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Human Dimensions and Visitors' Perspective in Freshwater Crayfish Conservation: The Case of a Protected Area in Italy

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Abstract: Human dimensions in endangered species conservation are often overlooked. However, including human dimensions in conservation projects can help conservationists integrate social and ecological dimensions and investigate individual or society's perspectives toward conservation efforts. The aim of this study was to investigate how visitors of a protected area perceived the conservation of the native white-clawed crayfish (*Austropotamobius pallipes*), a species recently brought to disappearance by the introduction of the spiny-cheek crayfish (*Faxonius limosus*). From August to October 2017, we distributed a questionnaire to park visitors, aiming to: (i) identify behaviors that could affect the conservation of the native crayfish after reintroduction; (ii) investigate if visitors' awareness and knowledge of native freshwater crayfish may increase approval for conservation initiatives. Of the 290 respondents, most (73%) had never heard of alien species. The respondents' inclination to be favorable to resource investment and alien crayfish eradication and to perform specific educational training was significantly related to their knowledge of crayfish features. Knowledge of freshwater crayfish features resulted in being a main determinant in affecting visitors' attitudes towards conservation initiatives. These results confirm that visitors' awareness can increase approval for conservation programs and the importance of investigating the proper human dimensions before establishing management actions for endangered species.

Keywords: crayfish conservation; freshwater; human dimensions; invasive alien species; local communities; protected areas; reintroduction; stakeholders' attitudes; survey; visitors impact



Citation: Mercugliano, E.; Messina, V.; Bonelli, M.; Manenti, R.; Scaccini, D.; Ferrante, L.; Biasetti, P.; de Mori, B. Human Dimensions and Visitors' Perspective in Freshwater Crayfish Conservation: The Case of a Protected Area in Italy. *Diversity* **2023**, *15*, 999. <https://doi.org/10.3390/d15090999>

Academic Editors: Simon Blanchet, Zoran Marinović and Simona Đuretanović

Received: 14 July 2023

Revised: 1 September 2023

Accepted: 5 September 2023

Published: 7 September 2023



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1. Introduction

The conservation of native crayfish is a central topic in freshwater biodiversity management, since these macroinvertebrates are keystone species that hold a vital role in the food web and provide critical ecosystem services [1–3]. Moreover, freshwater crayfish have relevant economic and cultural value [4]. Their management may have important reflections on the preservation of freshwater ecosystems' trophic network, as well as important food resources for humans [5,6]. In Europe, several anthropogenic factors threaten the native freshwater crayfish, such as habitat alteration, overexploitation, and the introduction of invasive crayfish [7–10]. Particularly, the occurrence of invasive North American

freshwater crayfish species is pushing native freshwater crayfish species toward disappearance. These invasive species are not only changing freshwater ecosystems [11,12] but are also carrying the crayfish plague (*Aphanomyces astaci* Schikora) [8,13,14]. This disease is responsible for extensive mass deaths of native crayfish [13]. The first disappearance events of native crayfish populations as a consequence of the crayfish plague were reported in Europe during the mid-19th century [15], with the first mass mortalities occurring in Northern Italy in the 1860s [16–18]. Since then, numerous crayfish plague outbreaks have been reported throughout Europe and are continuing today [19]. The spread of the crayfish plague initially followed the trade of crayfish and the rearing factories established in different regions of Europe [20], confining the remnant native species in the more isolated stretches of hydrographic basins [9]. This is particularly true for the populations of the white-clawed crayfish (*Austropotamobius pallipes* Lereboullet, 1858) of Northern Italy, where several populations became extinct in the last years [6].

Despite these losses, several conservation programs have been funded for the conservation of the white-clawed crayfish in Northern Italy, with both successes (LIFE08 NAT/IT/000352; LIFE00 NAT/IT/7159; LIFE03 NAT/IT/000137; LIFE03 NAT/IT/000147; LIFE10 NAT/IT/000239) and failures (R. Manenti, pers. comm.) [21]. The effectiveness of freshwater crayfish conservation programs has been recently linked to the different value conflicts that can emerge in the conservation management of threatened species [4]. Indeed, conservation projects of freshwater crayfish can involve multiple value dimensions, from the larger environmental protection of endangered freshwater species to local social and economic interests, leading to different conflicts that may affect conservation actions [4]. The involvement of social interests and values in nature conservation projects highlights the need to integrate social science and human dimensions (“Human dimensions of natural resource management”—HDNRM) into the management of natural resources for conservation purposes [22,23]. Social sciences and HDNRM can help conservationists integrate social and ecological dimensions and investigate individual or society’s perspectives, interests, needs, and attitudes [23,24], which are crucial factors for the long-term protection of endangered species [25]. On a local scale, integrating social sciences and HDNRM into conservation projects enables investigating stakeholders’ attitudes toward protected areas [23,26]). Although often neglected, stakeholders’ attitudes may have a strong impact on conservation efforts [27]. The case of freshwater crayfish is in this sense exemplary. Conservation programs concerning freshwater crayfish often involve small, protected areas where native crayfish species are endangered or recently disappeared, and rely on ark sites, such as isolated refuges free from crayfish plague spreading and the human introduction of alien species [28,29]. In these areas, local stakeholders play a central role, and urgent policies are needed to raise awareness and mitigate the impact of human actions. Efforts for freshwater crayfish conservation require interaction with different stakeholders [27] and are expected to provide rapid responses with limited funds. Almost eight million tourists that visit protected areas worldwide every year [30] are key stakeholders in the management of these areas. Their presence can be positively related to biodiversity support [31] and local economies [30], but they can also be a threat to the ecology of natural systems [32]. Visitors of protected areas may include several categories of stakeholders with different perspectives and potentially a strong impact on the conservation initiatives. Indeed, in general, the attitudes of society toward endangered and invasive species and conservation initiatives are shaped by public awareness and knowledge [33].

