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Assessing environmental awareness towards protection of the Alps: a case study

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ABSTRACT

The paper focuses on environmental awareness towards the protection of Alpine areas, and presents the results of a research aimed at assessing people's awareness in regards to certain topical environmental issues such as protected areas, ecological connectivity, and wildlife. The study area is the Julian Prealps Natural Park, in the region of Friuli Venezia Giulia (Northeast Italy). In order to obtain a measure of "environmental awareness", the Rasch model was applied. It allowed us first to identify which items are most suitable for this. The results obtained show that people are quite aware of some issues, e.g. that wellbeing is related to greener areas and that they can change things to solve environmental problems. We also found that it is easier to agree with items relating to the environment in general than with more specific issues, probably due to a lack of knowledge. However, the provision of pertinent information, in our case on ecological connectivity, can increase the level of environmental awareness. The model also showed that the level varies according to certain sociodemographic characteristics, particularly gender and age. These results could serve as a starting point for planning effective information activities aimed at raising environmental awareness and, possibly, bolstering participation in initiatives for protecting Alpine areas.

1. Introduction

The paper focuses on environmental awareness towards the protection of Alpine areas, and presents the results of a research aimed at assessing people's awareness in regard to certain topical environmental issues such as protected areas, ecological connectivity and wildlife.

In Europe, the Alps are one of the last remaining territorial expanses in which species diversity is still high and largely untouched areas persist. They are characterized not only by a mosaic of different natural areas, but also by a long-standing tradition of human use (Bartaletti, 2009; Bätzing, 2005). A process to protect these areas began in the 1970s. It led to the establishment of the Natura 2000 and the Emerald networks, the most important European networks of protected areas. Today, protected areas, such as parks and nature reserves, can be found throughout the Alps and cover about a quarter of the Alpine territory. They play a crucial role in conserving endangered species, as well as the social and cultural life of the Alpine range (EEA, 2012, 2017; Plassmann et al., 2016).

It is now widely recognized that this role cannot be played even by the best managed area if it is isolated. Indeed, long-term biodiversity conservation and sustainable development require a well-connected system of protected areas that allows animals and plants and/or their genes the freedom to move as needed, as well as spatially distributed ecosystem functions, such as soil and water processes (Chester and Hilty, 2010; Crooks and Sanjayan, 2006; Hannah, 2011; Hannah et al., 2007; Hilty et al., 2006). These movements can be facilitated by different types of habitats, not only natural but also semi-natural areas, such as agricultural landscapes (Dudley, 2008). Therefore even these latter areas can guarantee proper ecological connectivity, and the existence of traditional agro-ecosystems demonstrates that mutually beneficial relationships can be established between human activities and the environment (Baiamonte et al., 2015). To foster these relationships, it is worth including ecological concerns in territorial planning. Specifically, concepts and criteria of conservation and development should be integrated into ordinary planning where, traditionally, human and natural systems are analyzed independently (Battisti, 2003; Scolozzi and Geneletti, 2012; Tosini, 2015).

Some species, such as large carnivores, are particularly vulnerable

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to habitat fragmentation[1]. This is due to intrinsic biological traits, such as large body size, large area requirements, low densities, and slow population growth rates, as well as to external human threats, such as hunting and other forms of direct persecution (Crooks, 2002; Crooks et al., 2011). In Europe, large carnivore populations have increased since the mid-20th century, and the bulk of their distribution is in multiuse landscapes, often outside protected areas. In fact, even if they are often associated with wilderness, the European experience shows that they can also survive in heavily modified and domesticated landscapes. Their future in Europe depends on their continued persistence also in these modified landscapes as well as on ecological connectivity, since isolated protected areas are normally too small to support large groups of individuals (Linnell et al., 2015). It also depends on long-term human-carnivore coexistence, facilitated by efforts to mitigate potential conflicts (Dorresteijn et al., 2014; Howley et al., 2014; Morehouse and Boyce, 2017). Indeed, large carnivores are a hot topic, since their reintroduction and population growth has polarized public opinion. On the one hand, wildlife opponents raise concerns about the negative repercussions that may follow for local communities living within or around protected areas or along the ecological corridors; negative attitudes towards large carnivores are mainly expressed by people concerned about their personal and their family's safety and those who have experienced financial losses due to large carnivore proximity, e.g. farmers. On the other hand, wildlife advocates extol the positive impacts, such as the growth of wilderness tourism aimed at experiencing wildlife in their natural environment (Bradby et al., 2014; Ednarsson, 2006; Røskaft et al., 2007).

Ecological networks are not only of benefit to plants and animals, but also to humans. Places with varied landscapes and functioning ecosystems contribute to improving people's quality of life. They can also enhance the attractiveness of a region for economic activities, thereby fostering local development. As mentioned above, the interaction between human activities and biodiversity conservation can be contradictory. For instance, tourism growth in protected areas offers great opportunities for increasing regional income but could also represent a threat to the natural environment, especially when it comes to mass tourism; low-intensity agriculture can lead to high densities of species, while intensive agriculture is less conducive to biodiversity. The solution is not necessarily to prohibit human activities, but rather to plan them in such a way as to encourage good human-environment relationships, fostering the responsible use of natural resources, and protecting the landscape richness (Jose, 2012; McNeely, 2004; Niemela et al., 2005; Young et al., 2005). For this, it is important to get people not only to accept but also understand and appreciate environmental investments, as demonstrated in the case of waste management infrastructure (Kirkman and Voulvoulis, 2017), waste recycling (Chan, 1998), vernal pool conservation (McGreavy et al., 2012), and farming activities (Bradby et al., 2014; Hinojosa et al., 2018).

