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► **To cite this version:**

Mariam Maki Sy, Helene Rey-Valette, Charles Figuières, Monique Simier, Rutger de Wit. The impact of academic information supply and familiarity on preferences for ecosystem services. *Ecological Economics*, 2021, 183, pp.106959. 10.1016/j.ecolecon.2021.106959 . hal-03119760

**HAL Id: hal-03119760**

**<https://hal.science/hal-03119760v1>**

Submitted on 1 Feb 2021

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## **The Impact of Academic Information Supply and Familiarity on Preferences for Ecosystem Services**

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18

19 **Abstract**

20 Preferences elicitation can be a challenging exercise for citizens participating in assessment  
21 surveys. It is even more challenging when it comes to complex and unfamiliar ecosystems and  
22 the threatened ecosystem services they provide. Making people aware of the characteristics of the  
23 ecosystem services being valued is determinant for the assessment process. We investigated the  
24 impact of familiarity and academic information supply on people's preferences for twenty  
25 selected ecosystem services of French Mediterranean coastal lagoons. The results show that  
26 regardless of familiarity and information supply, there is a strong consensus about the highest  
27 importance of regulation and maintenance ecosystem services as well as environmental education  
28 and research opportunity ecosystem services. By contrast, nine of the cultural ecosystem services,  
29 together with two provisioning ecosystem services showed heterogeneous preferences among the  
30 different citizen groups. Using a combination of descriptive and inferential statistics these eleven  
31 ecosystem services split up into three clusters characterized as (i) contemplative leisure, (ii)  
32 heritage, and (iii) consumptive activities. Familiarity and academic information supply had a  
33 strong impact on the preferences for these three clusters of ecosystem services.

34 **Keywords:** preference elicitation, coastal lagoons, citizens' workshop, paternalism, cultural  
35 ecosystem services (CES), veil of ignorance

## 36 **1 Introduction**

37

38 Ecosystems are essential for human well-being. Therefore, understanding the link between  
39 ecological processes of ecosystems and human welfare is critical for a wide range of decision-  
40 making contexts (Fisher et al., 2009). Gathering information on complex ecosystem functioning  
41 and translating it into advantages society obtains from Nature has been widely carried out using  
42 the concept of ecosystem services (ESs) and through its economic valuation (see Costanza et al.,  
43 1997; Daily et al., 1997; Dendoncker et al., 2014; La Notte et al., 2015). ESs valuation includes  
44 assessing trade-offs among different options (e.g. ESs, ecological restoration projects, planning  
45 scenarios ...). Hence, in general, it is based on assigning relative importance to nature's diverse  
46 benefits to humans (Jacobs et al., 2016), and this process could facilitate more adequate  
47 conservation choices (Salles and Figuières, 2013).

48

49 In ecosystem goods and services related valuation practices, there is an ongoing debate about the  
50 process on how to achieve the preference elicitation (e.g. Dendoncker et al., 2014; Kenter et al.,  
51 2015; 2016; Jacobs et al., 2016; 2018). So far, little is known on how existing valuation methods  
52 actually elicit the different values (Jacobs et al., 2018). In this area, increasing research attention  
53 is focused on the development of non-monetary valuation methods in favor of multi-criteria  
54 approaches allowing to better study the justification for compromises between objectives of  
55 efficiency, fairness and sustainability (Costanza, 2020). Preferences elicitation can be a  
56 challenging exercise for citizens involved in assessment surveys especially when it comes to  
57 complex and unfamiliar goods or services. For instance, nature services like water purification or  
58 climate regulation are generated by a complex interplay of natural cycles (Daily et al., 1997),  
59 which is often hardly understood by the majority of the citizens. Even many researchers, often  
60 highly specialized in their disciplines, may have difficulties in fully understanding the complex  
61 interplay. In Economics literature, the easiest-to-study situation is when individuals have  
62 preferences for goods and services with diverse characteristics about which they are well  
63 informed, and when their preferences are exogenous and reliable (O'Neill and Spash, 2000). This  
64 ideal situation is considered as the benchmark for which using a standard kind of rationality, it  
65 has been postulated that individuals maximize their correctly understood self-interest i.e. personal  
66 benefit (Yamagishi et al., 2014).

67

68 However, many findings show that respondents involved in preference elicitation surveys are  
69 often not familiar and often do not hold appropriate information on the ecosystem goods and  
70 services being assessed (Whitehead and Blomquist, 1991; Hanley and Munro, 1992; Spash and  
71 Hanley, 1995; Blomquist and Whitehead, 1998; Lewan and Söderqvist, 2002; LaRiviere et al.,  
72 2014; Brahic and Rambonilaza, 2015; Czajkowski et al., 2016; Ami et al., 2018; De Ville  
73 D'Avray, 2018). Realistically, some ESs are clearly perceived by people while others are not (De  
74 Groot et al., 2012). In contrast, we assume that at least part of the relevant knowledge emanates  
75 from the citizens themselves, i.e. from their experience and the familiarity they have acquired  
76 with the natural environment. Hence, not only indigenous people (Díaz et al., 2018), but also  
77 citizens in Western countries that are familiar with ecosystems have often acquired local  
78 knowledge that is complementary to the scientific knowledge. This may comprise both  
79 knowledge about their ecology, i.e. the local ecological knowledge (LEK) identified in  
80 ethnobiology (Narchi et al., 2014), and the knowledge of their benefits for society.

81

82 The citizens' preferences are based on perceptions, which sometimes hide a lack of knowledge  
83 about ecosystems and the services they provide. These perceptions could, nevertheless, change  
84 progressively as more information is provided. The external information that citizens often do not  
85 possess *a priori* (Costanza, 2004) can be acquired either through increased familiarity with the  
86 ecosystems, or from academic information, or from a combination of both. Citizens who live in  
87 the proximity of the focal ecosystem or regularly visit it during holidays become familiar,  
88 meaning that they are well acquainted with this ecosystem. Personal appreciations may be based  
89 either on affection alone or on a combination of affection with increased knowledge (Van Giesen  
90 et al., 2015). Depending on the individual, familiarity may result in increased affection for and  
91 cognitive knowledge of the ecosystem. In contrast, the supply of academic information only  
92 targets to increase the cognitive knowledge of the recipient citizens. For instance, Ami et al.  
93 (2018) reported that the impact of scientific information about the effects of air pollution on  
94 respondents' preferences, expressed as their willingness to pay (WTP) values, was strong. A  
95 proportion of people (30%) receiving scientific information revised their WTP upwards relative  
96 to the mean WTP value. Similarly, presenting survey participants with objective signal regarding  
97 the accuracy of their knowledge about a public good caused a significant increase in their  
98 preferences (i.e., their WTP) for it (LaRiviere et al., 2014). Also, Czajkowski et al. (2016)  
99 observed the effects of different information sets on subjects' preferences for a public good.

100

101 This study analyses the determinants of preferences for ESs of coastal lagoons related to the level  
102 and type of access to information. More precisely, the aim is to test the hypothesis according to  
103 which familiarity and academic information impact citizens' preferences for the relative  
104 importance of the different coastal lagoon ESs. This study of questions related to information  
105 strengthening the intrinsic motivations for ESs conservation allows us to integrate the issues of  
106 prioritizing measures of institutional, organizational and behavioral change. It is about studying  
107 the conditions of acceptance and the legitimacy of these changes following the logic of collective  
108 action and behavioral economics rather than public action based on financial incentives or  
109 technical measures. This represents a dynamic approach that emphasizes individual and  
110 collective learning within governance mechanisms and for which the role of perceptions and  
111 information is essential.

112

113 We used the Palavas lagoons' complex, which comprises seven coastal lagoons on the  
114 Mediterranean coast close to the city of Montpellier (South of France), as our case study. Coastal  
115 lagoons are shallow water bodies located at the continent-sea interface. They are permanently or  
116 temporarily connected to the sea through inlets and are subjected to a flow of fresh water from  
117 the watershed. In addition to supporting a rich flora and fauna, lagoon areas have always been of  
118 great interest to humans (Newton et al., 2014). For instance, they are often used for recreational  
119 and commercial activities such as amateur fishing, bird watching, professional fishing, shellfish  
120 farming, etc. In most cases, lagoon systems face anthropogenic stressors such as the destruction  
121 of ecological habitats along the coastline, the discharge of wastewater, chemical contaminants,  
122 overfishing, invasive species introduced by human activity, intensive aquaculture, climate change  
123 or tourism (Kennish et al., 2014; Turner et al., 2000).

124

125 To test the role of information on preferences, a survey was carried out among two types of  
126 populations: inhabitants near the Palavas lagoons complex and a panel of citizens at the national  
127 level living in non-coastal areas. In order to disentangle the impact of academic information and  
128 familiarity on preferences, we controlled as much as possible the factors of change between these  
129 populations (e.g. demographic characteristics). Preferences were elicited using non-monetary ESs  
130 assessment through the Majority Judgement approach borrowed from Social choice literature  
131 (Balinski and Laraki, 2010). We carried out an analysis combining descriptive statistics and an

132 econometric model to test our hypothesis. Section 2 details the material and methods used.  
133 Sections 3 to 5 present, discuss, justify and conclude the main results.

