

LIFE+ LIMNOPIRINEUS: CONSERVATION OF AQUATIC HABITATS AND SPECIES IN HIGH MOUNTAINS OF THE PYRENEES

TECHNICAL REPORT



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AQUATIC HABITATS
AND SPECIES IN HIGH
MOUNTAINS OF THE
PYRENEES**

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COORDINATION

**Empar Carrillo
Josep Maria Ninot
Teresa Buchaca
Marc Ventura**

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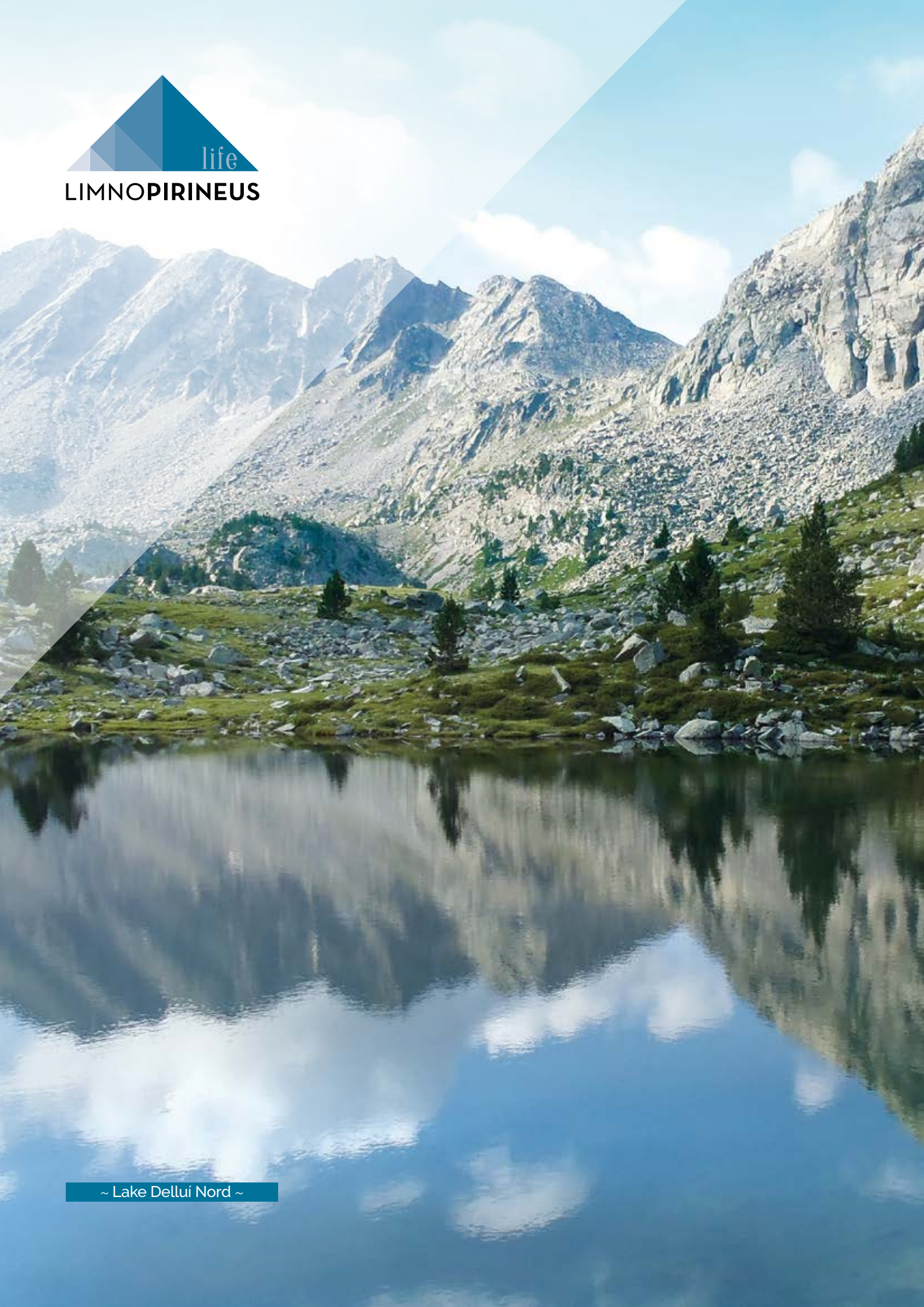


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~ Lake Delluì Nord ~



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EVALUATION OF THE PERCEPTION OF HIGH MOUNTAIN AQUATIC ECOSYSTEMS BY VISITORS AND NEARBY RESIDENTS OF THE NATIONAL PARK

Francesc ROMAGOSA (1), Teresa BUCHACA (2), Alexandre MIRÓ (2) & Marc VENTURA (2)

1. School of Tourism and Hotel Management and Department of Geography, Autonomous University of Barcelona, 08193 Bellaterra, Catalonia, Spain.

