Social perceptions of the impacts and benefits of invasive alien species: implications for management

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Abstract

Research on biological invasions has traditionally focused on the ecological component of invasive alien species, either without considering or by considering in a restringing way, the knowledge of the social component. Understanding the human dimension of invasions is critical to effectively tackling the problems associated with invasive species. We used questionnaires to evaluate the social perceptions and attitudes of different stakeholder groups affected by invasive alien species in the Doñana social-ecological system (SW Spain). Characteristics of respondents regarding their knowledge and attitudes toward biological invasions were categorized using hierarchical cluster and principal component analyses; while their potential support of eradication programs was assessed with a contingent valuation approach. Five stakeholder groups were recognized, differing in their degree of knowledge, perceptions, attitudes and willingness to pay for eradication. The fact that different stakeholders have remarkably different attitudes and perceptions about the impacts and benefits caused by alien invasive species should be considered in any decision-making process regarding their management, particularly for developing appropriate educational and informative programs. Public consultation with different stakeholders should also be encouraged from the beginning to avoid potential misunderstandings and to facilitate the implementation of management practices.

Keywords

Attitudes; Contingent valuation; Doñana social-ecological system; Eradication; Exotic species; Stakeholder analysis

1. Introduction

Biological invasions are closely linked to historical and current human activities. However, a massive biotic homogenization of the Earth‘s surface is taking place as a result of the breakdown of the major biotic barriers that have historically kept the flora and fauna of the various continents quite separate (Crosby, 1988; Mooney et al., 2005). Currently, invasive alien species (IAS) are considered one of the most important causes of biodiversity loss and one of the major drivers of global change (Sala et al., 2000). The risk of introduction of IAS is being reinforced worldwide due to the development of new and fast transport systems that enhance increasing trade and tourist activities throughout the world (Perrings et al., 2005; Meyerson and Mooney, 2007). Once established, some exotic species have the ability to displace or replace native plant and animal species, disrupt nutrient and fire cycles, cause changes in ecosystems, lower biodiversity, and impact economic enterprises such as agriculture, forestry, fisheries, power production, and international trade (Lovell and Stone, 2005). In spite of this, some exotic species also have economic uses (Kendle and Rose, 2000). For instance, the world food supply is supported by nearly 20 species of plants, most of which are cultivated far from their place of origin (Mooney et al., 2005). In general, for every case of invasion some sector of society makes a profit (Baskin, 2002).

In this context, IAS must not only be characterized by their ecological impacts, but also by their social dimension (Zavaleta et al., 2001). Humans are involved in the entire process of invasion through functioning as vectors of introductions (accidental or intentional), suffering the consequences, and having the capacity to act and make decisions for managing them. In this sense, invasive species are a socioeconomic problem; one that requires solutions from economics and sociology (Perrings et al., 2000, 2002). On one hand, the economic dimension of invasions began to be studied a decade ago (Perrings et al., 2000; Pimentel, 2002), but most research has focused on the quantification of direct economic costs of IAS, ex-post assessments and have methodological shortcomings compared to their theoretical basis (Born et al., 2005). Although the economics of IAS are still not well understood or documented, estimations indicate that the costs are quite high, in the range of millions to billions of dollars per year (Pimentel et al., 2005). This situation is creating a paradox for policymakers who aim to simultaneously encourage trade while minimizing the costs of invasive species (Lovell and

Stone, 2005; Keller and Lodge, 2007). On the other hand, relatively little attention has been focused on public attitudes toward IAS, probably because of the difficulty in measuring the social impacts it causes, and because of the conflicts between different stakeholders. However, in recent years, there has been an increasing effort to study public attitudes toward concrete eradication and control options (Fraser, 2006; Bremner and Park, 2007; Fischer and van der Wal, 2007), different ways to perform IAS risk analysis (Simberloff, 2003; Keller and Lodge, 2007), and control management plans (Simberloff, 2005; Hulme, 2006). Other studies have emphasized the necessity of involving different sectors of modern society in the management of IAS (McNeely, 2001). Despite this, there are still many gaps to be resolved in our knowledge of prevention, control, eradication, and management of IAS. In this sense, a better understanding of human knowledge, perception and attitudes toward IAS arises as an urgent problem that needs to be addressed as soon as possible.

In the face of global change, a better integration of research findings regarding biological invasions from the ecological and socioeconomic disciplines is needed for an improved understanding of the complexity of the problems associated with IAS. The economics of IAS help policy makers in designing management practices and could engage the public though the information available about financial cost (Meyerson and Mooney, 2007). However, public attitudes toward IAS could engage the public through their participation and could help the decision-making process.

The aim of our study is to assess the perception of different stakeholders affected by IAS and to evaluate the implications for public support of management practices. In particular, we focused on the differences between stakeholder perceptions about the impacts and benefits generated by IAS and their management. To achieve these goals we: (1) identified and characterized the different stakeholders positively or negatively involved with IAS, (2) evaluated their knowledge and perception of the problems associated with IAS, and (3) analyzed their attitudes toward IAS management, including their willingness to pay (WTP) for IAS eradication. This paper contributes in a significant way by taking an interdisciplinary approach to tackling the problem of IAS while considering economic, social and ecological dimensions to find the trade-offs involved

in the management of IAS. As far as we know, this is the first study that characterizes stakeholders based on social perceptions toward IAS.

2. Materials and methods

2.1. Study area

The study was performed in Doñana, one of the most emblematic wetlands in the Mediterranean Basin, which is located on the southwestern coast of Spain. In this paper, we consider Doñana as a social-ecological system (SES) (in the sense of Folke et al., 2003). Its ecological limits are referred to as the Greater Fluvial-Littoral Ecosystem of Doñana (2 207 km^2), which is composed of four different ecodistricts: marshes, aeolian sheets, coastal systems and an estuary (Montes et al., 1998) (Fig. 1).

Currently, Doñana is characterized by its conservation policies and management measures but also by its tourism, urbanization projects, and the expansion of agriculture. In this sense, although more than the 40% of Doñana is protected by the Natural Protected Area (NPA) -i.e., National and Natural Parks- and its population is no greater than 174 000 inhabitants, Doñana is suffering from important impacts of IAS, and therefore management is essential for the conservation of this valuable natural area (García-Novo and Marin, 2005).

2.2. Sampling strategy and questionnaire design

We obtained 472 questionnaires with three different sampling methods: (1) 366 direct face-to-face interviews developed at 19 sample points in the Doñana SES such as visitor centers of the NPA, urban zones, recreational areas, beaches, and agricultural fields (Fig. 1), (2) 55 indirect interviews conducted with managers in the Department of Environment of the Andalusian Government in Seville, where the questioner was present but we did not formulate the questions, and finally (3) 51 no-presence questionnaires that were sent out by mail to different researchers in Spain who knew about the problem of IAS in Doñana. This sampling methodology had certain limitations because the information would have been more homogeneous if we had conducted all the questionnaires using one unique method, but because of the difficulty of conducting direct face-to-face interviews with researchers in different locations throughout Spain, we developed their questionnaires by email.

The questionnaire was given to people older than 18 years of age between June 2006 - September 2007. Validation of the final data collection was checked against previous studies that focused on visitors (Gómez-Limón et al., 2003), and users of the Doñana SES (Martín-López et al., 2007).

Questionnaires consisted of five sections of questions about: (1) user activities in the Doñana SES, (2) knowledge and perception of the impacts of IAS, (3) user attitudes toward the introduction of IAS and management, including a question about their WTP for eradicating these species, (4) their general environmental behavior, and (5) socio-demographic information (see Appendix A).

The sample population was randomly selected because we were trying to question different users who may be affected by the introduction of IAS either positively or negatively. The sample population consisted of: users of services provided by the four ecodistricts (marshes, aeolian sheets, coastal systems and the estuary), tourists (beach, religious, nature and birdwatchers) and conservationists (managers and researchers).

2.3. Selection of target species

In total, respondents valuated the impact of 15 IAS (Table 1) of the nearly 200 exotic species recorded in the Doñana SES. To select the species, we considered ecological, social and management factors.