Starting with this premise, the research focused on people's awareness towards Alpine area protection and aimed at identifying a measure of "environmental awareness", a topical and still little explored research topic. Indeed, understanding the level of people's awareness regarding current environmental issues could improve the effectiveness of protected area management, which should also include the implementation of communication activities aimed at raising environmental awareness, promoting pro-environmental behavior, and possibly encouraging public participation in landscape planning (Andrade and Rhodes, 2012; Balzaretti and Gargiulo, 2011; Nastran, 2015). For the purpose of this research, the Rasch model was used since its properties make it suitable for identifying the measure of interest, as described in the Methods section. In the previous section we describe the study area, namely the Julian Prealps Natural Park, and in the following one the main results are presented. We lastly draw some general conclusions and implications for practical purposes and future research.

2. Study area

The study area is the Julian Prealps Natural Park[2] (Fig. 1), which extends over an area of approximately 10,000 hectares. It comprises the municipalities of Chiusaforte, Lusevera, Moggio Udinese, Resia, Resiutta, and Venzone, in the region of Friuli Venezia Giulia (Italy), and has its headquarters in Resia village. It borders the Slovenian Triglav National Park. The park was established under Regional Law no. 42/1996, which defines rules on regional parks and nature reserves, and is included in the Natura 2000 network. It straddles two distinct Alpine units: the Julian Alps and Julian Prealps, and includes a wide area around Monte Canin (2,587 m), one of the most beautiful peaks in the region. The park is of considerable importance due to its natural and geological features, wildlife, vegetation, and history.

Although it is not possible to define a socio-demographic structure of the Park because there are no stable settlements, a few data could describe its tendential dimensions. In 2011, there were 6,878 residents (-20.6% compared to 1991), mainly located in the municipalities of Venzone (2,242 people), Moggio Udinese (1,807) and Resia (1,092). Some indicators of population structure show that the average index of masculinity is equal to 100.14, with the highest value recorded in the municipality of Resia (106.43) and the lowest in Moggio Udinese. The average age is 48.83 years (50.30 in Resia and 45.81 in Venzone).

The Julian Prealps Natural Park is one of the Pilot Regions in the Ecological Network Platform of the Alpine Convention[3]. The Platform is one of the many activities conducted in the Alps aimed at implementing an Alpine ecological network, as defined in Article 12 of the "Nature protection and landscape conservation" Protocol[4] of the Alpine Convention. Since 2011, the Platform has designated ten Pilot Regions, which encompass existing protected areas but cover a much larger territory. The Pilot Regions are often cross-border, in which specific activities are undertaken in order to develop ecological connectivity (Angelini and Sammuri, 2017).

3. Methods

3.1. Questionnaire and data collection

To analyze environmental awareness towards mountain area protection, the research comprised: questionnaire planning, data collection, and data analysis.

The questionnaire was structured in three main sections. The first sought data on environmental awareness with regard to the items described in Table 1. They were selected considering the existing literature on environmental issues specifically focusing on protected areas, ecological connectivity, and wildlife (see Introduction). Most of these issues have also been surveyed by the European Commission (EC, 2015).

The second section of the questionnaire consisted of a specific item, namely "The information on ecological connectivity provided on the Julian Prealps Natural Park website is clear" (D16). It was included to obtain data on the correlation between environmental awareness and pertinent information, by inviting respondents to visit the Park website where we had previously inserted an *ad hoc* page with some information on biodiversity, habitat fragmentation,

[1] The four large European carnivore species are: bears, wolves, lynx, and wolverines (http://ec.europa.eu/environment/nature/conservation/species/carnivores/index_en.htm).

[2] www.parcoprealpigiulie.it.

[3] www.alpconv.org/it/organization/groups/WGEcologicalNetwork/default.html.

[4] http://www.alpconv.org/en/convention/protocols/Documents/protokoll_naturschutzGB.pdf.