This study focused on visitors of protected areas and how they perceive freshwater crayfish and their conservation. The chosen site was a small, protected mountain area in Northern Italy (Monte Barro Regional Park) where the white-clawed crayfish went extinct recently [34] prior to establishing a reintroduction program. A survey was administered to visitors of the area with the aim to: (i) describe basic visitors’ features and identify the occurrence of behaviors that could affect the conservation of the white-clawed crayfish after their reintroduction; (ii) verify if visitors’ awareness of native freshwater crayfish may play a role in conservation programs. We tested whether respondents’ abilities to

identify invasive and native species and respondents' frequency in visiting the protected area were related to: (1) the approval of funding initiatives for native crayfish protection actions; (2) a positive inclination toward the eradication of invasive crayfish species; and (3) the approval of the park's investment in education intended for the protection of native freshwater crayfish species.

2. Materials and Methods

2.1. Study Area and Target Species

The study was conducted in Monte Barro Regional Park, located in the Alpine biogeographical region [35] in Northern Italy, Lombardy, Lecco province (UTM WGS84—32T E 529448 N 5075507). Monte Barro is an Alpine Protected Area and a Special Area of Conservation (SAC), defined by the European Commission Habitat Directive (92/43/EEC) as an area designed for the conservation of habitats and species considered to be of “community interest” (i.e., listed in Annex I and Annex II of the Habitats Directive). Moreover, within the SAC, a Special Protection Area (SPA) is also present, granting further protection under the European Union Directive on the Conservation of Wild Birds (2009/147/EC) (Figure 1).

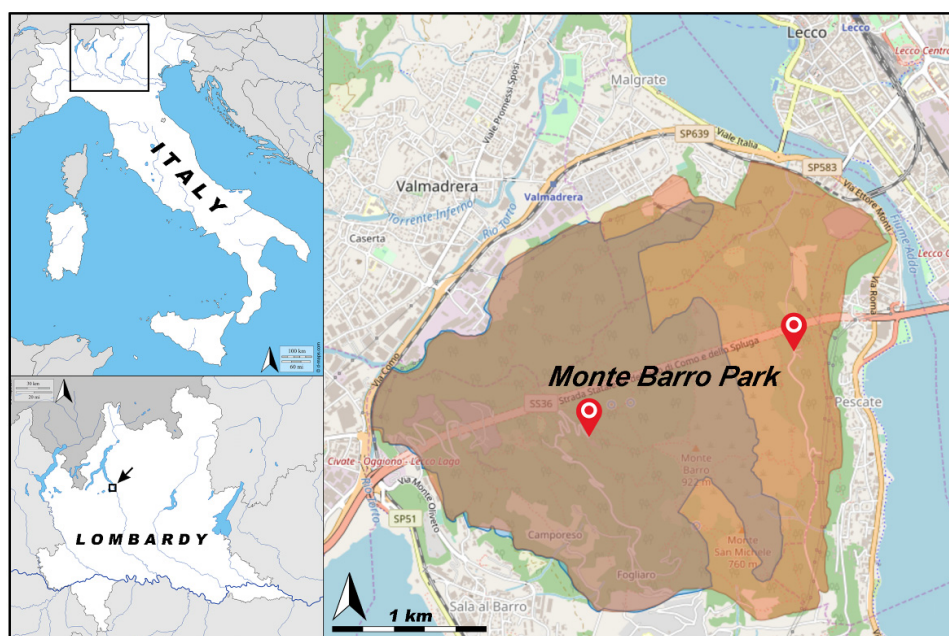


Figure 1. Map of the study area: Monte Barro Park geographical location and boundaries. The entire park (in orange) is a Special Area of Conservation and is under Italian protection as a regional park, while the western area (dark orange) is a Special Protection Area. The two red pins identify the collection points. Lombardy and Italy maps: www.d-maps.com (accessed on 1 May 2023); study area: © OpenStreetMap contributors, www.openstreetmap.org/copyright/en.

The target species is the threatened white-clawed crayfish, which was present in the small creeks of Monte Barro until 2013, when a direct human introduction of the spiny-cheek crayfish *Faxonius limosus* (Rafinesque, 1817) drove the local disappearance of the largest population of the area, possibly due to the spread of the crayfish plague [34]. The introduction was likely performed with individuals from one of the lakes that surround the park area and host alien crayfish species [34]. Immediately after finding the alien spiny-cheek crayfish, all individuals were removed from the area to start a reintroduction action of *A. pallipes* five years later [27].

2.2. Recruiting Visitors

We trained volunteers from the World Wide Fund for Nature section active in the province of Lecco (Associazione WWF Lecco) to recruit park's visitors on a voluntary basis. Surveys

were administered by two volunteers, from 9 a.m. to 5 p.m., for eight days: a weekday and a day of the weekend each month from August to October 2017, plus two additional days during local festivals (FestAmbiente on the 23 July and San Michele Sagra on 1 October 2017). We included weekends and days with park events to engage as many visitors as possible and to intercept a wide variety of people. For the same reason, the volunteers positioned themselves at a busy intersection of paths in each area, asking each potential respondent/visitor of the park over 18 years of age to self-fill a paper version of the survey. The same collection point was settled during weekdays (WD), weekends days (WE), and FestAmbiente (FA); during Sagra San Michele (SM), the volunteers positioned themselves near the festival that was held in an eastern area of the park (Figure 1). In the case of multiple compilers at once, respondents were spaced at least two meters apart to avoid any bias due to the possible copying of answers among subjects. Surveys were anonymous, and no reward was provided. The response rate (i.e., the number of respondents over the total number of people asked to fill in the questionnaire) was not investigated for technical reasons.