The ecological factors were represented by: (1) IAS competition with native species, (2) predation toward native species, (3) hybridization between IAS and native species, (4) impact on ecosystems structure and function caused by IAS, and (5) particular endangered species threatened by IAS, according to the National and Autonomic Catalogues of Threatened Species (Royal Decree 439/1990 and Law 8/2003, respectively) and the Red Lists of species at different scales: (1) International (Smith and Darwall, 2006), (2) National (Pleguezuelos et al., 2002; Bañares et al., 2004; Madroño et al., 2004) and (3) Autonomic (Blanca et al., 2002).

The social factors were related to socioeconomic uses of the species and their role in disease transmission.

Finally, we included management factors at a global scale, for example if the species had been recognized as threatening according to the "100 of the world's worst invasive alien species" list (Lowe et al., 2004), and at the local scale, i.e., if the Department of Environment of the Andalusian Government or the Doñana National Park had developed eradication, control, research or educational programs for IAS.

2.4. Data analysis

2.4.1. Identification and characterization of stakeholders

First, to classify stakeholder relationships with IAS, we used a hierarchical cluster analysis, using the Euclidean distance and Ward's method. Second, to characterize stakeholders, we used principal component analysis (PCA). For both characterizations, the explanatory variables were related to stakeholder knowledge, perception and attitudes toward the impacts of IAS, general environmental behavior, and socioeconomic variables. The variables used to identify and characterize stakeholders are presented in Table 2.

To analyze the differences among stakeholders regarding their knowledge and their attitudes toward the introduction of IAS, we carried out an analysis of variance (ANOVA).

2.4.2. Willingness to pay for IAS eradication

The contingent valuation (CV) method uses questions to elicit respondent preferences by finding the maximum amount that the respondent would be willing to pay for improvements in the quality and/or quantity contingent upon the creation of a hypothetical market (Mitchell and Carson, 1989). In this study, we used CV to identify stakeholder WTP for eradicating the selected IAS (Table 1). At this stage of the questionnaire, we showed a picture of the IAS to give more information to the respondents.

We used an open-ended elicitation format (see Appendix A). Many researchers prefer the closed-ended format because open-ended questions are more difficult to answer and the question format is not incentive compatible (Carson et al., 2000). However, by using open-ended questions we obtained a more realistic and direct measure of the maximum WTP without anchoring bias.

A common problem in the analysis of open-ended CV-bids (Mitchell and Carson, 1989) is that there are a large number of responses with zero WTP. One way to deal with this is to use a Heckman model (Heckit), wherein 'pay or not' is estimated first and the positive WTP is then estimated (Greene, 2000; Sigelman and Zeng, 1999).

Following Sigelman and Zeng (1999), the Heckit model is a response to sample selection bias, which arises when data are available only for cases in which a variable reflecting 'pay', *z**, exceeds zero.

$$z_i^* = w_i\gamma + \mu_i \qquad (1)$$

$$y_i^* = X_i\beta + \mu_i \text{ observed only if } z_i^* > 0 \qquad (2)$$

where for the *i*th individual, X_i is a vector of explanatory variables, β is a parameter vector common to all individuals, and μ_i is a random disturbance term. The error terms are assumed to follow a bivariate normal distribution with means 0, variances $\sigma_\mu = 1$ and σ_ε and correlation coefficient ρ. The observed variable is $z = 0$ if $z^* \le 0$ and $z = 1$ if $z^* > 0$; $y = 0$ if $z^* \le 0$ and $y = y^*$ if $z^* > 0$. The expected *Y* is:

$$E(y \mid z^* > 0) = X\beta + \rho\sigma_\varepsilon\lambda(-w\gamma) \qquad (3)$$

where $\lambda(-w\gamma) = \dfrac{\phi(-w\gamma)}{1-\Phi(-w\gamma)}$ is the inverse of the Mill's ratio, ϕ is the standard normal density function, and Φ the standard normal function.

Equation (3) implies that the conditional expectation of y is $X\beta$ only when the errors of Eqs (1) and (2) are uncorrelated. In the first stage, we obtained γ from a probit estimation of Eq. (1), where z = 1 if z* > 0 and 0 otherwise. Pseudo R^2 was calculated according to Veall and Zimmermann (1992). In the second stage, we estimated Eq. (3) using ordinary least squares (OLS) regression.

The variables used in both stages of the Heckit model are presented in Table 2.

Results obtained by the Heckit model were analyzed by ANOVA and Canonical Correspondence Analysis (CCA) to determine the non-economic factors that influence WTP and how they were related to stakeholder typology.

3. Results

3.1. Classification of stakeholders

Five groups of stakeholders were categorized in the cluster analysis with a coefficient of dissimilarity of 0.67 (Fig. 2): (1) *local users* (20%), *generalist tourists* (18%), *nature tourists* (35%), *conservation professionals-group 1* (13%), and *conservation professionals-group 2* (14%). At the highest coefficient of dissimilarity two different clusters were found: the first represented both groups of *conservation professionals*, and the second included the users of ecosystem services (i.e., both groups of *tourists* and *local users*).

Stakeholder category variance (54.1%) was explained by three factors in the PCA (Table 4). Factor 1 (27.23%) captured stakeholder general environmental behavior and general knowledge about IAS. While positive loadings reflected general environmental attitudes, knowledge about IAS and education level, being associated with *conservation professionals* and *nature tourists*; negative loadings reflected an absence of awareness toward the willingness to introduce exotic species, and were associated with *local users* and *general tourists*. Factor 2 (15.54%) captured the perception about the role of IAS, in which positive loadings reflected the impact of IAS on the social system, and negative loadings reflected the IAS impact on ecosystems. In this sense, we found two different views among stakeholder groups. While *generalist tourists, nature tourists and conservation professionals-group 2* perceived that IAS had an ecological role through the threats they posed to ecosystems, *local users* and *conservation professionals-group 1* considered that IAS are not only an ecological problem, but also have an important social component related to factors such as the economy, cultural identity and human health. In this manner, *local users* had a utilitarian or anthropocentric relationship with IAS. They considered that IAS had an economic benefit or, on the contrary, that these species could cause sanitary problems. Finally, *conservation professionals-group 1* perceived that IAS caused social impacts (Table 3). Factor 3 (11.30%) captured the sense of

place of the stakeholders. The variables that contributed most to this factor were the distance between the place of residence and Doñana, and the effect of IAS on cultural identity; both of these had positive loadings. *Local users* and both groups of *conservation professionals* were associated with positive loadings, and the two groups of *tourist*s with negative loadings.

The *local users* group was comprised of people whose site of origin was nearest the study area, education level was poor and environmental attitudes were poor (Table 3). In this group we could identify two subgroups of local people (Fig. 2). The first was formed by people with a strong relationship with provisioning services of Doñana (12% of *local users*) such as fishermen, beekeepers, crayfish fishermen, seafood collectors, rice farmers, and farmers in general. A second group formed by local people had a weak relationship with provisioning services (8% of *local users);* these were people associated with the building industry, shop assistants or housewives. In spite of this, the two subgroups were analyzed together in the *local users* group because their perception of IAS was similar. The motivation of *general tourists* was not directly related to the NPAs, because they preferred to go to the beach or to religious events. Consequently, this group was composed basically of beach tourists and pilgrims. Also some tourists were one-day visitors (Martín-López et al., 2007), whose motivation was to spend one day in the Doñana NPA. *Nature tourists* showed interest for visiting only the NPA to enjoy the natural landscapes and wildlife, usually linked with activities like bird-watching or nature guide routes. Finally, the two groups of *conservation professionals* were composed of managers and researchers, whose education level was the highest. The difference between these groups was their perception of the role of IAS and their environmental behavior. Whereas group 1 perceived that IAS caused social impacts and only 30% of them were members of an environmental NGO, group 2 perceived that IAS had an ecological role and 100% of them were a member of a NGO (Table 3).

3.2. Stakeholder knowledge and perception of the impact of IAS

Of all respondents, 75% knew the meaning of IAS, but a detailed comparison demonstrated the existence of significant differences among stakeholders (ANOVA, $F=70.64$, $p< 0.001$). The group with the lowest knowledge was the *generalist tourists* followed by the *local users.* The other three stakeholder groups had higher levels of knowledge (Table 3).

