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1 **Convergences and divergences in understanding the word biodiversity** 2 **among citizens: a French case study**

3 ***Running head:*** How do French citizens define biodiversity?

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1 **Abstract**

2 Biodiversity is undergoing a major crisis. Institutions, while launching initiatives tackling the issue,
3 are using and diffusing the term biodiversity and related expert knowledge. However, to collectively
4 address the biodiversity crisis, it is important that actors are able to communicate with each other.
5 This is particularly true in the three-part set including science, public institutions, and citizens. In
6 this paper, we explored this mutual understanding with a focus on laypeople: we assessed the
7 understanding of biodiversity in a sample of 1209 French adult citizens and explored the
8 convergences and divergences with institutional and academic definitions. With a classical
9 hypothetical-deductive approach, we first showed an overall congruence between laypeople and
10 institutions : 80% of respondents provided a descriptive definition of plant and animal species as
11 well as their diversity, which are main ideas diffused by institutions. However, based on the high
12 diversity of the collected definitions, with 57% of provided words in definitions mentioned only
13 once, we complemented this study with an inductive approach. We showed a discrepancy in the
14 definitions from lay people and from conservation science (based on evolutionary and dynamic
15 processes). We also highlighted that 18,5% of definitions are not descriptive and are referring to
16 specific actions for biodiversity conservation. We discuss these results in the context of social-
17 ecological transitions, and encourage conservation communities to acknowledge the range of
18 biodiversity definitions used by laypeople, and to form closer relationships with laypeople to anchor
19 conservation research and action with a bottom-up dynamic process of knowledge sharing.

20

21 **Keywords:** biodiversity understanding; questionnaire study; conservation; experience of nature

22 **1. Introduction**

23 Biodiversity is currently experiencing a major crisis, which also affects humanity. The conservation
24 science community has been mobilized for a long time in addressing this crisis, notably through
25 conservation biology (Soulé, 1985; Bennett et al., 2017). More than 15 000 scientists co-signed a
26 call to humanity for protecting biodiversity in December 2017 (Ripple et al., 2017). Scientific or
27 academic environmental bodies are producing information and definitions related to biodiversity
28 (e.g. Sarrazin and Lecomte, 2016; Primack, 2014) (Table 1). Despite their diversity, these academic
29 definitions consider biodiversity as a dynamic process, both at the long-term scale (through
30 evolutionary processes) and short-term scale (ecological dynamics).

31 International initiatives have also been trying for a long time to address this crisis, from the Rio
32 Earth Summit in 1992 to the current Strategic Plan for Biodiversity (2011-2020) designed by the
33 United Nations' Convention for Biological Diversity (CBD). This strategic plan has been available
34 at regional (e.g., Europe) and national levels (e.g., France). At more local levels, initiatives are also
35 increasingly flourishing, such as the differential management programme adopted by several
36 European cities (e.g., Amsterdam, Hamburg, Brussels, Paris) to enhance biodiversity in green
37 spaces. These institutional texts and declarations all refer to “biodiversity”, although providing
38 slightly different definitions. For instance, the CBD, European Commission and French government
39 institutional definitions (Table 1) include many similar terms (i.e., diversity, species, animals and
40 plants, ecosystem and life). These institutional definitions are grounded in the scientific and
41 academic definitions but usually lack the dynamic aspects.

42 The term “biodiversity” has also spread to society. For instance, the number of articles referring to
43 biodiversity in the French national mass media source “Le Monde” dramatically increased in 2010
44 and remained at a high level afterwards (unpublished data). At the European level, the number of
45 people aware of this notion increased by 9% from 2007 to 2013 (European Commission 2007,
46 European Commission 2013), and in 2015, at least eight out of ten Europeans were worried about
47 biodiversity loss (European Commission 2015).

48 In addition to this general increase in knowledge about biodiversity and awareness of related issues,
49 individual variations on these topics remain high (see, for instance Buijs et al., 2008 or Moss et al.,
50 2016). For instance, at the European level in 2013, the declarative level of knowledge of
51 biodiversity varied according to gender and education level: men and more educated Europeans
52 were more likely to say that they know about biodiversity (European Commission, 2013). More
53 precisely, in a Swiss study, Lindemann-Matthies and Bose (2008) found that the probability to never
54 come across the term biodiversity significantly decreases with age (from 10 to 70 years old).
55 Children's discourses about biodiversity are different according to their gender, with girls

56 mentioning more ornamental plants and boys mentioning more wild plants in a study conducted in
57 Argentina (Campos et al., 2012). Also in Argentina, students' understanding of biodiversity was
58 largely centred on species diversity, underestimating other ecologically meaningful characteristics
59 such as functional traits or species evenness (Bermundez and Lindemann-Mathies, 2018). In
60 addition to socio-demographic influences, individual life experience towards nature has also been
61 shown to impact people's knowledge of biodiversity: in England, Cox and Gaston (2015) showed
62 that knowledge on birds was related to connectedness with nature. Pilgrim et al. (2007) showed that
63 British people who walk in nature more often know more local species than people who do so less
64 often. Awareness of conservation issues is also highly variable, depending on individual and social
65 factors. Prévot et al. (2018) recently showed that French adults who are involved in local activities
66 in relation to biodiversity in their daily life know more about biodiversity than people who are not.
67 An understanding of biodiversity thus appears to vary according to gender, age, education, and
68 connectedness to nature and experiences of nature.

