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# Public Perceptions and Uses of Natural and Restored Salt Marshes

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**ABSTRACT** Only a few restoration projects incorporate public perception in their monitoring. However, participation of local people is a key process if social benefits are to be achieved. This study analyses, through a survey, citizens' perceptions and usage of natural and restored coastal marshes in the city of Huelva (southwest Iberian Peninsula, Spain), as well as landscape preferences. Most of Huelva's citizens recognised the benefits of coastal marshes (75%), a perception which increased with level of education. The majority of the respondents showed a low level of knowledge about the ecological services and functions of salt marshes. In addition, visitor numbers to the studied restoration project increased by 27% after restoration. Regarding landscape preferences, most of the respondents preferred the native *Chenopodiaceae* salt marsh, and the native *Spartina maritima* landscape was chosen less often. In light of our results, environmental education campaigns should be carried out in the city of Huelva to increase its citizens' knowledge of salt marshes.

**KEY WORDS:** landscape preference, Odiel Marshes, public use, restoration project, salt marsh monitoring, *Spartina*

## Introduction

Ecological restoration is becoming a common practice to improve the ecological quality of many degraded ecosystems (Mitsch, 2010). Once a restoration project has been carried out, good monitoring is essential to improving the restoration methodology for future applications and to solving unexpected problems (England *et al.*, 2008). During the monitoring, participation of local people is key to achieve social benefits; to detect problems of public use; and to improve management in restored ecosystems with the aim of increasing population acceptability (Casagrande, 1997; Sharp *et al.*, 2011; Shindler *et al.*, 2011; Webler & Tuler, 2001). Local residents attached importance to public consultation and expected to be consulted about restoration works (Tunstall *et al.*, 2000). Nevertheless, only a few restoration projects incorporate public perception into their monitoring.

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Salt marshes are one of the most impacted ecosystems globally, so restoration projects are being carried out to compensate for their degradation and loss (Broome *et al.*, 1988; Gedan *et al.*, 2009; Mitsch & Gosselink, 2000) and only a few of these projects incorporate public perception and use in their evaluation process (Burger, 2003; Casagrande, 1996; Myatt *et al.*, 2002, 2003a, 2003b).

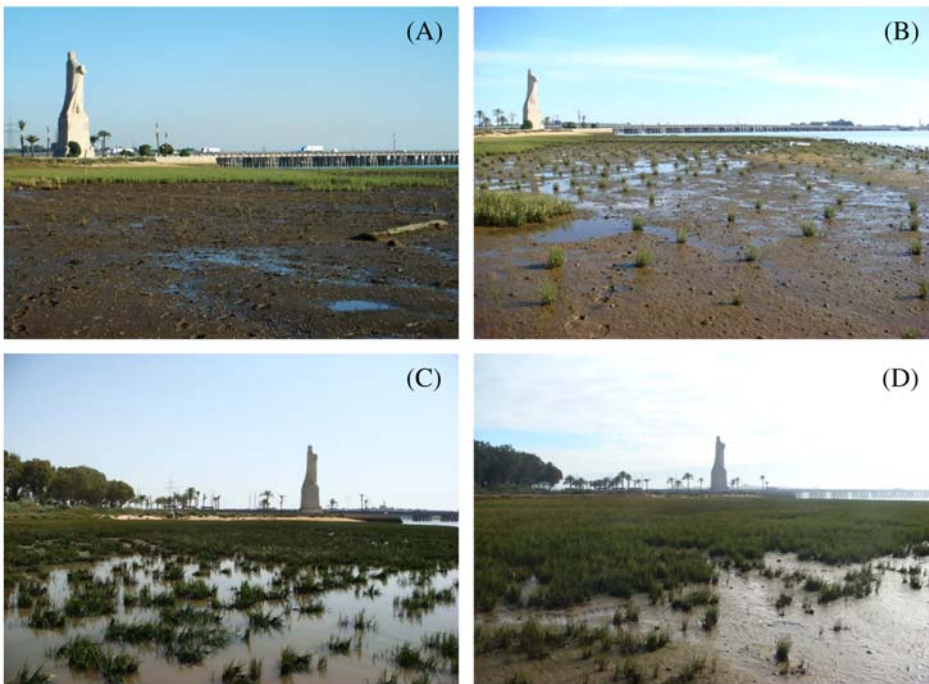
This study analyses, through a survey, citizens' perceptions and usage of natural and restored coastal marshes in the city of Huelva (Andalusia, Spain), specifically of a salt marsh restoration project next to the Chemical Pole (Castillo & Figueroa, 2009). The main goals were to understand the beliefs, perceptions and behaviour of the local population in respect to the surrounding salt marshes, and to compare natural and restored marshes from the viewpoint of the local population.

