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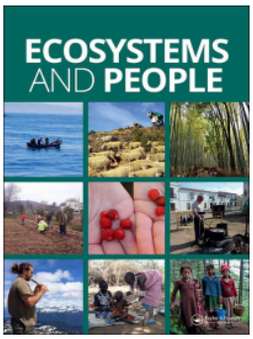

Ecosystems and People

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tbsm22

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To cite this article: Noemi Rota, Claudia Canedoli, Oscar Luigi Azzimonti, Harini Nagendra & Emilio Padoa-Schioppa (2025) Ecosystem services in the Alps: visitors' perceptions of two alpine protected areas, Ecosystems and People, 21:1, 2451274, DOI: 10.1080/26395916.2025.2451274

To link to this article: https://doi.org/10.1080/26395916.2025.2451274

ECOSYSTEMS AND PEOPLE
2025, VOL. 21, NO. 1, 2451274
https://doi.org/10.1080/26395916.2025.2451274

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RESEARCH

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Ecosystem services in the Alps: visitors' perceptions of two alpine protected areas

Noemi Rota [a], Claudia Canedoli [a], Oscar Luigi Azzimonti [b], Harini Nagendra [c] and Emilio Padoa-Schioppa [a]

[a]Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milan, Italy; [b]Department of Sociology and Social Research, University of Milan-Bicocca, Milan, Italy; [c]School of Climate Change and Sustainability, Azim Premji University, Bangalore, Karnataka, India

ABSTRACT

Understanding users' perception of natural areas and their ecosystem services is crucial for managers and policy makers as it directly informs decisions that balance conservation efforts with public acceptance. The alpine areas are particularly vulnerable to climate change, making it critical to understand how visitors perceive these areas to develop management strategies that minimize conflicts, helping to ensure long-term support for environmental protection. This study explores the perceptions of 21 ecosystem services – including cultural, regulating and provisioning services – among visitors of two protected alpine areas in Italy. We distributed 3,399 questionnaires to evaluate visitors' perceptions of the importance of key ecosystem services, their awareness of the ecosystem services concept and any shifts in perception due to COVID-19, as the study took place during an ease of restrictions caused by the pandemic. Additionally, we explored the relationship between perceptions and demographic factors. Results showed that visitor strongly perceived the importance of the aesthetic value of the landscape and biodiversity conservation. Perception of the overall importance of ES was strongly correlated with demographic factors, such as gender, age and a connection to outdoor and naturalistic activities. Visitors who were already aware of the ES concepts exhibited higher perceptions compared to those who did not acknowledge them, suggesting the need for targeted communication strategies to extend the awareness of the ES concept. This data provides critical insights for managers and policymakers to tailor communication efforts, fostering greater public awareness and support for the benefits provided by protected natural areas.

ARTICLE HISTORY
Received 27 September 2023
Accepted 2 January 2025

EDITED BY
Bas Amelung

KEYWORDS
Gran Paradiso National Park; Adamello Regional Park; tourism; mountain areas; conservation

1. Introduction

Ecosystem Services (ES) refer to the benefits ecosystems provide to human well-being (MEA 2005). The provision of these services faces growing challenges due to two main factors: the increasing demand driven by global population growth, and the diminishing supply capacity resulting from habitat fragmentation and the impacts of climate change (Scholes 2016; Brockerhoff et al. 2017). There is an urgent need to reverse the current trend and preserve ES delivery, especially in alpine protected areas, which are fundamental for the provision of many pivotal ES for human well-being (Mori et al. 2017; Canedoli et al. 2020; Rota et al. 2020). These include also cultural ecosystem services (CES), such as landscape aesthetic value, sense of belonging and artistic inspiration (Schirpke et al. 2018; Crouzat et al. 2022). Alpine protected areas attract hundreds of millions of tourists annually (The Guardian The Guardian view on the warming of the Alps: a challenge for tourism 2023), that benefit from the ES provided by the areas while doing various activities, from outdoor activities to relaxation (Rota et al. 2023). These areas are particularly vulnerable to climate change and human activities (Hock et al. 2019), and their degradation threatens the capacity to provide ES. It is crucial to take action to protect these areas and preserve their habitats and biodiversity, to safeguard both ecosystem functions and ES supply.

Understanding how stakeholders perceive the importance of ES, is critical for developing tailored management, communication and conservation strategies. In mountainous regions and green spaces, literature consistently highlights that the recreational and aesthetic value of outdoor spaces are among the most highly regarded ES by visitors (Bieling et al. 2014; Rall et al. 2017; Ament et al. 2017; Schirpke et al. 2022). However, the specific importance placed on these services can vary depending on the characteristics of the study area. This variation can lead to a preference for either recreational or aesthetic value, depending on factors such as the natural features,

CONTACT Claudia Canedoli Claudia.canedoli@unimib.it
Supplemental data for this article can be accessed online at https://doi.org/10.1080/26395916.2025.2451274

accessibility and overall landscape of the region (Schirpke et al. 2021). For example, in areas with particularly scenic landscapes, people may be more likely to perceive and appreciate their aesthetic value, whereas regions with well-developed outdoor activity facilities (e.g. ski resorts, hiking trails) may foster a stronger perception of the relevance of recreational value. Beyond recreation and aesthetics, other CES, such as symbolic significance, opportunities for relaxation in nature and a sense of place, are also frequently mentioned as highly important in studies regarding the perception of ES (Bieling et al. 2014; Hausmann et al. 2016; Schirpke et al. 2022). On the other hand, visitors and tourists tend to place less emphasis on provisioning (e.g. resources like food and water) and regulating (e.g. climate regulation, erosion control) services (Bieling et al. 2014). However, this perception generally just depends on the stakeholder group considered and their prior knowledge of ES concept and priorities (Riechers et al. 2018). For instance, stakeholders from professional backgrounds in environmental fields were found to assign higher importance to these provisioning and regulating services (Haida et al. 2016).

In alpine areas there is an urgent need for an integrated management, considering both nature conservation and social, economic and cultural needs of people (Hummel et al. 2019), since management strategies aimed at safeguarding nature could be difficult to pursue without public acceptance. This is influenced by factors such as familiarity with the place, personal values and sociodemographic features (Jones et al. 2022). The concept of ES is closely linked to beneficiaries (Gamfeldt et al. 2013), regardless of their awareness of the concept, and can be considered as a holistic tool for PAs management (de Groot et al. 2010). Acknowledging ES and recognizing our reliance on a healthy environment can raise environmental awareness, promote public participation in environmental activities, and engage the stakeholders in the decision-making process (Menzel and Teng 2010). This engagement can encourage more ecological behaviours and support of conservation measures (Ainsworth et al. 2020), even when they restrict some activities, such as limiting outdoor sports during the breeding season. This may lead to a more sustainable forest management, motivating stakeholders to actively support conservation programmes, and assisting managers and policymakers in management strategies by anticipating stakeholder responses, in terms of controversy or support (Elwell et al. 2018; O'Connor et al. 2019), ensuring stakeholder compliance. Indeed, the development of community-based management models, in which those affected by management decisions have a stake in the choices, was found to be more effective for natural resource management than a top-down approach (Bodin 2017; Van Bussel et al. 2020). Assessing public perceptions of ES can help identify different user categories and the importance they attach to specific ES. These insight can lead to the development of tailored communication strategies, customized on the interviews' findings, to raise awareness of specific ES, that might be underestimated due to their hidden functions, such as provisioning and regulating services (Dehghani Pour et al. 2023).