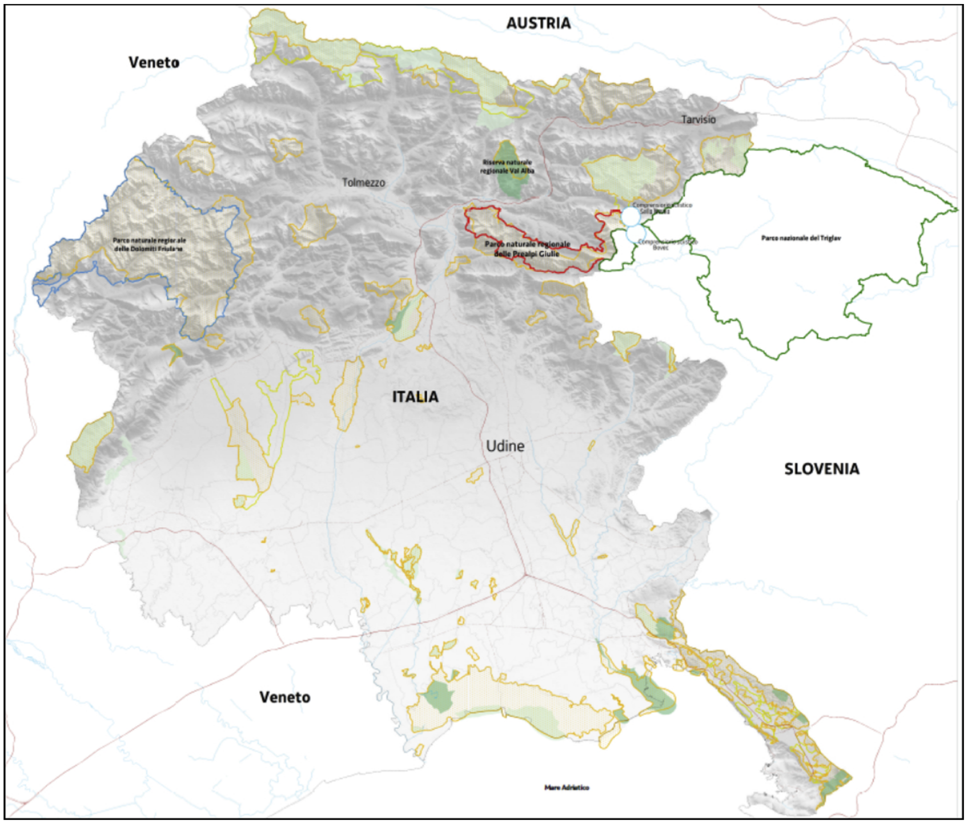

Fig. 1. Study area: Julian Prealps Natural Park.
Source: www.parcoprealpigiulie.it.

Table 1
Environmental items.

Sections	Items	Codes
Environment	Environmental communication is necessary to understand the delicate relationship between man and nature	D1
	The existence of protected areas in a region involves constraints solely for the local human population	D2
	Living in a greener area improves our wellbeing	D3
	Environmental concern is just a trend: there is no point in worrying, we can't change things	D4
	High biodiversity (plants, flowers, insects, mammals…) improves the quality of the environment in which I live	D5
Wildlife	It is a pleasure to see wild animals in their natural habitat	D6
	The presence of some animal species (wolf, bear, boar…) where I live may represent a danger	D7
	A territory should ensure wildlife both optimal living habitats (food, shelter…) and ability to move	D8
	Life is easier for wild animals where human presence is lower	D9
	Human settlements and infrastructure may considerably limit wildlife movement and determine high mortality rates	D10
Ecological connectivity	Ecological connectivity is important to counteract habitat fragmentation and ensure biodiversity preservation	D11
	Ecological connectivity should be included in territorial planning	D12
	Interventions to improve ecological connectivity brings advantages solely for the natural environment, and not for humans	D13
	An ecological network requires the presence of the same type of habitat in the territory, such as woodlands or meadows, without interruptions of continuity	D14
	Not only areas of high naturalness, such as protected areas, but also semi-natural areas, such as farmland, can guarantee proper ecological connectivity	D15

ecological connectivity and networks[5] .

For these two sections, data was collected utilizing a 7-point Likert scale - that is, respondents were asked to give a score to each item on a scale from 1 (maximum disagreement) to 7 (maximum agreement). Most of the items were described in such a way that a score of 7 corresponds to the maximum awareness, while a score of 1 to the minimum. However, for some items, namely D2, D4, D7, and D13, the scores have the opposite meaning, in other words 7 corresponds to the lowest awareness and 1 to the highest. The preliminary analysis conducted with the Winsteps program confirmed that these four items have inverse polarity, i.e. a negative correlation with the measure obtained from the other items. Hence, when analyzing the data, the scores given to those items were re-coded in the opposite direction in order to tune them with the others.

The last section of the questionnaire allowed us to gather data on the sociodemographic characteristics of the sample, namely gender, age, education level, and municipality of residence (inside or outside of the Julian Prealps Natural Park).

The questionnaire was administered via the CASI (Computer Assisted Self Interviewing) method. Citizens of the municipalities in the

[5] www.parcoprealpigiulie.it/it/Principale/Iniziative_e_progetti/Progetti_europei/Greenalps/Greenalps.aspx

study area, as well as academic staff and students of a north-eastern Italian University were invited to participate in the survey. The property of "specific objectivity" of Rasch methods (see the next section) allowed us to use convenience sampling for data collecting. Indeed, this property does not require probabilistic sampling in order to make inference on the items in the questionnaire and to establish the unidimensionality of the latent variable under study (Wright, 1967). Furthermore, this sampling method is reasonable when the objective of the research (aim) is to analyze a still unexplored field (Boyle, 2017). Finally, data collection from students is often able to well represent the point of view of a larger community (Ashraf and Merunka, 2017; Depositario et al., 2009; Mjelde et al., 2016).