2.3. Questionnaire Design

The survey was structured in four different sections (Table 1). The first section investigated visitors' use of the park (Table 1, items 1–6), including behaviors that could compromise the conservation efforts of the indigenous crayfish (Table 1, items 4–6). Based on research on threats to native crayfish species [8,20,36], specific items were created regarding illegal fishing, water contamination with equipment or items possibly infected with the crayfish plague, and the release of animals in the creeks (both alien species and native species not previously present in the creeks that can compromise ecosystem balance). In the case of illegal compromising behavior, the asked question refers to the knowledge of the respondent of this activity made by others, instead of asking about his/her direct involvement in them. Indeed, when science aims to investigate illegal practices of conservation concern, direct questions should be avoided, since respondents' answers are likely to be affected by non-response and social desirability biases, reducing data validity, while indirect questioning methods provide more accurate data on non-compliance [37,38]. The second section was intended to measure the respondent's knowledge of local freshwater species and pro-conservation behaviors towards them (Table 1, items 7–11). The demographic information of respondents (i.e., age, sex, education level, and postal code of residence) was investigated in the third section (Table 1, items 12–15). Finally, the last section assessed respondents' opinions about possible actions and strategies that the park could adopt to promote crayfish conservation (Table 1, items 16–19). To mitigate potential bias in respondents' answers due to the inclusion of crayfish in eight items, crayfish were mentioned alongside other species, and items solely referring to them were placed at the end of the survey when possible.

Table 1. Survey items. Possible answers are shown in brackets.

Survey Section	Survey Item	Theme
1st section	1. What activities have you been doing in the park in the last 12 months? (list of ten options: "hunting", "photography", "bike riding", "fishing", "working activities", "mushroom picking", "jogging", "hiking", "taking the dog for a walk", "other"; multiple responses allowed)	
	2. Have you been fishing outside the park in the last 12 months? (Yes/No)	Visitors' activities
	3. How often have you visited the park in the last 12 months? (list of six options: "every day or almost every day", "3/5 times a week", "1/2 times a week", "2/3 times a month", "once a month or every two months", "less than 6 times")	
	4. Have you ever done activities inside the creeks of Monte Barro Park, using items such as shoes, boots, pails, impermeable clothes, nets, boxes, etc.? (Yes/No)	
	5. In the last 2 years, have you ever heard of people releasing eggs or animals into the creeks of Monte Barro Park? (Yes/No)	Risky behavior
	6. In the last 2 years, have you ever heard of people fishing crayfish in the creeks of Monte Barro Park? (Yes/No)	

Table 1. Cont.

Survey Section	Survey Item	Theme
2nd section	7. Have you ever heard of alien species (species not native to an area)? (Yes/No)	Visitors' knowledge
	8. Which of the following animals live in the creeks of the park? (list of nine options: "crayfish", "crab", "freshwater snail", "toad", "frog", "newt", "trout", "salamander", "goby", plus a free-response question; multiple responses allowed)	
	9. How many legs do the following animals have? - insects - spiders - crayfish (open questions)	
	10. Can you list one or more actions that you can personally do to help the conservation of the species living in the streams of Monte Barro Park? (open question)	
	11. Are there any crayfish species in the lakes and watercourses of the province of Lecco introduced by people and not native to the territory? (list of six options: "no, none", "one", "two", "three", "more than three", "I do not know")	
3rd section	12. Age (open question)	Visitors' demographics
	13. Sex (Male/Female) (optional)	
	14. Postal code of residence (open question)	
	15. Level of education (list of four options: "Secondary school or lower", "High School", "University degree", "post-Master's")	
4th section	16. It is important that Monte Barro Park invests resources to protect the native freshwater crayfish (five options, from "completely disagree" to "completely agree")	Visitors' attitudes towards the park's conservation strategies
	17. To protect the native freshwater crayfish, it is fair to eradicate other crayfish species (five options, from "completely disagree" to "completely agree")	
	18. To protect the native freshwater crayfish, people should change their habits (five options, from "completely disagree" to "completely agree")	
	19. To protect the native freshwater crayfish, Monte Barro Park should invest in education projects (five options, from "completely disagree" to "completely agree")	