134

## 135 **2 Material and methods**

### 136 **2.1 Study area**

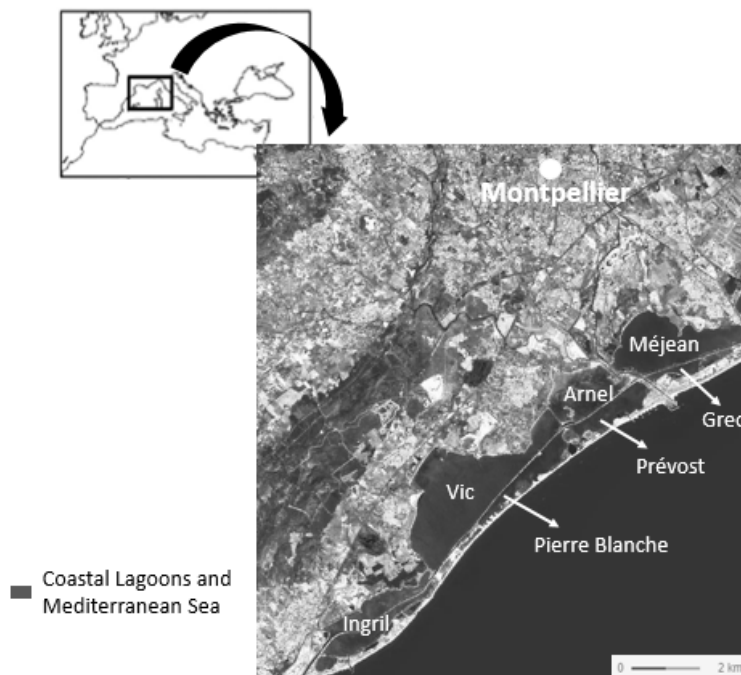
137 The Palavas lagoons complex is located in the southern part of France bordering the Gulf of Lion  
138 in the Mediterranean Sea (see Figure 1). In addition to the lagoons, the study site comprises also  
139 peripheral riparian zones such as wetlands, pasture and other natural areas. Palavas lagoons are  
140 representative of shallow lagoons (mean depth < 2 m) nearby an urban area, predominantly  
141 natural while used in the same time for recreational and fishing activities. Water quality in the  
142 lagoons had been strongly impacted by human activities mainly due to nutrient over-enrichment  
143 which occurred during more than four decades since the 1960's (De Wit et al., 2017; Sy et al.,  
144 2018). Climate change effects, in particular sea level rise, the increase in temperature or the  
145 variation in freshwater availability, could also have ecological consequences on the lagoons  
146 (Kuhfuss et al., 2016). In response to these issues, ecological restoration targeting good water  
147 quality and good ecological status were initiated by decision makers (De Wit et al., 2017; Leruste  
148 et al., 2016; De Wit et al., 2020). For instance, in 2005, the implementation of an 11-km offshore  
149 outfall system diverted the treated sewage effluents leading to a drastic reduction of  
150 anthropogenic inputs of nitrogen and phosphorus into the lagoons (Leruste et al., 2016; De Wit et  
151 al., 2020). Moreover, the area is a Natura 2000 site and also received the Ramsar designation as  
152 wetland of international importance in 2008 (Sy et al., 2018). The main characteristics of the  
153 Palavas lagoons are presented in Table 1 (adapted from Sy et al., 2018).

154

|   | Palavas lagoons   |
|---|---|
| Surface   |   |
| <i>Total lagoon surface</i>                     | 3,880 ha  |
| <i>Fringing wetland surface</i>                 | 2,120 ha  |
| <i>Watershed surface</i>                        | 60,000 ha   |
| Geographic coordinates                          | 43.51°N – 3.88 °E   |
| Average depth                                   | 0.4 m <sup>(2)</sup> to 1.2 m <sup>(3)</sup>  |
| Population                                      |   |
| <i>Main urban center (population size)</i>      | Montpellier (260,000 inhabitants)   |
| <i>Total population in watershed</i>            | 420,000 inhabitants   |
| Trophic status before management implementation | <i>Mesotrophic</i> <sup>(4)</sup> to <i>hypertrophic</i> <sup>(5)</sup>                               |
| Environmental management measures               |   |
| <i>Natura 2000</i>                              | <i>SCI</i> <sup>(6)</sup> - 6,600 ha (FR9101410);<br><i>SPA</i> <sup>(7)</sup> - 6,600 ha (FR9110042) |
| <i>Ramsar</i>                                   | Since 2008  |

156 Note: (1) The Palavas lagoons complex comprises 7 different lagoons that were created by compartmentalization of a  
 157 historic large lagoon; (2) Grec and Arnel lagoons; (3) Prévost lagoon; (4) Ingril lagoon; (5) Méjean and Grec  
 158 lagoons; (6) FR9101410 - SCI = Site of Community Interest (Habitats Directive); (7) FR9110042 - SPA = Special  
 159 Protection Area (Birds Directive). Note: the total area of the Natura 2000 site includes the Estagnol nature reserve.  
 160

161



162

163 *Figure 1. Palavas lagoons complex. Satellite images from IGN-Géoportail.*  
 164

## 165 2.2 Survey characteristics and data collection process

166 The surveys were conducted among randomly selected local citizens near the Palavas lagoons  
167 and non-local citizens living in non-coastal municipalities in France (see Table 3). Local citizens  
168 encountered either in the urban centers or walking on footpaths along the littoral zone of the  
169 Palavas lagoons were invited to participate in citizen workshops. The invitation was often  
170 received with interest and a certain degree of enthusiasm. However, despite our phone call the  
171 day before the workshops, it turned out that only a small fraction of the people solicited accepted  
172 and showed up at the citizen workshops (N = 38 in total, approximately 1 out of 10 of the solicited  
173 individuals). We realized that this number represent a relatively small sample of the total  
174 population, although workable for an analysis. This is the consequence of requesting more time  
175 availability than in classical surveys. Therefore, we used Coarsened Exact Matching (CEM)  
176 technique when this small sample was compared with the larger samples used for the internet  
177 survey (see section 2.3.1). The citizen workshops were carried out in May and June in 2017 and  
178 2018 with the 38 local residents living within a radius of 15 km from the study site. The  
179 demographic characteristics of the surveyed local residents are presented in Table 2. We  
180 compared the demographic characteristics of our sample to the ones of two municipalities,  
181 Villeneuve-lès-Maguelone and Lattes, which are among the most represented municipalities in  
182 our sample.

183

184 Generally, the citizens participating in the workshops represented a sample representative of local  
185 populations of Villeneuve-lès-Maguelone and Lattes for gender, education and median income  
186 (see Table 2). However, there was a difference in the proportions associated with age groups  
187 between this sample and the populations of the two municipalities. This difference might be  
188 explained by the fact that these municipalities are suburban with relatively more active young  
189 workers. Similarly, the difference in the median incomes can be explained by the fact that we  
190 have in our sample only individuals whose income are taxable, contrary to those of the  
191 populations of the considered municipalities.

192



193 *Table 2. Demographic characteristics of the surveyed local residents*

|  | Sample | Villeneuve | Lattes |
|--|--------|------------|--------|
|  | %      | %          | %      |
| Gender                                     |        |            |        |
| <i>Female</i>                              | 42.1   | 48.0       | 52.0   |
| Age (years)                                |        |            |        |
| <i>18-39</i>                               | 18.4   | 46.0       | 40.8   |
| <i>40-59</i>                               | 28.9   | 26.0       | 23.6   |
| <i>&gt; 60</i>                             | 52.6   | 28.0       | 35.6   |
| Education                                  |        |            |        |
| <i>Baccalaureate, certificates or none</i> | 47.4   | 51.0       | 58.6   |
| <i>Higher</i>                              | 52.6   | 49.0       | 41.4   |
| Median income (euros/year)                 | 29 723 | 21 720     | 24 370 |

Source : *The National Institute of Statistics and Economic Studies (INSEE) - Data of 2017.*

194  
 195 Note: the difference in the median incomes can be explained by the fact that we have in our sample only individuals  
 196 whose incomes are taxable, contrary to those of the populations of Villeneuve-lès-Maguelone and Lattes.  
 197

198 The survey involving 803 non-local citizens was carried out online in June 2018. From the data  
 199 set obtained, we retained the responses of two groups for the analysis. These groups were (i) a  
 200 subsample of 115 non-local citizens that are familiar with the lagoons and (ii) a subsample of 289  
 201 non-local citizens that are unfamiliar with the lagoons. We introduced the notion of familiarity to  
 202 indicate the proximity and frequency of visits of these lagoons. Non-local citizens who are  
 203 familiar with the lagoons reported that they visit them very regularly (i.e. more than two times  
 204 per year). Conversely, those who are unfamiliar with the lagoons never visited them. Hence,  
 205 among the surveyed 803 non-local citizens, we did not include in our analysis those who only  
 206 visited the lagoons once or twice.

207  
 208 Data were collected for both surveys using the same questionnaire (see the content of the  
 209 questionnaire in Appendix A) which was composed of two series of questions as recommended  
 210 in the literature on perceptions of ESs (see Blayac et al., 2014): open and spontaneous as well as  
 211 closed questions, mainly on perceptions of the activities and the characteristics of the lagoons  
 212 area (see Table 3).

213

214 *Table 3. Characteristics of the surveys and the surveyed population types*  
 215

| Population type                 | Non-Local Residents   |                 | Local Residents        |             |
|---------------------------------|---|-----------------|------------------------|-------------|
|                                 | Unfamiliar  | Familiar        | Local                  | Local bis   |
| Number of surveyed individuals  | 289   | 115             | 38                     |             |
| Familiarity with the study site | Never visited   | Regularly visit | Familiar               |             |
| Data collection method          | On line   |                 | Workshop               |             |
| Survey period                   | June 2018   |                 | May-June 2017 and 2018 |             |
| Perception type                 | Existing  |                 | Existing               | Constructed |
| Information supply              | None  |                 | None                   | Academic    |
| Questionnaire type              | Open, spontaneous and closed questions (37 questions)   |                 |                        |             |
| Categories of the questions     | Familiarity and use of the lagoons complex, preference elicitation questions for ecosystem services provided by the lagoons complex, level of knowledge of the lagoons complex and the services they provide, socio-demographic related questions |                 |                        |             |

216  
 217  
 218 A list of twenty ESs (see Table B in Appendix B) was selected before by focus groups of  
 219 scientists and lagoon managers. These ESs was considered as the relatively most important ESs,  
 220 in terms of conservation, provided by Palavas lagoons based on an original selection of 31 ESs  
 221 (see Sy et al., 2018). The general definition of the ESs was adapted from Liqueste et al. (2013),  
 222 who provided a classification of coastal ES that is now integrated in CICES 5 (Haines-Young and  
 223 Potschin, 2018). The twenty selected ESs were presented in a randomized order in the survey,  
 224 without any reference to ES categories. Preferences were elicited for the different ESs using the  
 225 Majority judgment (MJ), a voting method introduced by Balinski and Laraki (2010). We  
 226 borrowed MJ from Social Choice theory and to our knowledge it has never been used in research  
 227 related to environmental issues. Our MJ for ESs ranking is an absolute non-monetary method in  
 228 the sense that each ES is judged by its merit or grade in a common language independently from  
 229 the other services. According to work in the field of Social Choice, this type of ranking is  
 230 considered to offer a more robust selection basis (Balinski and Laraki, 2010).