3.2. Data analysis

In order to obtain a measure of "environmental awareness", according to the ordinal nature of the variables, for each respondent the Rasch Rating Scale model was applied through use of the Winsteps[6] software. The Rasch models are measurement models that use dichotomous or ordinal data in order to construct a measure of the latent quantity of interest (in this case, environmental awareness). Alternative methods like Principal Components Analysis and Factor Analysis require scale-level (interval or ratio) data. Likert-type rating data often are assumed to be scale-level, but given the availability of methods completely suitable for analyzing ordinal data, we preferred to use them. Alternative methods to Rasch models are Classical Test Theory (CTT) models (Allen and Yen, 2002) and Item Response Theory (IRT) models (Hambleton et al., 1991). It is often asserted that Rasch models are a particular type of IRT model, which could be more flexible having more parameters. But the problem here is not to deal with more flexible functions; instead we need a model based on strong theory of measurement to assess if the questionnaire is well constructed and a unidimensional latent variable exists. These theories are that of "concatenation axiom" for measurement and "specific objectivity", explained in the following. Both CTT and IRT do not satisfy such main properties, as instead Rasch models do. As for "concatenation", the optimal property of Rasch models arises from the fact that the variables satisfy this fundamental measurement axiom. It is easy to show that the weight of two lumps of clay joined into one is equal to the sum of the weights of the individual lumps. Weight is considered as a measurement system based on an empirical combining (concatenating) operation. Such a system allows more than just the comparison between single objects: it is possible to compare x concatenated with y to the object z (Campbell, 1920). Wright (1988) showed that measures derived by Rasch models satisfy this property.

Moreover, Rasch models satisfy "specific objectivity" (Rasch, 1960, 1977; Whitely and Dawis, 1974). This property requires that the comparison between two elements must be independent of whichever individual was instrumental for the comparison, and must also be independent of whatever other element within the considered class was also compared. Symmetrically, a comparison between two individuals must be independent of whatever element within the considered class was instrumental for the comparison, and must also be independent of whichever other individual was also compared, on the same or another occasion (Rasch, 1961). Given the "specific objectivity" property, the measurement process by means of Rasch models is sample independent, i.e. a random sample is not needed to validate the measures of "environmental awareness". In particular, convenience sampling can be used.

Given the optimal theoretical properties of the Rasch models, the main problem in the analysis is to understand how well the data fit the model. Several different Rasch models are available, depending on the nature of the variables. For two ordered categories, the Dichotomous Rasch model is provided (Rasch, 1960), while for higher ordered categories the Rating Scale model (Andrich, 1978) and the Partial Credit model (Masters, 1982) can be used. These models can be summarized as follows:

(1) Dichotomous Rasch model:

$$\ln\left(\frac{P(X_{ij}=1)}{P(X_{ij}=0)}\right)=\alpha_i-\beta_j,\quad X_{ij}\in\{0,1\}$$

where X_{ij} is the response of person I to item j, α_i is the "ability" of the person (level of the latent trait), and $\beta_j$is the difficulty of the item (expressed on the same scale as the latent trait).

(2) Rating Scale model:

$$\ln\left(\frac{P(X_{ij}=k)}{P(X_{ij}=k-1)}\right)=\alpha_i-\beta_j-\tau_k,\quad X_{ij}\in\{0,1,2\cdots K\}$$

where τ_k is a "threshold" that measures the difficulty in reaching category k, identical for every item.

(3) Partial Credit model:

$$\ln\left(\frac{P(X_{ij}=k)}{P(X_{ij}=k-1)}\right)=\alpha_i-\beta_j-\tau_{jk},\quad X_{ij}\in\{0,1,2\cdots K\}$$

where τ_{jk} is a "threshold" that measures the difficulty in reaching category k for the item j.

In the case under study, what can be assumed is that the latent variable "environmental awareness" exists and it can be related to some items, such as those listed in Table 1; giving a high score to these items denotes a high level of the latent variable. In the final stage, all the responses of a person to each item will be summarized by a "measure", and the person with the highest measure is the one deemed to show more of the variables assessed. For the research objectives, the higher measure will be associated to higher environmental awareness. It must also be underlined that the measures obtained with the Rasch models consider that errors can be made during the process and this is therefore taken into account in the calculation of the measure by automatically calculating the standard deviation of these errors. This standard deviation is not usually calculated in traditional measurement methods, and this can create a distortion in the result obtained, especially if the constructed variable is used as the explanatory variable in regression models. Thus, the Rasch models are of fundamental importance as they offset the drawbacks of the traditional methods by providing a way to correct the bias (Battauz et al., 2011).

The first step in applying Rasch models is to understand if the data are compatible with the model and satisfy its assumptions. Primarily, we must look at the correlation coefficient between the items observed and the estimated Rasch measure in order to assess how well the responses to the items are correlated with the results obtained. This initial assessment is generally also very useful for checking if there are any coding errors, and for identifying items with negative or zero correlation. Indeed, this could be an indication that items do not agree with the latent variables, in which case those items must be removed from the analysis or need their coding to be reversed. In addition, when using the Rating Scale model for continuous variables, another step in the analysis is to understand if the categories created assuming a value of 0, 1, 2, 3, etc., have an actual meaning and can therefore be interpreted. This issue will appear immediately once the model has been applied and after obtaining the first observation, as the results will not be in order. The indicator used to understand if the measures obtained are ordered or disordered is the Andrich Threshold (Linacre, 2001): if it turns out to be disordered, the solution is usually to reduce the number of categories.

