmes. Respondents' preferences are consistent both with the importance of maintaining cultural landscapes and traditional rural practices, as well as with current international biodiversity conservation policies which state that active landscape management is essential for the conservation of anthropogenic cultural landscapes. The relatively low WTP for enlarging the reserve compared to mowing area could also reflect society's mistrust of state nature protection instruments, a frequent opinion that was expressed in the follow-up questions. This falls in line with studies demonstrating that active methods yield quicker and more effective/concrete results than passive ones (Aronson et al. 2010). Thus, active conservation programmes seem more societally desirable despite their potentially higher costs. Nevertheless, more intensive efforts could be put forward to strengthen people's positive attitude towards officially established spatial conservation designations like *zakaźniks*, reserves, etc. in order to maintain environmentally optimal combination of active and passive conservation measures.

Coping with cultural and natural landscape degradation in Eastern Europe

Already von Thünen (1910), observed that the types and intensities of land use were related to the distance from the market. Loss of fen mire habitat in Europe is consistent with a generally expanding human footprint in terms of increasingly intensified land use from the core to the periphery of economic development (e.g., Gunst 1989). This has resulted in clear gradients of alteration, fragmentation and loss of both traditionally multifunctional cultural landscapes and naturally dynamic forest landscapes (Puumalainen et al. 2003;

Angelstam et al. 2017; Manton 2016). The West–East gradient is particularly interesting because it involves the eastern border of the European Union, which can be viewed as a fault line regarding the level of past modification of ecological systems with their better conservation status in the East than the West (e.g., Edman et al. 2011; Manton 2016).

However, after the collapse of the Soviet Union the rate of land cover change increased in Eastern Europe (Alcantara et al. 2013; Prishchepov et al. 2013; Angelstam et al. 2017). There is a current desire to intensify land use in order to gain short-term economic benefits (e.g., Naumov et al. 2016). This transition also enables natural resource extraction in previously protected areas (Naumov et al. 2017) and is associated with illegal and/or unregulated resource harvesting (Newell and Henry 2017), as well as a reduction in the allocation of resources for biodiversity conservation (Wells and Williams 1998). Concerning cultural landscapes, rural de-population is a ubiquitous trend (e.g., Burneika et al. 2014), thus leading to declining biocultural values of traditional cultural landscapes.

Mitigation of these issues concerning biocultural values needs to involve also the social system component of cultural landscapes. Throughout Europe, rural and peripheral areas like Paleśsie suffer stagnating economies and population decline. Creating and communicating positive images by branding is one feasible regional development strategy. However, there is no evidence of any positive effect of marketing campaigns on in-migration (Niedomysl 2007). In response to this, there is an emerging focus on particular places rather than sectors, and on investments in new jobs rather than subsidies. This stresses the need for building on local strengths and qualities for rural place marketing and lifestyle migration. Nature, including cultural landscapes, are key assets (Garrido et al. 2017a, b), as well as the social capital created by such values' importance for sense of place and cross-sectorial collaboration (Westlund and Kobayashi 2013). In this context, the considerable WTP stated by Belarusians for conservation of cultural landscape in case of the Zvaniec fen mire, a place being important for European and global biodiversity conservation, seems a promising signal.

Who should pay for biodiversity conservation, especially for costly active conservation management emulating traditional land use systems such as fen mires or other types of cultural landscapes? Processes in the West have already caused biodiversity loss, and the frontier of intensification is moving to more peripheral areas (e.g., Naumov et al. 2018). Is it only those in the East who currently want to intensify land use for human well-being (but began later than their Western counterparts)? Should those who benefitted financially and who also caused the biodiversity loss in the past from raw materials domestic extracting and importing (and thus won materially) pay? Within the EU, there are indeed policies and different types of funding schemes aimed at sharing costs among Member States and their regions; often also with some opportunities for non-EU countries in Eastern Europe. Nevertheless, regions with the least economic and political participation capacity tend to benefit the least and take on more of the dis-services accruing from industrialisation and the resulting footprint (Steger and Filcak 2008).

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