231  
 232 The respondents indicated their individual preferences for the different ESs by answering the  
 233 following question: “What do you think are the most important roles of the Palavas lagoons in  
 234 terms of conservation priority? Please check the box associated with each role according to its  
 235 level of conservation priority”. The list of the considered ESs (i.e. the roles) was presented in the  
 236 rows of a table and the columns presented different levels of conservation priority i.e. ‘high  
 237 priority’, ‘priority’, ‘neutral’, ‘low priority’, ‘not a priority’.

238

239 Responses of the local citizens were obtained during a workshop. Several workshop sessions  
240 were organized to vary the meeting places and facilitate discussions between participants (see  
241 Table 4). They were scheduled at the end of the day at 6.30 p.m. in order to allow the  
242 participation of people with a job. There were between 4 and 6 experts for each session, including  
243 three co-authors of the paper, so that they could easily facilitate and observe the discussions in  
244 the groups.

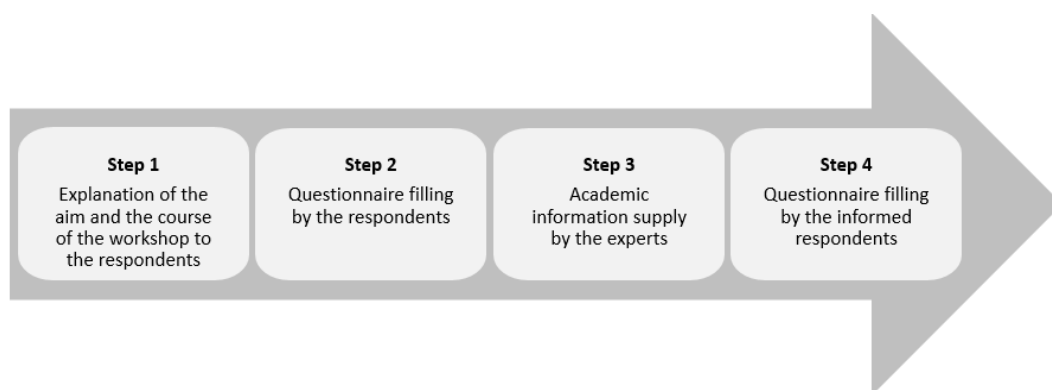
245

246 *Table 4. Workshop organization*

| Municipalities           | Date          | Number of participants | Workshop duration |
|--------------------------|---------------|------------------------|-------------------|
| Villeneuve-lès-Maguelone | May 22, 2017  | 20                     | 3h                |
| Lattes                   | June 19, 2017 | 8                      | 2h30              |
| Mireval                  | May 24, 2018  | 10                     | 2h30              |

247

248 The course of the workshop sessions is shown in Fig. 2. After an introduction, the respondents  
249 completed, individually and unaided, the questionnaire on paper. This latter part lasted between  
250 30 and 45 minutes. Subsequently, the academic information was provided by the experts in the  
251 form of oral presentations with the use of a PowerPoint support. A moment of conviviality  
252 around a drink closed each session by informally collecting the impressions of the participants  
253 regarding the interest of the session. In total the sessions lasted between 2:30 and 3 hours.



254

255 *Figure 2. The course of the workshop session.*

256

257 The academic information supply session lasted about an hour. The presentations focused on ESs  
 258 as well as aspects related to the ecological functioning, socio-economic dynamics and  
 259 management of the Palavas lagoons and their immediate surrounding areas see Table 5.

260

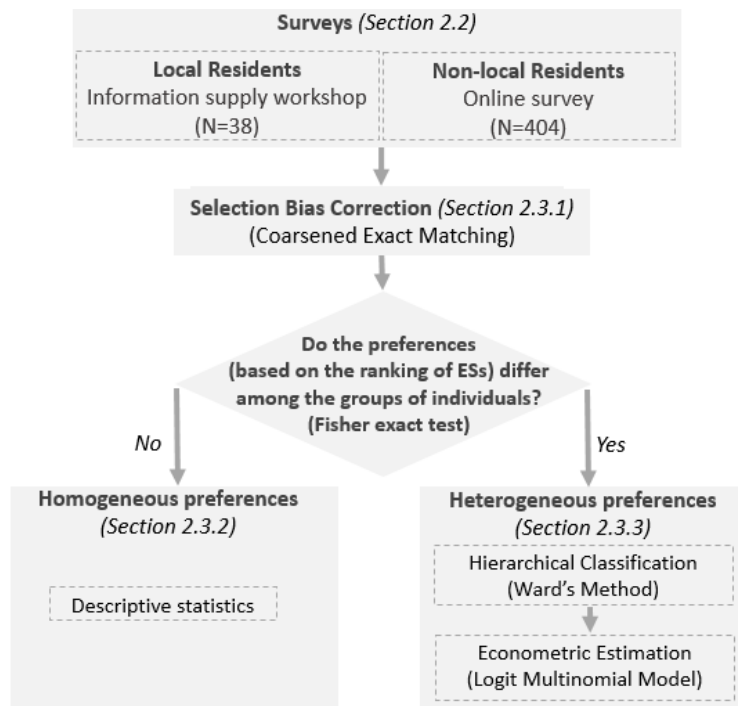
261 *Table 5. Details of the academic information provided*

| <b>Information type</b>   | <b>Details</b>   |
|---|--|
| Ecological functioning of the Palavas lagoons complex               | General information on the lagoons: definition, Mediterranean lagoons, natural history<br>Salinity, hydrogeological functioning, ecological interest<br>Issues: global warming and sea level rise, eutrophication, artificialization of the coast, the costs of restoring the lagoons<br>Some emblematic species of the Palavas lagoons complex  |
| Socio-economic dimensions of the Palavas lagoons complex management | Definition of the concept of value<br>The distinction between use and non-use values and the total economic value<br>Evolution of the lagoons' management policies: the effects of the management policies, from causes at sectoral scales to ecosystem-based and concerted approaches<br>Frameworks for analyzing interactions between nature and society: DPSIR (drivers, pressures, state, impact and response model of intervention) and ecosystem services<br>Local well-being assessment frameworks<br>The contributions of the lagoons to territorial well-being<br>Ways to measure the connection and attachment to nature |

262

### 263 2.3 Data treatment process

264 The overall work flow for data collection and treatment is presented in Figure 3. First, disparities  
 265 in sample sizes and characteristics of the different resident groups (see section 2.2) were  
 266 corrected using Coarsened Exact Matching (CEM) (see section 2.3.1). The second step consisted  
 267 of identifying ESs for which preferences were either homogeneous or heterogeneous among the  
 268 different groups of respondents. Then, we assumed that there were no impacts of academic  
 269 information and familiarity on those ESs for which preferences were homogeneous (see sections  
 270 2.3.2). The final step of the analysis consisted of identifying factors explaining the heterogeneity  
 271 of preferences for the remaining ESs using a logit multinomial model (see section 2.3.3).



272

273 *Figure 3. The work flow for data collection and treatment processes*

274

### 275 2.3.1 Correcting selection bias

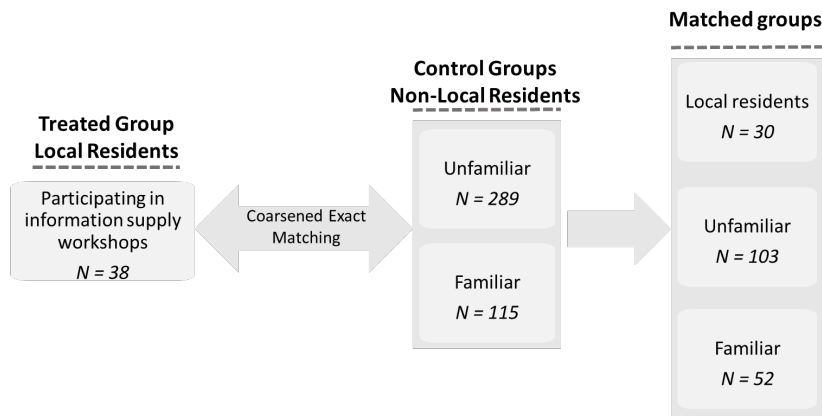
276

277 The characteristics and number of observations of the surveyed populations are different (see  
 278 Table 3). This selection bias was corrected using the CEM approach introduced by Iacus et al.  
 279 (2011). The main results are presented in the online supplementary material. The key goal of  
 280 matching is to prune observations from the data so that the remaining data have better balance  
 281 between the matching groups (Iacus et al., 2012). The authors demonstrated how CEM generates  
 282 matching solutions that are better balanced than methods under the older existing class based on  
 283 propensity scores, Mahalanobis distance, nearest neighbors, and optimal matching (Iacus et al.,  
 284 2011).

285

286 We applied CEM using four main covariates which are age, gender, level of education and  
 287 income. First, each covariate was coarsened using discrete values associated to the corresponding  
 288 nominal categories. For instance, the covariate age was coarsened replacing the nominal  
 289 categories 18 – 39 years, 40 – 59 years and 60 and over by 0, 1 and 2 respectively. Second, exact  
 290 matching between the treated and control groups was applied using the values of the coarsened  
 291 covariates. This step required sorting each observation into a stratum which includes unique  
 292 values of the coarsened covariates. Finally, the selected strata were those containing at least one

293 control and treated units. The strata with only control units were discarded. Treatment units that  
 294 did match simultaneously with control units from both the non-local resident groups were also  
 295 discarded. The control and treated groups are specified in Figure 4.