Two other important problems of fit are possible violation of the local independence hypothesis (Lord and Novick, 1968) and

[6] www.winsteps.com/index.htm.

multidimensionality (Linacre, 2011). Regarding the former, using Winsteps (Linacre, 2011), one of the best-known software applications for Rasch Analysis (Bond and Fox, 2007), we can look at the correlation of standardized residuals: if this is low (< 0.70) we can conclude that the local independence hypothesis is not violated[7] . Regarding the latter, in a dataset fitting the Rasch model we have variability that is due to the model, and residual variability that is due to randomness. The Rasch "Principal Component Analysis (PCA) of residuals" looks for patterns in the part of the data due to randomness. Such a pattern is the "unexpected" part of the data that may be due, among other reasons, to the presence of multiple dimensions in the data (Smith, 2002). In the Rasch PCA of residuals, we are looking for groups of items that share the same patterns of unexpectedness. In particular, the matrix of item correlations based on residuals is decomposed to identify possible "contrasts" (principal components) that may be affecting response patterns. Usually the contrast needs to have the strength (eigenvalue) of at least two items to be above the noise level: if the largest eigenvalue of PCA is around 2 or less then the latent measure under investigation may be considered unidimensional[8] .

Once these issues have been investigated and eventually resolved, we can look at the fit statistics, which are an estimation of the degree to which persons and items respond to our expectations based on the model. These fit statistics will therefore be a summary of all the residuals (the difference between what is observed and what was expected) of each item for each person. In this study, the fit statistic we used is the square mean deviation, which can assume a value between zero and infinity: values above 1 indicate that there is a greater variation than the one expected, while values of less than 1 indicate a lower variation than expected. In general, fit statistics are divided into two categories, one weighted called "infit", and the other unweighted called 'outfit'. Values of around 1 can be deemed to be acceptable (for suggestions regarding good practice interval, see Bond and Fox, 2007). The items and persons that do not fit will be removed from the model to increase the validity of the results obtained.

4. Results

After data cleaning, we retained 444 valid cases. They correspond to 0.74% of residents in the study area (5,155 people) and 1.86% of the university community (21,776 people), which had been invited to participate in the survey. Although the response rate is low, the sample size and specific objectivity property of Rasch models allow these cases to be analyzed.

Preliminary analysis identified 40 people who did not fit the model because they tended to assign random scores. Hence, 404 questionnaires were deemed suitable for data analysis. The characteristics of the sample are summarized in Table 2. The majority of respondents were female, predominantly between 20 and 29 years of age. More than half were graduates. Almost all respondents lived outside the area of the Julian Prealps Natural Park.

Preliminary analysis also identified the items not fitting the model, namely D7 ("The presence of some animal species… may represent a danger") and D14 ("An ecological network requires the presence of the same type of habitat…"). Indeed, in these cases, people tended to assign random scores, so they were removed from the analysis. It can be assumed that, for item D7, this is due to the broad nature of the subject and the ongoing debate regarding human-carnivore coexistence. In addition, its wording ("… may represent") could have led even the most aware person to express his/her agreement. Item D14 requires very specific knowledge: in fact, an ecological network *does not* require the presence of the same type of habitat without interruptions of continuity. The topic of ecological connectivity is still little known to the wider public: this is why we provided information through the Park website and added item D16. Hence, item D14 seems more suitable for measuring environmental knowledge rather than awareness.

Table 2
Characteristics of the sample (N = 404).

Characteristics	Classes	%
Gender	Female	51.2
Age (years)	< 20	4.0
	20-29	45.5
	30-39	11.4
	40-49	13.9
	50-59	19.6
	> 59	5.7
Education	Graduates	58.4
	High school	39.4
Residence	Outside Park area	91.3

The analysis also highlighted that the model thresholds tend to be messy when using the 7 score categories, most likely because this number is too high, and the answers are confusing. They were therefore recoded according to 4 new categories:

1 = 1, maximum disagreement
2, 3, 4 = 2, partial disagreement
5, 6 = 3, partial agreement
7 = 4, maximum agreement

This recoding provides the best results for adapting the data to the model; other recoding alternatives produced worse results in terms of fit (Table 3). In Fig. 2 the curves represent, from left to right, the probabilities of answering 1, 2, 3 or 4 to the items. It shows, for example, that a person with a measure of environmental awareness of -6 (x-axis) has a probability of around 0.9 (y-axis) of responding category 1, while a person with a measure of environmental awareness of -2 has a probability of around 0.7 of responding category 2. The well-ordered thresholds mean that when the measure of environmental awareness grows, so does the probability that a person will give the items a high score, which is logical. The model for the 7 score categories instead showed unordered thresholds.

Once all these operations had been performed, we obtained the results described below.