On 11 March 2020, the World Health Organisation declared the outbreak of COVID-19 pandemic. This period significantly impacted people's daily lives, mostly due to stringent lockdowns imposed by governments to avoid the spread of the pandemic, including self-isolation regulations, home-schooling, remote work and restricted mobility. These led to limitation to travels and the reduction of outdoor activities like hiking, walking, climbing and similar (Ugolini et al. 2020; Sansone-Pollock et al. 2023). Amidst these changes, certainty about the return to normal business remained elusive. Consequently, attendance in protected areas underwent substantial shifts throughout the pandemic. This deprivation of natural experiences was found to influence individuals' perceptions of nature (Colléony et al. 2022). Urban and peri-urban green spaces resulted pivotal in enhancing both the mental and physical well-being amidst the pandemic (Atalan 2020; Soga et al. 2021; Tansil et al. 2022). Although there are strong evidences on the increased appreciation and visitation of urban green spaces and forests (Ugolini et al. 2020; Larcher et al. 2021; Beckmann-Wübbelt et al. 2021), little information exists on Alpine protected areas and their perception during the pandemic. For major tourist areas the reduced access may have affected the perception of their ecosystem services, similar to urban green spaces.

This study aimed to investigate the perceived importance and benefits of specific ES among diverse stakeholders' categories in two alpine protected areas. The study examines 21 ES, which were identified from a literature review as particularly significant for the Italian Alps and were further explored through interviews with park managers. The study aims to explore whether and how users' profiles influence their perception of ecosystem services, seeking to clarify the underlying relationships. Data collection took place in summer 2021 in the Italian Alps during a temporary relaxation of the COVID-19 restriction. The period followed a series of lockdowns that included the establishment of red zones, where access to green areas was denied.

The study focuses on the following goals:

Determine how diverse stakeholders' categories perceive specific ES provided by two alpine protected areas, focusing on the personal importance of these services to their well-being;

a. Examine the users' awareness and recognition of the concept of ES;
b. Determine the relationships between the perception of ES and users' characteristics

(sociodemographic characteristics, main activities undertaken in the PA);

c. Examine whether and how the appreciation of natural areas changed after the COVID-19 pandemic.

2. Material and methods

2.1. Study areas

The study took place in two alpine protected areas in Northern Italy: the Adamello Regional Park (AD) and the Gran Paradiso National Park (PNGP). These areas were research areas for a broader project on the assessment of ES (Canedoli et al. 2020) and tourism in alpine areas (Rota et al. 2023) of our laboratory. Both PAs share similarities in the environmental features, including elevation range, habitats composition, flora and fauna. However, the areas are regulated under different laws being the PNGP a national park and the AD a regional park, potentially leading to differences in the management strategies. Established in 1922, the PNGP is the first Italian national park, covering 70,000 hectares, and represents a popular destination for mountaineering, mostly for its highest peak, the Gran Paradiso, one of the most famous European mountains (Figure 1). The PNGP is also widely known for its conservation efforts in the preservation of the Alpine Ibex (*Capra ibex)*(von Hardenberg 2021), which avoided its extinction in late XIX century.

The AD was founded in 1983, bridges two important Italian National Parks (the Stelvio National Park and the Adamello-Brenta National Park) and is strategically important for tourism activities and conservation projects. The AD has a higher level of local tourism (Rota et al. 2023), a smaller area (51.000 hectares) and a lower touristic vocation if compared to the PNGP (ISTAT CLASSIFICAZIONE DEI COMUNI IN BASE ALLA DENSITÀ TURISTICA 2023). Nevertheless, AD has a growing trend of outdoor and nature tourism, offering many possibilities for nature sightseeing, cultural attractions (such as petroglyphs) and outdoor recreational activities.

2.2. Questionnaire's structure

A total of 3399 questionnaires (Table S1) were administered, with 2340 at PNGP (Canedoli and Rota 2022a) and 1059 at AD (Canedoli and Rota 2022b). The data collection took place in summer 2021

Figure 1. Map of the study areas: below the contextualisation of Italian borders in Europe, top left the borders of the Grand Paradiso National Park, and top right the borders of the Adamello Regional Park.

(June–July). In compliance with GDPR, informed consent was obtained from all subjects involved in the study, who had access to a description of the study and of its scopes both in the paper and in the online questionnaires. We used a non-probability quota sampling, with pre-defined minimum quotas within each stakeholder category (Table S2). The values of the quotas were defined in semi-structured interviews with the managers of the parks, who thoroughly described the social environment of the parks and advised a minimum number of interviews for each stakeholders' category (Rota et al. 2023). Questionnaires were administered in highly frequented area, such as parking places at the beginning of hiking trails, central squares and information centres. Once we had gathered an adequate number of respondents according to the quotas from the largest stakeholder category (tourists), we engaged directly with local businesses, restaurants, producers and farmers, to ensure stakeholders' minimum quota representation beyond touristic only. Participants could fill the questionnaire on paper or online using the QR code provided on site. The questionnaire was administered by our team of researchers, PhDs and MSc students, who briefly introduced the study, and took around 15 minutes to be filled; 2694 respondents used the paper version. Questionnaires were also published online to remotely collect data from users (Canedoli & Rota, 2021a; Canedoli & Rota, 2021b). The main sections were: (1) perceived importance and personal benefits linked to ES in the PA, (2) sociodemographic data, type of stakeholder's category, frequency, duration of visits at the PA and activities carried out, (3) awareness of the concept of ES and its recognition (4) perception of natural areas after COVID-19 and changes in attendance of PAs. Section two, related to users' profile was analysed in a previous publication about touristic attitudes at the PAs (Rota et al. 2023), and data was used in this study as independent variables in the analyses. The questionnaire's structure included closed-answer questions to categorise users and positive statements about their perception of ES. Each statement asked respondents to value the personal perception of specific ecosystem services within the protected area in terms of importance (e.g. "For me it is important that the park preserve the biodiversity) or perceived benefits (e.g. 'This place gives me the chance to do recreational activities') (Table S1). Respondents were presented with a series of statements, and their level of agreement was measured on a scale ranging from strong agreement to strong disagreement. These were converted for analyses in a Likert scale from 1 to 5 (1: 'strong disagreement', 3: "neither agree nor disagree",5: 'strong agreement'). Additionally, respondents were asked about their awareness of ES in the survey, indicating the acquaintance of the concept without deep scientific knowledge. We proposed users two closed answered questions: a) 'Have you ever heard of Ecosystem Services?' b) 'If yes, have you recognized them in this questionnaire's statements?' The first question referred to the awareness of ES, the second to recognition of ES.