296

297 *Figure 4. Coarsened Exact Matching (CEM) of the control and treated groups*  
 298

### 299 2.3.2 Identification of ecosystem service presenting homogeneous preferences 300

301 Cross-tabulations and Fisher’s exact tests allowed to test the correlation of each ES with the  
 302 variable corresponding to the typology of the surveyed populations. In other words, the aim was  
 303 to identify ESs for which preferences were homogeneous regardless of population type. The  
 304 groups of respondents in question were the matched 30 local residents (before receiving academic  
 305 information), the same 30 matched local residents after receiving academic information), 52  
 306 matched familiar and 103 matched unfamiliar non-local citizens with the Palavas lagoons (see  
 307 Figure 4). Further Fisher’s exact tests were realized to analyze the relation between the identified  
 308 homogeneous preferences for ESs and the other explanatory variables presented in Table 6.

309

### 310 2.3.3 Analysis of ecosystem services presenting heterogeneous preferences 311

312 The remaining ESs that did not present homogeneous preferences for ESs among the groups of  
 313 respondents were analyzed separately. The aim was to identify explanatory factors that might  
 314 explain heterogeneity in preferences for the considered ESs. More precisely, we tested the impact  
 315 of several explanatory variables on the respondent choices for these ESs. The considered  
 316 explanatory variables included the variable “population type” (informed, uninformed, familiar or  
 317 unfamiliar), “age”, “gender”, “level of knowledge of Palavas lagoons” ... (see Table 6). To this

318 end we used a logit multinomial model as in Blayac et al. (2014). The dependent variable that  
 319 comprised different levels of ES categories was created through identifying different clusters (or  
 320 categories) of these ESs using Principal Component Analysis (PCA) followed by Ward’s  
 321 hierarchical classification (HC) method. Hence this clustering of ESs, in contrast to the use of  
 322 standard classification schemes (e.g. Liqueste et al., 2013; Millenium Ecosystem Assessment,  
 323 2005; TEEB, 2010), emerged from the respondents' preferences, based on the attributed levels of  
 324 priority. Only ESs within the identified clusters that contributed the most to the PCA axis were  
 325 retained. The dependent variable was then constructed by calculating an average score for each  
 326 cluster of ESs which were generated using Ward’s HC method. The preference for a cluster of  
 327 ESs for each respondent corresponded to the one with the maximum mean score.

328 A multinomial logit model was then used to estimate the preference for a cluster of ESs given a  
 329 set of qualitative explanatory variables (see Table 6). The model corresponds to choice  
 330 probabilities for the different ESs clusters (Blayac et al., 2014). Formally, the choice probabilities  
 331 are:

$$332 \quad Prob(Y = Cluster\ 1) = \frac{\exp(Z_{Cluster\ 1})}{1 + \exp(Z_{Cluster\ 1}) + \exp(Z_{Cluster\ 2})}$$

$$333 \quad Prob(Y = Cluster\ 2) = \frac{\exp(Z_{Cluster\ 2})}{1 + \exp(Z_{Cluster\ 2}) + \exp(Z_{Cluster\ 1})}$$

$$334 \quad Prob(Y = Reference\ cluster) = \frac{1}{1 + \exp(Z_{Cluster\ 1}) + \exp(Z_{Cluster\ 2})}$$

335 where  $Z$  is the coefficient vector including the intercept.

336  
 337 At first, we had a list of fourteen explanatory variables. To verify whether or not there was a  
 338 multicollinearity (correlation within the explanatory variables), we performed the Cramer’s V  
 339 test. After the test, we retained eight explanatory variables (see Table 6) out of the fourteen  
 340 previously listed. Moreover, interaction effects were observed for the retained variables  
 341 ‘population type’ and ‘donation to an environmental association’ as well as both variables  
 342 characterizing levels of knowledge. In addition, there were interaction effects between the  
 343 variables ‘donation to an environmental association’ and both variables characterizing levels of  
 344 knowledge. Finally, there was an interaction effect between both variables characterizing levels  
 345 of knowledge.

346

347 *Table 6. Factors explaining preferences for ecosystem services. The referent levels are indicated in bold.*

| Variable                     | Sub-Category                               | Full name                                | Level                                 |
|------------------------------|--|--|---------------------------------------|
| Dependent                    | Ecosystem services clusters                | Ecosystem services clusters              | Cluster 1                             |
|                              |  |  | Cluster 2                             |
| Explanatory                  | Population type                            | Type                                     | <b>Reference cluster</b>              |
|                              |  |  | <b>Unfamiliar non-local residents</b> |
|                              |  |  | Familiar non-local residents          |
|                              |  |  | Local residents                       |
|                              |  |  | Informed local residents              |
|                              | Sociodemographic characteristics           | Age ( <i>years</i> )                     | <b>18-39</b>                          |
|                              |  |  | 40-59                                 |
|                              |  |  | 60 and up                             |
|                              |  | Gender                                   | Female                                |
|                              |  |  | <b>Male</b>                           |
|                              |  | Education                                | <b>High school degree or none</b>     |
|                              | Bachelor                                   |  |                                       |
|                              | Income ( <i>euros per month</i> )          | Master and up                            |                                       |
| <b>750-1500</b>              |  |  |                                       |
| 1500-3000                    |  |  |                                       |
| 3000 and up                  |  |  |                                       |
| Behavior towards environment |  | Donation to an environmental association | <b>No</b>                             |
|                              | Yes  |  |                                       |
| Level of knowledge           | Perceived knowledge of Palavas lagoons     | <b>Limited</b>                           |                                       |
|                              |  | Average                                  |                                       |
|                              | Heard of the concept of ecosystem services | Good                                     |                                       |
|                              |  | <b>No</b>                                |                                       |
|                              |  | Yes                                      |                                       |

348  
349 The overall quality of the multinomial logit model was verified using Akaike Information  
350 Criterion (AIC). The aim was to progressively remove interaction effects and single explanatory  
351 variables that have no significant impact on the dependent variable from the general model, until  
352 the final model with the lowest AIC criterion was reached. The obtained final nested model was  
353 then validated based on two hypotheses testing i.e. the Likelihood ratio test and the Hausman and  
354 McFadden test. First, the choice for the nested model relative to the initial model was verified  
355 through the Likelihood ratio test. The null hypothesis consisted of choosing the final nested  
356 model. Secondly, the final nested model was validated through the independence of irrelevant  
357 alternatives (IIA) assumption using the Hausman and McFadden test (Hausman and McFadden,  
358 1984). This hypothesis is tested to ensure that removing any alternative (here, a cluster of ESs)  
359 from the dependent variable does not affect the odds of the remaining alternatives.



### 360 3 Results

#### 361 3.1 Coastal lagoon ESs: homogenous versus heterogeneous preferences of ESs among groups 362 of respondents

363 Table 7 lists the results of the Fisher's exact tests, which allowed us to identify whether the  
364 preferences for these different ESs were homogeneous among the four groups (ESs marked in  
365 italics,  $H_0$  retained,  $p > 0.05$ ) or heterogeneous (ESs marked in bold,  $H_0$  rejected,  $p < 0.05$ ).  
366 Eleven out of the twenty ESs presented heterogeneous preferences, and the remaining nine ESs  
367 presented homogeneous preferences. Interestingly, the latter included all five regulation and  
368 maintenance ESs as well as both environmental education and research opportunity ESs. Thus,  
369 regardless of familiarity and academic information supply, regulation and maintenance services  
370 as well as cognitive effects related services were judged as a priority by at least 90% of the  
371 respondents (see Table C in Appendix C). In addition, preferences of recreational hiking and  
372 walking ES and of fish resources ES were homogeneous, although both ESs were favored to a  
373 lesser degree compared to the former ones. The same results were also observed for the  
374 unmatched data (see Table C in Appendix C). Thus, preference elicitation of these services was  
375 very robust and did not change after applying CEM.

376  
377 Specific questions allowed to study the pertinence of possible factors explaining choices for those  
378 ESs presenting homogeneous preferences among the four groups of citizens (see Table 8). Hence,  
379 more than 98% of the respondents, who declared having either a good or a limited level of  
380 knowledge of the Palavas lagoons and the associated ESs, favor the regulation and maintenance  
381 ESs. The level of priority attributed to environmental education and research opportunity ESs  
382 increases with age. For instance, 70.6% of the respondents that are 18–39 years old favor these  
383 services against up to 90.6% for the 60 years and above.

