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Margaux Julien, Juliette Ducrettet, Mohamed Diallo, Eric Imbert, Bruno Colas, et al.. Plant Translocations in France: Identifying Gaps between Knowledge, Practice and Perception by Conservation Actors. *Environmental Management*, 2024, 74 (6), pp.1160-1172. 10.1007/s00267-024-02055-4 . hal-04712170

HAL Id: hal-04712170

<https://hal.science/hal-04712170v1>

Submitted on 27 Sep 2024

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1 **Plant translocations in France: identifying gaps between knowledge,**
2 **practice and perception by conservation actors**

3

4

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15

16 **Acknowledgments.**

17 We thank all the respondents to the questionnaire, Anne-Charlotte Vaissière and Sandrine Maurice for
18 her valuable comments and suggestions to improve the manuscript.

19 **Fundings.**

20 JD was funded by the OFB and Labex Cemeb RENPOP project, MJ by Ecotonia enterprise and MD
21 was financially supported by the initiative of Recherche Stratégique ACE-ICSEN from Université
22 Paris-Saclay, by the ‘Partenariats’ projects from LabEx BASC, and by a PEPS project from CNRS-
23 INEE.

24 **Authors contributions.**

25 All authors participated to the Conceptualization, Methodology, Validation and reviewed and editing
26 the final draft. Formal analyses and Visualization were done by MJ and JD. Data curation, by MJ, JD,
27 MD and BS. Investigation and original draft by MJ, JD and MD.

28 **Highlights**

- 29 • Plant translocation is a solution for the conservation of threatened species.
- 30 • This solution is currently ecologically risky and raises ethical and genetic questions.
- 31 • We identified three main perceptions (50% favorable/ 45% unfavorable/ 5% undecided).
- 32 • These ratios are similar among the different professional activities of respondents.
- 33 • Improving the feedback and success of translocations should improve its perception.

34 **Abstract**

35 In the current context of global changes, threatened flora is declining and homogenizing at the expense
36 of rare and protected species. Among conservation biology and ecological restoration techniques, plant
37 translocation is one of the recommendations increasingly used. However, translocation remains risky
38 and is recommended as a last resort to conserve protected flora in land use planning. Furthermore, it
39 raises ethical questions partly linked to genetic processes. In this context, we studied how plant
40 translocations are perceived by conservation actors in France, including their genetic aspects. The
41 analysis of translocation perception complements that of feedback on concrete translocation operations
42 and allows us to provide a qualitative assessment of current practices.

43 We have adopted an interdisciplinary approach to survey different types of actors in nature
44 conservation, involved or not in at least one stage of translocation operations (preparation,
45 implementation and monitoring). Three main types of translocation perception divide our sample quite
46 strongly (50% favorable/ 45% unfavorable/ 5% undecided). Surprisingly, their professional activity or
47 the level of involvement in such an operation have no influence on their opinion on translocation, nor
48 on the proposals of alternative measures. Only 15% of the actors involved in translocations used genetic
49 data at least once.

50 To conclude, it would be necessary to promote the sharing of feedback from past experiences. This
51 would allow an up-to-date list of species unacceptable for translocation. Comparing the results of
52 different protocols and implementation conditions for the same species or group should improve overall
53 translocation success rates.

54

55 **Keywords:** plant conservation, survey, mitigation hierarchy, population genetics

56 1. INTRODUCTION

57

58 Human activities are constantly increasing, with a significant influence on climate and
59 ecosystems (Dirzo et al., 2014; Otto, 2018). Consequently, direct destruction of non-human populations
60 and their habitats (due to urbanisation, artificialisation, pollution or overexploitation), like their
61 progressive alteration through climate change, also increases (Maxwell et al., 2016; Ceballos et al.,
62 2017; Doxa et al., 2017; Wang et al., 2019). These global changes have other direct consequences on
63 species, notably on their risk of extinction, on their phenology (*e.g.*, shifting of flowering or pollinator
64 emergence periods, Hutchings et al., 2018; Duchenne et al., 2020; Daru et al., 2021) and on the
65 functioning of ecosystems (IPBES, 2019; Medecc, 2020). Habitat destruction is particularly a threat for
66 rare plants, as spontaneous recovery in their natural habitats is constrained by the absence of propagules
67 occurring in the restored sites.