## Methodology

### Study Area

The focus of this study was the city of Huelva, a middle-sized industrial town, and the adjacent Odiel Marshes (lat. 37° 08'– 37° 20' N, long. 6° 45'– 7° 02' W; 7.158 ha), specifically 8.37 ha of restored salt marshes located in the city of Huelva (Andalusia, Spain) next to the Chemical Pole (Castillo & Figueroa, 2009). The Chemical Pole of Huelva is one of the biggest industrial concentrations in Spain, extending over more than 1500 ha with about 16 companies and about 6000 workers. Odiel Marshes are a site of international importance for migratory waders through the East Atlantic flyway (Sánchez *et al.*, 2006). They are protected as a Natural Park (Paraje Natural) and Biosphere Reserve. Odiel Marshes can be visited by car and boat and through a network of open-access hiking and biking trails that includes the restored salt marshes.

The typical plant zonation pattern at low marshes in southwest Iberian Peninsula includes dwarf eelgrass (*Zostera noltii* Hornemann) at lower elevations, small cordgrass (*Spartina maritima* [Curtis] Fernald) and slender glasswort (*Salicornia ramosissima* J. Woods) at medium elevations and the invasive dense-flowered cordgrass (*Spartina densiflora* Brongn.), perennial glasswort (*Sarcocornia perennis* [Mill.] Scott ssp. *perennis*), the hybrid *Sarcocornia perennis* x *fruticosa*, sea purslane (*Atriplex portulacoides* L.) and sea bitle (*Suaeda maritima* L. [Dumort]) at higher elevations. Restored salt marshes (37°13'86" N, 6°56'97" W) were planted, from November 2006 to January 2007, with *S. maritima* accompanied by *S. perennis* at a density of 1 clump m<sup>-2</sup> between +1.50 and +2.30 m Spanish Hydrographic Zero and with *Z. noltii* at the lowest elevations (isolated individuals) (Curado *et al.*, 2012). Restored marshes were outside the Natural Reserve in an area in which management was carried out by The Port Authority of Huelva. One of the main goals of this restoration project was to recover native vegetation, restoring the degraded landscape (Castillo & Figueroa, 2009). Two and a half years after the salt marsh restoration, *S. maritima* relative cover was c. 50% and *S. perennis* relative cover was c. 14% with the invasive *S. densiflora* colonising c. 5% of the marsh surface (Curado *et al.*, 2013). Restored marshes were intertidal mudflats slightly sloping to the main channel with narrow drainage channels running perpendicular to the tidal line, sparse shallow intertidal ponds and 1 m-tall intertidal sand dunes (Figure 1).



**Figure 1.** Restored marshes in the area of ‘Punta del Sebo’ at the periphery of Huelva city in Odriel Marshes (southwest Iberian Peninsula). (A) December 2006 (just after planting *Spartina maritima*); (B) December 2007; (C) April 2009; (D) December 2011.

### Survey Instrument

A two-page questionnaire with 10 questions was developed as a quantitative survey instrument (Appendix 1), primarily using a qualitative exploration of the thematic dimensions (Myers & Oetzel, 2003) of the public perception and usage of Odriel Marshes. In order to understand the beliefs, perceptions and behaviour of the local population with respect to the salt marshes, questions 1 and 4 indicated for us perception of value. Question 4 also elicited information about physical perception. Questions 2, 3, 7, 8 and 9 gave information about the use or utility of the Odriel Marshes for the respondent, and questions 2, 4, 5, 6 and 7 gave us further knowledge about the beliefs and behaviour of the local population. In order to compare natural and restored marshes from the viewpoint of the local population, we used the questions (3–9; 2–6, 7). The last question (10) incorporated three salt marsh landscape photographs representing different salt marsh communities (native *Spartina maritima* prairie, invasive *Spartina densiflora* prairie and Chenopodiaceae salt marsh), to evaluate visual public preference (Brown *et al.*, 1988; Misgav, 2000). Sex, age and education level were also included in the questionnaire (Appendix 1). Three levels of education were established: high (university degree), medium (secondary school diploma) and low (middle school, elementary school or none) (Lazzeri *et al.*, 2011). The questionnaire used multiple-choice questions with a variable number of response categories according to the targets

measured. The questionnaire was developed by us following our knowledge about salt marsh ecology and their public uses in Huelva and some recommendations of Haladyna & Downing (1989) about the format. The definitive survey was conducted after using the questionnaire on one sampling day in order to avoid possible misunderstandings in its redaction.