69 Despite these variations in understanding, the concept of biodiversity is a prominent point of
70 discussion between political spheres (at international and national levels), scientific communities
71 and the rest of society (see also Bermundez and Lindemann-Mathies, 2018). Recent works
72 addressed potential problems regarding information sharing between these communities: Moore et
73 al. (2019) showed that American citizens progressively lower their perception of temperature
74 abnormalities, which could explain the lack of support of public policies regarding climate change.
75 Meinard and Quetier (2014) showed that the term "biodiversity" remains vague and is anchored on
76 differing implicit knowledge between communities, notably scientists and conservation
77 practitioners. To collectively address the biodiversity crisis, it is important that all these spheres
78 understand each other. Citizens understanding of up-to-date biodiversity concepts should favour
79 their empowerment to make decisions on socioscientific issues, such as biodiversity management,
80 conservation or sustainable development (Bermundez and Lindemann-Matthies, 2018).

81 Mutual understanding among different individuals or social groups is encouraged when these
82 persons or groups share mental models or social representations (Buijs, 2009). Mental models are
83 cognitive frameworks that people use to understand and interpret the world (Biggs et al., 2011);
84 social representations are socially elaborated and shared knowledge that participates in the
85 construction of social groups (Moscovici, 1961). To address the issue of a mutual understanding
86 regarding biodiversity, it is therefore important to assess the convergences and divergences in the
87 definitions of biodiversity between the different spheres. In other words, do citizens understand
88 biodiversity the same way that institutions do? What about the scientific definitions? And if citizens

89 do not understand biodiversity in the way that scientists or institutions describe biodiversity, then
90 how do they describe it?

91 A recent work by Moss et al. (2015) focused on assessing the understanding of one definition of
92 biodiversity for people visiting at zoos. In their study, they provided a definition of biodiversity that
93 includes diversity, animal and plant species (see Table 2). Then, they ranked the level of
94 understanding of biodiversity for each person asked and compared it to the reference definition.
95 Overall, 75% of the 5661 definitions collected in this survey were somehow close to this reference
96 definition (Moss et al., 2015).

97 In this study, we focused on the understanding of biodiversity by citizens and on how this concept
98 was shared between citizens, institutions and academia. Using the proposed definition framed by
99 Moss et al. (2015), we explored French citizens' definitions of biodiversity. We hypothesized that
100 people provide definitions of biodiversity that are closer to institutional definitions than to scientific
101 definitions for several combined reasons: knowledge transfer towards the public is mainly based on
102 media communication; scientists have difficulties transferring their knowledge both to practitioners
103 (e.g., Francis and Goodman, 2010) and to journalists (Nisbet and Scheufele, 2009, Besley and
104 Tanner, 2011); public institutions are more directly involved than scientists in diffusing
105 conservation messages to the public. We therefore assessed the convergence between definitions
106 given by the citizens and institutional definitions, i.e., referring to diversity, animal and plant
107 species. Based on the literature (see above), we hypothesized that people who have experienced
108 nature regularly defined biodiversity in a more detailed manner than people who have not. To test
109 this hypothesis, we compared the definitions of biodiversity of people who grew up in the
110 countryside or sub-urban areas, to those of people who grew up as city-dwellers. Moreover, based
111 on the published results on the effects of gender, age and educational path on biodiversity
112 knowledge, we hypothesized that women, young people and students were more likely to provide
113 definitions closer to institutional ones than other people.

114 Our quantitative assessment of the alignment of citizens' definitions with institutional ones allowed
115 us to test these hypotheses. However, a reductive approach was used regarding the actual variety of
116 definitions given by citizens and it thus did not allow us to address this variety for all of the existing
117 understandings of biodiversity. Thus, we paired this hypothetical-deductive approach with an
118 inductive approach, using an analysis of the content of the definitions. This approach revealed high
119 potential for sharing and co-constructing knowledge of biodiversity conservation among scientists,
120 institutions and citizens.

121 **2. Method**

122 **2.1. Survey design**

123 We collected biodiversity definitions from 1260 French citizens across 6 years, by pooling data
124 from ten different questionnaire surveys. These surveys were all conducted by the same research
125 team working at the French National Museum of Natural History and explored components of the
126 human relationship to nature from different perspectives. They all included the same specific
127 questions regarding the respondent's definition of biodiversity, the respondents' age, gender, current
128 and childhood living places as well as their individual life experience with nature. Details of each
129 survey can be found in Table 2. Because 51 out of 1260 respondents did not give any definition of
130 biodiversity, we based our analysis on 1209 different definitions. All surveys were administered in
131 France to French-speaking respondents. Participants remained anonymous, and no personal
132 information allowing for identification was recorded. Participants were informed that the data were
133 collected only for research purposes. Respondents did not receive any compensation for their
134 participation. The process followed the ethical standards required by the French National
135 Commission of Computing and Liberties (CNIL, 2018). Questionnaires corresponding to the
136 subsets detailed in Table 2 are available as supplementary files.