68 To cope with these threats, and in particular habitat destruction, species translocation is one of
69 the conservation practices whose use is intensifying (Doyle et al., 2023) and results are increasingly
70 published (Seddon and Armstrong, 2019; Langridge et al., 2021). IUCN defines translocation as the
71 human-mediated movement of living organisms from one location to another (IUCN/SSC, 2013). Here
72 we focus on plant translocation defined as the deliberate transfer of plants or regenerative plant material
73 from an *ex-situ* collection or a natural population to a new location in the wild named a recipient site
74 (Commander et al., 2018). Translocations can be undertaken for different reasons. We focus on
75 mitigation-driven and conservation-driven translocations, which are often conducted in France.
76 Mitigation-driven translocations are undertaken in response to legislation on the environmental impacts
77 of development projects to minimise residual negative impacts on a protected species' population
78 (Bradley et al., 2020). Increasingly used, they can make a development project more acceptable by
79 offering a rescue solution for the impacted individuals (Fahsel, 2007; Germano et al., 2015; Silcock et
80 al., 2019; Bradley et al., 2020; Doyle et al., 2023). Conservation-driven translocations are voluntarily
81 undertaken by private or public actors, usually to improve the conservation status of a population,
82 species or ecosystem (IUCN/SSC, 2013). While these two types of translocations linked to different
83 motivations may meet the IUCN definition of conservation translocations, some mitigation-driven
84 translocations do not because they only aim at saving individuals in the short term without any objective

85 of maintaining or improving the viability of the population. Furthermore, in both cases, feedback helps
86 to improve translocation protocols, yet the results of mitigation-driven translocations are less often
87 published, and the monitoring is shorter than those of conservation-driven translocations (Silcock et al.,
88 2019; Julien et al., 2023).

89 Despite the increasing use of translocations, this practice entails significant risks on several
90 levels, from pre-translocation to the post-translocation phase. First, risks for the translocated individuals
91 are numerous and important, and their consideration is too often neglected, although they contribute to
92 explain translocation failures (Silcock et al., 2019; Julien et al., 2022a). Several risks are also associated
93 with translocations of small populations, in particular, in a recipient site carries risks, such as the Allee
94 effect (decrease in population growth rate due to low density, Frankham et al., 2010), genetic drift
95 (random sampling of alleles leading to loss of genetic diversity, van Rossum and Hardy, 2020), self-
96 incompatibility (a process that prevents reproduction between individuals that are too close genetically,
97 DeMauro, 1993), or inbreeding depression (decrease in fitness due to inbreeding, Weeks et al., 2011).
98 Therefore, a minimum number of individuals - ranging from 50 to 200 adult plants - to be translocated
99 is often recommended, depending on the species (van Groenendael et al., 1998; Monks et al., 2012;
100 Maschinski and Albrecht, 2017). Linked to the previous point on translocations of small population, it
101 is recommended to use genetically diverse plant material to promote genetic diversity (Schäfer et al.,
102 2020). However, genetic mixing can be associated with a risk of outbreeding depression but also with
103 a disruption of local adaptation of the native population (Edmands, 1999). Altogether, it is risky to only
104 consider habitat quality and demographic information and ignore genetic information. Moreover,
105 ecological risks are not to be neglected since translocating a plant population corresponds to modifying
106 the local plant community, thus inducing changes, for instance, in insect communities (Moir et al., 2012;
107 Luong et al., 2019) or the associated mycorrhizal fungi (Downing et al., 2017). The risks of biological
108 invasions when a translocation is carried out outside its area of distribution must be avoided (Schwartz,
109 2005; Ricciardi and Simberloff, 2009), as well as the risk of the spread of various pathogens, which
110 mainly affects individuals injured or weakened by the translocation (Zimmer et al., 2016). Fourth, there
111 are also logistical risks depending on the translocation protocol chosen to move the individuals. For
112 example, when moving by soil clod, there is a risk of damaging or even killing the individuals that are
113 on the edge of the soil clod. All these risks show that the use of plant translocation most often does not

114 guarantee translocation success (Germano et al., 2015; Bradley et al., 2020). In France, it is an expensive
115 practice (Julien et al., 2022b; Diallo et al., 2023) that currently gives few convincing results, depending
116 on species (Fahsel, 2007; Silcock et al., 2019) while failures are rarely reported and standards to define
117 success are not well-defined. All phases of translocation (pre-translocation to post-translocation) are
118 important to achieve success (for example, aftercare can be decisive; Corli et al., 2023).

119 Beyond the scientific and technical limits just highlighted, several ethical questions emerge
120 about the relevance of translocation, and they sometimes turn into challenges when it comes to assisted
121 migration (*i.e.*, the intentional translocation of individuals outside the natural range of a species, Hewitt
122 et al., 2011; Aitken and Whitlock, 2013; Hajjar and Kozak, 2015). Some pragmatists defend these
123 practices because humans are responsible for the current situation of ecological and climatic crisis, so
124 this practice compensates for some of our impacts (Vitt et al., 2016). Others believe that it is better to
125 focus on stopping the actions that cause harm, as these practices only serve to perpetuate our current
126 habits (Filbee-Dexter and Smajdor, 2019). The genetic aspects of translocations also seem to be a matter
127 of debate and are currently under-considered. For instance, there might be a reluctance to perform
128 genetic rescue due to concerns about the genetic uniqueness of the population to be rescued. This
129 reluctance to establish gene flow between populations contributed to a cultural barrier to use such
130 translocation action (Love Stowell et al., 2017) and has been shown in the context of conservation-
131 driven action in France for *Arenaria grandiflora* (Maurice, 2013).