2.3. List of values

Our survey methodology was based on Tessa Toolkit (Peh et al. 2013) Method M1c, tailored for CES perception surveys specifically. We utilized the TESSA classification as baseline for the list of ES. For clarity purposes we reported the TESSA classification categories, our statements and the CICES V.5 classification (Table S3), being the more updated and comprehensive in range of categories. Our main focus was on the evaluation of CES, however, we included statements for the provisioning and regulation categories as these are crucial in the PAs investigated. Based on the prior knowledge of the PAs and interviews with park managers, we selected the main services we encountered in alpine protected areas and the easiest to understand to the general public, obtaining 21 ES (Figure 2). Although biodiversity is not an ES per se, we included it in our questionnaire due to its pivotal role in underpinning ES provision. Hence, we included a statement on the perceived importance of biodiversity conservation, being a primary objective for PAs and crucial for maintaining ecosystem functionality. The inclusion aligns with the ES framework outlined in CICES V.5, where supporting biodiversity conservation is categorized as a regulating service (Table S3, code 2.2.2.3). Additionally, we considered as flora and fauna related services the recreational services such as flora and fauna observation or knowledge. These were considered as CES according to the CICES code 3.1.1.2 and 3.1.2.2. To ensure respondent comprehension, we formulated simple statements aligning with Method M1c, aiming to bridge the gap between technical terminology and common language, thus minimizing potential misunderstandings (Tengberg et al. 2012).

2.4. Data analysis

Analyses were performed using IBM SPSS version 29.0.0 (Verma 2012), and data visualisations were obtained using R Software. Questionnaires containing affirmations on ES perception were converted into a Likert scale. A Pearson Correlation investigated ES perceptions' synergies, and was plotted as correlograms with corrplot package in R (Taiyun and Simko 2021), filtering results according to the p-value ($p < 0.05$). We undertook Chi^2 Tests to evaluate the independency among the categorical values of awareness of ES, recognition of ES, appreciation

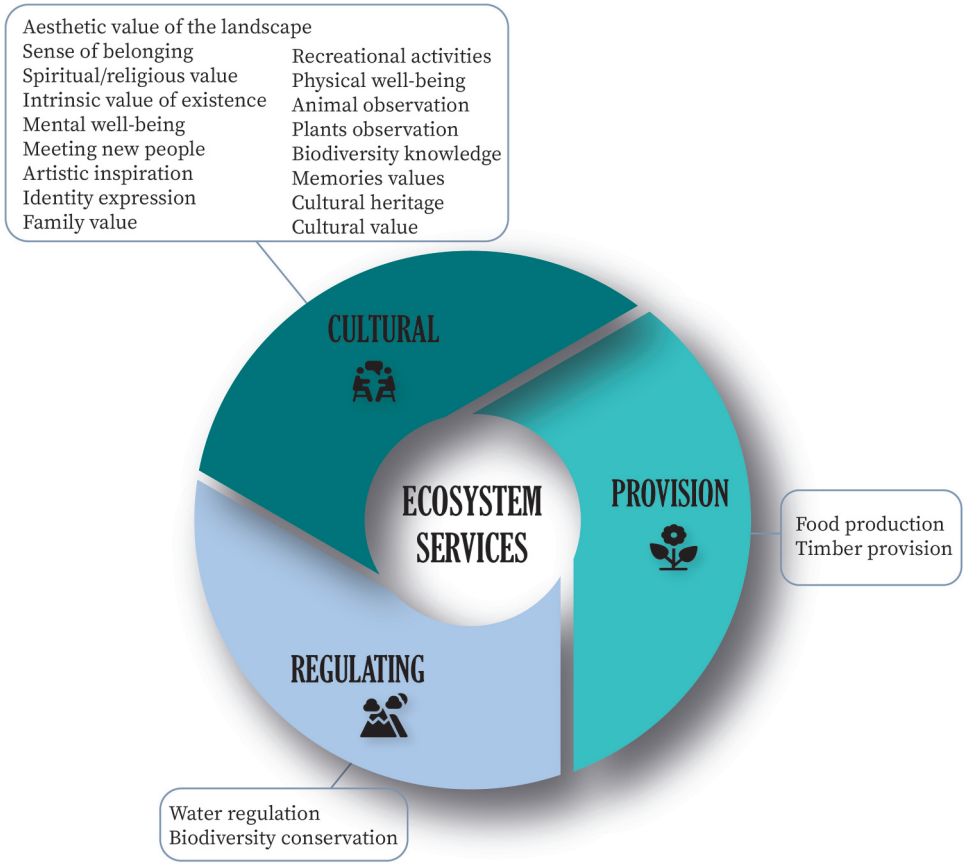

Figure 2. List of ES encompassed in the study using the abbreviated version.

after COVID-19 and PAs. ES were clustered into provision, regulating and cultural categories, and an ANOVA used to identify the relationship between ES perception and respondents' sociodemographic data. Heatmaps of the perception of ES among the diverse stakeholders' categories were created using the package ggplot in R software (Wickham and Wickham 2016). Eventually, we considered the average perception on a continuous scale ranging from 1 to 5, and sociodemographic data were pre-processed being converted into either dummy or categorical numeric variables, depending on the nature of each features, to use these variable to understand the impact of each sociodemographic feature on the dependent variable. A Stepwise Multivariate Regression Analysis aimed to detect significant relationships between the variables related to users' profile. The analysis, conducted separately for each PA, used average ES appreciation as the dependent variable. Independent variables included sociodemographic data, recognition and awareness of ES, and post-covid nature perceptions. ES were further divided into six subcategories – flora and faunarelated, aesthetic related, cultural and spiritual related, leisure and well-being related, regulating and provisioning (Table S3) – to conduct separate analyses to disentangle the effects of profile users on the perception of specific ES categories. Multicollinearity checks utilized SPSS software, examining key indicators such as Variance Inflation Factor (VIF), Eigenvalues and Condition Index to ensure predictor independence, enhancing the analysis's reliability.

3. Results

3.1. Perception of ES and respondent's categories

In both PAs, landscape aesthetic value was the most frequently mentioned (Figure 3). Visitors to AD primarily perceived biodiversity conservation as very important, whereas visitors to PNGP were more focused on observing wildlife. Mental and physical well-being, along with fauna and flora observation and biodiversity conservation, reached similar values in both areas. Provisioning services, such as timber production (e.g. '*For me it is important that the Park produces timber*'), reached the lowest values in both PAs, except for timber provision which varied was among the two areas. CES like spiritual, memories and social value were least considered. The PNGP scored higher than the AD in the importance of biodiversity conservation, recreation, personal well-being and the intrinsic value of existence, whereas higher scores at the AD were related to freshwater