137 **2.2. Questionnaire design**

138 **2.2.1. Definition of biodiversity**

139 All surveys asked respondents to give their definition of biodiversity with an open-ended question,
140 using the formulation "How would you define biodiversity?"

141 **2.2.2. Individual life experience with nature**

142 We assessed individual life experience with nature by using two proxies as follows. First, we
143 assessed the declared level of rurality of the childhood living place on a 5-point scale with the
144 following categories labelled from 1 to 5: big city, medium city, small city, village, and hamlet, i.e.,
145 a small settlement in a rural place usually set around a farm building. We used this information as a
146 proxy for individual life experiences with nature, as we considered that people who grew up in rural
147 places were more likely to be in contact with nature than people who grew up in urban
148 environments.

149 Second, we used a derived version of the Inclusion of Nature in Self (INS, Schultz, 2001) on a 5-
150 point scale. This scale provides a set of five overlapping circles labelled "nature" and "self". People
151 were asked to choose the assemblage that best defined their relationship to nature. Data were coded
152 from 1 for the less overlapping circles to 5 for the completely overlapping circles (Supplementary
153 Figure A.1). The INS scale has been widely used in research (Liefhänder et al., 2013) and phas

154 rovided an easy and quick way to measure individual life experiences with nature in sometimes
155 long questionnaires.

156 **2.2.3. Socio-demographic variables**

157 We also recorded age and gender (feminine/masculine). Depending on the surveys, age was
158 assessed by year of birth or by age categories. We therefore homogenized the data using seven age
159 categories (18-25; 26-30; 31-40; 41-50; 51-60; 61-70; over 70 years old). Because our surveys were
160 biased towards students, we distinguished students from non-students when the information was
161 available. We refer to this as the variable “student/non-student” hereafter.

162 **2.3. Hypothetical-deductive analyses**

163 **2.3.1. Convergences of citizens’ definitions with the institutional definition**

164 We evaluated the extent to which people’s definitions of biodiversity were close to the institutional
165 definition by using the same reference and the same scoring system as Moss et al. (2015). As such,
166 we assessed a score on a 5-point scale that we called the “Institutional proximity index” (IPI, see
167 Table 3). To check the consistency of this categorization process, three of the authors coded the
168 same random sample of 80 definitions. Inter-reliability was over 0.75 (0.89) and was considered
169 excellent (Cicchetti, 1994). One author coded all of the remaining datasets.

170 **2.3.2. Statistical analyses**

171 We used ordinal models (package ordinal for R, Christensen, 2015) to test the relationship between
172 the IPI and the following individual factors: INS, rurality of childhood living place, gender, age and
173 student/non-student. We included the data subset as a fixed effect, with subset C (French citizens 1)
174 being the reference factor. We also included an interaction term between age and the survey subset,
175 as well as between the student variable and the survey subset. We accounted for this because of a
176 partial knowledge of sampled respondents in each subset, one having been targeted more towards
177 students than others and a great proportion of these students were ecology/biology students.

178 More specifically, we first checked for the influence of the student variable compared to the age
179 variable, the student variable being not equally distributed across age groups (chi-square=595.06,
180 df=6, $p < 0.001$). We first used the portion of the dataset in which the student variable was available
181 to fit the model with both age and student variables, along with the other variables. If the student
182 variable had no significant effect, we fitted the model without it and used the full dataset.

183 **2.4. Inductive analyses**

184 **2.4.1. Content analyses of the definitions**

185 We changed conjugated verbs to infinitives, and plural nouns to their singular forms. We identified
186 articles, conjunctions and other grammatical operative words, and excluded them from our final set
187 of words (see example in Fig. 1). We therefore obtained a set of nouns, proper nouns, infinitive
188 verbs, adverbs and adjectives.

189 We then calculated the number of definitions in which each term of this set appeared. Among these
190 terms, we highlighted those that also belonged to institutional definitions, as well as terms that
191 specifically referred to academic definitions, i.e., biodiversity dynamics and evolution.

192 **2.4.2. Inductive categorization of definitions and statistical modelling**

193 Reading the citizens' definitions led us eventually to propose a categorization of three groups.

194 Groups were assessed and discussed by all authors for relevance. They are defined as follows:

195 - Group 1: definitions that referred to the ecological description of biodiversity and to perceptions,
196 with terms such as "habitat", "territory", "harmony", "beauty", e.g. "Diversity of living organisms,
197 of habitats, genes"; "All nature"

198 - Group 2: definitions that referred to actions related to biodiversity; actions could be general, with
199 terms such as "conservation", "preservation", or specific, such as buying local and organic food,
200 e.g. "Preserving species"; "To favour fauna and flora diversity in order to achieve natural
201 equilibrium, without synthetic additions"

202 - Group 3: definitions that did not refer to biodiversity, e.g. "no idea"

203 To check for consistency within the categorization process, three authors coded the same random
204 sample of 50 definitions. Inter-reliability was over 0.75 (0.83) and was considered excellent
205 (Cicchetti, 1994). One author coded all of the remaining datasets.