### *Survey Organisation and Participants*

The survey was carried out by means of a street questionnaire on the central street 'Concepción' in the city of Huelva. This location was selected because it encompasses a wide section of the population. In both zone and unit selections, we took into account recommendations adapted from Jaenson *et al.* (1992). The survey population comprised those living in the city of Huelva that were  $\geq 20$  years of age. A total of 1773 people were asked by trained interviewers to participate in the survey, with a response rate of 22.2% (a total of 394 completed questionnaires were ultimately obtained). This response rate, however low, was comparable to that of other studies of landscape perception (Junker & Buchecker, 2008; Ryan, 2002; Schaid, 2009; Van den Berg & Koole, 2006). The city of Huelva has a population of 108 957 inhabitants older than 20 years (Statistical Institute of Andalusia, 2001), and the minimum statistically significant sampling number was 383 people with a population variance of 0.25, an error probability of 0.05 and a precision error of 0.05 (calculated using the free software 'Muestreo Aleatorio Simple' by Manzano-Arrondo, 2000).

The survey was conducted between 10.00 a.m. and 1.00 p.m. and between 5.00 p.m. and 8.00 p.m. on working days in October 2010. The overall interview usually required only about 5 minutes. The sampling design followed the principles of Manzano-Arrondo (1998).

We used a mixed sampling with two main characteristics: 1) non-probability sample structure: quota sampling, applied to sex and estimated age; and 2) random selection: systematic sampling with random starting and constant period of 11 units. Period was calculated after observations about crowd flow at the sampling zone (see Kish, 1965).

### *Data Analysis*

The data collected were analysed using SigmaPlot for Windows v. 11.0. Data were tested for normality with the Kolmogorov–Smirnov test and for homogeneity of variance with the Levene test ( $p > 0.05$ ). The level of significance applied to all tests was  $p < 0.05$ . Differences between sex, age and educational level were compared by three-way ANOVA (Meister *et al.*, 2005). Tukey's test was used as post-hoc analysis.

## **Results**

Salt marshes were considered a beneficial ecosystem by 75% of the respondents (Question 1, Table 1), and 63% of respondents admitted to visiting Odiel Marshes at least once a year or more (Question 2, Table 1). The main use of Odiel Marshes by the population of the city of was hiking (81%), and running a less popular activity (4%). Odiel Marshes were used also by bird-watchers (14%), photographers (14%), fishers (13%) and cyclists (12%). People also used Odiel Marshes for relaxation, reading, inspiration

**Table 1.** Summary of the answers to the questionnaire

<i>Q 1</i> Ans. N (%)	Benef. 296 (75)	Harm. 30 (8)	Indif. 68 (17)	<i>Salt marshes are for you...</i>							
<i>Q 2</i> Ans. N (%)	Never 146 (37)	Rarely 128 (32)	Often 66 (17)	<i>You visit Odiel Marshes...</i>							
<i>Q 3</i> Ans. N (%)	Hiking 201 (81)	Fishing 32 (13)	Cycling 30 (12)	R 10 (4)	VO 54 (14)	<i>When you visit the salt marshes you go...</i>					
<i>Q 4</i> Ans. N (%)	BM 322 (82)	BF 205 (52)	PW 151 (38)	AT 156 (40)	RLS 291 (74)	W 26 (10)	BW 35 (14)	P 35 (14)	S 17 (7)	Others 24 (10)	
<i>Q 5</i> Ans. N (%)	Yes 327 (83)	No 67 (17)	<i>According to you, salt marshes:</i>								
<i>Q 6</i> Ans. N (%)	Yes 196 (60)	No 131 (40)	<i>Do you know the marsh restoration project?</i>								
<i>Q 7</i> Ans. N (%)	Rarely 84 (43)	Often 51 (26)	VO 61 (31)	<i>Have you ever visited the restored marshes since the restoration project was carried out?</i>							
<i>Q 8</i> Ans. N (%)	Yes 190 (48)	No 204 (52)	<i>How often do you visit the restored marshes?</i>								
<i>Q 9</i> Ans. N (%)	Hiking 151 (77)	Fishing 7 (4)	Cycling 29 (15)	R 8 (4)	W 20 (10)	BW 4 (2)	P 12 (6)	S 1 (1)	Others 21 (11)		
<i>Q 10</i> Ans. N (%)	abc 7 (2)	acb 9 (2)	bac 23 (6)	bca 39 (10)	cab 144 (36)	cba 172 (44)	<i>When you visited the restored marshes, you were.</i>				
<i>Landscape preferences</i>											