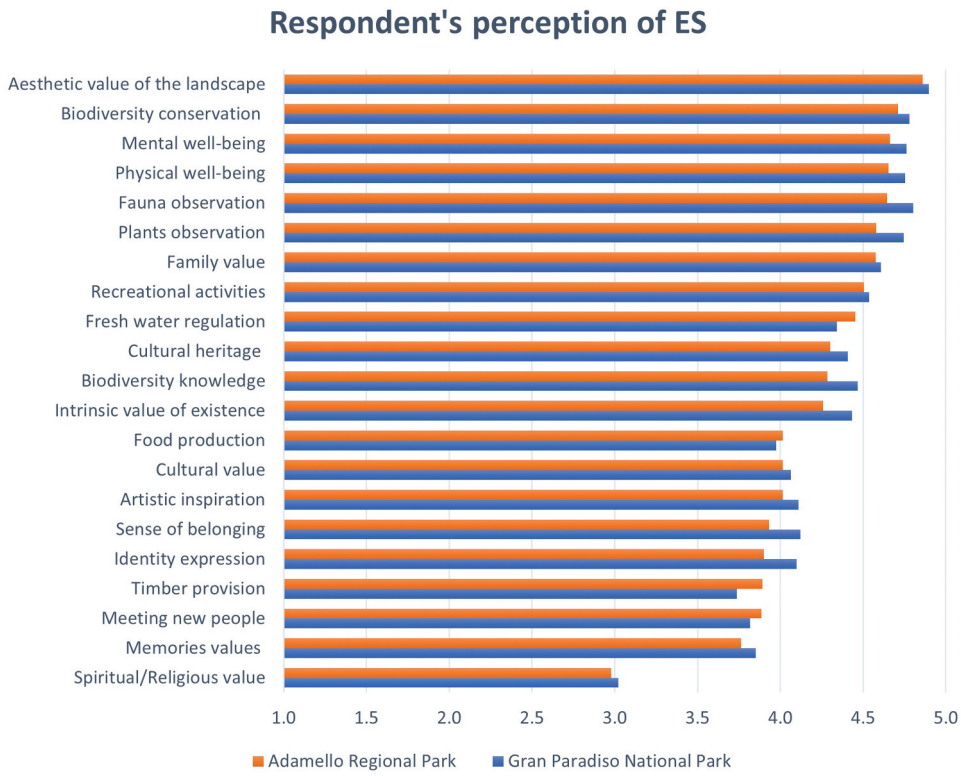

Figure 3. Average value of perception of ES at the Adamello (AD) and Gran Paradiso National Park (PNGP) on a Likert scale (1: strong disagreement, 5: strong agreement).

regulation, food production and timber provision rather than the PNGP.

The Pearson Correlation analysis showed strong positive correlations among most of the ES, showing specific synergies for each PA, and no negative correlations. Positive correlations indicate that as the value of the importance or appreciation of one ecosystem service increases, so does the value of the importance or appreciation of another service. This suggests a relationship, where recognizing the importance of one ecosystem service is associated with recognizing the importance of others; it reflects how people's understanding or appreciation of various ecosystem services is interconnected and tends to rise together. The PNGP (Figure 4) resulted in a strong positive correlation between landscape aesthetic and flora and fauna observations, as well as mental and physical well-being. This correlation was weaker at the AD (Figure 5). In both PAs there was a significant positive correlation between cultural and spiritual ES, being the sense of belonging correlated both with memories and identity services. Provision services – such as timber, food and water supply – also exhibited mutual correlations in both PAs.

3.2. Awareness and recognition of ES

Within the two PAs, we obtained significantly different values ($p < 0.001$) in the overall awareness of ES. Nearly half of the PNGP visitors (43%) reported a strong awareness, while at the AD, only 15% reported to be aware of ES. We examined how the results were distributed among the stakeholders' categories at the PAs (Table S4). People working in the environmental sector (e.g. Naturalistic associations and parks' workers) resulted the most aware of ES at the AD (Figure 6) and the PNGP (Figure 7). Other categories non-directly related to the environmental sector, such as tourism workers and residents in the PA, resulted in over 50% of users having an awareness of ES. Users' already aware of the concept also highly recognised as ES the statement, with approximately 83% of users at the PNGP and 81% at the AD.

3.3. How the perceptions of natural areas changed after COVID-19

In both PAs, there was a very positive response to how the pandemic influenced the perception of the relevance of natural areas (Figure 8), with a strong overall agreement of a new appreciation of natural areas, according to the statement stated in the questionnaire 'Covid-19 pandemic makes me better evaluate the importance of natural protected areas as leisure and wellness places'. Z scores (Fig S1) indicated similar trends of appreciation for both PAs. The Chi^2 Test assessed no statistically significant differences between the areas.

At the AD, almost 50% showed strong agreement in each stakeholder's category (Figure S2),

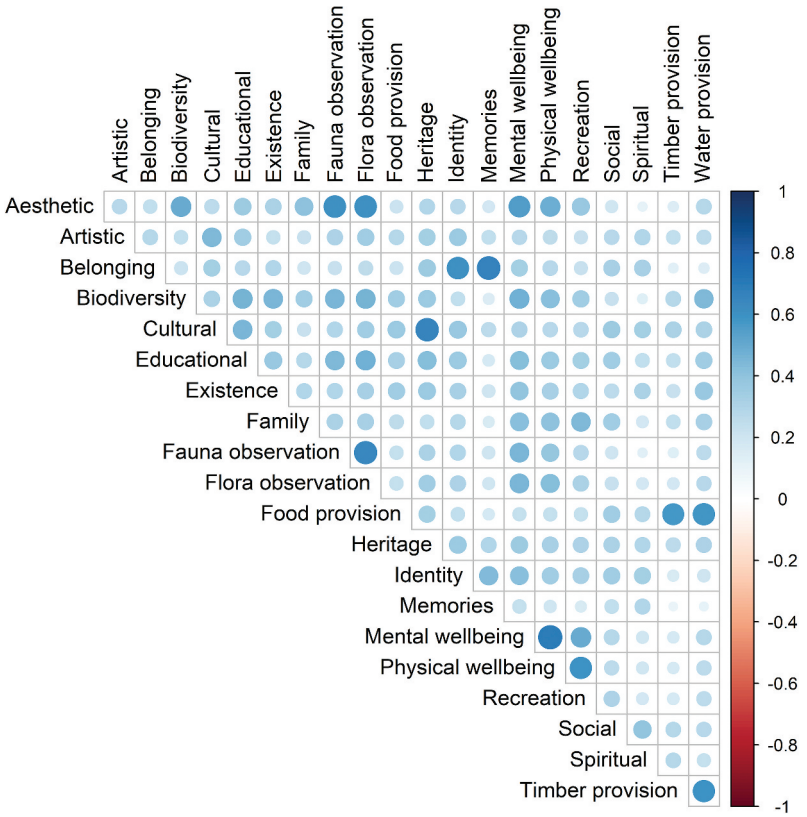

Figure 4. Pearson's Correlation at Gran Paradiso National Park among ES with a significance level of $p \leq 0.05$. Size of the circles represent the strength of the correlation, the gradient represents the type of correlation (positive: blue, negative: red).