132 We can thus state that concerning translocations, numerous risks have been identified, failures
133 are under-reported, and ethical dimension of this practice still raises questions. Therefore, it is pertinent
134 to document how translocations are perceived by conservation stakeholders and the factors influencing
135 this perception. Indeed, the perception of conservations' stakeholders provides insight into the gap
136 between scientific theory, existing regulations and practice, and possibly enable us to suggest ways of
137 better orienting research, sharing information among scientists and practitioners, and supporting public
138 policies mobilizing this approach.

139 To our knowledge, only two studies were carried out on opinions from practitioners and
140 researchers who had already performed translocations. These two studies were from Australia, one
141 focuses on determining guidelines on post-translocation monitoring (Hancock et al., 2014), and the
142 second compares mitigation-driven and conservation-driven translocations (Doyle et al., 2024). The

143 present study aims to determine the main features of the perception of translocations by the actors likely
144 to be familiar with these operations with a focus on practices in France and its national regulations,
145 whether they are conservation-driven or mitigation-driven translocations. We analysed the expression
146 of 386 respondents from different structures involved, or not, in the preparation, implementation, or
147 monitoring of translocations. We determined (1) the main general opinions of actors on translocations,
148 (2) how genetics is considered in current practice, and (3) how the respondents perceive the current
149 practice of translocations.

150

151 **2. MATERIALS AND METHODS**

152 **2.1 Questionnaire design and spread**

153 To collect the opinion of environmental actors on the practice of plant translocation in France, a survey
154 was created using the framaform platform, and then disseminated through email distribution lists
155 (distribution list of *Société Française d'écologie et d'évolution*), shared on social networks (Facebook),
156 and on specialised websites dedicated to ecology and botany (tela-botanica.org), targeting people
157 potentially aware of the practice of plant translocation in France. The objective was to obtain responses
158 from people working in various organizations (staff and students from research laboratories in ecology,
159 environmental consultancies, conservatories and natural areas, regulators, land planning companies,
160 and non-profit organizations) likely to be involved with plant translocations theory and/or practice.

161 The final survey is a 18 to 26 question survey depending on whether the contacted people
162 were directly involved in translocation or not (see Suppl. Doc. 3). The questions are numbered, and we
163 will refer to them in this article. One question (Q4 in Suppl. Doc. 1 & 2) was used to split into 2 groups:
164 those who had already been involved in translocation and those who have not (see the survey flow in
165 Suppl. Doc. 3). The group of involved respondents were asked questions about criteria that should be
166 used to design a protocol and the use of genetics. For the group of uninvolved respondents, only those
167 who were aware of a translocation project were asked questions about criteria that were used in the
168 design of the protocol they were aware or involved in. The complete set of questions is available in
169 Suppl. doc. 1 (French) and 2 (English). Our analysis focused on the responses we deemed the most
170 relevant to our research questions.

172 2.2 Sorting of the responses

173 The raw responses were first sorted: duplicates were removed (two respondents made a double
174 submission), and responses Q4, Q5, Q11, Q12 and Q22 were binary-coded. We collected 15 responses
175 from people who work outside France (12 from Switzerland, 1 from Belgium, 1 from Italy and 1 from
176 Canada) that we removed from the analyses to be able to make conclusions about the French case.

177 In the respondent profile, the department (a French administrative unit) of their main residence
178 was asked. We chose to group by region, the upper French administrative unit, to reduce the number of
179 categories. We also reclassified the work organisations according to what people responded in the
180 "Other" category. Finally, the 10 or 11-level Likert scale questions were simplified to the
181 disagree/neutral/agree categories to ensure the categories were sufficiently represented for this analysis.
182 For the ethics questions, the categories used are "Not ethical" (1-3), "Neutral" (4-6), and "Ethical" (7-
183 10); for the question on the frequency of use, we grouped the "Never used" modality with "Less used"
184 and for the 2 opinion questions, we created the categories "Disagree" (0-3), "Neutral" (4-6), and "Agree"
185 (7-10).

186

187 2.3 Analyses

188 2.3.1 Determination of respondent profiles based on their main opinion on translocation

189 All analyses were conducted using R, version 4.1.2. As a first step, we classified the
190 respondents according to their main opinion on translocation based on their responses to 7 questions.
191 We used four questions on ethics (Q3.1 through Q3.4; scale from 1 to 10), a question on the frequency
192 at which translocations should be carried out in their opinion (Q17; 5 possible responses), and two
193 questions on their opinion on the relevance and efficacy of the practice (Q18.1 and Q18.2; scale from
194 0 to 10). The questions were broad enough to allow opinions to be based on multiple experiences
195 whenever possible.