384

385 Table 7. The set of the twenty ecosystem services (ESs) used in this study. The ESs have been categorized according  
 386 to the classification designed for coastal and marine ESs by Liqueste et al. (2013) and currently included in CICES  
 387 version 5.1 (Haines-Young and Potschin, 2018). Fisher's exact tests were performed to test for the homogeneity of  
 388 preferences among the four groups of citizens (see section 2.2). Hence, ESs in italics presented homogeneous  
 389 preferences among the four groups of citizens. ESs in bold presented heterogeneous preferences among the four  
 390 groups.

| ES category                    | Ecosystem service  | Fisher exact test (p value) |
|--------------------------------|--|-----------------------------|
| Provisioning                   | <b>Biomass for grazing</b>   | p < 0.001***                |
|                                | <b>Shellfish farming</b>   | p < 0.001***                |
| Regulation and maintenance     | <i>Fish resources</i>  | 0.264                       |
|                                | <i>Water purification capacity</i>                                 | 0.298                       |
|                                | <i>Flooding and other extreme events regulation and protection</i> | 0.235                       |
|                                | <i>Banks reinforcement</i>   | 0.196                       |
|                                | <i>Microclimate regulation</i>                                     | 0.393                       |
|                                | <i>Nursery and biodiversity maintenance</i>                        | 0.281                       |
| Cultural                       | <b>Aesthetic value of landscapes</b>                               | p < 0.001***                |
|                                | <b>Local identity</b>  | p < 0.001***                |
|                                | <b>Aesthetic value of habitats or species</b>                      | p < 0.001***                |
|                                | <b>Historical sites</b>  | p < 0.001***                |
|                                | <b>Non-motorized water sport</b>                                   | p < 0.001***                |
|                                | <b>Bird watching</b>   | p < 0.001***                |
|                                | <b>Waterfowl hunting</b>   | p < 0.001***                |
|                                | <b>Sentiment of relaxation</b>                                     | 0.002**                     |
|                                | <i>Recreational hiking and walking</i>                             | 0.289                       |
|                                | <b>Recreational fishing</b>  | p < 0.001***                |
|                                | <i>Research opportunity</i>  | 0.869                       |
| <i>Environmental education</i> | 0.464  |                             |

391

### 392 3.2 Descriptive and inference statistics for ESs showing heterogeneous preferences among 393 groups of respondents

394 The clustering of the eleven ESs, for which preferences were heterogeneous among the  
 395 respondents, resulted in the identification of three clusters i.e. three levels of the dependent  
 396 variable (see Figure 5). We attributed descriptive qualifications to these three clusters based on  
 397 the following interpretations. The cluster comprising two cultural ESs, i.e. historical site and local  
 398 identity, is referred to as cultural heritage and was, therefore, named as 'Heritage'. The cluster  
 399 comprising the cultural ESs 'aesthetic value of habitats or species', 'aesthetic value of  
 400 landscapes', 'bird watching' and 'sentiment of relaxation' relates to leisure activities based on the  
 401 contemplation of the lagoon ecosystem rather than on the consumption of its resources.  
 402 Therefore, this cluster has been defined as 'contemplative leisure'. The cluster with the remaining

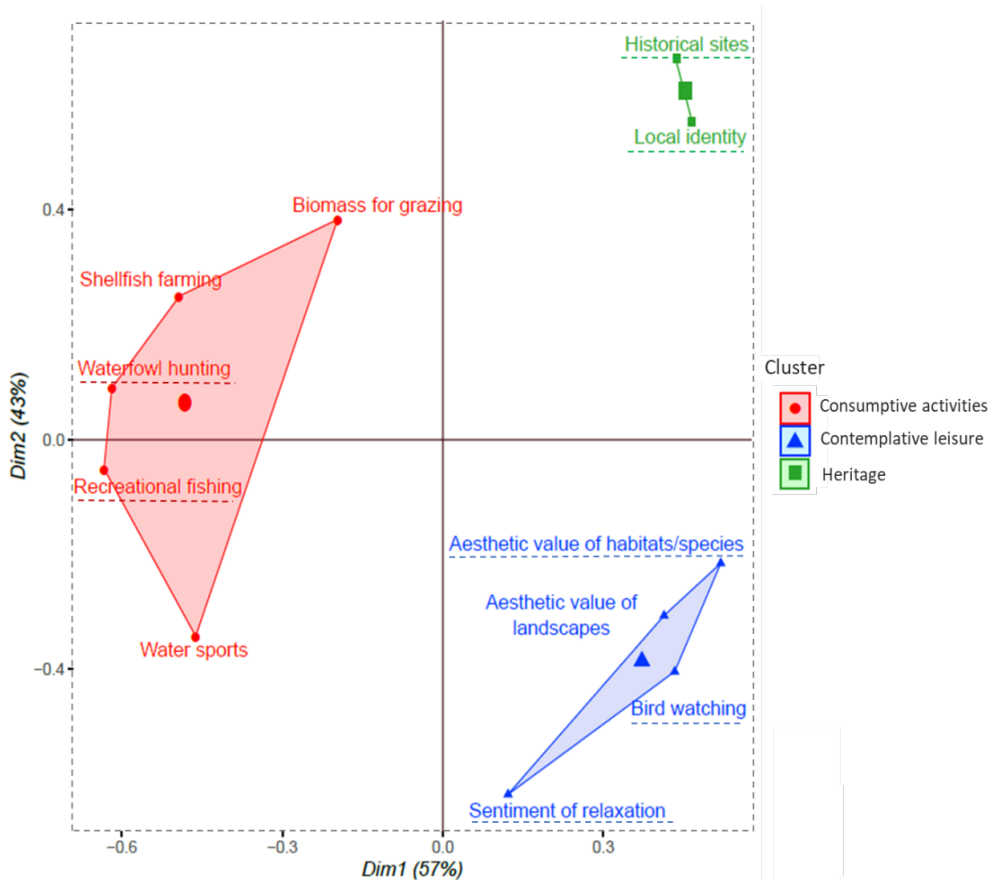
403 five ESs all of which imply consumption of natural resources, either for provisioning or for  
 404 leisure, has been defined as ‘consumptive activities’.

405 *Table 8. Factors explaining the level of priority attributed to ecosystem services presenting homogeneous*  
 406 *preferences among groups of citizens. P, N and NP stand for “Priority”, “Neutral” and “Not a priority”*  
 407 *respectively.*  
 408

| Explanatory variable                       | Level          | Regulation and maintenance |       |        | Fish resources |       |        | Recreational hiking and walking |       |        | Environmental education and research opportunity |       |        |
|--|----------------|----------------------------|-------|--------|----------------|-------|--------|---------------------------------|-------|--------|--|-------|--------|
|  |                | P (%)                      | N (%) | NP (%) | P (%)          | N (%) | NP (%) | P (%)                           | N (%) | NP (%) | P (%)  | N (%) | NP (%) |
| Heard of the concept of ecosystem services | <i>P-Value</i> | <b>0.030**</b>             |       |        | 0.964          |       |        | 0.808                           |       |        | 0.121  |       |        |
|  | Yes            | 98.8                       | 1.2   | 0.0    | 38.4           | 41.9  | 19.8   | 60.5                            | 25.6  | 14.0   | 90.7   | 8.1   | 1.2    |
|  | No             | 91.5                       | 8.5   | 0.0    | 37.2           | 41.1  | 21.7   | 59.7                            | 28.7  | 11.6   | 80.6   | 14.7  | 4.7    |
| Perceived knowledge of Palavas lagoons     | <i>P-Value</i> | <b>0.002***</b>            |       |        | 0.746          |       |        | 0.884                           |       |        | 0.543  |       |        |
|  | Good           | 98.6                       | 1.4   | 0.0    | 31.9           | 45.8  | 22.2   | 58.3                            | 29.2  | 12.5   | 88.9   | 8.3   | 2.8    |
|  | Average        | 86.8                       | 13.2  | 0.0    | 42.1           | 39.5  | 18.4   | 61.8                            | 23.7  | 14.5   | 81.6   | 13.2  | 5.3    |
|  | Limited        | 98.5                       | 1.5   | 0.0    | 38.8           | 38.8  | 22.4   | 59.7                            | 29.9  | 10.4   | 83.6   | 14.9  | 1.5    |
| Age (years)                                | <i>P-Value</i> | 0.718                      |       |        | 0.667          |       |        | 0.474                           |       |        | <b>0.012**</b>                                   |       |        |
|  | 60 and up      | 94.2                       | 5.8   | 0.0    | 40.6           | 39.9  | 19.6   | 61.6                            | 28.3  | 10.1   | 90.6   | 7.2   | 2.2    |
|  | 40-59          | 93.3                       | 6.7   | 0.0    | 35.0           | 41.7  | 23.3   | 60.0                            | 23.3  | 16.7   | 75.0   | 20.0  | 5.0    |
|  | 18-39          | 100.0                      | 0.0   | 0.0    | 23.5           | 52.9  | 23.5   | 47.1                            | 35.3  | 17.6   | 70.6   | 23.5  | 5.9    |

409 Note: the rows of the table correspond to the factors explaining the level of priority attributed to ecosystem services  
 410 presenting homogeneous preferences among groups of citizens. For the first row and first column for instance, the  
 411 table is read as follow: up to 98.8% of the responds who already heard of the concept of ESs before the survey  
 412 significantly consider regulation and maintenance services as a priority in terms of conservation. Likewise, 1.2% and  
 413 0% of these respondents are neutral about the conservation of regulation and maintenance services and consider them  
 414 as not of a priority for conservation, respectively.  
 415

416



417

418 *Figure 5. Classification of the 11 ecosystem services (presenting heterogeneous preferences among the groups of*  
 419 *respondents, in bold in Table 7) based on the results of the principal component analysis (PCA). The underlined*

420 *ecosystem services are the ones that contributes the most to the two axes. See Table B in Appendix B for the*  
421 *definitions of the corresponding ecosystem services.*  
422

423 The general logit multinomial model includes all the explanatory variables listed in Table 6. The  
424 reference variables are indicated in bold. Also, the ‘heritage’ cluster was used as the reference  
425 level of the independent variable. The final nested logit multinomial model was validated based  
426 on the results of the two hypotheses testing, i.e., the Likelihood ratio test and the IIA test. The  
427 econometric estimations are presented in Table 9. First, the choice for the nested model relative  
428 to the initial model was verified through the Likelihood ratio test. The null hypothesis consisted  
429 of choosing the final nested model. It was accepted based on the fact that the likelihood ratio test  
430 statistic (see “Chi2” in Table 9) was smaller than the theoretical chi-square with a margin of error  
431 of 5% and a degree of freedom (Df) of 54 in our case. Secondly, for the IIA assumption using the  
432 Hausman and McFadden test, the test statistic relative to the cluster consumptive activities was  
433 negative (-0.015, in Table 9). This is evidence that the IIA holds (Hausman and McFadden, 1984,  
434 P.1226 cited in Franses and Paap, 2003).

435

436 According to this final nested model (Table 9), compared to the unfamiliar non-local residents,  
437 the local residents are 5.8 times more likely to choose the ‘contemplative leisure’ ESs over  
438 ‘heritage’ ESs. However, this odds ratio decreased to 2.8 after academic information supply  
439 during the citizens’ workshops. In other words, relative to the ‘heritage’ ESs cluster and after  
440 receiving academic information, local residents’ preferences of the level of priority towards  
441 ‘contemplative leisure’ ESs decreased. Moreover, unfamiliar non-local residents were 0.23 and  
442 0.21 times less likely to choose contemplative leisure ESs and ‘consumptive activities’ ESs,  
443 respectively.