In Table 4 we can observe that the reliability index of measurements for people is 0.82, while that for items is 0.99. These values are clearly very high. The Cronbach Alfa measure is also quite high, and equals 0.85. The average level of people's measurements is 2.92, meaning that it is relatively easy for people to agree with the items in the questionnaire: the average level of measurements of items is conventionally set at zero. The infit indices for items vary between 0.76 and 1.33, and the outfit indices between 0.66 and 1.36, which are both within the established limits (0.6-1.4) for the good adaptation of a Rating Scale model (Bond and Fox, 2007). From Fig. 3, we may also observe that out of the sample of 404 people, 392 are registered as "non-extreme", while only 12 are "extreme". Extreme scores are the highest and lowest possible scores given by people in response to the items. They include zero and perfect scores. These are represented in the table as "minimum estimate measure" and "maximum estimate measure". Mathematically, they correspond to infinite or indefinite measures on the latent variable and so are not directly estimable. As such, people with extreme scores are dropped for the duration of the measurement estimation process. After the measures of all non-extreme items and persons have been estimated, the extreme scores are then reinstated. Reasonable extreme measures are imputed to them (using a Bayesian approach), so that all persons and items have measures.

As mentioned above, the Rasch PCA of residuals looks for patterns in the part of the data due to randomness. Such a pattern is the "unexpected" part of the data that may be due, among other things (Smith, 2002), to the presence of multiple dimensions in the data. In the Rasch

[7] www.winsteps.com/winman/table23_99.htm.
[8] www.rasch.org/rmt/rmt191h.htm.

Table 3
Summary of category structure.

Observed Category				Observed Sample		Infit MNSQ	Outfit MNSQ	Andrich Threshold	Category Measure
Label	Score	Count	%	Average	Expect				
1	1	27	1	−0.22	−1.52	1.89	1.84	none	−4.21
2	2	542	10	1.02	0.95	1.11	1.14	−3.09	−1.44
3	3	2,120	40	2.15	2.25	0.89	0.77	0.24	1.55
4	4	2,563	49	3.80	3.75	0.98	0.99	2.85	4.00

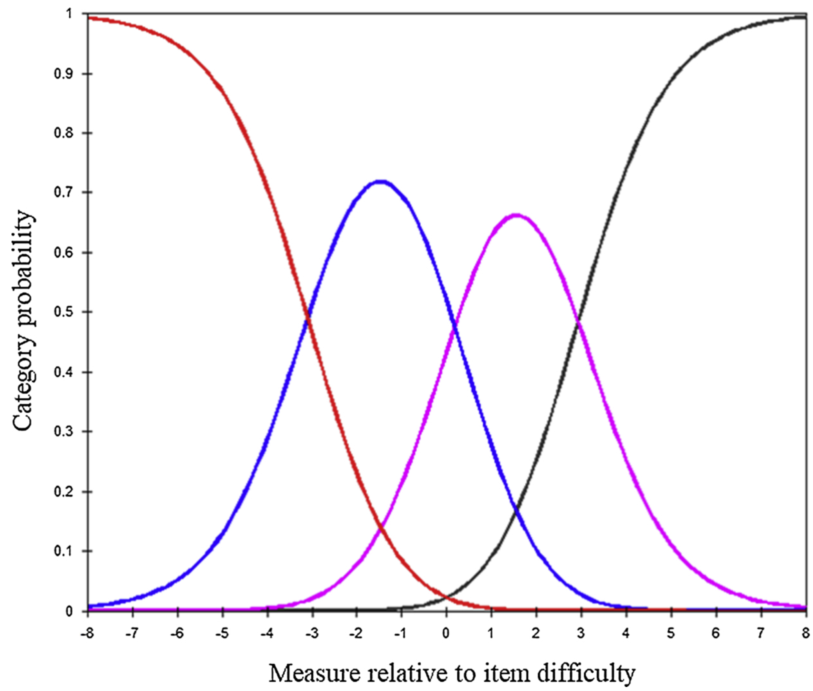

Fig. 2. Andrich thresholds.

Table 4
Main indices of model fitting.

	Total score	Measure	Infit		Outfit	
			MNSQ	ZSTD	MNSQ	ZSTD
392 non-extreme persons (Person reliability 0.82):						
Mean	43.6	2.80	1.02	0.0	0.96	−0.1
Max	51.0	5.61	2.60	3.1	2.55	3.1
Min	20.0	−3.08	0.22	−3.1	0.20	−3.0
404 extreme and non-extreme persons (Person reliability 0.82 - Person correlation 0.97 - Cronbach α 0.85):						
Mean	43.9	2.92				
Max	52.0	6.88				
Min	20.0	−3.08				
13 measured non-extreme items (Item reliability 0.99):						
Mean	1,363.3	0.00	1.01	0.0	0.96	−0.3
Max	1,497.0	1.09	1.33	4.5	1.36	4.8
Min	1,236.0	−1.35	0.76	−3.9	0.66	−3.9

PCA of residuals, we are looking for groups of items sharing the same patterns of unexpectedness. In particular, the matrix of item correlations based on residuals is decomposed to identify possible "contrasts" (principal components) that may be affecting response patterns. Usually the contrast needs to have the strength (eigenvalue) of at least two items to be above the noise level: if the highest eigenvalue of PCA is around 2 or less the latent measure under investigation can be considered unidimensional. In this case, because the highest eigenvalue is 1.68, we may conclude in favor of the uniqueness of the dimension investigated (there are no other dimensions in the data).

Fig. 3 shows the item ranking. The most difficult items on which to express maximum agreement are D15 and D9; this means that persons who give a higher score to these items are those with the higher level of environmental awareness. On the contrary, the items on which it is easier to give the same high score are D3 and D4; this means that persons who gave lower scores to these items are those with the lowest level of environmental awareness. The figure also shows (at the bottom) that the distribution of people's measurements is well shifted to the right of the scale - which is also reflected in the high positive value of the mean (2.92). From the figure, we may observe that a value of "environmental awareness" of 3 implies having assigned 4 (7 before recoding) to the easier items D3 and D4, and having answered 3.5 on average to the more difficult one, D15.