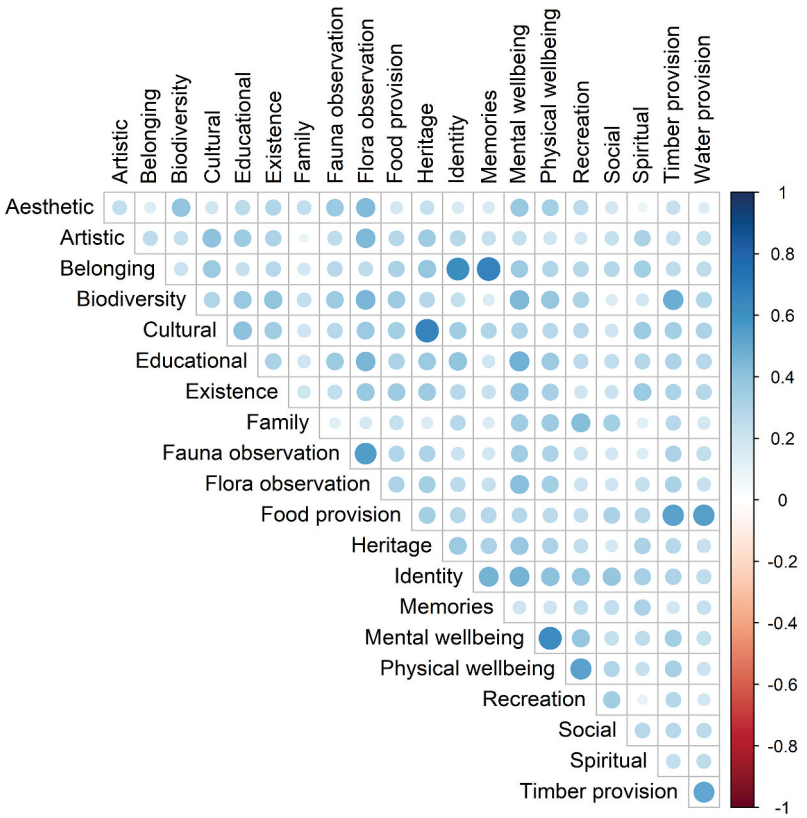

Figure 5. Pearson's Correlation at Adamello Regional Park among ES with a significance level of $p \leq 0.05$. Size of the circles represents the strength of the correlation, the gradient represents the type of correlation (positive: blue, negative: red).

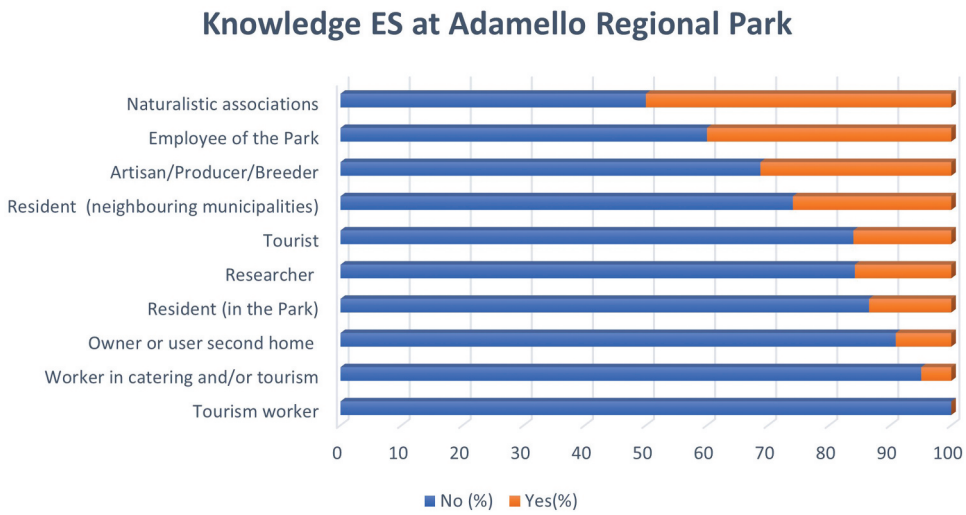

Figure 6. Percentage of stakeholders declaring to be familiar with the concept of ecosystem services at the Adamello Regional Park.

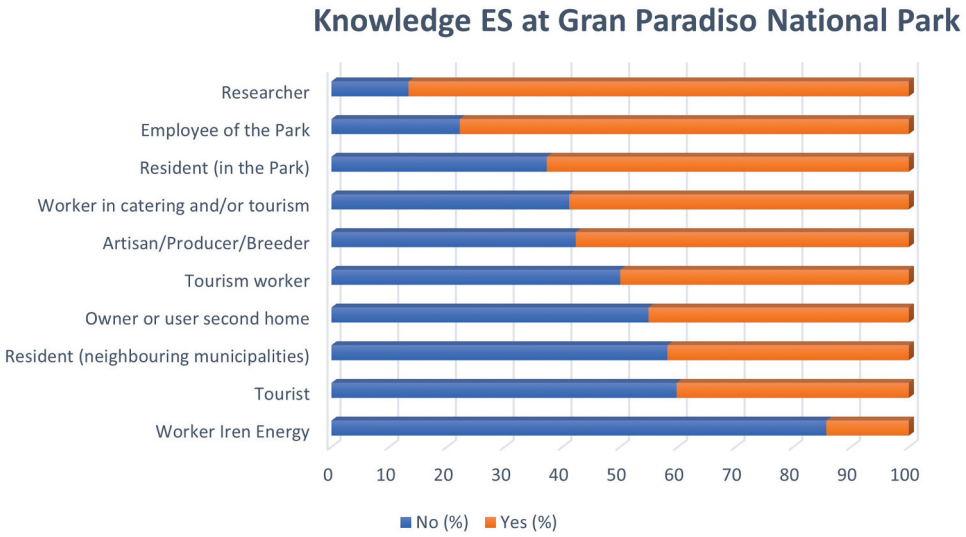

Figure 7. Percentage of stakeholders declaring to be familiar with the concept of ecosystem services at the Gran Paradiso National Park.

and 80% of overall agreement (strong and slight agreement) with a new positive opinion on Parks after the COVID pandemic. Park employees showed a 40% of unchanged perception of the benefits. Residents showed the lowest agreement (48% of strong agreement). The PNGP also lacked a complete agreement of a positive change. IREN Energy workers showed minimal change perception (20% strong agreement, 64% neutral). The strongest disagreement was among workers in the tourism and hospitality sectors (12%).

3.4. Relationships between ES perception and users' profile

Depending on the stakeholders' categories a different perception of ES was found. The heatmaps (Figure 9) showed the average appreciation of ES ranging from 1 (low) to 5 (high), clustering hierarchically the outcomes. There was an overall appreciation in all the stakeholders' categories of mental well-being, physical well-being, flora and fauna observation, biodiversity conservation and recreational values. Some services, such as educational, artistic and cultural services at the AD, were predominantly perceived by naturalistic associations. Similarly, educational and existence values at the PNGP were mostly recognized by researchers, indicating that these services were more marginalized and associated with specific user categories. Also, we identified some stakeholders' categories poorly perceived the ES in general; for instance, IREN energy workers gave the lowest ratings to ES at PNGP, except for physical well-being.