Abbreviations: Q = Question, Ans. = Answer, N = number of people who responded to a particular response; % = percentage of people who responded to a particular response: Question 1: Benef. = Beneficial; Harm. = Harmful; Indif. = Indifferent. Question 2 and 7: VO = Very often. Question 3 and 9: R = Running; W = Working; BW = Bird-watching; P = Photography; S = Sailing. Question 4: BM = Breeding mosquitoes; BF = Breeding fish; PW = Purify water; AT = Attract trash; FC = Flood control; RLS = Red list species; SB = Smell bad; FCC = fighting climate change; B = Beautiful; SD = Source of diseases.

In the multiple-choice questions (3, 4 and 9), sum of % is different than 100 due to people being able to answer with more than one option. Question 10 shows the order of photographs choice, the first letter corresponding to the photo that was most liked (a = *S. maritima* prairie; b = *S. densiflora* prairie and c = Chenopodiaceae salt marsh).



and painting (Question 3, Table 1). On the other hand, 82% of respondents reported that salt marshes were a habitat for mosquitoes, but only 23% thought that marshes were a source of disease. Most of the citizens interviewed thought that salt marshes were a habitat for red list species (74%) and offered beautiful landscapes (80%). However, only about half of the respondents recognised the ecological services provided by salt marshes, such as water purification and flood control, fighting climate change and being a habitat for breeding fish and shellfish species (Question 4, Table 1).

The salt marsh restoration project was known to 83% of respondents, of which 60% had visited it, and more than half of the visitors had been there three or more times a year (Questions 5, 6 and 7, Table 1). Restored marshes had been visited by 50% of respondents since their restoration, increasing visits to the area by 27% after the restoration project was implemented (Question 8, Table 1). The most popular public uses given to the walkway over the restored marshes were hiking (77%) and cycling (15%). It was also used by Chemical Pole workers during lunch and rest breaks (10%). Other uses (11%) were reading, skating, barbecuing and relaxing (Question 9, Table 1).

Chenopodiaceae salt marsh was the favourite landscape for 80% of respondents versus 16% who chose the invasive *Spartina densiflora* prairie and only 4% who chose

**Table 2.** Results of three-way ANOVAs that presented significant differences in the questions with simple responses (Questions: 1, 2, 5, 6, 7, 8 y 10). Significant results are marked in bold.

Factor		Sex	Age	Educational level	Sex x Age	Age x Educational level	Sex x Age x Educational level	Total
Degree of freedom		1	2	2	2	4	4	393
<i>Question 1: Salt marshes are for you: beneficial, harmful or indifferent</i>	SS	0.668	0.999	0.342	0.0686	<b>5.823</b>	0.355	146.416
	MS	0.668	0.499	0.171	0.0343	<b>1.456</b>	0.0887	0.373
	F	1.891	1.412	0.484	0.097	<b>4.118</b>	0.251	
	P	0.17	0.245	0.617	0.908	<b>0.003</b>	0.909	
<i>Question 5: Do you know the marsh restoration project?</i>	SS	0.0196	1.79	1.196	0.195	<b>5.625</b>	1.108	219.777
	MS	0.0196	0.895	0.598	0.0973	<b>1.406</b>	0.277	0.559
	F	0.0351	1.603	1.071	0.174	<b>2.519</b>	0.496	
	P	0.851	0.203	0.344	0.84	<b>0.041</b>	0.739	
<i>Question 8: Did you visit the restored marshes before the restoration project?</i>	SS	0.742	<b>37.393</b>	0.303	5.042	4.745	0.815	393.503
	MS	0.742	<b>18.697</b>	0.151	2.521	1.186	0.204	1.001
	F	0.846	<b>21.337</b>	0.173	2.877	1.354	0.233	
	P	0.358	<b>&lt;0.001</b>	0.841	0.058	0.249	0.92	
<i>Question 10: Landscape preferences</i>	SS	<b>3.426</b>	<b>1.536</b>	1.113	<b>1.513</b>	<b>8.353</b>	<b>4.985</b>	114.596
	MS	<b>3.426</b>	<b>0.768</b>	0.557	<b>0.756</b>	<b>2.088</b>	<b>1.246</b>	0.295
	F	<b>14.979</b>	<b>3.358</b>	2.434	<b>3.308</b>	<b>9.132</b>	<b>5.45</b>	
	P	<b>&lt;0.001</b>	<b>0.036</b>	0.089	<b>0.038</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	