When stakeholders were asked to name which exotic species they knew to exist in Doñana, *local users* only recognized those species that brought economic benefits to them, such as *Procambarus clarkii* to the crayfish fishermen. In the same way, *P. clarkii* was the most mentioned species by *generalist tourists*. The other three stakeholder groups had a high level of knowledge about the exotic species in Doñana (Table 3). In general, at least 30 species were recognized as having been introduced. The taxonomic group that was mentioned more was vegetation (44% of respondents recognized a plant as an exotic species), followed by vertebrates (32%), and invertebrates (24%). Specifically, the most commonly mentioned species were: *P. clarkii* (29%), *Carpobrotus edulis* (17%), *Trachemys scripta* (17%), *Eucalyptus* spp. (14%), and *Azolla filiculoides* (9%). Many of the respondents only recognized those species that have informative panels or exhibits in the NPA (i.e., *C. edulis* and *T. scripta*).

When we evaluated the respondents' historic memory, the most recognized exotic species were *P. clarkii*, which was introduced in 1974 (Habsburgo-Lorena, 1986), and *Eucalyptus* spp. which was first cited by Rivas-Martínez et al. (1980). These two species were recognized as exotic species by 90.5% and 65.7% of respondents, respectively. In contrast, species introduced in the past such as *Dama dama,* which was introduced at the beginning of the 20th century (Blanco, 1998), *Cyprinus carpio,* which was introduced in the 17th century during de Habsburgo´s dynasty (Lozano-Rey, 1935), and *Genetta genetta,* which was an Arabian introduction in the 8th -14th centuries (García-Novo and Marin, 2005), were only recognized by a small proportion of the respondents (32.6%, 41.5%, and 22.0%, respectively). Thus, there was a relationship between the number of people that knew about the introduction of a species and the time period of its introduction (Fig. 3).

Finally, the species perceived to be the most threatening IAS by respondents were: *P. clarkii* (72% of respondents perceived this as the most threatening species), *Eucalyptus* spp. (49%), *T. scripta* (46%), *C. edulis* (37%), *A. filiculoides* (36%), *C. carpio* (27%), *Oxyura jamaicensis* (20%), *Eriocheir sinensis* (18%), *Linepithema humile* (17%), and *Pelodiscus sinensis* (15%).

3.3. Stakeholder attitudes toward the introduction of IAS and management

There was a small percentage of respondents (18%) willing to introduce exotic species if they could obtain an economic or recreational benefit for themselves, but we found differences among stakeholder groups (ANOVA, $F=65.22$, $p< 0.001$). While the awareness of *generalist tourists* about the impacts of introduced species was very low (60% of them were willing to introduce an exotic species), and nearly 30% of *local users* considered that the introduction of exotic species would be positive if they profited from this action, the other three groups were not willing to do it.

A total of 454 respondents (97%) agreed that eradication of some IAS that have negative impacts is necessary. All stakeholders agreed that the impact of IAS on ecosystems is an important motive for their eradication. Some respondents had different motivations. For example, while *local users* and *conservation professionals-group 1* considered the importance of the impacts on the local economy, *generalist tourists* thought about the existence value of the species threatened by IAS (i.e., the right that endangered species have to exist) (Table 3).

3.3.1. Willingness to pay for IAS eradication

A total of 280 respondents (59.3%) refused to participate in the CV procedure. Zero values were recorded for 93 of them (19.7%) and 187 respondents (39.6%) gave protest responses because of different motives. Some respondents who gave protest zeros (16.3%) felt that the responsibility for solving the problem lay with the Environmental Government; others did not agree with the payment of new taxes for funding eradication programs (11.4%). Some were worried about Government policies (3%), others did not live in the Doñana SES or near it (2.3%), and some preferred to help the process with their work and advice, but not in paying for it (2.1%). A total of 21 respondents (4.5%) had other specific motives for not paying for IAS eradication.

We found 7 significant variables which explained the probability of participation in the hypothetical market in the Probit regression (Table 5). The variables ECONOMY, DISEASE, EDUCATION, AGE and HOUSESIZE were statistically negative, and DISTANCE and ATTITUDE were positive. If the respondent was receptive to the questionnaire, the probability of

participation in the hypothetical market was higher; this also happened with more DISTANCE. As we expected, the AGE variable showed that younger people were more aware of IAS concerns than older people, and a smaller HOUSESIZE also had a higher probability of participating in the hypothetical market. On the other hand, people that recognized the economic role of IAS and respondents with high education levels were less willing to participate in the hypothetical market.

On the second stage of the Heckit model (Table 6), we found 4 statistically positive variables: DISTANCE, INCOME, ATTITUDE, and UNDERSTANDING; and 3 negative ones: ECONOMY, EDUCATION, and HOUSESIZE. As we expected, a better UNDERSTANDING and ATTITUDE toward the questionnaire influenced the respondents to say that they would pay higher amounts of money. Also, WTP strongly depends on higher INCOME and greater DISTANCE. In this sense, people who had traveled further to visit Doñana were more likely to contribute higher WTP than local people.

Conversely, people who recognized the economic role of IAS contributed to the IAS eradication with lower amounts of money, because they related IAS with direct economic benefits (e.g., crayfish fishermen that profited from *P. clarkii*, or beekeepers whose beehives depend mostly on *Eucalyptus* spp.). Similarly, people who had high EDUCATION were associated with lower WTP because these people usually suggest other kinds of solutions (e.g., they prefer to help with their work and advice, but not with money). Finally, as we expected, a larger HOUSESIZE was negatively related to WTP.

The attitudes towards WTP for IAS eradication showed that stakeholders were more willing to pay for species that produce acute impacts on ecosystems (i.e., *C. carpio,* freshwater plants *such as A. filiculoides and P. stratiotes,* and *Eucalyptus* spp.) than for those that had more diffuse effects on ecosystems, but were easily identifiable with impacts over emblematic or particular endemic species (i.e., *O. jamaicensis, T. scripta,* or other fishes such as *Fundulus heteroclitus, Lepomis gibbosus,* and *Micropterus salmoides*) (Table 7). Furthermore, WTP for *L. humile* eradication may be related to a kind of phobia toward insects.

Differences among stakeholder WTP for eradication of particular species were found (Table 7), especially for those species that received the lowest amount of money for being eradicated (e.g., fishes*, T. scripta, C. edulis,* and *Gambusia holbrooki*). In this sense, stakeholders with a higher awareness for eradicating these species were both *conservation professionals* groups and *nature tourists*.

Different relationships between stakeholders and their WTP for eradication of particular species were also found in the CCA (Table 8, Fig. 4). Factor 1 captured those IAS that had eradication or research programs. The two groups of *conservation professionals* were positively associated with factor 1, while *local users* and *tourists* were negatively associated. On the one hand, species such as *T. scripta, C. edulis,* and *Eucalyptus* spp. have been the targets of important eradication programs in Doñana and *O. jamaicensis* have been the object of eradication programs at a national scale. On the other hand, species such as *P. clarkii, A. filiculoides*, and *L. humile* have been objects of research programs. Factor 2 captured the popularity-threat perception attributes. *Nature tourists* and *conservation professionals-group 1* were positively related, whereas *generalist tourists*, *local users*, and *conservation professionals-group 2* were negatively related. On one hand, *nature tourists* were related with popular species that had easily identifiable impacts on the structure and functioning of the ecosystem, e.g., freshwater plants*, Eucalyptus* spp. and *P. clarkii.* Similarly, the *conservation professionals-group 1* was willing to pay for eradicating species with a particular social role. These species were *Eucalyptus* spp., which had a strong eradication campaign, *T. scripta,* which had an awareness campaign, and other fishes, which were strong related with human uses (recreational or ornamental). On the other hand, *generalist tourists*, *local users*, and *conservationist professionals-group 2* were WTP for those IAS that affected them specifically. For example, while *local users* preferred to eradicate *L. humile* because it affects different crops (Carpintero et al., 2001), *conservationist professionals-group 2* preferred to eradicate *O. jamaicensis* or *C. edulis* because they had large ecological impacts.

4. Discussion

Social perception about IAS has been studied under different approaches: (1) randomly taking into account the general public (Jetter and Paine, 2004), (2) including only those stakeholders involved in IAS management (Bardsley and Edward-Jones, 2006), or (3) characterizing stakeholders by reviewing institutional context (Binimelis et al., 2007). In this study, we tried to collect a sample of all stakeholders, positively or negatively involved with IAS, some of them having influence on IAS management and some with no influence. Our analysis revealed the existence of different stakeholders related to: (1) knowledge of IAS meaning, (2) knowledge about the number of introduced species (3) perception of the role of IAS in the ecosystem and the social system, (4) motivation for eradication, (5) willingness to introduce exotic species, and (6) WTP for IAS eradication.