206 We used generalized linear models (package lme4 for R, Bates et al., 2015) with logit link (binomial
207 family) to test the relationship between the respective proportions of the first two groups of
208 definitions and the following individual factors: INS, rurality of childhood living place, gender, age
209 and student/non-student. We included the data subset as a fixed effect, with subset C (French
210 citizens 1) being the reference factor.

211 All statistical analyses were performed using R 3.4.3 (R Core Team, 2017).

212 **3. Results**

213 **3.1. Dataset description**

214 The overall dataset included 1209 respondents. It included 61.4% of women and the most
215 represented age class included 18-25 year old (34.0%). We did not find any significant difference
216 between the different surveys for the declared rurality of the childhood living place or for gender
217 (chi-squared=25.25, df=20, p-value=0.19, and chi-squared=7.684, df=5, p-value=0.17,
218 respectively). However, age distributions differed between the surveys (chi-squared=587.19, df=30,
219 p-value<0.001), as did as the student/non student distributions, when that information was available
220 (chi-squared=272.88, df=3, p-value<0.001).

221 **3.2. Degree of convergence of citizens' definitions with the institutional definition**

222 The institutional proximity index (IPI) mostly commonly obtained was 3 (34.8% of the dataset
223 definitions, see also Table 3). The IPI was significantly related to the age of respondents, with older
224 respondents providing definitions that were less convergent with the institutional definition (Table
225 4). The IPI was not significantly related to gender or individual history of experiences with nature
226 (INS, rurality of childhood living places).

227 **3.3. Core definition, diversity of definitions and appearance of academic biological** 228 **terms**

229 Definitions given by respondents included 13.5 words on average. The full set of definitions
230 provided 1065 different words, i.e., nouns, proper nouns, adjectives, adverbs or infinitive verbs. Out
231 of this total, 57% were only mentioned by a single respondent, and 1% (i.e., 11 terms) were used by
232 more than 100 respondents. Most of these 11 terms echoed the institutional definition with terms
233 such as “species”, “living”, “diversity” or “ecosystem”. Others belong to the scientific vocabulary,
234 such as “fauna” and “flora”. The term “species” was the most reported, with more than 50% of the
235 respondents using it in their definition (Table 5).

236 Among the 1209 definitions, only 7 included the term “dynamics” and only 19 included the terms
237 “evolution” or “evolutionary”. More specifically, 4 out of the 7 definitions with “dynamics”
238 referred to both dynamics and evolution. Only 1 referred to selective processes, and it was one of
239 the 7 abovementioned definitions (see Supplementary material Table A.2). We noticed that
240 definitions sometimes referred to terms linked to ecological processes: 24 definitions mentioned the
241 term “balance” and 85 mentioned “interactions”. We found six definitions referring to ecosystem
242 services: 4 explicitly mentioned “services”, and 2 mentioned the “beauty” of biodiversity (which
243 could refer to a cultural service).

244 **3.4. Definitions categorization and relationship to individual factors**

245 We found that 965 (80%) of the definitions provided were descriptive (846 definitions) or related to
246 perceptions about biodiversity (119 definitions) (group 1), e.g., “Diversity of living organisms, of
247 habitats, genes”; “All nature”. Action-related definitions (group 2) accounted for 224 definitions
248 (18.5%), e.g., “Preserving species”; “To favour fauna and flora diversity in order to achieve a
249 natural equilibrium, without synthetic additions”. Overall, 29 out of these 224 action-related
250 definitions mentioned precise actions: 14 referred to agricultural changes, 6 referred to individual
251 connection with nature and 9 mentioned a behaviour of consumption. The other 1.5% of the
252 definitions (n=20) were categorized in the third group, e.g., “no idea”.

253 We found that non-students were significantly more prone to giving definitions related to
254 conservation actions (Table 6). We did not find any other correlations between the respective
255 proportions of descriptive/action-related definitions and the following individual factors: gender,
256 age, INS, rurality of childhood living places.

257 **4. Discussion**

258 In this study, we explored the convergence between definitions of biodiversity provided by
259 institutions, academics and the rest of society. We combined two approaches: through the IPI, we
260 assessed the diffusion of expert institutional knowledge towards society; through inductive
261 categorization, we assessed local knowledge of lay people. Indeed, expert institutional knowledge
262 and local knowledge coexist within society, interact with each other and take part in conceptual
263 definitions.

264 **4.1. Citizens collectively define biodiversity similarly to institutions**

265 Our study revealed that 11 words were employed by more than 100 respondents each, for a total of
266 1065 different words. This points towards a common basis for the representation of biodiversity
267 among respondents. Concepts such as species, ecosystems, and diversity are part of this common
268 representation. The notion of interactions between elements of biodiversity is also present (even if
269 less abundant), with 85 definitions including words referring to these interactions. These commonly
270 shared terms indicated that the collected definitions were quite close to the definitions used by
271 institutions (e.g., the CBD, European Union regulations and the French government, see Table 1).
272 They indeed underlined the diversity of individuals, species, and ecosystems, together with
273 interactions and ecological networks. Diversity was also the most important component of
274 biodiversity understanding in the Bermudez and Lindemann-Matthies (2018) study in Argentina
275 with students, as well as in the Fiebelkorn and Menzel (2012) study in Costa-Rica and Germany
276 with student biology teachers and in the Kilinc et al. (2013) study in Turkey with students. Buijs