The ranking obtained shows that it is easier to agree with items relating to the environment in general, while it is more difficult to reach a high level of agreement when the issues are more specific, such as those that consider the relationship between wildlife and human elements (farming activities, infrastructure, settlements, etc.). This could be due to a lack of knowledge about the topic concerned.

Analysis of the DIF (Differential Item Functioning), aimed at assessing whether the difficulties of the items show a different level for males and females (Fig. 4), does not show significant differences: even for item D3, for which the DIF seems higher, the t test is within the limits (-2.58, +2.58). The same result was achieved with regard to age classes (Fig. 5). Lastly, no significant DIF was observed for the other two sociodemographic characteristics either.

Lastly, we considered the correlation between the measure

```
-6        -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
1             1    :       2       :       5     :   7    7   15  D15
1             1   :        2       :       5     :   7    7    9  D9
|                                                           |
1            1    :       2       :       5     :   7     7   10  D10
|                                                           |
7           7    :       4       :       2     :   1      1   13  D13
7           7    :       4       :       2     :   1      1    2  D2
|                                                           |
1          1    :       2       :       5     :   7       7   11  D11
|                                                           |
1         1    :       2       :       5     :   7        7    8  D8
1         1    :       2       :       5     :   7        7   12  D12
|                                                           |
|                                                           |
1      1    :       2       :       5     :   7           7    6  D6
1      1    :      2       :      5      :   7            7    5  D5
1     1    :       2       :      5     :   7             7    1  D1
|                                                           |
7  7    :       4       :       2     :   1               1    4  D4
1 1    :       2       :      5     :   7                 7    3  D3
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
-6        -4        -2         0         2         4         6

                                    1121223 322 32 2  3    1 1
               11        1  1 13446 90517369 383 15 0  5    5 2  PERSON
                                  T       S       M       S       T
               0                       10  20 40 60 70 80 90     99  PERCENTILE
```

Fig. 3. Item ranking in relation to the difficulty in answering and expected scores (":" half-point measures).

identified and the sociodemographic characteristics of the sample. With regard to gender, the analysis showed that the level of female environmental awareness is 3.10, therefore above the average (2.92), and that of males is 2.73, therefore below the average. The analysis of variance indicates that this difference is statistically significant (p-value = 0.0115). In regard to age, the level of awareness tends to increase with age: it is above the average among those over 40 years of age. In this case, the analysis of variance shows that this difference is also statistically significant (p-value = 0.0170).

Conversely, there are no statistically significant differences in the level of awareness between people holding different education qualifications (p-value = 0.3943), or between people based on their place of residence (p-value = 0.2717).

We also considered the correlation between the measure identified and the item "The information on ecological connectivity provided on the Julian Prealps Natural Park website is clear" (D16), assuming that the respondents had read this information and that high scores assigned to the item (i.e., information is clear) correspond to a better understanding of the issues described (biodiversity, habitat fragmentation, ecological connectivity and networks). The analysis shows that the level of awareness tends to be higher for those who gave a high score to this item. The analysis of variance indicates that this difference is statistically significant (p-value = 0.000). In other words, the provision of pertinent information seems to positively affect the level of environmental awareness of the respondents.

Overall, although there are no similar studies for a constructive comparison of the results, our research shows that the questionnaire proposed is well suited for measuring the level of "environmental awareness" in relation to the items of interest. The majority of responses fitted the Rasch model well, with the exclusion of D7 and D14, once the score categories had been reduced to 4. The measure obtained is unidimensional and does not show any significant differential item functioning with respect to the main sociodemographic variables considered. The validity of the measure is also confirmed by the fact that the difficulty in ordering the items (D15 and D9 being the hardest, and D3 and D4 the easiest to endorse) was as expected. Moreover, it can be seen that the "environmental awareness" measure is affected by certain sociodemographic characteristics, namely gender and age, as well as by the pertinent information that was provided.

5. Conclusions

The research allowed us to obtain a measure of "environmental awareness", with an emphasis on protected areas, ecological connectivity, and wildlife. The results may be used in the management of protected areas for planning effective information activities aimed at raising environmental awareness and, possibly, for bolstering public participation in biodiversity conservation and sustainable development initiatives. Indeed, we found that people are quite aware of some issues, e.g. that wellbeing is related to greener areas and that they can change things to solve environmental problems. This information can help not only in promoting a responsible utilization of protected areas, for