444

445 *Table 9. The final nested model issued from the econometric analysis. It explains the choices for the three clustered*  
 446 *categories of ecosystem services that presented heterogeneous preferences among the groups of citizens.*

| Variable  | Contemplative leisure vs. Heritage |               |                     |              | Consumptive activities vs. Heritage |               |         |           |
|---|------------------------------------|---------------|---------------------|--------------|-------------------------------------|---------------|---------|-----------|
|   | Estimate<br>(SE)                   | Odds<br>Ratio | Z value             | Pr (> Z )    | Estimate<br>(SE)                    | Odds<br>Ratio | Z value | Pr (> Z ) |
| <b>Type</b>   |                                    |               |                     |              |                                     |               |         |           |
| <i>Unfamiliar</i>   | Ref.                               |               |                     |              | Ref.                                |               |         |           |
| <i>Familiar</i>   | 0.014<br>(0.471)                   | 1.014         | 0.029               | 0.9771       | -0.054<br>(0.502)                   | 0.947         | -0.1084 | 0.9136    |
| <i>Informed local<br/>residents</i>                                     | 1.055<br>(0.476)                   | 2.872         | 2.217               | 0.0265*      | -0.584<br>(0.791)                   | 0.557         | -0.7309 | 0.4648    |
| <i>Local residents</i>  | 1.759<br>(0.461)                   | 5.807         | 3.817               | p < 0.001*** | -7.281<br>(23.018)                  | 0.001         | -0.3163 | 0.7517    |
| <b>_intercept</b>   | -1.490<br>(0.277)                  | 0.225         | -5.386              | p < 0.001*** | -1.555<br>(0.284)                   | 0.211         | -5.4725 | p < 0.00  |
| <b>Final nested model<br/>validation tests</b>                          | <b>Df</b>                          | <b>Chi2</b>   | <b>P-<br/>value</b> |              |                                     |               |         |           |
| <b>Likelihood ratio test</b>  | 54                                 | 62.544        | 0.199               |              |                                     |               |         |           |
| <b>Independence of<br/>irrelevant alternatives<br/>(IIA) assumption</b> |                                    |               |                     |              |                                     |               |         |           |
| <i>Heritage</i>   | 1                                  | < 0.001       | 0.999               |              |                                     |               |         |           |
| <i>Contemplative leisure</i>  | 1                                  | < 0.001       | 0.999               |              |                                     |               |         |           |
| <i>Consumptive activities</i>   | 4                                  | -0.015        |                     |              |                                     |               |         |           |

447  
 448 **4 Discussion**  
 449 This study focused on the role of information and familiarity in the individual preferences of ESs  
 450 in Mediterranean coastal lagoons with the aim of assisting the design of public policies.  
 451 Therefore, we studied how different variables impact the preferences of the respondents, using a  
 452 logit multinomial model. We considered (i) the level of respondents' knowledge, i.e., whether  
 453 they are informed and/or familiar or not, (ii) their behavior towards environment and (iii) their  
 454 sociodemographic profile (see Table 6).

455  
 456 **4.1 Identification of consensus and understanding of the heterogeneity of preferences**  
 457 Surveys for ES assessments need to restrict the number of ESs under consideration for practical  
 458 reasons. In our study, we used a list of 20 ESs selected from an original collection of 31 ESs (Sy  
 459 et al., 2018) under the guidance of a focus group. A longer list in these questionnaires could  
 460 introduce confusion and fatigue. Hence, the selection of ESs for ES assessments, including those

461 based on preference elicitation, is a major issue to facilitate the use of these assessments in public  
462 policies. Thus, it has been invoked that ES assessments should concentrate only on a limited  
463 number of ESs by selecting those that are most susceptible to variations induced by the different  
464 management options (Pendleton et al., 2015). Nevertheless, a longer list without a priori  
465 judgments by the policy makers is needed to reveal the preferences based among the populations  
466 to respect their different worldviews and multiple values of nature (Diaz et al., 2019). The Q-  
467 method, which as a serious card game is more ludic than questionnaires, easily allows  
468 considering a larger set of ESs under study without creating confusion (e.g. 31 ESs in the study of  
469 Sy et al., 2018). However, such a Q-method cannot be easily implemented for an on-line survey.  
470

471 The logic of our survey is consistent with the socio-cultural approach developed by Martin-Lopez  
472 et al. (2014). Our results show in the first place a large consensus for 9 of the 20 studied ESs,  
473 shown by homogeneity of preferences (see Table 7). These nine ESs included all 5 ESs of the  
474 category Regulation and maintenance services, 1 out of 3 provisioning services (i.e., fisheries)  
475 and only 3 out of 12 cultural ESs. This pattern of preferences was thus independent of familiarity  
476 and information supply and appeared to be accepted *a priori* by an overwhelming majority. This  
477 may reflect that nowadays, particularly within the French society, a large majority (85 %) of the  
478 general public attaches a high importance to biodiversity and is convinced of the need for its  
479 conservation (Croutte, 2015). But while recognizing the importance of biodiversity for supporting  
480 life on earth, knowledge of biodiversity and awareness of its importance for well-being is less  
481 developed among the general public (Croutte, 2015). It appears that, even when possessing little  
482 precise knowledge, the general public trusts and supports the messages delivered by the  
483 biodiversity experts. The latter may explain that the ESs research opportunities and  
484 environmental education were also homogeneously perceived as relatively very important (see  
485 Table 7). Similar results were obtained according the socio-economic approach in the study of  
486 Martín-López et al. (2014), which also showed that comparably their monetary assessments  
487 tended to underestimate most of the regulating ESs and the ESs research opportunities and  
488 environmental education. A study using Q-methodology among highly-involved stakeholders,  
489 including different experts, in Palavas lagoons also showed a strong consensus concerning the  
490 major relative importance of regulation and maintenance ESs (Sy et al., 2018). Hence, concerning  
491 biodiversity and the regulation and maintenance ESs of emblematic ecosystems, there is no major  
492 conflict of preferences and opinions between the general public and the experts.  
493

494 In contrast, the concept of Cultural ESs (CES) has been subjected to a large debate and  
495 controversy in the literature. Some authors suggest revising and broadening the standard  
496 frameworks of the concept or discarding the term “cultural” itself (Chan et al., 2012a, 2012b;  
497 Winthrop, 2014; Fish et al., 2016; Small et al., 2017) or even abandoning the concept (Kirchhoff,  
498 2019). One of the main criticism is that it tries to combine all notions of cultural value (e.g.  
499 moral, religious, aesthetic) under a single term (Small et al., 2017). In addition, Díaz et al. (2018)  
500 insisted on the role of culture and local knowledge in the way people understand the importance  
501 of all ESs, including those that have been classically categorized as provisioning and regulating  
502 services. Indeed, the notion of nature’s contribution to people (NCP), which is one of the more  
503 recent key elements of the IPBES conceptual framework, recognizes the central and pervasive  
504 role that culture and local knowledge play in defining and understanding all links between people  
505 and nature (Diaz et al., 2018). Therefore, the cultural background strongly determines how people  
506 assess the need for ESs conservation. The paramount role of these cultural factors justifies  
507 understanding the preferences and levels of knowledge. This involves psychological and  
508 sociological approaches in order to explain determinants of these preferences. The  
509 anthropocentric nature of ES is often put forward for its ability to rally individuals more easily in  
510 favor of their conservation, while the link between well-functioning ecosystems and their ability  
511 to provide ESs is not always well understood. Furthermore, this relationship is not necessarily  
512 equivalent depending on the type of ESs, the contexts or the state of conservation of the  
513 ecosystems (Barnaud and Antona, 2014). In addition to the lack of information on ecological  
514 processes, individuals have a limited ability to process information. And the instability of their  
515 preferences over time and the varying context should also be taken into account.

516

517 Our interpretation of the results of this study gave rise to an original typology of CES. The  
518 distinction among those CES refers to different motivations regarding conservation depending on  
519 whether they are hedonic (i.e. motivations that fulfill personal pleasure or benefit) or stemming  
520 from a broader interest in favor of the quality and the identity of the territory. Inductive  
521 approaches have been used to empirically study people’s preferences about CES (Dou et al.,  
522 2019; Maraja et al., 2016; Pike et al., 2015; Stålhammar and Pedersen, 2017). Comparably, we  
523 used such an inductive approach for the 11 ESs with heterogeneous preferences, which indicated  
524 that the 9 CES split up into 3 main clusters based on people’s preferences. The eleven remaining  
525 ESs were clustered through a PCA followed by Ward’s hierarchical classification method. A  
526 multinomial logit model was then developed to determine factors explaining the choice for the  
527 identified clusters issued from these eleven ESs. Thus, our results propose a categorization of

528 CES according to whether they imply individual or collective benefits, and whether these are  
529 consumptive (implying consumption of natural resources and often creating a higher level of  
530 disturbance) or contemplative (enjoyment of nature based on observation and sensitivity for  
531 surroundings causing only minor disturbance). Interestingly, the two provisioning services  
532 (biomass for grazing, shellfish farming) were grouped together with consumptive leisure ESs to  
533 constitute the cluster ‘consumptive activities’.

534

535 We assume that hedonic motivations (i.e. motivations that fulfill personal pleasure or benefit) for  
536 ESs are directly related to the use of the lagoons and therefore to familiarity. On the other hand,  
537 we assume that the heritage services and the impacts of the uses on the lagoons involve cognitive  
538 knowledge which can be acquired through academic information. Thus, our results show that  
539 local residents strongly favored contemplative leisure compared to the unfamiliar citizens (see  
540 Table 9). However, this trend decreased with academic information supply which led the local  
541 citizens to prioritize more the collective services (heritage services) at the expense of the self-  
542 centered ESs (i.e. those ESs that contribute to personal well-being, here contemplative leisure).  
543 Interestingly, consumptive leisure (hunting and recreational fishing) as well as provisioning  
544 services, grouped together in the cluster ‘consumptive activities’, were relatively less favored by  
545 the respondents (see Table 9). This is probably related to the fact that these ESs benefit only a  
546 limited number of practitioners in the Palavas lagoons site. Also, their activities often induce  
547 disturbances to the natural system and nuisance to other people.