277 and Elands (2013) explored the social representations of nature in a group of 364 Dutch lay people,
278 whom they asked to associate up to 5 words to the term “nature”. Similar to our results, some of the
279 terms most often associated with the concept of nature for people interviewed were general terms
280 such as “animals” (50% of their respondents), plants (22%) and everything living (10%). Most often
281 mentioned terms were also tree/forest (37%) and meadows (10%). In Chile, Cerda and Bidegain
282 (2018) explored the representations of biodiversity by 45 people from different social groups in a
283 Biosphere Reserve; they found that “all the groups of respondents thought that biodiversity had
284 something to do with the diversity of animals and plants” (p. 206), which corresponds to the general
285 finding of our study. Similarly, in a study with focus-groups in Scotland, Fischer and Young (2007)
286 found that both experts and non-experts in natural history “perceived and appreciated the diversity
287 in their surrounding” (p.274).

288 Eighty percent of the collected definitions corresponded to a description or a perception of
289 biodiversity (Group 1 in the results section). This high proportion is encouraging, regarding the
290 fulfilment of the current Strategic Plan for Biodiversity of the CBD and the associated Aichi targets.
291 In particular, the first target states that “by 2020, at the latest, people are aware of the values of
292 biodiversity and the steps they can take to conserve and use it sustainably”, values here being
293 “interpreted in the broadest sense, including environmental, cultural, economic and intrinsic values”
294 (<https://www.cbd.int/doc/strategic-plan/targets/T1-quick-guide-en.pdf>). However, gathered
295 definitions seldom mentioned these values specifically, and when they did, the mentioned values
296 were mostly environmental and intrinsic values of biodiversity. While the first Aichi target also
297 encompasses ecosystem services, economic or social values, those were mentioned by a negligible
298 proportion of respondents. The big picture of biodiversity does not seem to be fully recognized by
299 citizens so far.

300 We found that young people defined biodiversity according to the institutional definitions more
301 often than older ones, and that students gave relatively more descriptive definitions than non-
302 students. We did not find any other correlation, notably regarding gender and individual life
303 experience with nature. The fact that students gave more descriptive definitions than other people
304 was expected in our study because the students surveyed were predominantly studying ecology.
305 However, the absence of correlations with the other individual factors was first surprising, because
306 the knowledge and awareness of biodiversity do vary between individuals (e.g., European
307 Commission, 2014), notably according to one’s individual life experience with nature (e.g., Chawla,
308 1998). However, the apparent discrepancy of our results with the literature can be explained by at
309 least two reasons: first, our index of institutional proximity did not embrace biodiversity knowledge
310 as a whole. Indeed, following Frick et al. (2004), environmental knowledge is composed of at least

311 three components: declarative or factual knowledge (what is it), action-related knowledge (what can
312 I do) and effectiveness knowledge (how are my actions efficient?). Our index only partly
313 encompassed the first level of knowledge. Second, the way we assessed individual life experience
314 with nature was also very restrictive: the declared rurality of childhood living place may not have
315 reflected the varying lifestyles among respondents. Furthermore, although the Inclusion of Nature in
316 Self (INS) is one of the existing scales to assess the individual level of connection with nature, it is
317 mostly dedicated to the cognitive relationship and does not embrace wider connections (Tam,
318 2013).

319 **4.2. Contrary to conservation scientists, citizens do not embrace any dynamic** 320 **component in their understanding of biodiversity**

321 The collected definitions seldom mention the dynamics or evolution of biodiversity, even if they are
322 of importance in ecological and conservation biology science (Sarrazin and Lecomte, 2016). Thus,
323 the biodiversity they refer to is not fully consistent with the current academic definition usually
324 used in ecology.

325 The fact that the definitions of biodiversity used by most people converge with the static definition
326 provided by institutions rather than with a dynamic one shared by the scientific community (which
327 relies on the dynamics and evolution of biodiversity) indirectly reveals a side issue for conservation
328 scientists: the concepts of equilibrium or balance of nature are still present in institutional visions,
329 even if they are no longer the single vision within the scientific community (e.g., Couix and Hazard,
330 2013, Robert et al., 2017, Mace, 2014). These links with dynamic and evolutionary processes are
331 now essential in biodiversity conservation (Sarrazin and Lecomte, 2016) and seemed to be lacking
332 in this study dataset. However, some published elements suggest that the dynamic vision of
333 biodiversity is present in professionals such as foresters (Buijs et al., 2008) and that farmers
334 recognize the complexity of biodiversity (Kelemen et al., 2013). We therefore encourage the
335 ecological scientific community to communicate more widely what is relevant now in this current
336 and very fast changing period, i.e., on the dynamic processes underlying biodiversity functioning
337 and interactions with humans (see also Mace, 2013).