We found two different conservation professional groups due to their different perceptions of the role of IAS. In spite of this, they were usually considered to be one group (Kennedy, 1985). C*onservation professionals-group* 1 were more willing to consider the different ecological and social factors involved in the process of invasion and though that it was necessary to incorporate human practices, attitudes and perceptions in the management of IAS. On the other hand, c*onservation professionals-group* 2 thought that the ecological impact caused by IAS was a strong enough reason by itself for IAS management. This group specifically considered the intrinsic value of biodiversity as the main reason for managing biological invasions.

Regarding the conception of the term alien invasive species, we found a relationship between the number of respondents who recognized a species as being introduced and the historical date of introduction. In a study of stakeholder perceptions of the impacts of IAS conducted in the Mediterranean islands (Bardsley and Edward-Jones, 2006), many respondents were surprised that naturalized exotic species were not native. Furthermore, they considered the introduction and naturalization of exotic species to be part of an ongoing process of environmental change. Another study by Fischer and van der Wal (2007) showed that *Lavatera arborea*, which has invaded one of the largest UK colonies along the east coast of Scotland, was not perceived as a “new” species by 75% of respondents. In our study, species introduced in the past, such as *C. carpio, D. dama* and *G. genetta* were only recognized as being exotic by a low percentage of respondents, while recent introductions such as *P. clarkii* or *Eucalyptus*

spp. were mostly recognized by respondents as invasive. These results suggest that the meaning of IAS is a social dynamical concept, in which the more recent the species introduction the more recognizable is the species as being exotic by respondents.

With regard to the term of IAS and its knowledge, we found that the most renowned introduced species in our study were: *P. clarkii, C. edulis, T. scripta, Eucalyptus* spp. and *A. filiculoides. Carpobrotus* spp. and *Eucalyptus* spp. were also identified in a ranking of most commonly mentioned invasive exotic plants in the Mediterranean islands (Bardsley and Edward-Jones, 2007). Furthermore, two of the five most commonly mentioned species in our study (*C. edulis* and *T. scripta*) have been the objective of informative campaigns in the Doñana NPA, suggesting that society is sensitive to educational and informative programs. Such campaigns have also been undertaken in other Mediterranean regions with success (Bardsley and Edward-Jones, 2007). Consequently, our findings have important implications in environmental policies regarding IAS management, because the knowledge acquired in educational and informative programs could influence individual attitudes and behaviors toward IAS.

Developing public awareness campaigns to support IAS management, including sharing information about IAS impacts, is a useful and interesting tool for engaging the general public. In this sense, several studies have demonstrated the importance of stakeholder engagement in IAS management (Stokes et al., 2006) and the necessity of counting on their support as the key to success or failure of the projects undertaken by conservation managers (Bremner and Park, 2007). The opposition from a part of society could cause the failure of an eradication project (Genovesi and Bertolino, 2001). We found that the majority of respondents (97%) agreed that eradication of some potentially negative IAS could be necessary. Other studies have obtained similar results (Philip and Macmillan, 2005; Bardsley and Edward-Jones, 2006; Bremner and Park, 2007). These high levels of support show that public participation is possible.

An interesting tool for evaluating social support with regard to IAS eradication is the CV method. We found that higher WTP amounts for eradicating species would be given to those IAS that produce general impacts on ecosystems (i.e., *C. carpio, A. filiculoides, P. stratiotes,* and *Eucalyptus* spp.) and to those species that traditionally cause biophobia (e.g., *L. humile*).

Consequently, future research should focus on analyzing the relationships between stakeholder perceptions and WTP for eradicating species, as well as the relationship between IAS and the supply of ecosystem services, and how the impact of IAS on ecosystem services is perceived by stakeholder groups.

5. Conclusions

Accounting for the importance of social perceptions and stakeholder attitudes in relation to exotic species, some considerations emerge from our study that could be relevant for IAS management. Our results are consistent with the widely accepted idea that the human dimension is critical for successful IAS management. Policies that did not have public support in the past have usually failed (Mack et al., 2000; Genovesi and Bertolino, 2001).

It should be noted that most stakeholders and decision makers have only a limited perception of the problem and, therefore, education and public awareness campaigns are extremely important for any successful management of the problems associated with IAS (UE, 2003). Awareness campaigns are critical activities, not only for preventing new invasions but also for changing public perceptions and for ensuring public support on eradication and control programs (Tavares, 1997; Wittenberg and Cock, 2001).

However, the fact that different stakeholders have remarkably different attitudes and perceptions about the impacts and benefits generated by IAS deserves special attention and should be taken into account in any decision-making process. In this sense, appropriate educational and informative programs should be designed for specific groups of stakeholders if they are to be effective. These programs should take into account stakeholder interests, educational levels, environmental behaviors and personal experiences.

Public consultation with different local user groups and institutional stakeholders at different spatial scales should also be encouraged from the beginning of any program to avoid potential misunderstandings and to facilitate the implementation of management practices.

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7. Appendix A. Structure and content of the questionnaire

7.1. *User activities in the Doñana SES*

Information about the motivation of the activities in the Doñana SES of the respondent, such as: research, management, resting, going to the beach, religious travel, etc.

7.2. Knowledge and perception of the impact of IAS in Doñana SES

a. Definition of the term alien invasive species.
b. Knowledge of any exotic species in Doñana SES.
c. Knowledge about the introduction of five exotic species into Doñana SES with the objective of evaluating historic memory. Specifically we asked about eucalyptus (*Eucalyptus* spp.), red swamp crayfish (*P. clarkii*), common carp (*C. carpio)*, fallow deer (*D. dama*) and genet (*G. genetta*).
d. Perception of the more threatening species. For this question, we showed 15 exotic species in Doñana SES with different levels of impacts and asked respondents to select the six most dangerous specimens; each IAS was illustrated with a picture. These species were: *A. filiculoides, C. edulis, Eucalyptus* spp., *Pinus pinea, L. humile, E. sinensis, P. clarkii, P. sinensis, T. scripta, C. carpio, L. gibbosus, M. salmoides, Oncorhynchus mykiiss, O. jamaicensis* and *D. dama;* respondents could also suggest other species not listed, or ones that they thought were an important threat.
e. Perception of the role of IAS in Doñana SES.

7.3. Attitudes toward the introduction of IAS and IAS management

a. Willingness to introduce exotic species if they could obtain an economic or recreational benefit for themselves.
b. If they consider eradication to be a good management option and why it may be necessary.

c. WTP for IAS eradication: To determine people's awareness and level of participation toward the impact of IAS in the Doñana SES, we asked them about their WTP for eradicating IAS that we selected. The purpose of this question was to explore stakeholder attitudes toward paying for IAS eradication, and to know which species were most important to which stakeholders. For this question, each IAS was illustrated with a picture and a description explaining the ecological and socioeconomic impacts that they had on biodiversity and ecosystem services of the Doñana SES. In this context, within the CV framework, we suggested the following question:

'With the knowledge that you have about the impacts generated by the presence of (species name), would you be willing to pay an annual contribution to a fund created by the Environmental Government to eradicate this species in Doñana SES?'

If respondents answered 'No,' then they were asked the reason for not contributing to the fund to differentiate protest answers from zero values. If respondents answered 'Yes,' we asked them how much money (€) they would contribute. The elicitation of WTP was an open-ended format question.

7.4. General environmental behavior

This was measured by traditional variables that are considered to be indicators of respondent interest in nature (Requena, 1998):

a. If the respondent held a membership in an environmental organization.
b. Number of other natural protected areas that the respondent had visited during the previous year.

7.5. Socio-demographic information

Social and demographic information included variables of age, gender, education level, employment, household size, monthly family income and place of residence to estimate how far respondents had traveled.

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735 Table 1. List of species selected considering ecological, social and management factors. C = Competition; P = Predation; H = Hybridization; G.C. = Geotic
736 control; E.C. = Eradication and/or control programs; R = Research programs; Ed. = Educational programs; D.T. = Disease transmission.