To understand if visitors were aware of the occurrence of the crayfish in the park, respondents were given a list of nine animals—crayfish included—plus a free-response question and were asked to note which ones were present inside the park (Table 1, item 8). This question was meant to assess the level of knowledge of respondents about the fauna of the park. Visitors' awareness of wildlife occurrence in protected areas is generally correlated to the awareness of environmental conservation [39]; this information can thus reveal if expanding programs and facilities in the protected areas could be necessary or not. Respondent's familiarity with features of invertebrates was investigated by asking about the number of legs that insects, spiders, and crayfishes have, as a proxy for their knowledge on the topic (Table 1, item 9). Respondents were asked to report actions they can engage in that might help the conservation of freshwater species in the park (Table 1, item 10), and the answers were divided into 12 categories according to the aspects of human impact on the environment they were related to: "Pollution/garbage" for correct garbage and pollutants management; "Protection/respect" for avoiding habitat damage; "To disturb" to avoid direct interaction with animals and the water; "Fishing/hunting" for the abstinence of harming animals; "Collect flower/Damage plants" for the avoidance of damaging plants; "Dissemination/education" for the spreading of correct information; "To modify creeks" for not creating barriers or entering the rivers; "Promotion of the park" for creating events and media advertisement; "To know/to inform" for searching and giving information about the park's species; "To report" for notifying harmful behaviors; "Species" for favoring native species instead of alien species, for example with illegal releases. The category "Other" included responses that did not fit in the previous categories, such as "Vegetarianism". Furthermore, we explored respondents' awareness about the presence of invasive crayfishes in the lakes around the park by asking if they knew any case of human-introduced alien crayfish species in freshwater bodies of the province of Lecco (Table 1, item 11). Finally,

respondents were asked to note the extent of their agreement with a set of hypothetical strategies related to native freshwater crayfish conservation (Table 1, fourth section).

2.4. Statistical Analyses

Linear mixed-effects models (LMMs) were used to test if visitors' awareness of native freshwater crayfish may increase the approval for conservation programs. In the first model, we used the log-transformed score of the level of agreement indicated by the respondents to the statement "It is important that Monte Barro Park invests resources to protect the native freshwater crayfish" (rank 1: "completely disagree", to 5: "completely agree") as a dependent variable. In the second model, we used instead the log-transformed score of the level of agreement to the statement "To protect the native freshwater crayfish, it is fair to eradicate other crayfish species" (rank 1: "completely disagree", to 5: "completely agree"). In all models, we used the binomial variables that indicated if the respondents correctly knew crayfish morphological features (particularly their number of legs) and if the respondents correctly mentioned (or not) alien crayfish as alien species as fixed factors. As covariates, we considered the number of visits that respondents declared to perform to the park, respondents' age, and sex. For each model, respondents' visit occasion (WD, WE, FA, SM) was added to the model as a random factor. We assessed the significance of the fixed variables through Wald tests. The sample size was not homogeneous among random factors; therefore, degrees of freedom were approximated and could be non-integer [40]. Mixed models were built using lme4 and lmerTest in R 3.5.0 (R Development Core Team, 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>).

3. Results

3.1. General Visitors' Features

In total, 290 visitors were interviewed. About one-third of respondents ($n = 89$) filled out the survey at FA, less than one-fifth ($n = 51$) were interviewed both at SM and during WD, and a little more than a third ($n = 99$) were interviewed during WE. Table 2 presents the respondents' characteristics of the total sample. The age of the respondents ranged from 18 to 85 years old, with a mean of 45.0 ± 15.6 years (mean \pm SEM). They were almost equally divided into females (45.2%) and males (50.7%). Most of the respondents visited the park less than six times per year (54.1%), and only some of them visited the park weekly (16.2%). Most of the respondents had a high school degree (50.7%), and about a third had a university degree (30.4%). More than half of the respondents (54.1%) were residents of the park's province (i.e., Lecco), and almost all were from Italy, except for a few foreign respondents (1.7%), who were able to easily read and understand Italian. The great majority of the respondents (78.9%) said they came to the park to hike (77.6%), but several other activities were also reported (i.e., dog-walking, 15.2%; bicycling, 10.7%). Four respondents came to the park to take photos, and three reported to work or to volunteer in the park (these results were extrapolated from multiple-choice items, and respondents could choose more than one option). Few respondents (3.4%) reported that they went fishing outside the park in the last year.

Visitors revealed the occurrence of some human behaviors that could harm the conservation of native crayfish species. Ten respondents indicated that they did perform harmful behaviors, and among them, seven of them reported using various kinds of items in the park's creeks (i.e., boots, waterproof equipment, nets) that could potentially carry the crayfish plague spores. Four of these ten respondents reported that they were frequent visitors to the park (visiting it two to three times a month or more). Another risky behavior studied was the unauthorized introduction of animals—both invasive alien species and native ones—into the park's creeks. Ten people reported that they had heard about animals' stockings in the park's creeks in the last two years. The specimens supposed to be introduced were juvenile fishes, salamander larvae, crayfishes, frog eggs, and tadpoles. Concerning illegal fishing, eleven respondents said they heard about this phenomenon in the last two years.

Table 2. Details of respondents' characteristics.

Variable	Category	N. (%)
Sex	Female	131 (45.2%)
	Male	147 (50.7%)
	Unspecified	12 (4.1%)
Age (years)	18–24	31 (11.3%)
	25–34	41 (14.0%)
	35–44	70 (24.1%)
	45–54	51 (17.7%)
	55–64	48 (16.4%)
	65+	33 (11.1%)
	Unspecified	16 (5.5%)
Province ¹	Lecco (LC; park's province)	157 (54.1%)
	Milan (MI)	35 (12.1%)
	Monza Brianza (MB)	35 (12.1%)
	Como (CO)	12 (4.1%)
	Other	8 (2.6%)
	Abroad	5 (1.7%)
	Unspecified	38 (13.1%)
Level of education	Secondary school or lower	46 (15.9%)
	High school	147 (50.7%)
	University degree	77 (26.6%)
	Post-master's	11 (3.8%)
	Unspecified	9 (3.1%)
Frequency of park visit	Every day or almost every day	10 (3.4%)
	3/5 times per week	15 (5.2%)
	1/2 times per week	22 (7.6%)
	2/3 times per month	38 (13.1%)
	1 time per month or every two months	48 (16.6%)
	Less than 6 times a year	157 (54.1%)
Park's activities ²	Hiking	224 (78.9%)
	Taking the dog for a walk	44 (15.5%)
	Taking photos	34 (12.0%)
	Bike riding	31 (10.9%)
	Jogging	25 (8.8%)
	Hunting	1 (0.4%)
	Working or volunteering	22 (7.7%)
	Collecting mushrooms	6 (2.1%)
	Other	18 (6.3%)
	Unspecified	6 (2.1%)
	Fishers (outside the park)	Yes
No		273 (94.1%)
Unspecified		7 (2.4%)