2. Integrative Freshwater Ecology group, Centre for Advanced Studies of Blanes (CEAB-CSIC). Accés Cala St. Francesc, 14, 17300, Blanes, Catalonia, Spain.

ABSTRACT

The study analysed the perception that visitors and nearby residents of the Aigüestortes i Estany de Sant Maurici National Park and the Alt Pirineu Natural Park have with respect to high mountain aquatic ecosystems. The study has allowed the identification of the different degrees of social knowledge and evaluation (from the ecological, landscape, and leisure points of view) of the four types of aquatic ecosystems analysed, with the lakes the best known, followed by rivers and streams, while carbonated springs and peat bogs are relatively unknown.

INTRODUCTION

This study is part of the LIFE+ LimnoPirineus project - “Restoration of lentic habitats and aquatic species of community interest” (2014 to 2019). Within the framework of this project, the study considered analysing the relationship between the habitats subject to intervention by the LIFE+ LimnoPirineus project (the high mountain aquatic ecosystems of the Catalan Pyrenees: lakes, rivers and streams, peat bogs and carbonated springs) and the society that lives nearby (the residents of the areas surrounding the project’s study area) or who visit the places where we find these ecosystems (the visitors).

Thus, the main objective of this study when developing it, was the empirical knowledge of the perception of high mountain aquatic ecosystems in the case of the Catalan Pyrenees, both by the population residing within the environment of these ecosystems as well as the visitors who frequent these ecosystems (tourists and hikers). More specifically, the study aimed to know the different perceptions that may exist between the two social groups (visitors and residents), but also between the two main territorial areas under study: firstly, the Aigüestortes i

Estany de Sant Maurici National Park, and secondly, the Alt Pirineu Natural Park.

The research questions raised by the study are the following:

- What type of high mountain aquatic ecosystem is the best known?
- What type of high mountain aquatic ecosystem is the most valued?
- What differences in perception can be identified in relation to the sociodemographic profile of those questioned?
- What is the level of social evaluation of the actions proposed within the framework of the LIFE+ LimnoPirineus project for the restoration of high mountain aquatic habitats?
- What is the level of knowledge regarding the problem of invasive species, especially in high mountain lakes?

CONTEXTUALIZATION

The relationships between aquatic ecosystems and humans are complex. It is widely known that they provide a vast range of services that contribute to the human wealth (for example, water supply and treatment, climate regulation and reduction of flooding risks, source of hydroelectric energy, maintenance of biodiversity, leisure opportunities and nature tourism, scientific knowledge, amongst many other ecosystem services) (Millennium Ecosystem Assessment, 2005; Borja et al., 2012). Regarding those services related with leisure and tourism – within those services named cultural services - recently there has been an increasing emphasis on the importance of the visits in natural areas and therefore, to the aquatic ecosystems, for the human health and welfare (Bowler et al., 2010; Hartig et al., 2014; Kaplan, 1995; Romagosa et al., 2015; Dustin et al., 2018).

However, these ecosystems degrade more rapidly than other ecosystems types. Knight and Cole (1990) already

warned three decades ago that aquatic ecosystems such as lakes and rivers were probably the most threatened since they are both attractive and scarce, and therefore have a higher recreational pressure and suffer harmful uses for the environment. Despite the elapsed time, the situation has not changed substantially. In the case of aquatic ecosystems in Spain, for example, in recent decades a change in the aforementioned ecosystem services has been identified, which has manifested itself in the proliferation of invasive species, an increase in water pollution and the effects of climate change (increased drought, overexploitation of aquifers, etc.) (Borja *et al.*, 2012).

In protected environments, such as those that are part of our study, this degradation is obviously more limited, thanks to conservation and management actions. However, human activity also alters these habitats and causes a number of impacts that their managers have to deal with, many of which result from increased tourist and leisure visits (Newsome *et al.*, 2002; Romagosa, 2008) that ends up affecting the services of cultural ecosystems (Taff *et al.*, 2019).