the native *Spartina maritima* prairie (Question 10, Table 1). *S. maritima* prairie was the least-liked landscape (54%) (Table 1).

The three-way ANOVA showed that age had a significant effect on the answers to Question 8 (visiting before restoration) and Question 10 (landscape preferences). Thus, people over 60 years visited the restored area before the implementation of the restoration project more frequently (78%) and they had a greater preference for the invasive *S. densiflora* prairie (30%) than other age groups ( $F$ -statistics are shown in Table 2).

The educational level influenced the perception of salt marshes as beneficial ecosystems. The high educational level group more frequently answered that salt marshes were beneficial (86%) (Question 1, Table 2), and less frequently (25%) that they 'smell bad' (ANOVA,  $F = 7.770$ ,  $p < 0.001$ , d.f. = 2; Tukey's test,  $p < 0.05$ ) and 'attract trash' (ANOVA,  $F = 7.669$ ,  $p < 0.001$ , d.f. = 2; Tukey's test,  $p < 0.05$ ) (Question 4). The interaction between age, sex and educational level showed that men younger than 40 years with medium educational level preferred *S. densiflora* landscape more than other groups (88%) (Question 10) and that respondents older than 60 years with low educational level were more unaware of the marsh restoration project (37%) (Question 5, Table 2).

The sex of the respondents influenced only the public use of salt marshes (Question 3), with men fishing more frequently (20%) than women (8%) (ANOVA,  $F = 5.400$ ,  $p < 0.05$ , d.f. = 1) (Table 2).

## Discussion

This work provided very positive responses by local residents of the city of Huelva to salt marsh restoration using *Spartina maritima* plantations. Most of Huelva's citizens recognised the benefits of coastal marshes (75%), a perception which increased with increasing educational level. Previous studies have pointed out that local people generally agree with river restoration, recognising the benefits to restored ecosystems (Buijs *et al.*, 2009; Junker & Buchecker, 2008).

The majority of the respondents showed a low level of knowledge about the ecological services and functions of salt marshes, a result in agreement with the low level of ecological knowledge typical of urban areas (Kellert, 1984). Previous works have illustrated that restoration projects increase the use of the ecosystem for wildlife, and that they are an educational and recreational resource for local people (e.g. Armitage *et al.*, 2007; Burger, 2003; Natuhara *et al.*, 2005; Tunstall *et al.*, 1999). In view of our results, environmental education campaigns should be carried out in Huelva to increase its citizens' knowledge of the values and services provided by salt marshes, a threatened ecosystem that virtually surrounds the city. With this aim, environmental educational display boards, giving information about different elements and processes of the ecosystem, have been erected along the trail in the restored marshes: these are a very good location to carry out educational campaigns since they are well-equipped and easily accessible on foot from the city. In this sense, an interpretive centre showing different aspects of salt marsh ecology, conservation and uses could improve the site opportunities for environmental education. Particular effort should be directed at school-age users (Anderson and Moss, 1993), which could be very effective when incorporated into local school curricula (Tanner *et al.*, 1992).



Respondents over 60 years with low educational level were those less aware about the studied restoration project. Anderson & Moss (1993) concluded that conditioning from literature, television and oral communication leads to negative adult perceptions about wetlands. Historically, people have considered wetlands to be unhealthy places and a source of disease (Borca, 2000), but this social perception seemed to be changing, since 77% of respondents thought that marshes were not a source of infection, 74% said that marshes had protected species, and 80% said that they are a beautiful ecosystem. According to Casagrande (1997), some interviewed fishermen were very knowledgeable about the restored area's wildlife and history, since they had frequently worked in those marshes in the past.