¹ Respondents were asked for their postal codes. From each postal code, the area of origin was obtained, and then, the different areas were grouped by province. ² For this item, multiple choices were allowed; thus, the total percentage is higher than 100%.

3.2. Respondents' Awareness and Attitudes towards Conservation Strategies

The awareness of the presence of crayfish in the park was found in a minority of respondents (42.1%) that correctly said that the crayfish is present in the park. Regarding familiarity with invertebrates, respondents tended to know the correct answer for spiders ($n = 160$; 55.2%), while only about 40% knew that insects have six legs ($n = 117$), and only 24 people (8.3%) knew the number of legs crayfishes have; only 16 respondents (5.5%) knew how many legs all three invertebrates have.

Most of the respondents ($n = 212$; 73.1%) said they had never heard about alien species. Among those who had heard about alien species, only 47 (16.2%) were able to give a correct example of a species that is non-native to Italy. The more common examples of them were

crayfish species ($n = 19$; 6.6%), squirrels ($n = 16$; 5.5%), and turtles ($n = 8$; 2.8%); respondents also noted invasive plant species, including the tree of heaven *Ailanthus altissima* (Mill.) Swingle ($n = 6$; 2.1%) and black locust *Robinia pseudoacacia* L. ($n = 3$; 1.0%). More than half of the respondents ($n = 150$; 51.7%) said that they did not know about the presence of alien crayfish in the lakes around the park, while some ($n = 30$; 10.3%) reported that there were no invasive alien crayfish in those lakes. Only 20 people (6.9%) gave the correct answer, that two alien crayfish species are present in the freshwater bodies in the park’s province.

Regarding the actions that humans can engage in that may help the conservation of freshwater species in the park, about 40% ($n = 120$) of the respondents reported at least one activity. Only 29.7% of participants were able to report a possible action that promotes the conservation of freshwater species. The total actions mentioned were 154. Five of these actions were not considered in the analysis because they were not comprehensible, and the remaining 149 were grouped into 12 categories (Table 3). The great majority of the actions reported were general ones, such as “do not pollute”, “respect nature”, and “do not disturb the animals” (e.g., categories 1, 2, and 3); some others were not directly related to the freshwater species conservation, such as “do not collect flowers” and “do not light fires” (e.g., categories 5 and 12). Only a few actions were specific and feasible by a visitor, such as “do not fish”, “do not step into the creeks”, “do not build barriers inside the creeks”, and “to report if I see any anomalies or problems” (e.g., categories 4, 7, and 10). Only three actions mentioned the alien species issue or the introduction of new species (category 11).

Table 3. Examples of elicited actions grouped by category.

N.	Category	Sentences	Frequency
1	Pollution/garbage	“Do not pollute”; “Do not throw garbage”; “Collect/reduce plastic”; “Keep clean”; “Do not pollute the aquifers”	53
2	Protection/respect	“To respect the environment”; “Protection and respect for the habitat”; “Do not build new pounds with no following maintenance”; “Do not damage the habitat”; “Do not make a mess, do not influence the ecosystem”; “Do not impoverish the species”	22
3	To disturb	“Let them live in peace”; “Do not scare them or catch them”; “Do not touch dens”	11
4	Fishing/hunting	“Do not fish”; “Do not fish in streams”; “Do not try to kill them”	12
5	Collect flower/damage plants	“Do not pick flowers”; “Do not damage plants”; “Leave the flora intact”	10
6	Dissemination/education	“Fishing education”; “Spread”; “Spread information”; “Spread respect for nature”	7
7	To modify creeks	“Do not destroy the creeks”; “Do not create dams or barriers with stones or woods”; “Cleaning the pounds”; “Do not walk into the creeks”; “Avoid entering into streams”; “Do not enter into the river”; “Do not enter into water with items used in other water bodies to avoid the spread of diseases”; “Do not throw stones in creeks”	10
8	Promotion of the park	“Come back to visit and advertise the place”; “To organize educational events/nature excursions from the hostel”; “Take photos to be sent to newspaper and TV channels”	4
9	To know/to inform	“To learn about streams”; “To inform me about the species and what could damage them”	4
10	To report	“To report if I see people who have incorrect behaviors”; “To report any irregularity during the visit”	3
11	Species	“Do not introduce new or different species that would alienate the balance of pre-existing ones”; “To remove invasive species”; “To protect native species”	3
12	Other	“Breeding species without killing them”; “Vegetarianism”; “Do not use cars in the park”; “Release after fishing”; “To control and sensitize tourists not to pollute”; “Control”; “Volunteering”; “Save animals if they are in difficulties”; “Do not light fires”; “Periodically check the flow of nutrients in the streams to ensure the conservation of the species that live there”	10

The extent of respondents’ agreement with a set of hypothetical strategies related to conservation is reported in Table 4. The respondents reported similar levels of agree-

ment with the items that dealt with the change of habits, opportunities of educational investments, and generic investments of resources in conservation; for the three items, the most common answer was “completely agree”. Instead, concerning eradication, the most common response was “neither agree nor disagree”, and the second-most frequent attitude was to be completely in disagreement with eradication (Table 4).