Non-native invasive species			**Ecological factors**				**Management factors**					**Social factors**		**References**
Latin name	Common name	Origin	C	P	H	G.C.	Endangered species	UICN list	E.C.	R	Ed	Socioeconomic uses	D T.	
Plants														
Azolla filiculoides	Red waterfern	South America	✔			✔			✔	✔		Rice fertilizer		Gratwicke and Marshall, 2001; de Macalel and Vlek, 2004; Fernández-Zamudio et al., 2006
Pistia stratiotes	Water lettuce	South America	✔			✔			✔			Ornamental Waste water treatment Bioindicator of metals		Meerhoff and Mazzeo, 2004; García-Murillo et al., 2005
Carpobrotus edulis	Ice plant	South Africa	✔				*Limonium emarginatum* *Juniperus oxycedrus*		✔		✔	Ornamental Soil fixation Medicinal plant		Blanca et al., 2000; CMA, 2003; Figueroa-Clemente, 2003; Bañares et al., 2004; GEIB, 2006
Eucalyptus spp. (*E. globulus* and *E. camaldulensis)*	Eucalyptus	Australia	✔			✔			✔			Apiculture// Wood Medicinal plant		Dana et al., 2005
Invertebrates														
Procambarus clarkii	Red swamp crayfish	North America	✔	✔		✔				✔		Food	✔	CPA, 2001; Madroño et al., 2004; Geiger et al., 2005
Eriocheir sinensis[*]	Chinese mitten crab	China							✔	✔	✔		✔	Lowe et al., 2004; GEIB, 2006
Linepithema humile	Argentine ant	Argentina	✔					✔		✔				Carpintero et al., 2001; Lowe et al., 2004; Carpintero et al., 2007
Vertebrates														
Cyprinus carpio	Common carp	Europe and Asia	✔	✔		✔	*Oxyura leucocephala*	✔				Recreational fishing Food		Gómez-Caruana and Díaz-Luna, 1991; Lowe et al., 2004; Madroño et al., 2004; Jiménez-Pérez and Delibes de Castro, 2005; Miller and Crowl, 2006; Garcia-Berthou, 2007
Fundulus heteroclitus	Mummichog	North America	✔	✔			*Aphanius baeticus*					Aquarium fish		Gómez-Caruana and Díaz-Luna, 1991; Doadrio et al., 2001; Smith and Darwall, 2006
Gambusia holbrooki	Mosquitofish	North America	✔	✔			*A. baeticus*	✔				Biological control agent		García-Berthou and Moreno-Amich 2000; Doadrio et al., 2001; Smith and Darwall, 2006
Lepomis gibbosus	Pumpkinseed	North America	✔	✔								Recreational fishing		Fernández-Delgado et al., 2000
Micropterus salmoides	Largemouth bass	North America	✔	✔				✔				Recreational fishing		Fernández-Delgado et al., 2000; García-Berthou, 2002; Lowe et al., 2004

[*] Included in the attitudes and perception objectives of the study because of the social interest of this species among local people during the sampling. This was not selected for the economic valuation.

Trachemys scripta	Red-eared slider turtle	North America	✔	✔		*Emys orbicularis Mauremys leprosa*	✔	✔	✔	Pet	✔	Pleguezuelos, 2002; Lowe et al., 2004; GEIB, 2006
Oxyura jamaicensis	Ruddy duck	North and Central America	✔		✔	*O. leucocephala*						Garrido and Sáenz de Buruaga, 2002; Madroño et al., 2004

Table 2. Summary of the non-parametric variables used in the analyses performed at different scales, their main attributes and the analysis for which they were used.

Variables	Type	Attributes	Analysis
Knowledge, perception and attitudes variables			
IAS_MEANING	Dummy	Definition of the term alien invasive species (1=Knowledge of the meaning; 0=otherwise)	Cluster analysis Factor analysis Heckit model (Probit)
WILLING_INTRODUCE	Dummy	Willingness to introduce an exotic species (1= not willing to do it; 0=otherwise)	Cluster analysis Factor analysis Heckit model (Probit) Heckit model (OLS)
EXOTIC_KNOWN	Ordinal	Ln (Number of introduced species known)	Cluster analysis Factor analysis
		Square root (Number of introduced species known)	Heckit model (OLS)
Role of IAS in Doñana SES			
ECOSYSTEMS	Dummy	1=threaten ecosystems; 0=otherwise	Cluster analysis Factor analysis
ECONOMY	Dummy	1=effect on economy; 0=otherwise	Cluster analysis Factor analysis Heckit model (Probit) Heckit model (OLS)
DISEASE	Dummy	1=disease transmission; 0=otherwise	Cluster analysis Heckit model (Probit) Heckit model (OLS)
CULTURAL IDENTITY	Dummy	1=effect on cultural identity; 0=otherwise	Cluster analysis Factor analysis
WORK	Dummy	1=effect on work; 0=otherwise	Heckit model (Probit)
Environmental attitudes variables			
NGO	Dummy	Member of environmental NGO=1; 0=otherwise	Cluster analysis Factor analysis Heckit model (Probit) Heckit model (OLS)
NPAs	Ordinal	Ln (Number of visited other NPAs the last year)	Cluster analysis
		Square root (Number of visited other NPAs the last year)	Factor analysis Heckit model (Probit) Heckit model (OLS)
Socioeconomic variables			
DISTANCE	Continuous	Ln (Distance from place of residence to the interview place (kilometres))	Factor analysis Heckit model (Probit) Heckit model (OLS)
EDUCATION	Ordinal	Ln (Education level (0=none; 1=primary; 2=secondary; 3=university))	Cluster analysis
		Education level (0=none; 1=primary; 2=secondary; 3=university)	Factor analysis Heckit model (Probit) Heckit model (OLS)
GENDER	Dummy	1=male; 0=female	Heckit model (OLS)
AGE	Continuous	Ln (Age (years))	Heckit model (Probit)
HOUSESIZE	Ordinal	Household size (members)	Heckit model (Probit) Heckit model (OLS)
INCOME	Semi-continuous	Ln (Monthly family income which reflected the mid-point of six income intervals (0-900€=600€; 900-1 500€=1 200€; 1 500-2 100=1 800€; 2 100-2 700€ =2 400€; 2 700-3 300=3 000 €; ≥3 300=3 600 €) (1€=US$ 1.32, average June 2006-Sep 2007)	Heckit model (Probit) Heckit model (OLS)
Other variables			
ATTITUDE	Ordinal	Respondent's attitude towards the questionnaire (1=not receptive; 2 = indifferent; 3=receptive)	Heckit model (Probit) Heckit model (OLS)
UNDERSTANDING	Ordinal	Respondent's understanding of the questionnaire (1=low; 2= regular, 3=high)	Heckit model (Probit) Heckit model (OLS)

Table 3. Characterization of the five stakeholder groups obtained in the cluster analysis based on knowledge and perception of the impacts of IAS, attitudes toward the introduction of IAS and IAS management, environmental behavior and socioeconomic variables. E. H. = economically harmful because of the effect on provisioning ecosystem services; E. = damage to ecosystems; B = damage to biodiversity because of the effect on rights of existence of the species threatened by alien species.

Stakeholders (%)	**Knowledge and perception of the impact of IAS**				**Attitudes toward the introduction of IAS and their management**		**Environmental behaviour**		**Socioeconomic variables**		
	IAS_MEANING*	EXOTIC_KNOWN	Most impact species†	Role of IAS in Doñana SES‡	Motives for management§	WILLING_INTRODUCE*	NPAs*	NGO *	Place of residence**	EDUCATION	INCOME (1€=US$ 1.32, average June 2006-Sep 2007)
Local users (20%)	52%	*Procambarus clarkii*	*P. clarkii*	ECONOMY DISEASE	E.H. E	32%	33%	2%	Doñana Huelva-Seville-Cádiz	Primary Secondary	900-1 500 €
Generalist tourists (18%)	33%	*P. clarkii*	*P. clarkii* *Eucalyptus* spp. *T. scripta*	ECOSYSTEMS	E By	60%	45%	5%	Doñana Huelva-Seville-Cádiz Spain	Secondary	900-1 500 €
Nature tourists (35%)	100%	*P. clarkii* *Carpobrotus edulis* *Eucalyptus* spp. *Trachemys scripta*	*P. clarkii* *C. edulis* *Eucalyptus* spp. *T. scripta* *A. filiculoides*	ECOSYSTEMS	E	0%	62%	0%	Huelva-Seville-Cádiz Spain	Secondary University	900-1 500 € 1 500-2 100 €
Conservation professionals-group 1 (13%)	83%	*P. clarkii* *C. edulis* *Eucalyptus* spp. *T. scripta* *Azolla filiculoides*	*P. clarkii* *C. edulis* *Eucalyptus* spp. *T. scripta* *A. filiculoides*	ECOSYSTEMS ECONOMY CULTURAL IDENTITY	E.H. E	7%	80%	30%	Huelva-Seville-Cádiz Spain	University	1 500-2 100 €
Conservation professionals-group 2 (14%)	94%	*P. clarkii* *C. edulis* *Eucalyptus* spp. *T. scripta* *A. filiculoides* *Eriocheir sinensis* *Linepithema humile* *Nicotiana glauca*	*P. clarkii* *C. edulis* *Eucalyptus* spp. *T. scripta* *A. filiculoides* *Cyprinus carpio* *Oxyura jamaicensis*	ECOSYSTEMS	E	0%	88%	100%	Huelva-Seville-Cádiz Spain	University	1 500-2 100 €

* Percentage of stakeholders in each category.
† Species selected by more than 30% of the stakeholders in each category
‡ Role of the IAS in Doñana SES selected by more than 25% of the stakeholders in each category.
§ Motives for management of IAS selected by more than 25% of the stakeholders in each category.
** Place of residence for more than 20% of the stakeholders in each category.