Regarding landscape preferences, most of the respondents preferred the native Chenopodiaceae salt marsh; the native *S. maritima* landscape was chosen less (Appendix 1). The public's aesthetic preferences based on photographs were primarily influenced by perceived naturalness (Junker & Buchecker, 2008), plant colours, that is, preferring green to yellow or brown (Kaufman & Lohr, 2004), and the amount and diversity of colours (Hands & Brown, 2002). Then, the differences showed in our work could be related to the colours of our photographs, since the Chenopodiaceae salt marsh presented a darker green colour and a higher diversity of tones of colour than the two cordgrass prairies, which were more yellowish and homogeneous. The studied restoration project was based mainly in *S. maritima* plantations, which was the less favoured landscape, but this native cordgrass facilitates the development of ecological succession, resulting in Chenopodiaceae salt marsh, the preferred landscape, at higher elevations (Castellanos *et al.*, 1994; Figueroa *et al.*, 2003).

The studied restoration project increased its visitor numbers by 27%. According to respondents' comments, this increase of visitors was related to improved access to the marshes by installation of a walkway, as well as to enhancing the landscape. In contrast, Tunstall *et al.* (1999) found significantly fewer visitors after the restoration of river banks in England. Respondents over 60 years visited the restored area more frequently than other age groups, which may be related to a greater amount of free time after retirement, and to their visits to the area before its degradation coinciding with the building of the Chemical Pole in the 1960s. In agreement with our results, Casagrande (1996) and Burger (2003) described that respondents highly valued passive activities, including walking, relaxing and enjoying views in urban wetlands. They tended to place lower values on active uses, including fishing (more popular for men than women) and boating.

Our results are useful for future marsh restoration efforts. First of all, our study shows that the restoration of salt marshes in combination with the construction of a walkway increases the visitor rate to the restored area, which should encourage public administrations to develop this kind of projects that count on a high public recognition. Second, our findings about salt marsh public uses help to focus the design of future restoration projects to responses to people's preferences and to adapt the ecological restoration to them. Moreover, our study is helpful in improving public uses in the salt marsh restored area in Odiel Marshes, for example, constructing barbecue facilities and bird observatories. In general, this kind of study about landscape and public use preferences should be carried out also before designing restoration projects in order to improve their specific outcome.

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### **Appendix 1. Questionnaire to Huelva Citizens about the Perception and Use of Odiel Marshes**

Sex ... Age ...

Education level (1 = low (middle school, elementary school or none), 2 = medium (secondary school diploma), 3 = high (university degree)).

**(1) Salt marshes are for you:**

- (a) Beneficial.
- (b) Harmful.
- (c) Indifferent.

**(2) You visit Odiel Marshes:**

- (a) Never.
- (b) Rarely (1–2 times per year).
- (c) Often (3–6 times per year).
- (d) Very often (> 6 times per year).

**(3) When you visit the salt marshes you go:**

- (a) Hiking.
- (b) Fishing.
- (c) Cycling.
- (d) Running.
- (e) Working (catch bait, fishing.. ).
- (f) Bird-watching.
- (g) Photography.
- (h) Sailing.
- (i) Others.

**(4) According to you, salt marshes:**

- (a) Breed mosquitoes.
- (b) Breed fish and shellfish.
- (c) Purify water.
- (d) Attract trash.
- (e) Flood control.
- (f) Are habitat for Red List species.
- (g) Smell bad.
- (h) Fight against climate change.
- (i) Are beautiful.
- (j) Are a source of diseases.

- (5) **Do you know the marsh restoration project located between the ‘Nuevo Colombino’ stadium and ‘Punta del Sebo’?**
- (a) Yes
  - (b) No
- (6) **Have you ever visited the restored marshes since the restoration project was carried out?**
- (a) Yes
  - (b) No
- (7) **If the above answer is ‘yes’, how often do you visit the restored marshes?**
- (a) Rarely (1–2 times per year).
  - (b) Often (3–6 times per year).
  - (c) Very often (> 6 times per year).
- (8) **Did you visit the restored marshes before the restoration project was carried out?**
- (a) Yes
  - (b) No
- (9) **When you visited the restored marshes, you were...**
- (a) Hiking.
  - (b) Fishing.
  - (c) Cycling.
  - (d) Running.
  - (e) Working (catch bait, fishing.. ).
  - (f) Bird-watching.
  - (g) Photography.
  - (h) Sailing.
  - (i) Others.
- (10) **Please order these images, with the first the most beautiful and the last the least attractive.**



(A)



(B)



(C)