Table 4. Respondents’ agreement scores for each park’s conservation strategy. Darker colors represent higher values.

Agreement with the Sentences	Completely Disagree	Disagree	Neither Agree nor Disagree	Agree	Completely Agree
It is important that Monte Barro Park invests resources to protect the native freshwater crayfish.	5.90%	2.90%	11.00%	37.50%	41.90%
To protect the native freshwater crayfish, it is right to eradicate other crayfish species.	19.20%	16.60%	36.90%	13.70%	13.70%
To protect the native freshwater crayfish, people should change their habits.	8.40%	4.80%	12.80%	35.20%	38.80%
To protect the native freshwater crayfish, Monte Barro Park should invest in education projects.	7.00%	3.30%	6.60%	28.90%	54.20%

The respondents’ inclination to be favorable toward resource investment, alien crayfish eradication, and performing specific educational training to protect the native crayfish was significantly related to their knowledge of crayfish features (Table 5). People who correctly identified a crayfish’s number of legs were more favorable to these activities than people that were not aware of crayfish features. The level of park frequentation was not related to any of the actions. Moreover, females were significantly more favorable toward funding projects on native crayfish conservation. In general, stakeholders seem to support conservation when they possess awareness and knowledge about alien species and biological invasions [33], while for native species, these factors seem to be less relevant.

Table 5. LMM analysis of the factors determining the respondents’ inclination to be favorable toward actions for the protection of native crayfish species. Effects with significant *p*-values are indicated in bold.

Pattern	Effect	Estimate	NumDF	DenDF	F	<i>p</i> -Value
Funding native crayfish protection actions	Correct alien crayfish mention	+	1	252.79	7.13	<0.01
	Park frequentation	+	1	178.87	1.38	0.24
	Respondents’ sex (female)	+	1	251.07	6.7	0.01
	Respondents’ age	+	1	233.21	0.17	0.67
	Correct identification of crayfish features (number of legs)	+	1	256.67255	3.373	0.06
Eradication of alien crayfish to protect native ones	Correct alien crayfish mention	+	1	252	22.38	<0.0001
	Park frequentation	+	1	252	1.02	0.31
	Stakeholders’ sex (female)		1	252	0.01	0.91
	Stakeholders’ age		1	252	0.75	0.38
	Correct identification of crayfish features (number of legs)	+	1	252	0.52	0.46
Establishment of educational trainings	Correct alien crayfish mention	+	1	256.73255	4.6682	0.023
	Park frequentation	-	1	255	0.01	0.90
	Stakeholders’ sex (female)		1	255	3.26	0.07
	Stakeholders’ age		1	255	0.01	0.92
	Correct identification of crayfish features (number of legs)	-	1	255	1.32	0.25

4. Discussion

Our study was intended to provide a useful case study that integrates HDNRM into conservation programs, investigating how human behavior, attitudes, knowledge, and perceptions can be involved in increasing the effectiveness of conservation projects inside protected areas. In particular, we included human behaviors as a fundamental aspect to investigate before implementing conservation projects, such as reintroduction actions of endangered species or mitigations of existing threats [41,42], taking into account that conservation projects may change the environment in which people live and limit their activities, enhancing the need to develop measures to prevent detrimental conflicts [43]. Moreover, impediments to effective wildlife management in Italy appear to have been less well-studied compared to other countries [44].

Our results show that a good share of visitors moved even from outside the park's province and region to visit the protected area. The considerable distance traveled to reach the area may be due to visitors' willingness to travel to a natural area that provides recreational features, including the ones related to landscape and wildlife [45]. In addition, it seems not due to the presence of festivals, since the number of visitors interviewed were similar to weekends and weekdays.

The central goal of our study was to identify and quantify human behaviors that could harm freshwater conservation species and, in particular, the native crayfish after reintroduction. Therefore, the occurrence of illegal fishing and the stocking of waterways without authorization were investigated. Results of the survey showed that 3.8% of respondents denounced the illegal fishing of crayfish inside the park, and 3.4% denounced unauthorized stocking. Even if these threats seem to be sporadic, they are present in the area and should be monitored in the future. Nevertheless, it is likely that the advantages linked to better knowledge among local people about crayfish presence and conservation threats probably outweigh the risk of illegal fishing. As highlighted by Lipták et al. [33], public awareness is a key factor in shaping a positive attitude toward native fish and crayfish species protection. Increasing people's awareness may reduce the risk of an unconscious introduction of alien species that led to more dangerous consequences for *A. pallipes* than poaching, as already happened in Monte Barro Park in 2013 [33]. The data collected are important since human behaviors may contribute to large-scale—and often unintended—ecological harm [46]. Moreover, risky behaviors are more difficult to analyze properly precisely because of their occasional nature [47].

Furthermore, a few ($n = 10$) respondents claimed to have entered the park's creeks with equipment or items that may be contaminated by other bodies of water. This was a target behavior in our study because the use of equipment (e.g., boots, nets, bins) that has been in contact with water contaminated with alien species can be a vector of crayfish diseases [14,15,48,49], and thus, they should be managed in crayfish conservation strategies.