Table 4. Factor loadings of the PCA results for stakeholder characterization.

Variables	Factor scores		
	F1:environmental behavior and IAS knowledge	F2: role of IAS	F3: sense of place
DISTANCE	0.133	-0.504	0.600
IAS_MEANING	0.617	0.060	-0.402
WILLING_INTRODUCE	-0.518	0.232	-0.171
EXOTIC_KNOWN	0.660	0.374	-0.337
ECOSYSTEMS	0.610	-0.461	-0.233
ECONOMY	-0.061	0.758	0.070
CULTURAL IDENTITY	0.140	0.504	0.531
NGO	0.566	0.144	0.150
NPAs	0.649	0.191	0.279
EDUCATION	0.697	-0.064	0.155
Stakeholders			
Local users	-0.538	0.363	0.031
Generalist tourists	-0.360	-0.248	-0.009
Nature tourists	0.223	-0.462	-0.307
Conservation professionals-group 1	0.240	0.571	0.385
Conservation professionals-group 2	0.486	-0.059	0.027
Eigenvalue	2.72	1.55	1.13
Percentage variance explained	27.23	15.54	11.30

Table 5. Probit regression results regarding willingness to pay (WTP) or not to pay for IAS eradication (first stage of Heckit model). Dependent variable: 0 when WTP=0 and 1 when WTP>0. n=464, significance ***= 1%, **=5% and *=10%.

Variables	**Coefficient**	**t-value**
DISTANCE	0.062**	2.429
IAS_MEANING	-0.113	-0.692
WILLING_INTRODUCE	-0.218	-1.224
ECONOMY	-0.295*	-1.670
DISEASE	-0.327*	-1.756
WORK	-0.303	-0.881
NGO	0.162	0.945
NPAs	-0.032	-0.416
EDUCATION	-0.146*	-1.678
AGE	-0.521***	-2.708
INCOME	0.099	0.835
HOUSESIZE	-0.169***	-2.733
ATTITUDE	0.423***	3.309
UNDERSTANDING	0.191	1.468
Log likelihood	-284.69	
Chi-square	53.85	
Pseudo-R^2	0.18	
p-value	<0.10	
% correct predictions	81%	

Table 6. Sample selection for the two-stage least squares regression results (second stage of Heckit model). Dependent variable: Ln (WTP), n=464, significance ***=1% and *=10%.

Variables	**Coefficient**	**t-value**
CONSTANT	-2.500	0.001
DISTANCE	0.109***	5.979
WILLING_INTRODUCE	-0.164	-1.244
EXOTIC_KNOWN	0.074	1.190
ECONOMY	-0.370***	-3.071
DISEASE	-0.192	-1.491
NGO	0.187	1.470
NPAs	-0.056	-0.941
EDUCATION	-0.103*	-1.602
INCOME	0.277***	2.631
HOUSESIZE	-0.363***	-7.758
GENDER	-0.151	-1.525
ATTITUDE	0.376***	3.685
UNDERSTANDING	0.401***	4.231
Inverse Mill´s Ratio	-3.000	0.001
Log likelihood	-645.22	
Adjusted R^2	0.75	

853 Table 7. Mean scores and F-values (ANOVA) for WTP for IAS eradication (1€ = US$ 1.32,

854 average June 2006 - Sep 2007), n= 439, significance ***=1%, **=5% and *=10%.

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Species (in order to WTP for total users)	**Total users**		***Local users***		***Generalist tourists***		***Nature tourists***		***Conservation professionals-group 1***		***Conservation professionals-group 2***		**F-value**
	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.	
Linepithema humile	4.20	0.65	2.35	0.97	4.05	1.60	5.15	1.23	3.19	1.89	5.91	1.83	0.922
Cyprinus carpio	3.77	0.50	3.08	0.94	3.36	1.12	4.47	0.94	1.89	0.91	5.47	1.67	1.109
Freshwater plants*	3.54	0.55	1.79	0.70	2.54	0.85	4.40	1.05	4.91	2.14	4.34	1.73	1.190
Eucalyptus spp.	3.21	0.57	0.95	0.66	2.96	1.19	3.78	1.03	5.48	2.35	3.72	1.64	1.460
Oxyura jamaicensis	2.87	0.41	1.54	0.75	2.94	0.90	3.07	0.73	3.15	1.32	4.18	1.28	0.908
Procambarus clarkii	2.58	0.38	1.19	0.53	3.19	0.99	2.80	0.67	2.59	1.08	3.49	1.21	1.074
Gambusia holbrooki	2.77	0.41	1.64	0.81	2.80	0.95	3.95	0.84	0.85	0.52	3.30	1.00	1.854*
Carpobrotus edulis	1.77	0.33	0.31	0.25	1.97	0.76	1.61	0.48	2.27	1.27	3.93	1.34	2.644**
Trachemys scripta	1.58	0.29	0.15	0.11	1.02	0.57	1.55	0.46	2.34	1.06	4.19	1.26	4.537***
Other fishes†	1.58	0.29	0.15	0.11	1.02	0.57	1.55	0.46	2.34	1.06	4.19	1.26	4.537***

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* Referring to: *Azolla filiculoides* and *Pistia stratiotes* because of their similar ecological roles.

† Referring to: *Fundulus heteroclitus, Lepomis gibbosus, Micropterus salmoides* because sampling assessed these species to have similar roles.

Table 8. Factor loading produced by the CCA for the relationships between stakeholders and their WTP for eradication of particular species.