338 **4.3. In addition, what else ?**

339 The third main result of our study is that it revealed great diversity in the understanding of
340 biodiversity by lay people around the common representation. Indeed, in addition to the 11 most
341 cited words, the collected definitions included more than 1000 other words, with 57% of the total
342 number of words being mentioned only once and thus giving an idea of the variety of citizen
343 interpretations of biodiversity. Similarly, in their study asking for association with the term
344 “nature”, Buijs and Elands (2013) collected 670 different terms, of which only 22 were mentioned

345 by more than 4 people. A very large proportion of the terms appeared thus to be mentioned by less
346 than 4 people, revealing a very high diversity in the perception of nature by those interviewed. This
347 result confirms that citizens commonly link biodiversity to other concepts: in Fischer and Young
348 study (2007), Scottish people who were interviewed rooted biodiversity in specific places,
349 biodiversity contributing to specific spatial patterns, as well as to concepts such as natural flows
350 (e.g. food chains). Buijs et al. (2008) found that people interviewed in the Netherlands, Scotland
351 and Germany “used broad definitions, often including diversity of landscapes and cultural diversity
352 in, for example, land use or even cuisine” (p.70). This last example echoes the definitions in our
353 sample that defined biodiversity as a whole assemblage of interacting elements, including humans.
354 Notably, some respondents mentioned the need for more appropriate interactions between humans
355 and other species, using terms such as “live together”. These definitions may reflect a diversity of
356 worldviews about nature or relationships to biodiversity (e.g. van den Born, 2008), notably the
357 proposed “relational value” for human-nature relationships (Chan et al., 2016).

358 This diversity also appeared when considering a small group of definitions, which were related to
359 actions. The existence of this group may be partly due to the national context when the study was
360 conducted. First, all but one survey took place in 2015 or early 2016, and France hosted COP21 at
361 the end of 2015. Thus, 2015 was a year of preparation and popularization of the associated issues,
362 with biodiversity being among them: on this occasion, environmental issues were very present in
363 media communications (e.g., a public book gathered “30 questions to understand the Paris
364 conference”, Canfin and Staime, 2015) as well as in citizen mobilizations (e.g., Coalition Climat 21,
365 <http://coalitionclimat21.org/en>). Second, biodiversity was highlighted by French national policy-
366 makers in 2016, with the combination of a new important law for biodiversity (JO, 2016) and the
367 launching of the French Agency for Biodiversity. However, most of the 224 action-based definitions
368 referred to very general attitudes or behaviours, such as respect or a general need to protect or
369 conserve nature. This could be due to the history of the dissemination of the term biodiversity in
370 society since 1992, which has always been accompanied by associated threats (Maris, 2016).
371 However, surprisingly, no action mentioned related to activism or social involvement towards
372 biodiversity, such as social environmentalism (*sensus* Larson et al., 2015). This was surprising
373 because a significant proportion of students were part of the data set and since young people are
374 more prone to activism (Stern, 1999), we could have expected for it to have been mentioned in such
375 a political context.

376 Considering this variety of definitions, we should also consider what could be gained or lost by
377 adopting one universal definition of biodiversity. The adoption of a universal unequivocal definition
378 of biodiversity with a precise meaning may be seen as a great help to design and implement policies

379 and programmes for biodiversity conservation now and in the future (Swingland 2013). Erwin
380 (1991) argued that science allows transcultural policies. Basing the biodiversity definition on
381 science might thus help the related worldwide, transcultural conservations. However, the extensive
382 work of Takacs (1996) showed that scientific statements about biodiversity are informed by culture
383 and that biologists have only a part of the solution regarding biodiversity issues (pp. 332-336). A
384 diversity of biodiversity definitions, encompassing scientific and citizen definitions, could then be
385 helpful in understanding related local and global challenges, such as environmental justice.

386 Finally, interesting results would likely come from studying occurrences of biodiversity and its
387 definition in school and high school programmes. French school and high school programs
388 regularly change (every ten years roughly) and have incorporated biodiversity *per se* quite recently:
389 oldest respondents might not have come across the term at school. However, it may have appeared
390 indirectly, and a whole study would be necessary to understand the impact of French school
391 learning experiences on the understanding of biodiversity.

392 **4.4. Study limitations**

393 Our study faced limitations that are frequently encountered when gathering data from several
394 different studies. While allowing for larger datasets, the various sample sets were not collected with
395 exactly the same designs. However, all surveys were designed collaboratively within the same
396 research team using similar methods, and many questions were very similar. In addition, we
397 included the questionnaire subsets in our analyses to take this possible source of variability into
398 account. In all of the surveys, we obtained an over-representation of high socio-professional
399 categories, making our sample not statistically representative of French society. However, the high
400 sample size makes us confident in saying that this part of French society is aware of the
401 institutionally-defined biodiversity concept.

402 **5. Conclusion and perspectives**

403 Our results suggest several possible routes for conservation. First, the high proportion of people that
404 accurately defined biodiversity should make conservation scientists confident in the existence of a
405 general common understanding of biodiversity. The next issue for conservation scientists could be
406 therefore to increase the understanding of the components of biodiversity, such as the dynamic
407 properties, for instance through closer collaborations with the media. The gap between this static
408 definition and the dynamic one of conservation science is likely to close progressively thanks to
409 communication and education on the definition of biodiversity.