In order to gain critical information for reducing risky behaviors, Arias [50] suggests answering the following five key questions: who, what, when, where, and why. The use of contaminated equipment was studied considering the characteristics of the respondents who self-reported this behavior. Data allowed us to address Arias' [50] "who" question: eight of the ten respondents who reported having stepped into the park's creeks were residents of the park's province, and six had never heard talk about alien species. Concerning "why", we found that the action of entering the creeks was linked to specific visitors' categories, such as workers, volunteers, and photographers. Even in this case, education programs should be planned to target first these groups, for instance, by planning specific courses to improve their knowledge of wildlife conservation. This is demonstrated by the results of the analyses that evidenced a clear relationship between people's awareness of native species' importance, alien species' detrimental effects, and its inclination toward favoring investment for conservation actions. Moreover, people who correctly mentioned crayfish as alien species were more favorable to their eradication and to funding conservation actions. This result suggests that a better knowledge of the alien species concerns could increase local support for the park's conservation strategies, including the eradication of

alien species. Our findings are in line with results obtained by Lipták et al. [33], which demonstrated that public knowledge about biological invasions positively influences native and invasive species identification and the support for native crayfish conservation initiatives. Furthermore, prior knowledge about conservation can lead to higher support for the management of invasive alien species [33,51].

Public awareness of the species could be helpful in promoting wildlife conservation, but the opportunity to disseminate information about the presence of a species in a given area may be influenced by circumstances [52]. For crayfish, for example, publicizing that the species is present in a creek may favor illegal fishing, and such concern should influence the information given to local people [53]. In the case of Monte Barro Park, our survey provided case-specific information: forty percent of respondents correctly reported that the crayfish were present in the park, but this data should be considered carefully because it could have been distorted by the repeated mention of crayfish along the survey. When trying to figure out how familiar the visitors were with crayfish compared to other invertebrates, it turned out that only a few respondents knew how many legs a crayfish had compared to those who gave the correct answer for spiders and insects. Public knowledge and perception can be different for diverse taxa, such as the more frequent correct identification of fish compared to crayfish species found by Lipták et al. [33]. Lipták and colleagues suggested that this difference can derive from well-established information or the perception of some species in the public. The low familiarity of respondents should be taken into account when planning future activities for the wildlife awareness of people visiting the park in order to provide further information and to engage a larger group of stakeholders.

We also found different levels of knowledge about conservation issues. About 30% of the interviewed people reported that they heard about alien species, but only one respondent out of six was able to give a correct example. Our data described a much lower awareness of alien species among respondents than in previous studies [33,54]. For instance, in a study about the public perception of non-native species in the Netherlands, Verbrugge et al. [54] found that more than half of the sample was able to name a correct example of alien species. On the contrary, the low knowledge detected by us is similar to the one found by Clusa et al. [55] in a study based in Asturias, Spain. Such comparisons suggest heterogeneity in alien species awareness among European countries and regions. In addition, it should be considered that being able to provide an example of alien crayfish does not mean that the person can recognize that species in the wild. This aspect should be considered in conservation projects because difficulties in discriminating native species from invasive ones may lead to dangerous introductions [56] or, on the other hand, unjustified killings [57,58]. It must be noted that even the fire salamander (*Salamandra salamandra* Linnaeus, 1758), which is a very iconic and common amphibian species of the Monte Barro Regional Park, with different populations connected across the different small catchment basins in the area [59,60], has been considered by respondents to be an introduced species. Providing correct and effective information that allows visitors/tourists to discriminate between native and introduced species can become crucial for the management of protected areas [61].

Previous research has suggested that stakeholders' perception of an endangered species conservation importance could be related to their level of experience or local ecological knowledge [25]. However, environmental knowledge should be considered a necessary, but not sufficient, precondition to predict adequate conservation behavior among the public [62]. Moreover, a disconnection between knowledge about the species and effective support for conservation can be found, for example, when people perceive conservation issues as geographically far from them or with no link to their daily activities [63].

Therefore, besides the knowledge, the survey aimed to investigate awareness among visitors about their individual role and concrete involvement in supporting the conservation of the park's freshwater species. When respondents were asked to list actions that they could personally adopt to help the conservation of freshwater species in the park, about 60% of them did not even list an action. This is consistent with the results of a

European report about the attitudes of citizens towards the environment that mentioned that only 39% of Italian respondents believed they can play a role in protecting the environment [64]. Few studies investigated the attitudes of Italians toward pro-environmental behaviors and, to our knowledge, no studies focused on species conservation actions. Punzo et al. [65] found that, even if, in Italy, altruistic and biospheric values were directly linked to pro-environmental behaviors, these actions found a relatively low percentage of application. As for climate change, this could be due to the negative effect of ecoanxiety on self-efficacy, which leads to negative thoughts and the feeling of being helpless toward the current situation. This scenario could prevent some people from adopting sustainable actions, sometimes experiencing eco-paralysis [66]. According to Carducci et al. [67], Italian university students had a positive attitude toward pro-environmental behaviors. However, the adoption of these behaviors was lower than the students' positive attitude toward nature-friendly behaviors. The main obstacle of the adoption of sustainable behaviors was linked to the lack of institutional support, together with the expansive cost of some products. Since the frequency of adoption of some behaviors was related to a higher health risk perception index, a negative attitude toward individual impact could be related to a lower index value. Further studies are needed to better understand these aspects' influence on Italians' perceived self-efficacy in pro-environmental actions for species conservation. Self-confidence is important to influence environmental protection (i.e., [68]), but it is more likely that the explicit reference to positive and negative behaviors that influence the species encourages people to change behaviors and have positive impacts on endangered species and their habitats [69]. In this study, most of the actions mentioned by respondents were generic, e.g., noting the need "to respect nature" or the need to "not pollute". Only a few respondents were able to name specific actions for the conservation of freshwater species, even including the issue related to the presence or introduction of alien species. Likely, the great majority of the park visitors did not know what they should or should not do to favor the conservation of freshwater species.