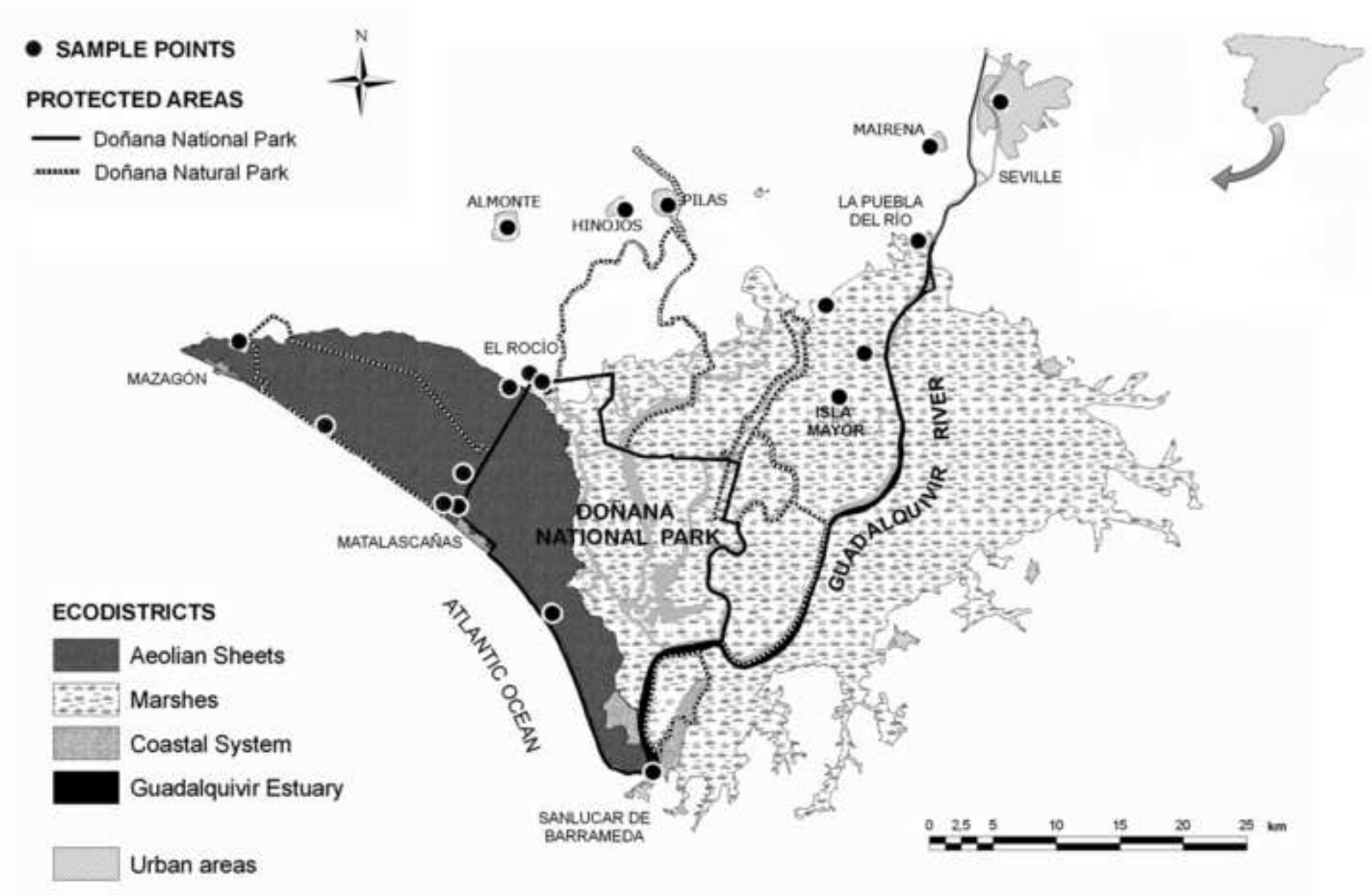
Species	**CCA Standard coefficients**	
	F1: Eradication v/s research	F2: Popularity-threat perception
Freshwater plants	-0.536	1.248
C. edulis	1.433	-1.427
Eucalyptus spp.	-0.075	1.566
P. clarkii	-0.401	0.035
L. humile	-0.689	-0.584
C. carpio	-0.910	-0.442
G. holbrooki	-0.987	-0.437
Other fishes	1.984	0.835
T. scripta	1.984	0.835
O. jamaicensis	0.721	-1.446
Stakeholders		
Local users	-0.469	-0.273
Generalist tourists	-0.200	-0.287
Nature tourists	-0.515	0.470
Conservation professionals-group 1	0.544	0.667
Conservation professionals-group 2	0.672	-0.664
Eigenvalue	0.069	0.031
Percentage variance explained	58.59	26.32
Total inertia	3.170	

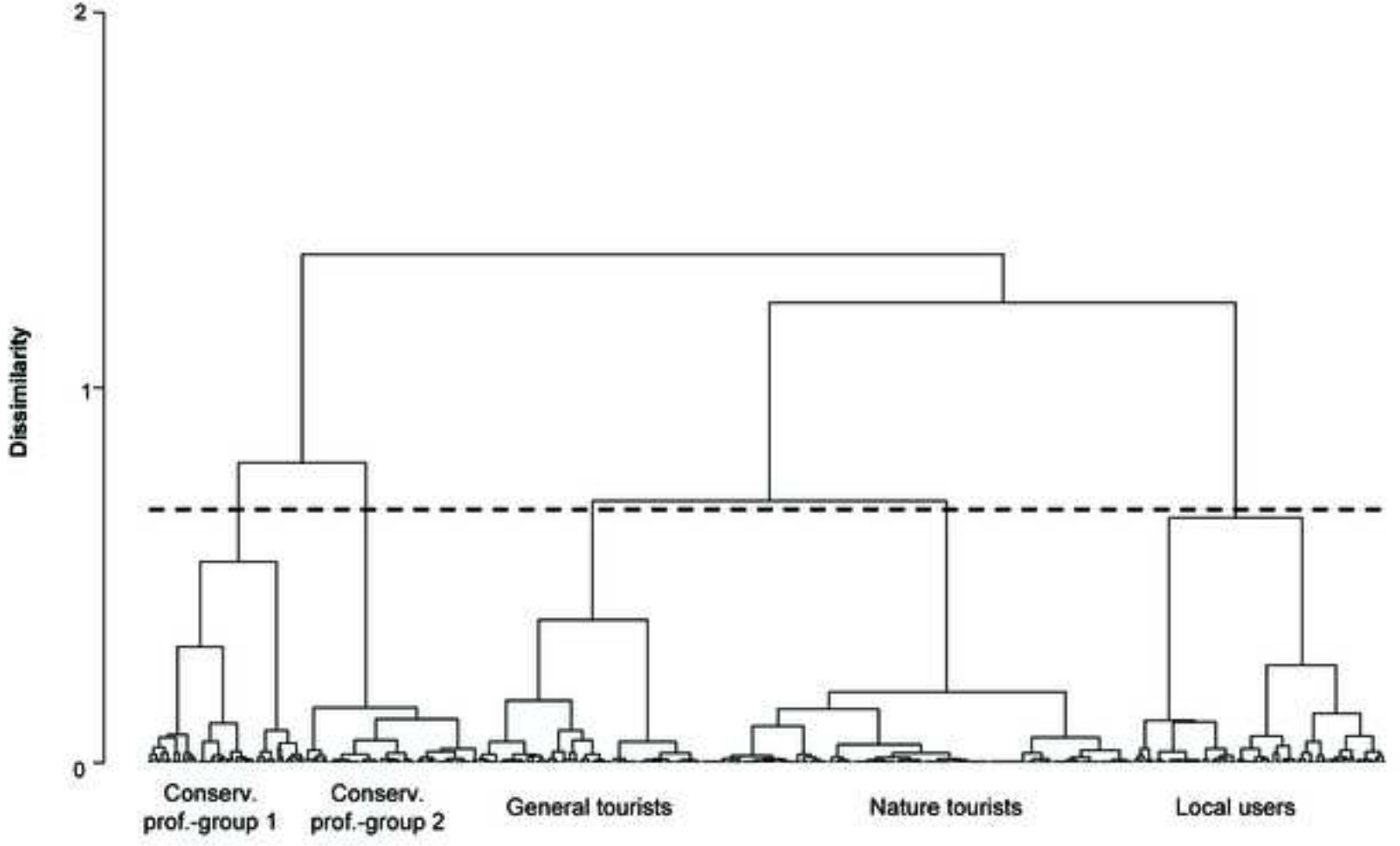
Fig. 1. Location of the Doñana SES and sample points.