The ANOVA (Table S6) revealed significant differences between the perception of ES among sociodemographic features and the perception of ES clustered into provisioning, regulating and cultural. It resulted that the ES perception varied among all

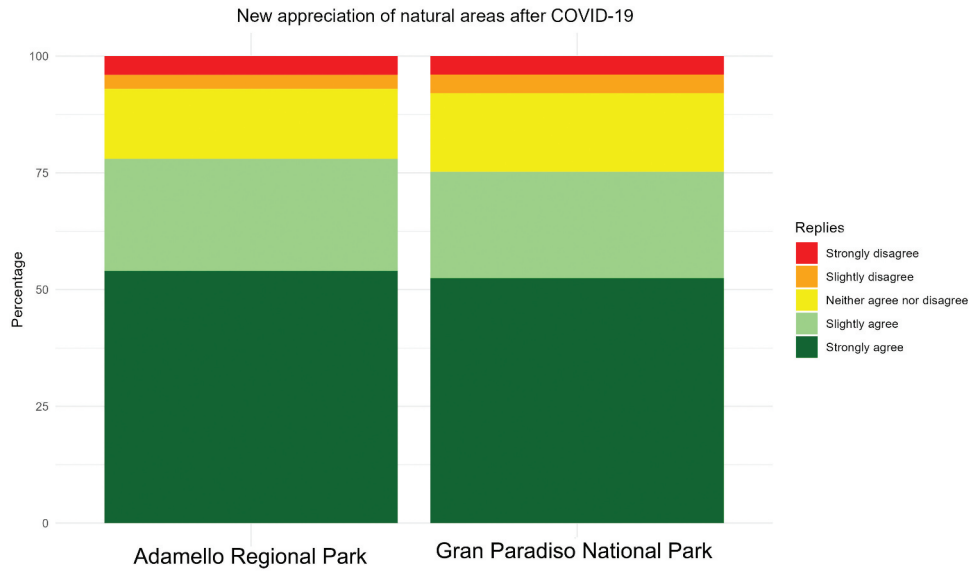

Figure 8. Percentages of changes in the perception of the importance of natural areas after COVID-19 pandemic.

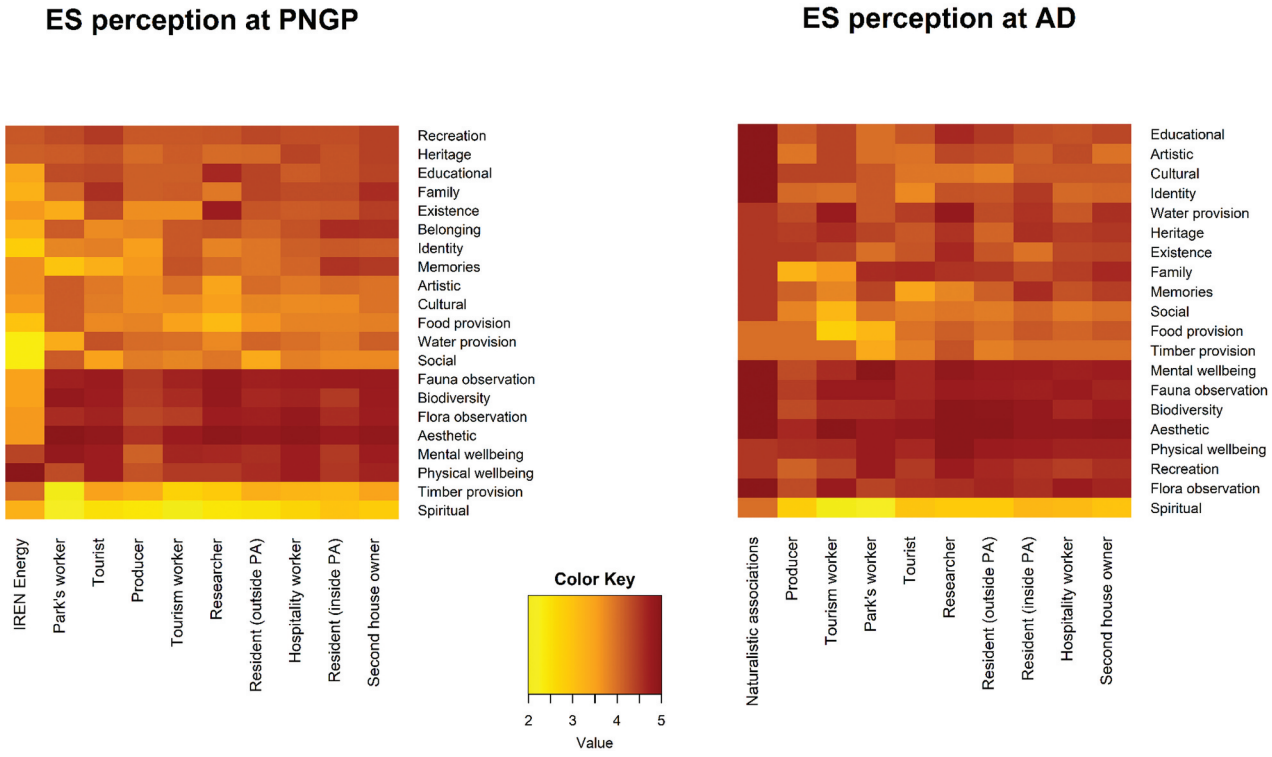

Figure 9. Heatmaps showing the perception of ES from the diverse categories of stakeholders on average, ranging from 1 (low perception) to 5 (high perception).

the different sociodemographic features, in particular for cultural and provisioning services.

At the AD, sociodemographic characteristics like age and gender showed significant differences across all three categories of ES, with female and senior users generally expressing higher overall agreement with positive statements compared to males and younger visitors. The stakeholders' category resulted in significant differences only for the cultural services. Similarly, at the PNGP we found significant variance between users' features sociodemographic features such as age, gender, stakeholders' and activities categories.

The forward stepwise multiple linear regression was undertaken to detect the relationships with the average perception of relevance of ES. The R^2 scores were 0.220 at the AD (Table 1) and 0.221 at PNGP (Table 2) indicating that the 22% of

Table 1. Results of multivariate linear regression analysis using the average ES appreciation as dependent variable at the AD. The codes "Likert_afterCovid" represented the positive appreciation after COVID and "Recognition ES" referred to a positive reply to the recognition of ES in.

Adamello Regional Park

	B	Standard error	Beta	t	Sign.
Constant	3,352	0,074		45,158	0,000
Age	0,072	0,008	0,254	8,839	0,000
Likert after Covid	0,105	0,014	0,208	7,366	0,000
Frequency of visits	0,061	0,014	0,138	4,510	0,000
Gender	−0,109	0,030	−0,103	−3,659	0,000
Sport tourism	−0,192	0,053	−0,100	−3,624	0,000
Duration	0,030	0,011	0,084	2,687	0,007
Researcher	0,256	0,109	0,064	2,342	0,019
Food and sport tourism	−0,234	0,101	−0,063	−2,308	0,021
Nature tourism	−0,222	0,101	−0,060	−2,189	0,029
Recognition ES	0,091	0,042	0,060	2,149	0,032

R^2 score: 0.220.

Table 2. Results of multivariate linear regression analysis using the average ES appreciation as the dependent variable at the PNGP. The codes "Likert_afterCovid" represented the positive appreciation after COVID and "Recognition ES" referred to a positive reply to the recognition of ES in the questionnaire.