410 However, the general understanding of biodiversity should not disguise the high diversity of
411 individual appropriations and interpretations of this term in society. In particular, some definitions

412 include interconnections between humans and nature. Because biodiversity serves the common
413 goods, this range of definitions should be considered as an advantage; we encourage conservation
414 scientists to encourage and take part in a co-construction of the meaning of biodiversity through
415 bottom-up approaches. This could address the issue of the separation of modern societies from
416 nature (Moscovici, 1976), or of the disconnection from nature and the ‘extinction of experience’
417 (Pyle, 2003; Soga et al., 2016).

418 Furthermore, the existence of action-based definitions of biodiversity suggests the personal
419 involvement of laypeople in biodiversity issues. However, most cited actions rely on general
420 injunctions to implement so-called “better” practices. One final conservation route could be to
421 encourage individuals to enrich their definition of biodiversity based on their own experiences of
422 nature and associated emotions and affects.

423 All these complementary routes would be a fertile ground to engage people and society in a social-
424 ecological transition. We strongly encourage the conservationist community to disseminate more of
425 their results, but also to encourage, explore and highlight relationships between citizens and nature
426 that are likely to generate emotions and practices and to anchor their future research and
427 communication strategies in this richness.

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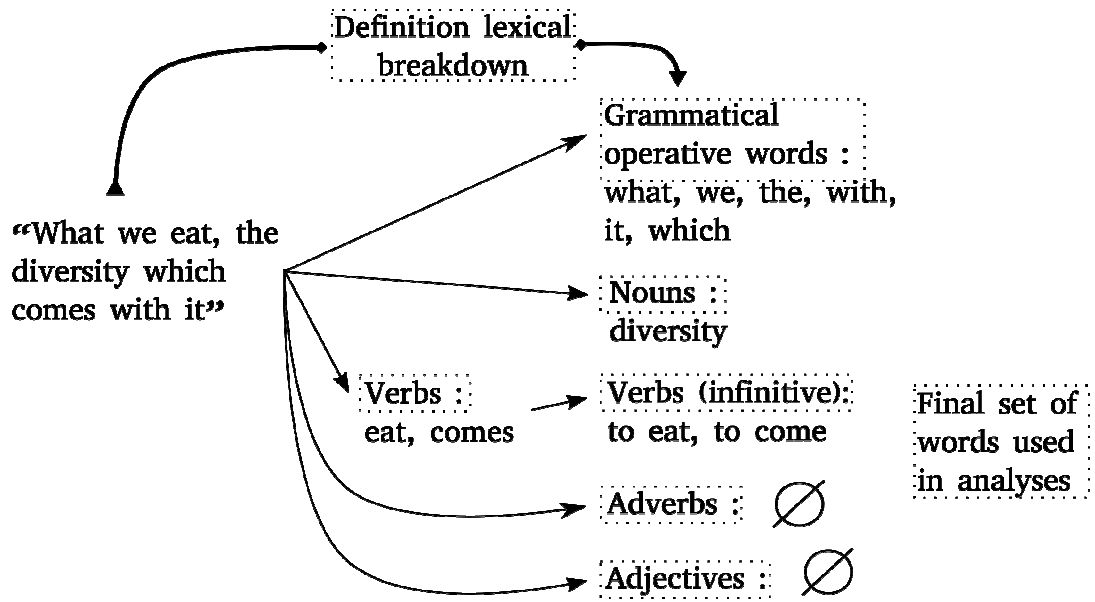
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1 **Figures**

2 Figure 1. Description of the content analysis of the definitions.



3

1 **Tables**

2 Table 1. Four examples of definitions provided by institutional bodies. Regarding the academic
3 sphere, we included an example of a definition from a very popular textbook (Primack 2014).

4 Table 2. Description of questionnaire surveys.

5 Table 3. Characteristics associated with the IPI scoring of definitions (adapted from Moss et al.,
6 2015).

7 Table 4. Estimates and p-values for the IPI ordinal model (N=1190). Interaction terms were not
8 significant and are not shown; feminine gender and C survey are references factors for categorical
9 data.

10 Table 5. List of the 11 words appearing in at least 100 definitions (French translation of words in
11 brackets) and example of definitions given by respondents. French translations of examples are
12 given in supplementary Table S1.

13 Table 6. Estimates and p-values for the proportions of definitions related to an action
14 (categorization group 2), according to the tested dependent variables (N=902). Only significant
15 interaction terms are shown; feminine gender, non-student category and C survey are references
16 factors for categorical data.

17 Table 1. Four examples of definitions provided by institutional bodies. Regarding the academic
 18 sphere, we included an example of a definition from a very popular textbook (Primack 2014).

Institutional/Academic body	Definition	Source
CBD	“The variety of life on Earth. It includes all organisms, species and populations; the genetic variation among them; and their complex assemblages of communities and ecosystems”	https://www.cbd.int/2011-2020/about/biodiversity
European Commission	“The variety of life on Earth. It refers not just to species but also to ecosystems and differences in genes within a single species”	http://ec.europa.eu/environment/nature/biodiversity/intro/index_en.htm
French government	The “variability of living organisms from all origins, including terrestrial, marine and other aquatic ecosystems, as well as the ecological complexes they belong to. It encompasses diversity within species and between species, ecosystem diversity and interactions between living organisms”	JO, 2016
Conservation biologists	“a set of information, material and energy fluxes relying on dynamical processes at various spatial and temporal scales. [...] Biodiversity arises from ecological, evolutionary and developmental processes”	Primack, 2014