196 We performed a multiple correspondence analysis (MCA), a commonly used analysis for
197 surveys to group respondents according to their responses. We then performed a hierarchical ascendant
198 classification (cluster analysis) and a K-means partitioning to group the respondents with similar

199 responses. This analysis resulted in three clusters of main opinion on translocations (favourable,
200 undecided, or unfavourable), which are used in further analyses. Each cluster can be described to
201 determine which modalities best represent it. We used the respondent profile categories as additional
202 variables to investigate whether certain aspects of the profile predict whether an individual is favourable
203 or not to translocation practice. The MCA and cluster analysis were performed using the *FactoMineR*
204 and *factoextra* packages from R (Husson et al., 2020; Kassambara and Mundt, 2020, R version 4.1.2).

205 The involvement in translocations was defined using question Q2. To determine if there is a
206 link between perception and involvement, a χ^2 test was carried out for favourable and unfavourable
207 respondents. Finally, throughout the questionnaire, we let free expression spaces to allow respondents
208 to complete their responses and we qualitatively analysed them by grouping answers proposing similar
209 ideas. These free opinions were classified firstly according to whether the comment was positive,
210 negative or neutral in relation to translocation. We then highlighted the main themes raised by the
211 respondents. These are then discussed in the results.

212

213 **2.3.2 Consideration of genetics in current translocations practice**

214 Only respondents involved in a translocation were considered for analyses on genetic aspects (Q4, yes,
215 n=217). Using previous analyses, each respondent was assigned to a cluster based on their opinion about
216 translocation (favourable, undecided, or unfavourable). Next, the need to consider the potential
217 uniqueness of the population concerned in the translocation action was defined based on questions Q9.5,
218 Q9.6, Q9.7 and Q9.9. Responses were recoded into "disagree," "neutral," and "agree" to ensure that
219 categories were sufficiently represented. A MCA was used to group respondents based on their
220 responses to the questions.

221 The perception of the importance of genetic diversity for species persistence was estimated with
222 Q18.1, and the use of genetic analyses in translocation actions was estimated using Q12. We have
223 assessed the respondents' perspective of conducting genetic analyses: time necessary for genetic
224 analyses (Q18.4), and cost of genetic analyses (Q18.5). Respondents were also asked what they expect
225 from an expert in Q14 (determination of genotypes, analysis of raw data, discussion of the implications
226 of the results). Respondents were allowed to check 1 to 3 responses; the number of responses checked
227 by the respondent was used for calculating the weighted percentages. Throughout the survey, we let

228 free expression to allow respondents to complete their responses on considerations of genetics in current
229 translocation practice.

230

231 **2.3.3 What is the current practice of translocation according to the respondents?**

232 Through responses related to the current practice of translocation (Q2R1-Q2R11) and those
233 related to alternatives to translocation in the context of a development project (Q21R1-Q21R6), we
234 studied the modalities chosen by respondents without distinction of clusters, then according to their
235 cluster membership (main opinion on translocations, for the record) and their professional activity. In
236 these two questions, respondents had to choose an unlimited number of modalities among several ones.
237 To give equal weight to each respondent, we considered that each response weighed $1/N_r$ where N is
238 the total number of responses for the respondent r.

239

240 **3. RESULTS**

241 **3.1 Respondents' characteristics**

242

243 A total of 386 people completed the survey (Table 1), residing in all the French regions (except in
244 Mayotte, Saint-Barthélemy, Saint-Martin, Wallis-et-Futuna, Polynésie française, which are overseas
245 territories). Most respondents are men (>56%), between 26 and 50 years old (>58%), have a high level
246 of education (>80% with at least master/engineer degree), live outside urban centres (edge of town and
247 countryside, > 78%) and are generally members of an environmental association (>70%), but not in
248 scientific committee (Table 1). 217 respondents have already been involved in a translocation project,
249 and 148 have never been involved but were aware of a particular project. Of these 148 individuals,
250 35.1% learned about the translocation project from a naturalist association, 25.0% from word of mouth,
251 22.3% from specialised media, 7.4% from social networks, 4.7% from local media, and 0.7% from a
252 city hall posting. Finally, 21 respondents were unaware of a translocation operation (5.4%).