#### 548 4.2 Role of information for public policies focusing on learning and engagement of users and 549 residents

550

551 As mentioned in the introduction, several studies have shown the role of intrinsic motivations on  
552 the personal engagement of individuals with respect to conservation issues, beyond the  
553 sociodemographic variables and specific knowledge levels (Wilson, 1984). In addition to the  
554 positive impact of nature on health (Capaldi et al., 2014 ; Sandifer et al., 2015), several studies  
555 show the role of positive feelings, attachment and bonding with nature on the intrinsic  
556 motivations in favor of nature conservation (De Young, 1985 ; Kollmuss and Agyeman, 2002 ;  
557 Mayer et al., 2009 ; MacKerron and Mourato, 2013 ; de Bell, 2017, Lapointe et al., 2020 ; Lima  
558 and Bastos, 2020 ; Kaltenborn et al. 2020). Hence different situations need to be identified for  
559 designing the measures in public policies, particularly those enhancing learning processes.



560

561 Our assessments of the role of information from academic and empiric sources aim at  
562 contributing to develop pro-environmental behavior of citizens based on their intrinsic  
563 motivations. These can be influenced by a better knowledge by the citizens of the ecosystems.  
564 This way, our approach is opposed to an attitude of paternalism (for a philosophical study, see  
565 Dworkin, 1972) adopted by some scientists and public authorities who plead for a predominating  
566 role of experts in environmental decision making. Such paternalism reflects the belief that public  
567 policies ought to be grounded on scientific-based assessments, rather than on citizens'  
568 perceptions that could lead to "erroneous" preferences. This paternalistic approach clearly  
569 conflicts with the democratic ideal. However, hybrid forms do exist as in the work of Thaler and  
570 Sunstein (2008) on nudges falls halfway between paternalism and liberalism. It exploits the most  
571 recent advances of behavioral economics to design an architecture of choices in a way that  
572 preserves freedom of choice and at the same time navigates people towards the goals that are  
573 considered socially desirable. However, Thaler and Sunstein (2008) underline the need for  
574 information, highlighting that "people make good choices in contexts in which they have  
575 experience, good information, and prompt feedback". Moreover, they emphasized conversely that  
576 "people are most likely to need nudges for decisions that are difficult, complex, and infrequent,  
577 and when they have poor feedback and few opportunities for learning". The procedure adopted  
578 during the citizen workshops, allowed a respect for freedom of choice with the engagement of a  
579 dialogue with experts and that the information thus supplied could be used as nudges.

580

581 In this context, our research aims to better understand the types of knowledge needs in terms of  
582 ESs and individual profiles in order to propose learning processes, which, by improving this  
583 knowledge, generate greater motivation to preserve ESs. As such, this type of survey comprises a  
584 way to associate the general public, the local populations in public policies and develop  
585 participative scenarios allowing for a better management for the conservation and ecological  
586 restoration of protected areas as recommended by the IPBES global assessment report assessment  
587 of biodiversity and ecosystem services of 2019. Accordingly, this should lead to better managing  
588 the trade-offs between social objectives that represent different worldviews and multiple values  
589 of nature (Diaz et al., 2019). The learning processes thus lead to understand the involvement of  
590 populations in ecosystem management as a co-evolution process Delgado et al. (2019). And,  
591 knowing that collective learning through participatory approaches combining experience and  
592 expertise (Pendleton et al., 2015; Beaumont et al., 2017) promote the creation of new values in

593 favor of ESs conservation (Strokosch and Osborne, 2020). The issue is then to question learning  
594 processes, which, may be the result of single or double loop processes (Argyris and Schön, 1996).  
595 Single loop refers to learning that is applied straightforwardly, while double loop refers to  
596 learning that provokes a profound change in the reference systems of individuals and their  
597 understanding of the subject (definitions adapted from Argyris and Schön (1996)).

598  
599 The central questions we addressed concerned the impact of information on preferences taking  
600 into account how the information was acquired by the citizens. Information acquired by  
601 familiarity with a natural environment according to the frequency of visits can be differentiated  
602 from those resulting from academic trainings or those that are more contextualized and are  
603 offered as awareness-raising measures. Hence, information supply can reduce bias by making  
604 individual choices more informed and may lead to the reorganization of preferences. This may  
605 even lead to changing the value systems of the citizens (i.e., double loop processes). In the case  
606 of knowledge related to the functioning of ecosystems and the contribution of ESs to the well-  
607 being of society in general, individuals' preferences are influenced by cultural dimensions that  
608 must be taken into account. These include the links of individuals to nature as well as their  
609 cultural proximity to ESs (i.e. these ESs are part of their culture). Hence, the fact that unfamiliar  
610 populations attributed a greater consideration for heritage services is striking. We think that this  
611 is because these populations are neither directly concerned by the direct consumptive nor by the  
612 contemplative benefits of these ecosystems and therefore not influenced by their own interest and  
613 affection for these natural areas. This lack of concernment can be linked to the notion of veil of  
614 ignorance popularized by Rawls (Rawls, 1971). According to the ethics suggested by Rawls,  
615 parties who judge policy and management options are supposed to adopt a veil of ignorance. This  
616 implies a thought experiment for the participants, which purpose is to fully neutralize the  
617 influence of their specific individual interests. Under such a veil of ignorance, the parties will  
618 hopefully tend to evaluate the options only on the basis of considerations of general interest  
619 (Rawls, 1971). It appears that the unfamiliar populations, that might not be aware of how the  
620 various alternatives will affect their own particular case, seem to evaluate the ESs spontaneously  
621 in accordance with this veil of ignorance. This observation advocates the interest to involve  
622 diverse populations in preference elicitation surveys. Indeed, mobilizing only local knowledge  
623 when carrying out ESs assessment might present a risk of favoring particular individual and local  
624 interests.

625

626 In terms of public policy, the splitting up of the CES and the differential impacts of familiarity  
627 and information supply on preferences for the different CES raises the question on the  
628 mechanisms which allow the citizens to perceive and value these CES. Information economists  
629 dealing with goods traded on markets have adopted a classification scheme based on the  
630 difficulty with which consumers can assess their quality or obtain the pertinent information.  
631 Accordingly, at least three types of goods have been identified i.e. (i) *search goods*, (ii)  
632 *experience goods* and (iii) *credence goods*. The *search goods* category (Nelson, 1970) comprises  
633 the goods for which the attributes can be ascertained *prior* to consumption, i.e. by inspection and  
634 information gathering. This category comprises most products and typical examples include  
635 clothing and staple food. *Experience goods* (Nelson, 1970) can be accurately evaluated only *after*  
636 they have been used or consumed (e.g. restaurant, holiday). Finally, *credence goods* (Darby and  
637 Karni, 1973) are difficult or impossible to evaluate even after consumption has occurred. That is,  
638 the consumer might lack the knowledge or the expertise, or because the information is too costly  
639 to acquire compared to its expected benefits (e.g. medical treatments). This approach may be  
640 inspiring when assessing ESs. To our knowledge, non-market goods and services and particularly  
641 ESs have never been investigated through the lens of this typology. We propose that future  
642 studies could be useful to develop a similar typology for ESs. For example, it appears obvious  
643 that the sentiment of relaxation can be considered as an experience ESs. Many of the  
644 maintenance and regulation ESs, for which most citizens lack the detailed ecological knowledge,  
645 can perhaps been categorized as credence ESs. However, for the ESs microclimate regulation and  
646 flooding and other extreme event regulation the situation is more ambivalent. Most people living  
647 in the coastal zone experience how the lagoons contribute to temper the climate (lower maximum  
648 and higher minimum temperatures than in more continental settings), which means that  
649 microclimate regulation could also be considered as an experience ES. Some people that live in  
650 the coastal area since a long time may recall disastrous extreme flash floods from rivers and have  
651 experienced how coastal lagoons can store large quantities of water and thus prevent dangerous  
652 submersions. Their experience of such dramatic events often has a long-lasting impact on their  
653 preferences. Finally, for some ESs it will be easier for the citizens to search for information, e.g.  
654 particularly for several provisioning services which could therefore be categorized as search ESs.  
655 Hence, the development of a comparable classification of ESs will allow to consider the access to  
656 information and knowledge (familiarity and academic) for the different ESs in order to better  
657 target programs and forms of awareness raising.

658

## 659 **5 Conclusion**

660

661 In this study, we assumed that local populations are familiar with the focal ecosystem and that  
662 they possess knowledge about their ecology and benefits for society. The main results that  
663 emerged from our analysis show that there is a high interest for regulation and maintenance as  
664 well as environmental education and research opportunity services regardless of population type.  
665 By contrast, nine of the cultural ESs (CES) together with two provisioning ESs showed, however,  
666 heterogeneous preferences among the different groups of citizens. These eleven ESs were split up  
667 into three clusters comprising (i) contemplative leisure, (ii) heritage and (iii) consumptive  
668 activities.

669

670 We addressed two main questions: (i) does familiarity impact citizens' preferences of the relative  
671 importance of the different coastal lagoon ESs? and (ii) do the preferences of familiar citizens  
672 change after receiving academic information? Familiarity with the ecosystem particularly  
673 impacted the CES. Thus, familiar local citizens valued the contemplative leisure much more than  
674 others, presumably because of their hedonic self-centered approach based on personal pleasure or  
675 benefit. This effect was attenuated by academic information supply. Finally, non-locals who  
676 never visited Palavas lagoons attribute greater priority to heritage services compared to  
677 consumptive activities and contemplative leisure. Hence, our hypothesis about the impact of  
678 academic information supply and familiarity on preferences is supported by our observations for  
679 heritage services, contemplative leisure and consumptive activities.