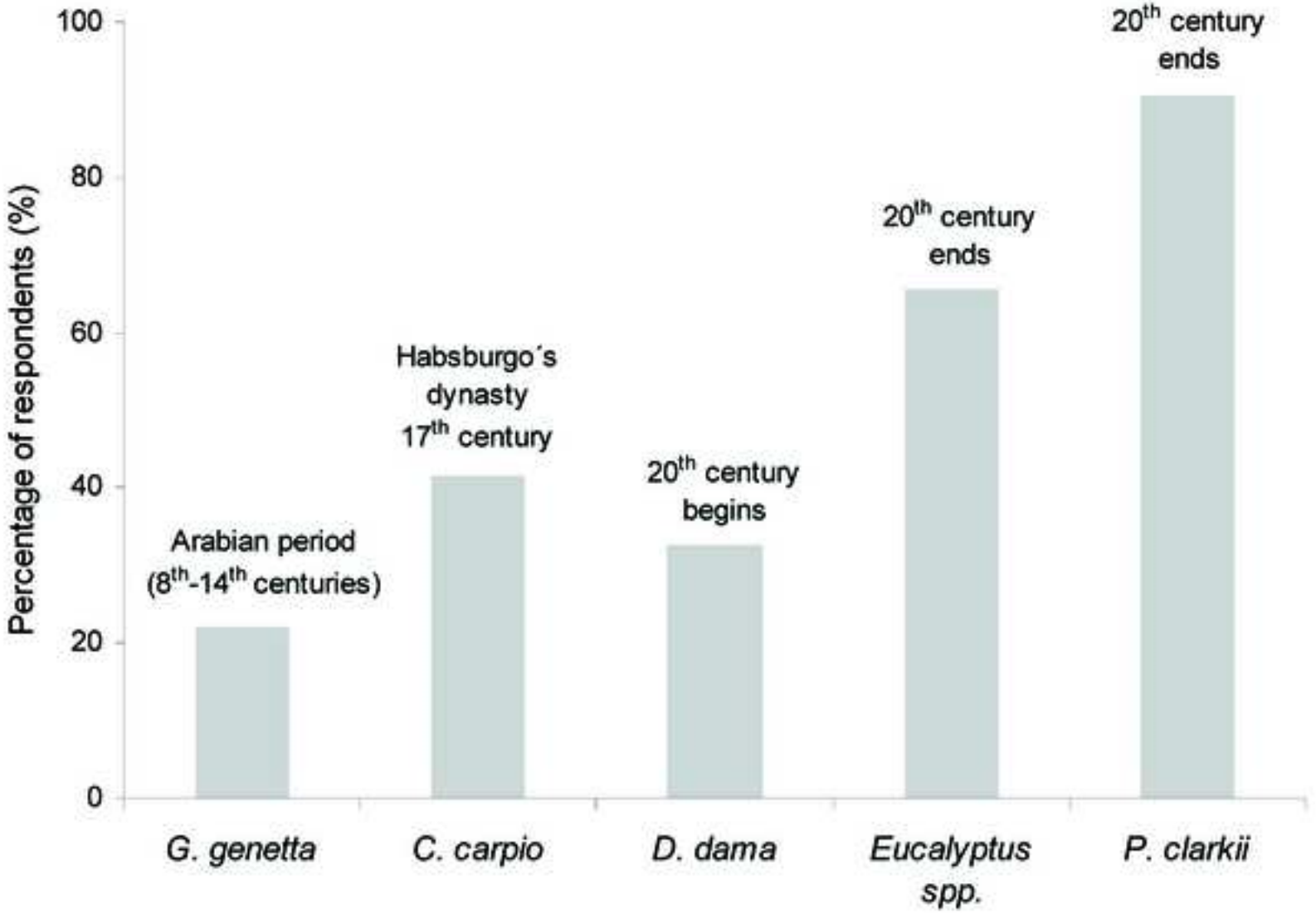
Fig. 2. Cluster analysis for the categorization of stakeholder groups related to: degree of knowledge, perception and attitudes towards IAS, environmental attitudes and socioeconomic variables. Five stakeholder groups were categorized with a coefficient of dissimilarity of 0.67.

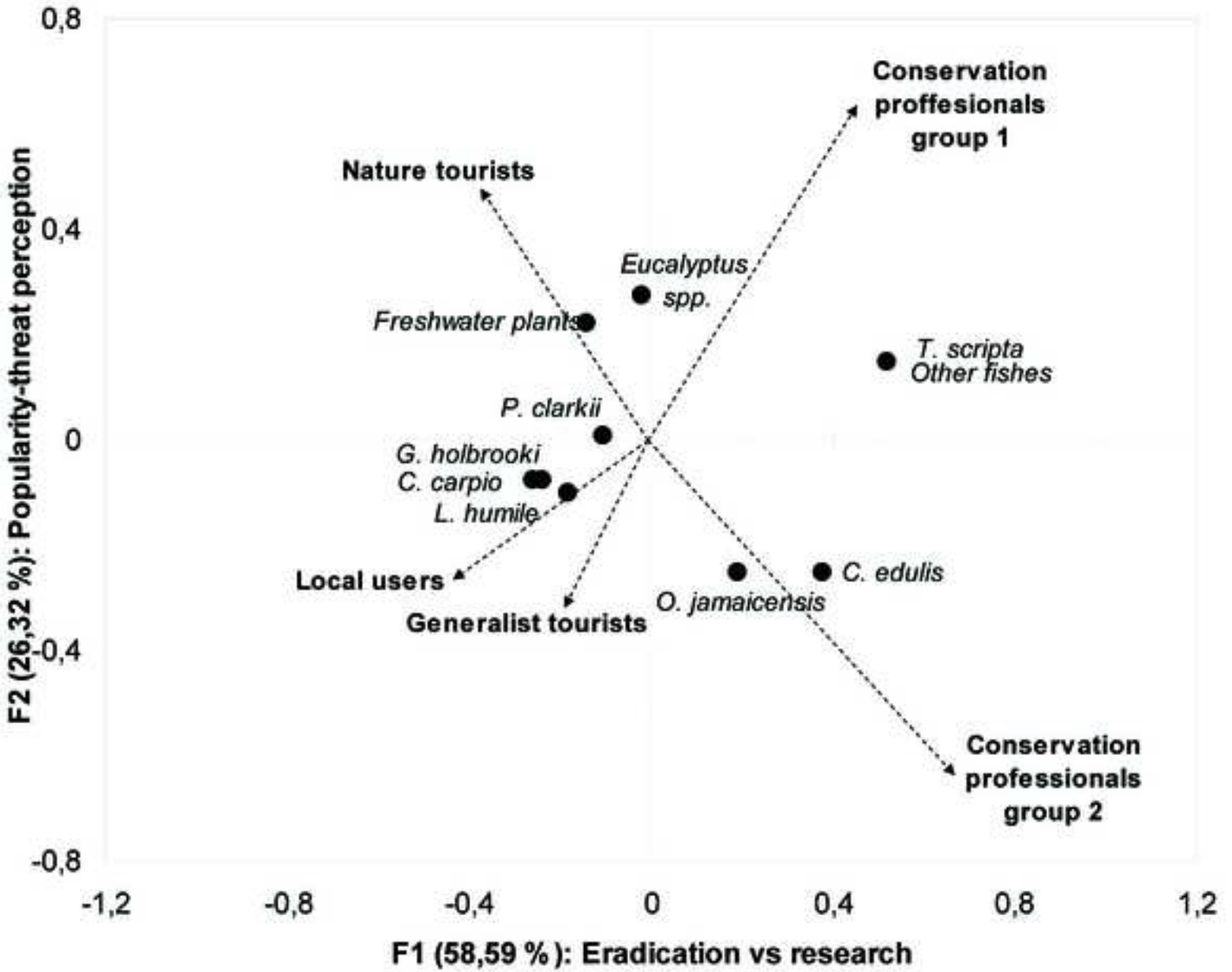
Fig. 3. Relationship between the percentage of people that knew about the introduction of a species and the period of its introduction for five exotic species in Doñana SES.

Fig. 4. Ordination diagram produced by the CCA showing the relationship between stakeholders and their WTP for eradication of particular species.


SAMPLE POINTS
PROTECTED AREAS
Doñana National Park
Doñana Natural Park
N
ALMONTE
HINOJOS
PILAS
MAIRENA
SEVILLE
LA PUEBLA DEL RÍO
EL ROCÍO
MAZAGÓN
ISLA MAYOR
GUADALQUIVIR RIVER
DOÑANA NATIONAL PARK
MATALASCAÑAS
ATLANTIC OCEAN
SANLUCAR DE BARRAMEDA
ECODISTRICTS
Aeolian Sheets
Marshes
Coastal System
Guadalquivir Estuary
Urban areas
0 2.5 5 10 15 20 25 km


Dissimilarity
2
1
0
Conserv. prof.-group 1
Conserv. prof.-group 2
General tourists
Nature tourists
Local users


Percentage of respondents (%)
100
80
60
40
20
0
Arabian period (8th-14th centuries)
Habsburgo´s dynasty 17th century
20th century begins
20th century ends
20th century ends
G. genetta
C. carpio
D. dama
Eucalyptus spp.
P. clarkii


0,8
0,4
0
-0,4
-0,8
-1,2
-0,8
-0,4
0
0,4
0,8
1,2
F2 (26,32 %): Popularity-threat perception
F1 (58,59 %): Eradication vs research
Conservation proffesionals group 1
Nature tourists
Eucalyptus spp.
Freshwater plants
T. scripta
Other fishes
P. clarkii
G. holbrooki
C. carpio
L. humile
Local users
Generalist tourists
C. edulis
O. jamaicensis
Conservation professionals group 2