253

254 Table 1: Characteristics of respondents to the survey. Regions represent administrative French
255 territories.

Topic	Category	Number	Percentage
Professional activity	Naturalist association	39	10
	Environmental consultancy	82	21
	Conservatory and natural area	77	20

	*Local collectivity	22	6
	Land planning firm	10	3
	Student in environment	20	5
	Laboratory and university	62	16
	**Regulators	22	6
	Other	28	7
	No response	24	6
Age	18-25	37	10
	26-35	104	27
	36-50	125	32
	51-60	51	13
	>60	58	15
	No response	11	3
Level of higher education	No post-bac graduation	13	3
	Undergraduate	54	14
	Master, engineer	236	61
	PhD	76	20
	No response	7	2
Gender	Female	130	34
	Male	217	56
	Other	2	0.52
	No response	37	10
Environmental non-profit organization membership	Yes	271	70
	No	113	29
	No response	2	0.52
Member of a scientific committee	Yes	38	10
	No	343	89
	No response	5	1.3
Place of residence	Downtown	101	26
	Edge of town	86	22
	Village / Countryside	177	46
	No response	22	6
Region	Auvergne-Rhône-Alpes	44	11
	Bourgogne-Franche-Comté	20	5
	Bretagne	20	5
	Centre-Val de Loire	5	1
	Corse	5	1
	Grand Est	15	4
	Hauts-De-France	38	10
	Ile-de-France	29	8
	Normandie	11	3
	Nouvelle-Aquitaine	25	6
	Occitanie	65	17
	Overseas territories	25	6
	Pays de la Loire	15	4
	Provence-Alpes-Côte-d'Azur	48	12
	No response	21	5

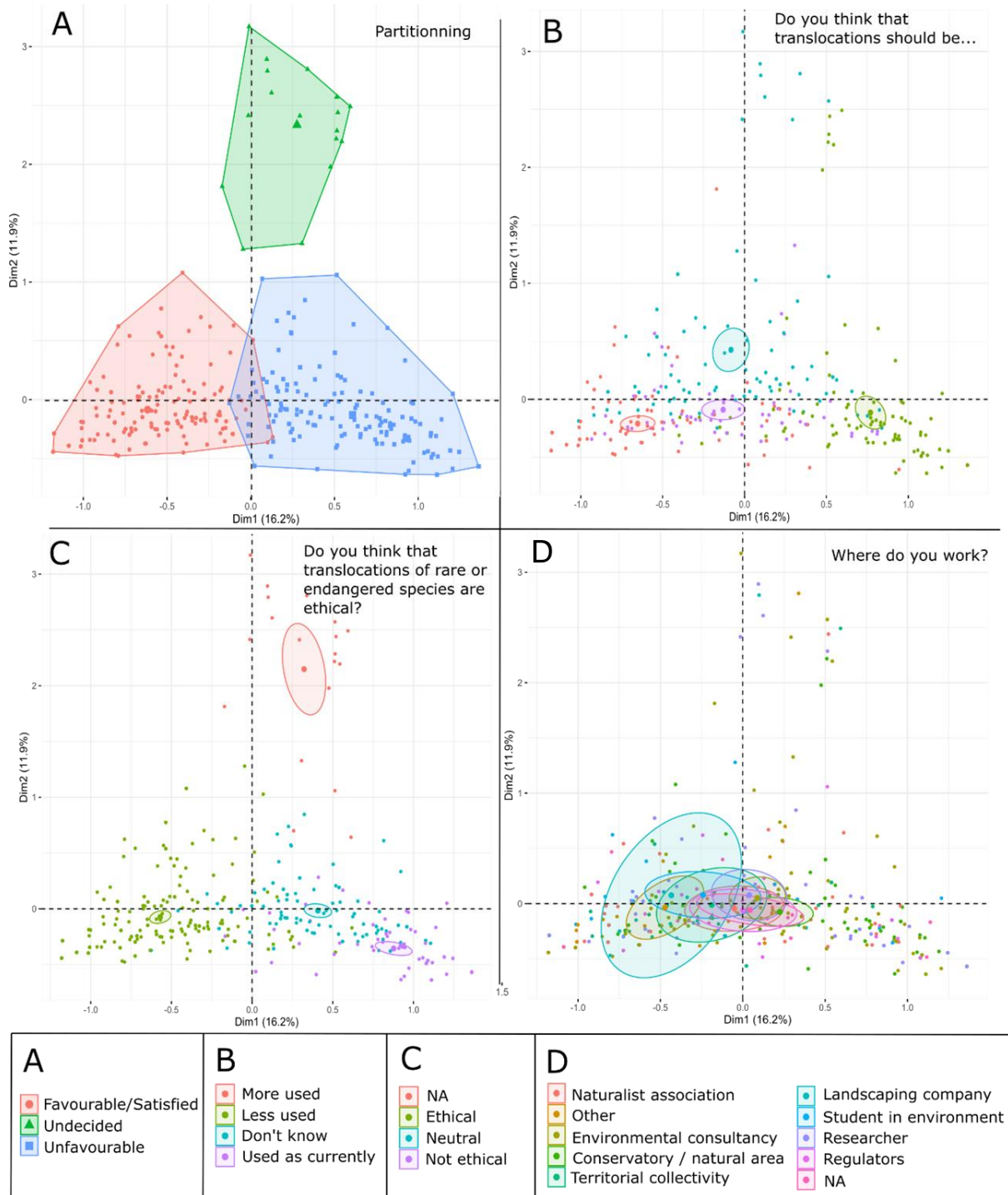
256 * Local collectivity means *Collectivité territoriale*. It can also be translated into local authority. They are
257 administrative entity that exercises competencies within a defined territory (for example, municipalities or
258 regions). They can be at the origin of a translocation.