Gran Paradiso National Park

	B	Standard error	Beta	t	Sign.
Constant	3,083	0,060		51,073	0,000
Liker after Covid	0,146	0,009	0,307	16,378	0,000
Frequency of visits	0,064	0,009	0,150	6,918	0,000
Age	0,043	0,006	0,147	7,745	0,000
Sport tourism	−0,148	0,029	−0,095	−5,049	0,000
Recognition of ES	0,088	0,020	0,084	4,490	0,000
Duration of stay	0,033	0,007	0,098	4,774	0,000
Nature tourism	−0,199	0,047	−0,079	−4,275	0,000
Gender	−0,068	0,019	0,066	3,542	0,000
IREN energy worker	−0,385	0,124	−0,058	−3,097	0,002
Tourist	0,068	0,022	0,063	3,054	0,002

R^2 score: 0.221.

variance can be explained by our predictor variables. At the AD We found a positive significant relationship between a higher agreement on the importance of ES and senior visitors, recurrent visitors and female gender, whereas negative relationships emerged within categories such as sport and enogastronomic mixed categories of activity. Also, we detected a positive relationship with users that were already familiar with the concept. Moreover, positive relationship was found with users related to higher agreement in a new positive perception of nature after the COVID-19, being one of the important variables at the AD and PNGP. Concerning stakeholder categories, we observed a positive relationship with researchers at AD and with tourists at PNGP, whereas a negative relationship was identified at PNGP for the IREN energy category. A linear regression analysis was conducted using the average perception scores also for each ES subcategory (Table S3). For the PNGP (Table S8), it was evident that post-COVID perception and recognition of ES consistently showed a positive correlation with perception of ES across all categories. In addition, various user-related variables, including the activities undertaken and the stakeholder category, emerged as significant predictors of different models, with effects that varied depending on the ES category considered. For example, individuals employed as IREN energy workers showed a significant association with lower values on the perception of the relevance of regulatory services. The overall R^2 varied between models, generally ranging from 10% to 15%, indicating that the predictor variables collectively accounted for a modest proportion of the variability in ES scores. For AD (Table S7), slightly higher R^2 values were observed, ranging from 8.9% to 20.5%. Again, post-COVID valuation remained significant in all regressions, together with age. In addition, tourism activities and stakeholder categories showed significant associations with positive ES perceptions. For example, being a researcher was positively associated with perceptions of the importance of ES regulation, while being a craftsman/producer/breeder was associated with low values on the agreement on the relevance of leisure and well-being services.

4. Discussion

4.1. Perceived importance of ES and their benefits, and the impact of sociodemographic characteristics

The ES most frequently perceived as important in the PA by users resulted to be the aesthetic value of the landscape, aligning with literature concerning CES mountain areas (Zoderer et al. 2016), probably since the provision of scenic landscape in mountain areas is more perceived in natural landscapes rather than in urban areas (Schirpke et al. 2016), and due to the remoteness of the area (Schirpke et al. 2021). The aesthetic value was perceived even more important than the biodiversity conservation value, which ranked as the second most relevant ES. However, the values of the perception of the importance of biodiversity conservation and flora and fauna observation were remarkably strong. This result aligns with the objectives of the PAs, highlighting that visitors were aware of the purpose of the PAs and the benefits related to its biodiversity during their visits, and highly value these benefits, ranking them as the second most important, even above outdoor and recreational services. This outcome underscores the potential for communication between managers and users concerning the importance of nature conservation and management. Using CES can facilitate the public acceptance of management strategies (Qiu et al. 2013; Peña et al. 2015), even amidst potential conflict between human activities and nature conservation (Ainsworth et al. 2020). We partly confirmed the recreational value of outdoor experiences as one of the most important benefit perceived in the PAs, as already highlighted in literature (Liu et al. 2017; Malchrowicz-Mośko et al. 2019; Schirpke et al. 2021). However other services, such as users' mental and physical well-being, were considered as important benefits most frequently than recreational values (Hausmann et al. 2016). People generally perceive the associated benefits and importance of CES more than regulating and provisioning services (García-Llorente et al. 2020), and the questionnaire confirmed it, especially at the PNGP where the majority of regulating and provision values appeared in the ten least perceived. Cultural values may be easier to perceive and understand by the general public, whereas provision and regulating services might be considered abstract, or even difficult to understand and they provide less direct personal benefit to the respondents, and this could partly explain the outcome. Also, the areas seemed to be mostly perceived as suppliers of recreational activities rather than productive activities, probably because the majority of respondents were tourists. Spiritual value was mostly considered as a subordinate ES, aligning with existing literature (Zoderer et al. 2016); however, no sharp disagreement was detected, probably because some users might perceive spirituality in these areas, as well as because of the presence of sanctuaries on high elevations. Furthermore, we found that there were synergies among all the ES studied, indicating a general consistency in how they were perceived. Some correlations tended to be stronger, such as the cultural and spiritual ES (memories, belonging) or the provisioning ES. This suggests the possibility of developing an improved awareness of the relevance of ES in natural protected areas by targeting specific ES. Such targeting could reduce the effort required for communication strategies, that could be aimed towards synergetic ES.

Since the awareness of ES was significantly different between the PAs, different communication strategies should be employed in these two locations. This study also revealed significant differences between PAs, in terms of the user categories most aware of ES. Visitors related to the environmental sector were the most aware of ES as expected, since we assume that during their working activities they encountered the topic of ES, but depending on the PA, the percentage of aware users changed. At PNGP most of park's workers had already heard about ES, whereas at the AD less than a half of the park's workers did. Without broader public recognition of ES, their integration into policymaking processes would not be achievable (Lewan and Söderqvist 2002), hence it is crucial to broaden the concept of ES and develop campaigns that explain the concept of ES and its advantages to wider audiences. The effectiveness of these communication campaigns could be improved by focusing on the categories of visitors that are not aware of the concept of ES (Beery et al. 2016; Paul and Nagendra 2017). Furthermore, we noticed that both locals and tourists were more aware of ES at the PNGP, comparing to the AD. We assume that the differences between the PAs may be related to events carried out by the Parks and the presence of widespread information points in the area. As already stated, the PNGP is more popular for being the first Italian National park and during time it has developed many dissemination events, in which residents were one of the main targets (Parco Nazionale del Gran Paradi 2023).

We obtained significant differences in the perception of the relevance of ES in the PA, in relation to users' characteristics such as frequency of visits, duration of the stay, sociodemographic features, stakeholder category and activities category, remarking that the appreciation of ES is linked with users' profile (Small et al. 2017; Schirpke et al. 2022). We acknowledge that the perception of the importance of ES and their benefits is a complex topic, and more

variables are needed to provide a complete explanation, however we believe that our analysis has contributed to the understanding of the topic and will help to make informed decisions and target actions to spread the knowledge of ES. We determined that the new appreciation of natural areas after the COVID-pandemic is largely positively related with higher values of overall ES perception, corroborating findings from studies conducted in urban areas. Thus, nature deprivation due to the COVID-19 pandemic may have led people to develop a greater new appreciation of protected areas (Tomasso et al. 2021; Pichlerová et al. 2023).

According to our findings, older users are more aware of the relevance of ES than younger users, confirming previous research in environmental psychology which demonstrates that ecological awareness and behaviour is correlated with age (Otto and Kaiser 2014). Gender was also positively related to ES perception, with women more likely to perceive more ES rather than men, again confirming other findings from literature (Plieninger et al. 2013; Nowak-Olejnik et al. 2020; Schirpke et al. 2022). These aspects are fundamental for managers to understand whom environmental communication should target. For instance we suggest engaging young generations in ES communications, promoting events that are likely to be appealing for young people, via specific communications formats (Corner et al. 2015). Another interesting result concerned the positive appreciation of ES as related to familiarity both with the area and the concept of ES. Users that were recurrent visitors and staying for longer visits could be considered as familiar with the PA (Rota et al. 2023) had a positive opinion on the relevance of ES.