The aim of this study of social perception is to analyse mountain aquatic ecosystems. Perception is an essential part of how people experience and use ecosystems and the environment in general (Relph, 1976). Perceptual studies on the natural environment are abundant internationally (e.g., Barber *et al.*, 2003; Mayer-Smith and Burgess, 2011; Khew *et al.*, 2014; Weiler and Moyle, 2017; Colley and Craig, 2019). In the case of Spain, for example, studies have been carried out on the perception of the landscape, especially from the perspective of the use of the natural environment as a place of leisure. For example, Schmitz *et al.* (2007) addressed this issue in the province of Madrid, while Atauri *et al.* (2000) did so for the specific case of the Guadarrama mountain range, also in Madrid. Múgica and De Lucio (1996) had previously analysed the landscape preferences of visitors to protected areas as a reference for improving attitudes towards these areas.

In the case of the social perception of high mountain ecosystems, there is no evidence of studies that have specifically analysed this type of habitat in Spain, although some international studies have analysed certain aquatic ecosystems, such as coastal environments, both marine and fluvial, as is the case with a series of studies conducted by Springett-Walker *et al.* (2016) in different parts of Europe and Oceania. The study by Faggi *et al.* (2013), on the other hand, may be one of the few studies that have examined the assessments of «water landscapes» by residents and visitors to a certain place, in this case, the natural areas that have elements of water in the metropolitan area of Buenos Aires (Argentina). More specifically for mountain areas, a recent study by Wlejaczka *et al.* (2018) analysed residents' perceptions of a proposed dam and reservoir in the Indian part of the Himalayas.

In terms of its geographical area (Aigüestortes i Estany de Sant Maurici National Park and Alt Pirineu Natural Park), this study is unprecedented. There have been previous studies on the profile of visitors from both

protected areas focussing on one of the social groups studied in this project, visitors (Farias *et al.*, 2005; Farias, 2011), but neither has compared visitors and residents, and even less has analysed aquatic ecosystems.

METHODOLOGY

The first step in developing the study was to design the survey to be conducted on visitors and residents of the two fields of study. The study's technical team prepared an initial survey proposal based on previous experience in other studies of social perception and the environment. This proposal was outlined and finalised from the contributions of those responsible for management and the technical staff of the two natural areas subject to the study and the LIFE+ LimnoPirineus project technical team.

The survey finally conducted on visitors of the parks and residents of the areas surrounding the parks has as its central axis the perception of these two groups on the high mountain aquatic ecosystems and, more specifically, on the problem of fish proliferation in the lakes. In this sense, the first part of the survey asks visitors and residents of the area for their assessment of the level of knowledge and evaluation of these ecosystems, as well as the conservation actions proposed by the LIFE+ LimnoPirineus project. In order to facilitate the answer to the questions referring to these aspects, a Likert scale from 1 to 5, from less to greater importance, was used.

Those responsible for management and the technical staff of both protected areas worked together to establish and agree the protocol for conducting the field survey, with the aim of ensuring a correct selection of the sample as well as the maximum representation of the sample group, which is the set of visitors for the two protected areas, as well as the resident population in these environments. Regarding the location of the sampling points for conducting the survey, several points were chosen for each park where it would be relatively easy to access visitors. As for the residents, the surveys were conducted mostly in the towns themselves (Espot and Boí, in the case of the National Park, Àreu, Alins, Tavascan, Lladorre, Ribera de Cardós and Llavorsí, in the case of the Natural Park).

The method for conducting the field survey was the random approach to potential respondents by the interviewer, who briefly explained the objectives of the study and asked them to answer the questionnaire, ensuring confidentiality and anonymity in the answers. The answers were, for the most part, numerical in nature, so they could be subsequently processed with the SPSS statistical analysis program (version 21). In this sense, the statistical analyses carried out consisted, essentially, in the calculation of: 1) the percentages of the sociodemographic profile of the respondents and of the different numerical answers to the questions included in the survey; 2) the mean values of the subjective evaluations of different aspects included in the survey; and 3) the correlations

(Spearman's rho) between the sociodemographic profile of the respondents and the subjective assessments of different aspects included in the survey.

The survey was conducted in two batches (summer 2016 and Easter 2017), reaching a total of 519 people surveyed, distributed as follows:

- Aigüestortes i Estany de Sant Maurici National Park: 318 questionnaires (258 visitors and 61 residents).
- Alt Pirineu Nature Park: 201 questionnaires (150 visitors and 50 residents).