259 ** Regulator means *Service instructeur(Direction Régionale de l'Environnement, de l'Aménagement et du*
260 *Logement, Direction Départementale des Territoires, etc)*. A regulator is an administrative entity in charge of the
261 instruction of an administrative file with environmental impact, *i.e.*, the examination and the evaluation of the
262 request filed by an individual or a company. They review files that may include a translocation project.
263

264 **3.2 Determination of three respondent profiles based on their main opinion on**
265 **translocation**

266 Using a set of 7 questions, we could define 3 clusters of respondents based on their general opinion on
267 translocations (Figure 1A):

- 268 - Favourable respondents: (n=187) have mostly responded that translocations are ethical, whatever
269 the situation. They agree with the proposition that "Translocation is a good conservation tool".
270 According to them, translocations should be used more or as currently used.
- 271 - Undecided respondents (n=17) did not express an opinion on most of the questions studied (no
272 response or neutral opinion).
- 273 - Unfavourable respondents (n=182) are neutral or think that translocation is non-ethical in any
274 situation. They disagree with the proposition that "Translocation is a good conservation tool."
275 According to them, translocations should be less used.



277 7 questions to ascertain the opinions of respondents. Four questions are related to the ethics of
 278 translocations (Q3.1 through Q3.4). One question is linked to the respondent's opinion on the
 279 appropriate frequency to use translocations (Q17), and the last two questions are about the respondent's
 280 opinion for the statements: "translocation is a good conservation tool" and "translocations generally
 281 lead to failures" (Q18.1 and Q18.2).

282

283 Hereafter, favourable/undecided/unfavourable respondents will be used to refer to respondents
284 attached to one of the 3 clusters respectively. Each of the 7 selected questions well characterised the
285 clusters (p-values $< 10^{-9}$ for χ^2 tests). The two axes of the MCA discriminated individuals based on
286 responses Q5 and Q6 (Fig. 1A). Q47 and Q48 are well represented by the first axis, and this axis explains
287 16.2% of the variance. The second axis discriminated individuals with Q14, explaining 11.9% of the
288 variance. While the first axis discriminates individuals in favour of translocations on the left and
289 individuals not in favour of translocations on the right, the second axis discriminates against undecided
290 respondents in contrast to unfavourable / favourable (Figure 1A).

291 Next, we considered the distribution of respondents according to 2 major questions that
292 participated in the construction of the axes: a clear separation is visible along the first dimension of the
293 MCA considering the frequency of utilisation of translocation (Q5, Figure 1B) and the ethical issues
294 (Q47, Figure 1C). Therefore, people who answered that translocations should be less used are more
295 likely to consider that translocations are not an ethical practice. Similar patterns are observed for the
296 other 5 questions used to construct the axes (data not shown).

297 The profile of the respondents based on their general opinion on translocations did not allow
298 them to discriminate between other aspects of their profile, including their professional activity (see
299 Table 1; Graph 1D for work structure), but some trends emerge. Among those working in environmental
300 consultancies, 38.6% of the respondents are favourable, and 54.2% are unfavourable to translocations.
301 The percentages are similar for conservatories and natural areas (37.7% and 59.7%, respectively). The
302 ratios are balanced for people working in research, with 48.4% favourable and 45.2% unfavourable, as
303 well as with the naturalist associations (48.7% favourable and 48.7% unfavourable). The ratios are
304 reversed for the local collectivities (61.9% favourable and 33.3% unfavourable) and the regulators
305 (54.5% favourable and 45.5% unfavourable), but for these 2 groups, the sample size are low (see Table
306 1; Figure 1D for work organisation). Further trends emerge (detailed table in Supplementary material
307 4): undergraduate respondents and the age group 18-25 years are more likely to be favourable to
308 translocation. Unfavourable respondents are more likely to have a “master, engineer” level of education,
309 be older (age group 26-35 years), and work in environmental consultancies or conservatories and natural
310 areas. Finally, there is no link between respondents’ involvement in the practice of translocation and

311 their perception of the practice (χ -squared=4.17; df=3; p-value=0.244). Moreover,
312 favourable/unfavourable respondents also differed in the choice of the criteria of translocation success
313 (Supp. Doc 5).