680

681 The analysis of perceptions of the ESs provided by ecosystems is increasingly demanded by  
682 environmental policy managers. Therefore, the surveys reported in this article were designed in  
683 collaboration with local managers. The perceptions revealed by the surveys represent a proxy  
684 allowing a better understanding of the demand for ESs that, so far, has been poorly addressed  
685 compared to the supply of ESs. For example, the MAES working group (Mapping and  
686 Assessment of Ecosystems and their Services - Burkhard and Maes, 2017; Burkhard et al., 2018)  
687 produced maps of ESs supply that allow identifying trade-offs and links among ESs, using the  
688 concept of ES bundles. The combination of these ES supply maps with land use maps in  
689 territorial planning documents is increasingly practiced for a better integration of development  
690 policies and ecosystem conservation policies (Le Clec'h et al., 2014; Furst et al., 2014; Maes et

691 al., 2015). These maps strengthen the ability to identify strategic areas for integrated territorial  
692 management. Nevertheless, this approach in spatial planning, which often results in zoning, does  
693 not a priori accommodate the questions about the social acceptability of conservation measures.  
694 To increase the social acceptability, information about the perceptions of the populations of ESs  
695 and their demands is of paramount importance for spatial planning. Taking into account the plural  
696 forms of access to ES knowledge (Nelson, 1970), familiarity with ecosystems, when based on a  
697 reasoned use of these ecosystems, appears to be a determining factor for reinforcing the intrinsic  
698 motivations for pro-environmental behavior (Kollmuss and Ageyman, 2002).

699

700

701 **6 Appendix**

702

703 Appendix A: The content of the survey

704

705 The questionnaire was composed of open, spontaneous and closed questions (37 questions). It  
706 included four main categories:

707 **A. The ‘Familiarity and use of the lagoons complex’ category included questions like:**

- 708 • What is your city of residence and for how long have you been living there?  
709 • Approximately how often do you go near the lagoons? (Never, 1 or 2 times a year, About  
710 once a week except winter, About once a week all year long, More often),  
711 • What activities do you do, frequently, from time to time or never, around the lagoons?  
712 Check each activity according to the frequency. The activities listed were, among others:  
713 jogging, horse riding, water sports...

714

715 **B. The ‘preference elicitation’ category included one question which was formulated as**  
716 **follow:**

717 ‘What do you think are the most important roles of the Palavas lagoons in terms of conservation  
718 priority’? Please check the box associated with each role according to its level of conservation  
719 priority.

720 The roles (i.e. the list of the ecosystem services considered in the study) was presented in the  
721 rows of a table and the columns presented different levels of conservation priority i.e. ‘high  
722 priority’, ‘priority’, ‘neutral’, ‘low priority’, ‘not a priority’.

723

724 **C. The ‘level of knowledge of the lagoons complex and the services they provide’ category**  
725 **included questions as:**

- 726 • Have you ever heard of the term "ecosystem service" before this survey?  
727 • How would you rate your level of knowledge regarding the ecological functioning and the  
728 services provided by the Palavas lagoons complex?  
729 • Which of the following statements are true or false for the Palavas lagoons complex?  
730 Please answer "I don't know" for neither case. [There was a total of twelve statements]  
731 ○ *“The Palavas lagoon complex provides a natural environment for many activities*  
732 *such as fishing, non-motorized water sport, discovery of natural spaces, waterfowl*  
733 *hunting, ...”*  
734 ○ *“The Palavas lagoons complex is the property of the French Department of*  
735 *Hérault”*  
736 ○ *“The Palavas lagoons complex provides natural resources (fish, shellfish, fodder,*  
737 *etc.) necessary for the functioning of many economic activities such as*  
738 *professional fishing, tourism, etc.”*  
739 ○ *“Shellfish farming is the most important economic activity of the Palavas lagoons*  
740 *complex area”*

- 741                   ○ *“The Palavas lagoons complex prevents the runoff of flood water”*  
742                   ○ *“The Palavas lagoons complex plays an important role in the cycle of nutrients*  
743                   *(nitrogen and phosphorus) which are essential for the maintenance of aquatic*  
744                   *life”.*  
745                   ○ *“The Palavas lagoons complex is an essential habitat for bird nesting and the life*  
746                   *cycle of many species”.*  
747                   ○ *Etc.*

748

749   **D. Finally, the ‘sociodemographic profile’ category included questions about, for instance,**  
750   the respondents’ age, gender, and behavior towards environment (whether she or he is a member  
751   or donates to an environmental association for instance, respondents’ connectedness to nature  
752   ...).

753

754 Appendix B: the list of the ecosystem services used in the study

755 *Table B. The set of the twenty ecosystem services (ESs) used in this study. The ESs have been categorized according*  
 756 *to the classification designed for coastal and marine ESs by Liquete et al. (2013) and currently included in CICES*  
 757 *version 5.1 (Haines-Young and Potschin, 2018).*

| ES category                | ES subcategory                | Ecosystem services   | General definition   |
|----------------------------|-------------------------------|--|--|
| Provisioning               | Food provision                | Biomass for grazing  | The provision of biomass for human consumption and the conditions to grow it. It mostly relates to cropping, animal husbandry and fisheries. |
|                            |                               | Shellfish farming<br>Fish resources  |  |
| Regulation and maintenance | Water provision               | Water purification capacity  | Biochemical and physicochemical processes involved in the removal of wastes and pollutants from the aquatic environment.                     |
|                            | Coastal protection            | Flooding and other extreme events regulation and protection<br>Banks reinforcement | Protection against floods, droughts, hurricanes, erosion and other extreme events.   |
|                            | Climate regulation            | Microclimate regulation  | Regulation of greenhouse and climate active gases. The most common proxies are the uptake, storage and sequestration of carbon dioxide.      |
| Cultural services          | Life cycle maintenance        | Nursery and biodiversity maintenance   | Biological and physical support to facilitate the healthy and diverse reproduction of species.   |
|                            | Symbolic and aesthetic values | Aesthetic value of landscapes<br>Local identity                                    | Heritage and aesthetic values of the natural environment.  |
|                            |                               | Aesthetic value of habitats or species<br>Historical sites                         |  |
|                            |                               | Recreation and tourism   |  |
|                            | Cognitive effects             | Research opportunity<br>Environmental education                                    | Trigger of mental processes like knowing, developing, perceiving, or being aware resulting from natural landscapes or living organisms.      |

758

759



760 Appendix C. Levels of priority of ecosystem services presenting homogeneous preferences  
 761 among the groups of respondents according to familiarity and academic information supply

762

763 *Table C. Levels of priority of ecosystem services presenting homogeneous preferences among the groups of*  
 764 *respondents according to familiarity and academic information supply. The corresponding level of priorities are*  
 765 *indicated in the table as P, N and NP which stand for “Priority”, “Neutral” and “Not a priority”, respectively.*  
 766

| Ecosystem services presenting homogeneous references | P-Value | Level of priority | Local residents |                | Matched observations for non-local residents |                    | Initial observations for non-local residents |            |
|--|---------|-------------------|-----------------|----------------|--|--------------------|--|------------|
|  |         |                   | Local           | Informed Local | Matched Familiar                             | Matched Unfamiliar | Familiar                                     | Unfamiliar |
| Regulation and maintenance                           | 0.431   | P                 | 93.3%           | 100.0%         | 96.2%  | 92.2%              | 95.7%  | 93.4%      |
|  |         | N                 | 6.7%            | 0.0%           | 3.8%   | 7.8%               | 4.3%   | 6.6%       |
|  |         | NP                | 0.0%            | 0.0%           | 0.0%   | 0.0%               | 0.0%   | 0.0%       |
| Fish resources                                       | 0.264   | P                 | 26.7%           | 26.7%          | 51.9%  | 36.9%              | 47.0%  | 25.6%      |
|  |         | N                 | 50.0%           | 50.0%          | 30.8%  | 41.7%              | 30.4%  | 43.6%      |
|  |         | NP                | 23.3%           | 23.3%          | 17.3%  | 21.4%              | 22.6%  | 30.8%      |
| Recreational hiking and walking                      | 0.288   | P                 | 53.3%           | 46.7%          | 67.3%  | 62.1%              | 76.5%  | 61.6%      |
|  |         | N                 | 26.7%           | 36.7%          | 19.2%  | 29.1%              | 15.7%  | 31.1%      |
|  |         | NP                | 20.0%           | 16.7%          | 13.5%  | 8.7%               | 7.8%   | 7.3%       |
| Environmental education and research opportunity     | 0.741   | P                 | 93.3%           | 90.0%          | 92.3%  | 90.3%              | 96.5%  | 91.7%      |
|  |         | N                 | 3.3%            | 10.0%          | 7.7%   | 8.7%               | 3.5%   | 7.6%       |
|  |         | NP                | 3.3%            | 0.0%           | 0.0%   | 1.0%               | 0.0%   | 0.7%       |

767

768

769

## 770 **7 Acknowledgments**

771 Mariam Maki Sy benefitted from a PhD fellowship from the DRIIHM LabEx (ANR-11-LABX-  
772 0010\_DRIIHM), “Device for Interdisciplinary Research on human-environments Interactions”  
773 within the framework of the Human-environment observatory “Mediterranean coastline”. The  
774 authors thank the members of the former Syndicat Mixte des Etangs Littoraux (SIEL) for their  
775 support and advice during the data collection process. Mylène Farge and Nicole Lautrédou-  
776 Audouy are thanked for their help in organizing the citizen workshops. We are most thankful to  
777 the thirty-eight citizens who participated in the citizens’ workshop on a voluntary basis and  
778 genuinely provided their time for this study. We also acknowledge the participation of the  
779 respondents in the internet survey. All data have been treated anonymously in compliance with  
780 the EU General Data Protection Regulation (GDPR).

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