This study was conducted during a temporary relaxation of COVID restrictions and following a long period of home confinement, hence we considered the period as 'unconventional' times. Literature underscores the profound impact of pandemic-induced limitations, and the consequent reduced possibility of people to experience nature that led to nature deprivation, on people's connection with nature (Tomasso et al. 2021; Colléony et al. 2022). We observed that users had an overall increased appreciation of natural areas after pandemic, considering them as places for leisure and well-being. Natural areas were places related to well-being even before the pandemic (Hartig et al. 2014; Frumkin et al. 2017), but as literature highlighted, we found that that after this particular period people felt an enhanced benefit from them (Beckmann-Wübbelt et al. 2021; Zhai and Lange 2021). Throughout the pandemic, natural areas emerged as pivotal for human well-being, a trend consistent in alpine regions, which have received less attention in COVID-related studies compared to urban green spaces. Based on our results, we can hypothesize that people's reactions to confinement were similar to their responses regarding urban green spaces (Larcher et al. 2021; Tansil et al. 2022). The majority of participants reported appreciating natural areas more after the pandemic, but further studies are needed to determine whether this was a temporary effect. Despite the fact that certain ES such as landscape aesthetic and recreational value were already well perceived even before the COVID-19 pandemic (Schirpke et al. 2016, 2021), our results suggested that the pandemic may have played an important role in developing a new or increased perception of the importance of natural areas and possibly the related ES. Contrary to some studies, which reported increased awareness of regulating services during COVID (Park and Chang 2022), we noticed a low level of awareness of their relevance, which is likely related to the touristic purpose of the visits (Rota et al. 2023).

4.2. Policy implications

Through the valuation of how visitors perceive ES provided by a natural protected area, managers could benefit by understanding visitors' preferences (Zhang et al. 2020), having insights of how people perceive the area, and on what to implement for resources allocation and management strategies. It is expected that people that are aware of the relevance and of the value of ES in the area are more likely to support the conservation actions. In addition to aesthetic beauty, most users agreed that flora and fauna related services are more relevant than the other ES, suggesting that biodiversity was considered as a salient feature in both PAs. In contrast, provisioning services, especially timber and food, and regulating services did not draw users' attention, being hidden values and therefore difficult to understand. For this reason, appropriate environmental education should be carried out, focusing on the hidden values that are fundamental to our well-being, such as the provision of food and timber. As shown in the study, these services are perceived synergistically, so we believe that through targeted education strategies their value and perception in the PAs will increase. Educational initiatives need to provide examples of the complexity of ecosystem processes and service provision and how they contribute to our well-being (Dehghani Pour et al. 2023). Since the awareness of ES is known as an efficient tool for supporting decision making (Breure et al. 2012), being useful for encompassing the natural capital into the decision making process (Daily and Matson 2008), and to help stakeholders in the management process (Daily et al. 2009), we stress the necessity of developing a more stratified communication strategy using ES as an educational

tool for raising an awareness towards environmental topics (Beery et al. 2016), above all in smaller areas, aiming to engage specific stakeholders categories. This was evident for the category of IREN Workers, which attend the area mainly for working purposes, and record the lowest levels of awareness of ES at the PNGP. Our study also identified categories of users that may be a more urgent target for communication strategies due to their lower awareness and perception of the relevance of ES, for example male and younger users. It is fundamental to involve these other categories of users. Since ES are easy to understand even for people that do not have a prior knowledge of the topic (Lewan and Söderqvist 2002), we consider them as a tool for developing an awareness of the benefits provided (Beery et al. 2016) and to reinforce the current support to forest protection, improving the engagement in conservation actions (Grêt-Regamey et al. 2012) and limiting possible conflicts.

The concept of ES might have some uncertainties in terms of its understanding by policymakers and non-scientific audience, and being misunderstood could lead in the development of a sense of distrust (Norgaard 2010). For this reason scientists must communicate efficiently to the audience the topic of ES, enabling the comprehension of complex ecological topics (Cartwright et al. 2016), using a facilitated language for non-scientific audiences (Thompson et al. 2016). Due to the many possibilities of using ES as a tool (Mckenzie et al. 2014), we believe that through the development of awareness of the ES, and environmental topics in general, users will develop an improved environmental awareness (Paul and Nagendra 2017) and a pro-active behaviour towards environmental safeguards. Finally, our results gave insights on users' perception after a long period of travel restrictions, which led to an increased positive perception of natural protected areas. This was also found to be a key factor in the higher perception of ES in general. After being deprived of nature, people felt a greater need to spend time outdoors, as indicated by the increased number of visitors to the area, and they perceived the importance of natural areas to be greater. Educational programmes should stress the importance of preserving natural protected areas, also in the light of these results: the drastic changes expected in the Alps as a result of climate change may change the way we experience them.

5. Limitations of the study and future research

Our study is constrained by several key limitations. Firstly, the research was conducted during a unique period linked to the COVID pandemic and immediately following a series of prolonged lockdowns, which may have influenced participants' perceptions of natural areas after extended confinement. A follow-up study could determine whether this improved perception of natural spaces persists or was a temporary effect. Secondly, data collection occurred during the peak summer tourist season, suggesting our findings likely reflect primarily specific tourist perspectives. Future research during different seasons, such as winter when recreational activities predominate, could reveal seasonal variations in the perceived importance of ES. Furthermore, digitalizing questionnaires and collaborating with local facilities could enable a multi-year, continuous study with geolocation data. This approach would allow us to identify correlations between specific areas of the PAs and ES perceptions, as well as detect shifts in ES importance perceptions following significant events, such as natural hazards. Addressing these limitations in future research would help in disentangling how various factors influence perceptions of ecosystem services in protected areas.

6. Conclusions

This study investigated how visitors perceived the personal benefits and the importance of ES in alpine protected areas. We considered sociodemographic data, ES awareness and changes post-covid to understand the perception of the importance of ES in the PAs. We provided insights to policymakers and managers for enhancing ES perception and arising an environmental awareness in visitors. Our findings revealed that the ES perceived as most important were the aesthetic value of landscape, biodiversity conservation and flora and fauna related services. We also noticed that perception was dependent on users' categories, awareness of ES and a new positive perception of natural areas after the COVID-19 pandemic. This could be an incentive for targeting communication activities in the PAs, focusing on new formats and specific categories. Further studies should be carried out to assess whether these changes post-pandemic were temporary or indicative of permanent shifts.

Acknowledgements

We would like to thank all the students involved in the data collection.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Informed consent statement

Informed consent was obtained from all subjects involved in the study, questionnaires were anonymous, and users acknowledged that data would have been used for research purposes.

ORCID

Noemi Rota http://orcid.org/0000-0001-6151-0950
Claudia Canedoli http://orcid.org/0000-0003-3041-3968
Oscar Luigi Azzimonti http://orcid.org/0000-0002-3119-1597
Harini Nagendra http://orcid.org/0000-0002-1585-0724
Emilio Padoa-Schioppa http://orcid.org/0000-0003-2383-5441

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