314

315 We collected 46 testimonies, and the respondents we classified in the undecided cluster gave
316 more often an opinion (29.4%, 5 out of 17) than the unfavourable respondents (15.9%, 29 out of 182).
317 The favourable respondents were the least likely to give a free opinion (6.4%, 12 out of 187). Several
318 ideas are frequently mentioned in these testimonies. Ten respondents stated that their responses
319 depended on the purpose of the translocation project: a mitigation-driven translocation seems less
320 acceptable than a conservation-driven translocation. Three respondents mentioned that translocations
321 are acceptable but only as the last resort. Respondents opposed to translocation often expressed strong
322 positions such as "they are only excuses for destruction", "decoys to validate developments", "to ease
323 their conscience", or comparing translocation with "a lifebuoy". Moreover, these testimonies also give
324 an idea of the conditions under which mitigation-driven translocations are carried out: control over land
325 can be a hindrance, with little room for the research department to choose a recipient site with a similar
326 habitat to the site destroyed, and time constraints are important, with protocols sometimes carried out
327 "in a rush". Even if there are differences in how consultancies operate, financial constraints, which limit
328 post-translocation monitoring, are also often mentioned. However, this view is not shared by all, with
329 one opinion mentioning an obligation of results on the part of the consultancy firm and an obligation of
330 means on the part of the project owner. Finally, many stakeholders denounce the possible abuses of the
331 overuse of translocations: proposing a translocation could make it easier to accept a development
332 project, even if there is no guarantee that the translocation will succeed.

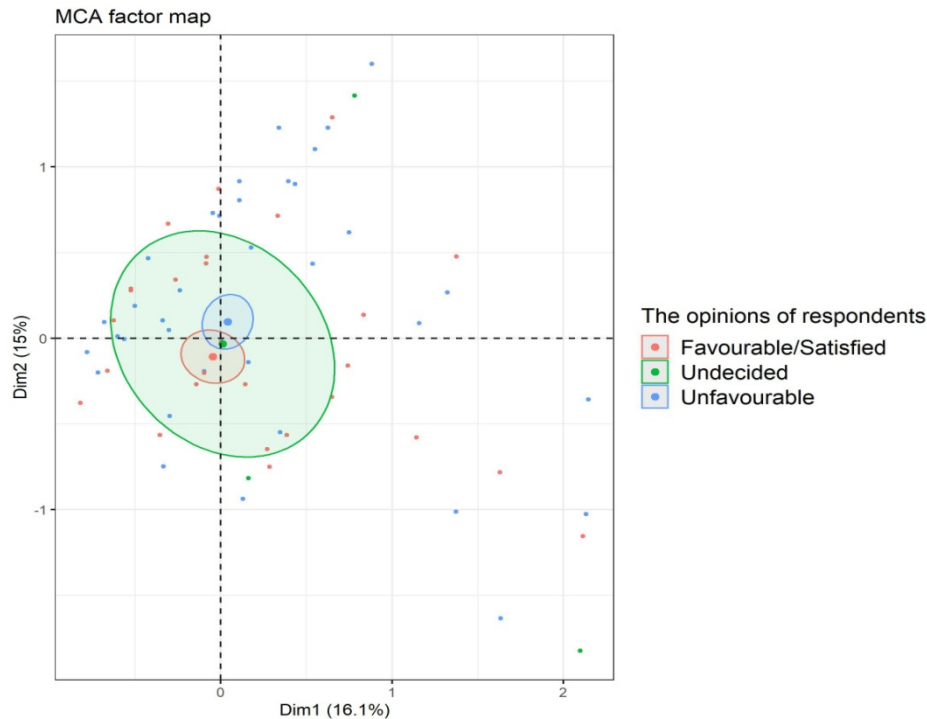
333

334 **3.3 Considerations of genetics in current translocations practice**

335 Integration of the potential uniqueness of the populations in translocation projects according to the
336 respondent was evaluated using Q9.1 through Q9.9. In the MCA, the first axis only explained 16.1% of
337 the total variance and the second axis 15%. Being favourable or unfavourable to translocations does not
338 predict whether respondents value respect for the uniqueness of populations for translocations (Figure
339 2).

340

341



342 Figure 2: Respect for the uniqueness of populations for translocations and respondents' opinions on
343 translocations. Respondents' opinion is the variable constructed from the previous analysis (Figure 1).
344 Dimensions 1 and 2 were built from Q25 through Q29.