Limitation of the Study and Future Developments

Some limitations characterize the present study. The focus on risky behaviors without considering visitors' willingness to change them can prevent our capacity to predict the future human impact on the reintroduced populations of crayfish. This could be helpful also in determining if concrete actions in favor of conservation are likely to be taken by different stakeholders in the future. Since conservation actions suggested by stakeholders in the present study can be linked to their direct and personal experience [25], future education activities in Monte Barro Park should try to fill this gap by providing explicit examples of what visitors could do in favor of freshwater species conservation. Education initiatives focused on crayfish species can help to establish them as examples of native and alien species, building a more aware perception in the general public, as suggested by Lipták et al. [33]. In addition, increasing stakeholders' knowledge of endangered species can lead to positive attitudes and higher support for conservation programs (e.g., [70,71]). Our results highlight the strengths of applying the human dimensions in conservation to integrate social and ecological data. This approach allowed us to identify respondents' perspectives, attitudes, and behaviors, and thus, priority actions can be applied to increase visitors' support for white-clawed crayfish reintroduction and conservation. According to our results, the following aspects could be considered as the most important recommendations for future conservation programs: (1) investigate stakeholders' attitudes before starting a conservation project; (2) educate the public and visitors about actions they can adopt and harmful behavior to avoid; (3) explore the motivation behind the adoption of pro-environmental behaviors; (4) investigate stakeholders' support for conservation actions; (5) accurately monitor reintroduction areas with funds dedicated to supervising the adoption of harmful behaviors. These actions should be carried out with the collaboration of parks and local organizations to have a direct link and impact on the territory. Recognizing the human role in conservation implies the involvement of stakeholders as part of the solu-

tion, identifying human priorities while addressing conservation goals. Thus, including the values and ethical demands that stakeholders associate with native species and ecosystems in consultation studies can be a starting point for future participatory approaches. Indeed, shaping the future of protected areas and native species can be more effective with the active and direct involvement of stakeholders as part of participated conservation.

5. Conclusions

The integration of human dimensions in conservation allows conservationists to identify human interests and attitudes toward wildlife, crucial factors for the success of a wildlife management project. This is even more important when endangered species and vulnerable habitats are involved. The disappearance and reintroduction of the native white-clawed crayfish within the Monte Barro Regional Park provided an opportunity for including visitors' perceptions on conservation project management. The lack of public knowledge and awareness of native and alien species and specific actions for conservation underlined the necessity to improve education efforts. Concerning both the features of the respondents and their attitudes toward conservation strategies, our results allowed us to understand that conservation and education efforts had to be encircled at a more local and residential scale than that of the other park visitors. This led to performing an intense dissemination activity directed toward resident people in order to avoid new introductions of alien crayfish prior to reintroducing the native white-clawed crayfish into the park [27]. To enhance the future of crayfish conservation, we encourage institutions and organizations to focus education programs on proposing activities and pro-environmental actions linked to the values and emotions stakeholders associate with the native crayfish to foster their involvement in sustainable behavior adoption, to potentially increase their self-efficacy, and to change habits. Researchers should also investigate stakeholders' willingness to change habits for conservation, their past experiences, and the motivations behind this choice to establish a link between the adopted action and the modification of habits. A further step could be the investigation of the link between pro-nature behaviors and social and cultural aspects that shape individual choices. On a broader scale, comparative studies in Europe about people's knowledge of nature, traditions' role in conservation, useful or useless practices for nature protection, and the impact of population acceptability of conservation actions will provide new insight that can positively impact future conservation program management and success. In both a local and international context, the investigation of the human dimensions gains importance in establishing management actions, recognizing humans as an active part in protecting endangered species.

Author Contributions: Conceptualization, M.B., D.S. and L.F.; methodology, D.S.; formal analysis, R.M.; investigation, M.B.; data curation, M.B.; writing—original draft preparation, D.S. and L.F.; writing—review and editing E.M., V.M., M.B., R.M., D.S., P.B. and B.d.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: At the time when the study was performed, no approval of ethical committees was needed in the country where the study was performed for this type of investigation. Additionally, informed consent was provided by all the participants, and data were collected anonymously and analyzed in an aggregate way.

Informed Consent Statement: All subjects gave their informed consent for inclusion before they participated in the study.

Data Availability Statement: The data presented in this study are available on reasonable request from the corresponding authors.

Acknowledgments: This study is the result of a collaboration between the Department of Comparative Biomedicine and Food Science (University of Padua), Monte Barro Park, and the Associazione WWF Lecco. The Authors are grateful to the Monte Barro Park authority for their support during the research and to the volunteers of the Associazione WWF Lecco for their precious help in the

administration of the survey. Moreover, advice given by Riccardo Da Re (University of Padua, TeSAF Department) was a great help in designing the survey. Finally, the authors are thankful to all the survey respondents and the local community.

Conflicts of Interest: The authors declare no conflict of interest.

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