RESULTS

The results of the first part of the survey showed the high subjective evaluation that visitors and residents have of high mountain aquatic ecosystems. Specifically, the water spaces, together with the high mountain landscape, were the best valued element or characteristic of the park, above forests and meadows, wildlife, cultural heritage, or other elements. This evaluation was slightly higher in the case of the National Park than that of the Natural Park (Table 1).

The survey asked visitors and residents about the level of subjective knowledge they had about the different types of high mountain aquatic ecosystems: a) lakes; b) rivers and streams; c) peat bogs, and d) natural sources/springs. The results show different levels of knowledge of the four types of aquatic ecosystems analysed, with the lakes the best known, rivers and streams in second place, significantly above the carbonated springs and peat bogs (the latter turned out to be the least known by all respondent groups). Residents showed a higher level of knowledge compared to visitors for all four ecosystems, both in the National Park and the Natural Park (Table 2).

In addition to the level of knowledge of the high mountain aquatic ecosystems, the survey also asked visitors and residents about their overall evaluation of each of the four types of ecosystem analysed. It was specified that the value given from the ecological, landscape and leisure points of view was understood as a general evaluation. Visitors to both parks rated the four types of aquatic ecosystem with almost the highest score (average rating of 4.9 out of 5), while residents also gave them almost the highest score, although slightly lower than that of the visitors (average rating of 4.7) (Table 3).

The survey included an issue that explicitly referred to the LIFE+ LimnoPirineus project, with the aim of knowing the evaluation of visitors and residents for the conservation activities of the high mountain aquatic ecosystems proposed within the framework of this European project. The average assessment of the LIFE+ LimnoPirineus project actions by the total respondents was 4.7 on a scale of 1 to 5. In general terms, visitors tended to value project actions more positively (4.8) than residents (4.4). A slightly better evaluation of the actions was also observed by the respondents at the Aigüestortes National Park compared to the respondents in the Alt Pirineu Natural Park, although the differences were not

significant (Table 4). The only significant difference, from the point of view of the sociodemographic profile of respondents, was that older residents tended to value the conservation actions proposed by the project less positively (Table 5).

The second part of the survey allowed more depth, with further detail in aspects more directly related to the specific problem of the proliferation of fish in high mountain lakes. Specifically, the survey asked about the knowledge of the different types of animal species that respondents believed could be found in high mountain lakes, giving frogs, insects, crustaceans, fish, newts and a final category entitled "others" as possible options. The purpose of including this question in the survey was, in addition to making it easier for respondents to recognise the existence of high biodiversity in high mountain lakes, to identify the importance of the perception of the association of fish in the lakes. In this sense, the results showed that this association exists, since the fish were precisely the most mentioned group among the possible answers provided. Specifically, nine out of ten respondents (visitors and residents almost alike) took for granted that fish are types of species that can naturally be expected to find high mountain lakes. The other answers given, after fish, were insects and frogs, and at a much lower rate, the newt, others and crustaceans. In all cases, although the differences between visitors and residents are not significant, the visitors mentioned a greater number of species compared to residents (Table 6).

The following question was, in fact, in three parts, given that by viewing the lake at Closell before (2013) and after (2015) the actions carried out within the framework of the LIFE+ LimnoPirineus project, which consisted of previously eliminating fish introduced by human action (mainly minnow) that had led to high eutrophication and turbidity of the water, respondents were asked (without any details about the images) in which of the two situations they believed that: a) the lake was in a more optimal condition; b) greater species diversity could be expected; and c) one might expect to find fish.

The answers showed that the main perception was that the lake with the clearest and most transparent water is mostly associated with the one with the most optimal condition (85.5%), which has the greatest diversity of species (73.9%), and where one could expect to find fish (85.5%). It must be said that of the three perceptions mentioned, the last one is the one furthest from reality, since this image is precisely of the lake without fish.

Finally, the survey asked visitors and residents of the territory about the knowledge of the problem of invasive species in high mountain lakes, and specifically about the case of minnow. A vast difference of perception between residents and visitors became evident here. While more than half of the residents stated that they knew or had heard of the problem (34% and 28.3%, respectively), the visitors mostly did not know it (82.3%) (Figure 1).

CONCLUSIONS

In conclusion, the study showed how there is a fairly wide perception among visitors and residents of high mountain lakes as biodiverse ecosystems, where the presence of fish is a specific attribute of these, without knowledge of, to a large extent, the problem of invasive species, particularly fish.