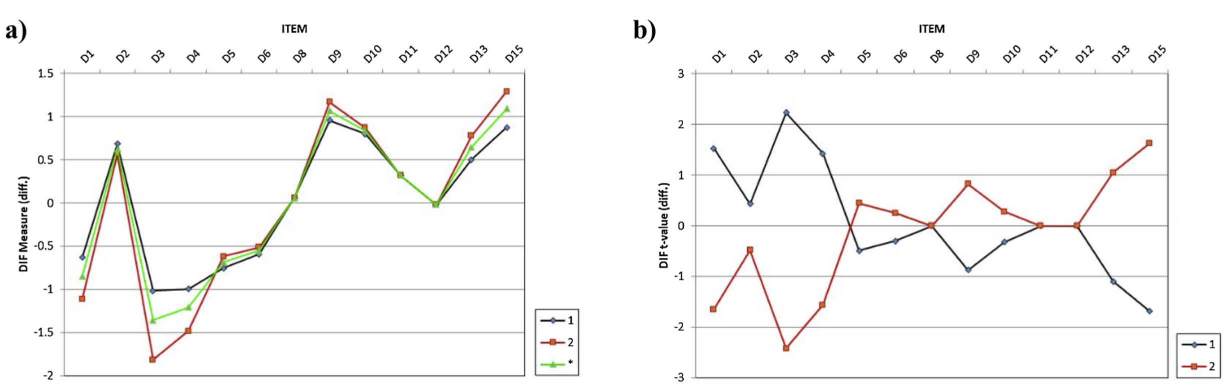

Fig. 4. DIF for gender: measure (a), t-value (b).
Legend: 1 = male; 2 = female; * = average.

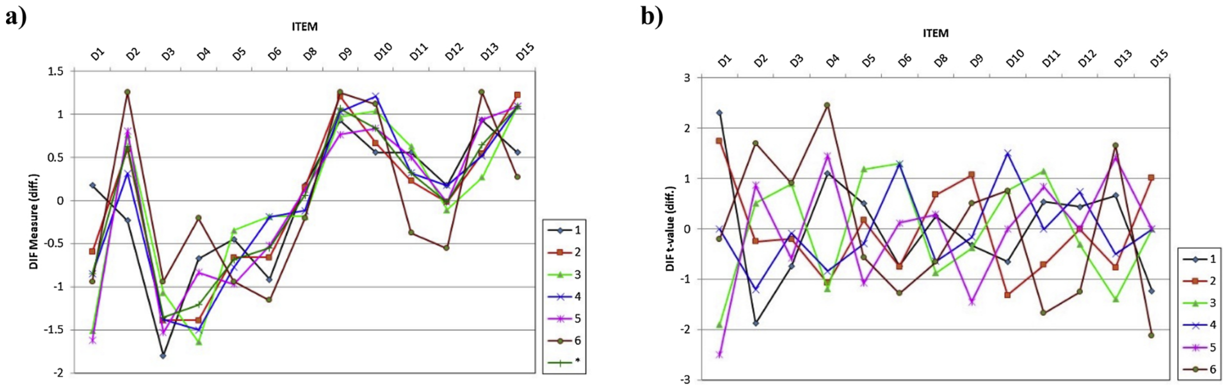

Fig. 5. DIF for Age: measure (a), t-value (b).
Legend: 1 = under 20; 2 = 20-29; 3 = 30-39; 4 = 40-49; 5 = 50-59; 6 = over 59; * = average.

example in terms of tourism, farming, and other relevant economic activities, but also in directly involving people (local communities, youngsters, members of environmental associations, etc.) in initiatives and projects aimed at safeguarding the natural and cultural resources of these areas, for example through maintaining ecological links and wildlife monitoring.

Our research also pointed out that if it is easy to agree with items relating to the environment in general, it is more difficult to reach a high level of agreement when the issues are more specific. This is the case for those concerning the impact of wildlife and ecological connectivity on human activities. As mentioned above, in this case it is useful to provide pertinent information in advance, so as to have a greater chance of success in biodiversity conservation projects, which require a strong involvement of local stakeholders. Indeed, implementing conservation measures (wildlife protection programs, corridors between protected areas, etc.) generates global environmental benefits on the one hand, and potential negative local impacts on the other. The conflict between humans and large carnivores, one of the most pressing and intractable concerns in conservation, is paradigmatic. Not less important are the effects of ecological links on semi-natural areas, such as farmland. Beside the fact that the implementation of conservation measures needs to be planned with adapted tools and legal frameworks, it should also be considered as a process of continuous exchange between communities that are being asked to undertake certain activities (Gouveia et al., 2004). Hence, the involvement of stakeholders from the outset, first and foremost local communities, is important to better predict and mitigate conflict, improve societal acceptance, and optimize conservation and land-use planning (Atwood and Breck, 2012; Bell et al., 2005).

The methodology we propose allows the level of awareness on specific issues to be measured and to plan actions for improving the effectiveness of protected area management. Indeed, the goodness of fit of the data to the Rasch model, in the light of its specific objectivity property, ensures that other studies conducted with this questionnaire would give results similar to those obtained in this paper. The issues we considered are relevant for Alpine areas involved in improving ecological connectivity throughout the Alps. However, environmental issues consistent with other environmental conservation and development programs should be tested in future investigations.

Finally, even if the measurement process by means of Rasch models does not require a random sample to validate the measures of "environmental awareness", alternative and more representative samples in terms of sociodemographic characteristics, size and geographical area, should be investigated to improve the understanding on the research issues. Furthermore, alternative data collection methods should be applied to improve the participation of local stakeholders in the survey. For instance, face-to-face methods could be used, these having proved to be effective not only for data collection, but also for transferring knowledge and strengthening awareness about research issues (Bassi et al., 2014; Batini and Capecchi, 2005).

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