19 Table 2. Description of questionnaire surveys.

Sampling period	Targeted public	Method	Number of provided definitions of biodiversity	Total length of the questionnaire (location of the question)	Subset
2010 & 2015	Parisian zoo visitors	Face-to-face	135 & 32	20 questions (#4) & 21 questions (#8)	B Zoo
2015	French citizens	Self-administered (online or paper survey)	393	25 questions (#16)	C French 1
	Inhabitants of the south of Paris	Self-administered online survey	152	23 questions (#6)	D South Parisian1
	French citizens		310	36 questions (#6)	E French 2
2016	Inhabitants of the south of Paris, near the Fontainebleau Forest	Face-to-face	79	30 questions (#7)	F South Parisian 2
	Visitors of 3 Parisian parks		108	15 questions (#10)	A Parks

20 Table 3. Characteristics associated with the IPI scoring of definitions (adapted from Moss et al.,
21 2015).

Score	Definition characteristics	Number of definitions (this study)
1	Inaccurate, too vague to indicate accurate knowledge	154
2	Some accurate descriptions and some inaccurate ones	261
3	Positive evidence, mention of biological objects or concepts related to biodiversity (e.g., species), no details	421
4	Accurate descriptions, mention of animals or plants but not both, vague but accurate descriptions (e.g., variety of species on Earth)	243
5	No inaccurate elements, mention of both animals and plants	130

22

23 Table 4. Estimates and p-values for the IPI ordinal model (N=1190). Interaction terms were not
 24 significant and are not shown; feminine gender and C survey are references factors for categorical
 25 data.

Dependent variable	Estimate +/- SD	p-value ^a
Age	- 0.23 +/- 0.068	0.0006 ***
INS	-	0.53
Childhood living place	-	0.26
Gender (masculine)	-	0.83
Subset A	-	0.53
Subset B	- 1.32 +/- 0.41	0.0011 **
Subset D	- 0.93 +/- 0.35	0.009 **
Subset E	-	0.59
Subset F	- 2.2 +/- 0.69	0.0012 **

26 ^a Significance codes: *: <0.05; **: <0.01; ***: <0.001.

27 Table 5. List of the 11 words appearing in at least 100 definitions (French translation of words in
 28 brackets) and example of definitions given by respondents. French translations of examples are
 29 given in supplementary Table S1.

Word (French word)	Number of definitions with this word (%)	Examples
Species (Espèce)	522 (43.1)	“ <i>All species, living beings in their environment, their interactions</i> ” “ <i>Preserving species</i> ”
Living ^a (Vivant)	356 (29.4)	“ <i>Several living systems which coexist, by natural link</i> ” “ <i>Diversity of living organisms, of habitats, genes</i> ”
Diversity (Diversité)	304 (25.1)	“ <i>Diversity of animal, plant and mineral species</i> ” “ <i>What we eat, the diversity which comes with it</i> ”
All (Ensemble)	214 (17.7)	“ <i>All animals, nature and humans; what lives on Earth</i> ” “ <i>All nature</i> ”
Ecosystem (Écosystème)	170 (14.0)	“ <i>It is an ecosystem with relationships among species</i> ” “ <i>An ecosystem to protect</i> ”
Animal (Animal)	169 (14.0)	“ <i>Cohabitation of high number of species (animal, plant, fungi, etc.) in a place, with equilibrium in resources sharing</i> ” “ <i>The quantity of animal and plant species</i> ”
Plant (Végétal)	159 (13.1)	“ <i>A mix of several species (animal or plants) which manage to live together!</i> ” “ <i>Quantity but also, and firstly, quality of species (animal, plant, etc.) constituting an ecosystem</i> ”

Nature (Nature)	150 (12.4)	<p><i>“Numerous plant and nature essences”</i></p> <p><i>“Equilibrium between man-nature; to have a right place”</i></p>
Being (Être)	148 (12.2)	<p><i>“All beings who live in nature”</i></p> <p><i>“Diversity of landscapes, number of different living beings (qualitatively and quantitatively) in a given area”</i></p>
Fauna (Faune)	102 (8.4)	<p><i>“To preserve the multiplicity of species (fauna and flora) in their natural habitat”</i></p> <p><i>“Diversity fauna flora”</i></p>
Flora (Flore)	102(8.4)	<p><i>“Fauna, flora as well as the environment they live in”</i></p> <p><i>“To favour fauna and flora diversity in order to achieve natural equilibrium, without synthetic additions”</i></p>

30 ^a The word “living” has been separated from the expression “living being”.

31 Table 6. Estimates and p-values for the proportions of definitions related to an action
 32 (categorization group 2), according to the tested dependent variables (N=902). Only significant
 33 interaction terms are shown; feminine gender, non-student category and C survey are reference
 34 factors for categorical data

Dependent variable	Estimate +/- SD	p-value ^a
Age	-	0.50
Student (student)	-1.9 +/- 0.99	0.049*
INS	-	0.11
Childhood living place	-	0.74
Gender (Masculine)	-	0.51
Subset E	-1.6 +/- 0.78	0.037*
Subset E : age class	0.50 +/- 0.19	0.007**