Likewise, the study has highlighted the importance of the need to document and disseminate the characteristics, values, status and problems of high mountain aquatic ecosystems.

The study has contributed to provide knowledge from a more social perspective of an essentially ecological matter, such as that addressed by the LIFE+ LimnoPirineus project, in line with the call from the scientific community advocating the growing need to incorporate social sciences in the analysis and management of ecosystems

in general or of aquatic ecosystems in particular and the challenges they currently face, especially from the perspective of ecosystem services.

Finally, the study has also allowed social dissemination of the project objectives, through the two batches of surveys, which have reached more than 500 people, between visitors and residents of the field of study, enhancing the connection between society and ecosystem conservation and management.

Elements or characteristics of the park	Aigüestortes NP		Alt Pirineu NP	
	Visitors	Residents	Visitors	Residents
Forests	4.9	4.8	4.9	4.6
Meadows	4.7	4.7	4.6	4.1
Water spaces	5.0	5.0	4.9	4.7
Wildlife	4.8	4.6	4.8	4.3
Livestock	4.6	4.4	4.6	4.4
High mountain landscape	5.0	5.0	4.9	4.8
Cultural heritage	4.8	4.7	4.7	4.2
Clean air and environment	5.0	4.8	4.9	4.8
Peace and tranquility	4.9	4.7	4.8	4.6
Park equipment and services	4.5	3.6	4.0	3.3
Activities organised by the park	3.8	3.8	3.5	3.2

▲ **Table 1.** Subjective importance of the elements or characteristics of the park (average score, scale 1-5)

Type of aquatic ecosystem	Aigüestortes NP		Alt Pirineu NP	
	Visitors	Residents	Visitors	Residents
Lakes	2.7	3.9	2.8	3.7
Rivers and streams	2.0	3.5	2.6	3.7
Peat bogs	1.5	2.9	1.9	2.6
FNatural sources/springs	1.8	3.1	2.1	3.1

▲ **Table 2.** Level of subjective knowledge of the different types of high mountain aquatic ecosystems (average score, scale 1-5)

Type of aquatic ecosystem	Aigüestortes NP		Alt Pirineu NP	
	Visitors	Residents	Visitors	Residents
Lakes	4.9	4.7	4.9	4.7
Rivers and streams	4.9	4.7	4.9	4.7
Peat bogs	4.9	4.7	4.8	4.6
Natural sources/springs	4.9	4.7	4.8	4.7

▲ **Table 3.** General evaluation (ecological, landscape and leisure value) of the different types of high mountain aquatic ecosystems (average score, scale 1-5)

Aigüestortes NP		Alt Pirineu NP	
Visitors	Residents	Visitors	Residents
4.8	4.5	4.7	4.3

▲ **Table 4.** Average evaluation of the LIFE+ LimnoPirineus project conservation actions (scale 1-5)

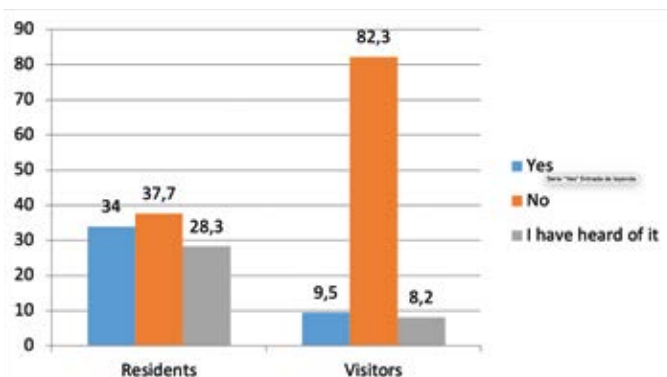
Age		Level of education		Gender	
Visitors	Residents	Visitors	Residents	Visitors	Residents
-0.10	-0.28*	0.10	0.02	0.05	-0.06

* The correlation is significant at level 0.01 (bilateral).

▲ **Table 5.** Correlations between the level of agreement regarding the LIFE+ LimnoPirineus project conservation actions and the sociodemographic profile of the respondents

	Visitors	Residents
Fish	89.1	88.7
Insects	84.4	79.2
Frogs	70.7	62.3
Newts	29.9	28.3
Others	29.9	26.4
Crustaceans	12.9	7.5

▲ **Table 6.** Level of knowledge regarding the species present in high mountain lakes (percentages)



◀ **Figure 1.** Level of knowledge regarding the problem of invasive species in high mountain lakes (percentages)

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