345

346 While 77.0% of the respondents indicated that the persistence of a species depends in part on
347 its genetic diversity, genetic analyses are rarely integrated. Indeed, only 14.8% of the 217 respondents
348 involved in translocation projects are aware of genetic analyses in the translocation project they
349 participated to. Those who have integrated genetic analyses work primarily in botanical conservatories
350 and management of natural areas (46.9%), and 21.9% are academics (Research Laboratory / University
351 category). 62.5% of them are favourable to translocation. In contrast, most respondents who did not
352 incorporate genetic analyses were unfavourable to translocation (58.4%). Interviewees gave their view
353 on the statement that 'genetic testing takes too long in comparison to the benefit it provides': 29.0%
354 disagreed with this statement, 19.4% were neutral, 18.4% agreed and 33.2 % gave no opinion. Similarly,
355 interviewees gave their view on the statement 'genetic testing are too expensive in comparison to the
356 benefit it provides': 28.6% disagreed with this statement, 18.9% were neutral, 22.6% agreed and 29.9%
357 gave no opinion. When it was suggested that respondents hire an expert to integrate genetic analyses
358 (14, n=217 respondents, of which 26.1% had no opinion), they expected that this expert would discuss
359 with them the implications of the results on the translocation project (46.7% of respondents), determine

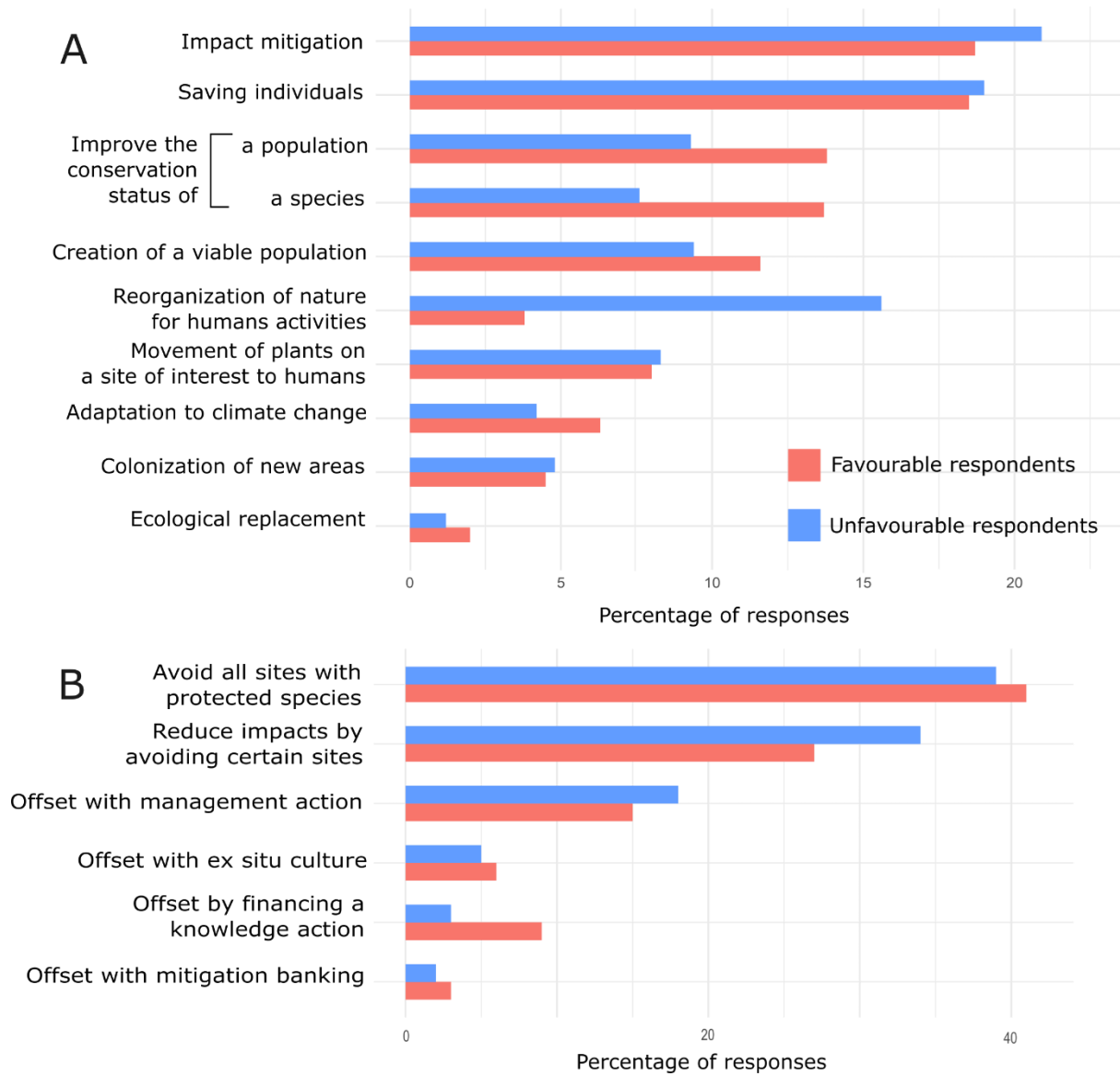
360 the genotypes of individuals (19.2%), and/or analyse the raw data (8.1%). Other reasons for
361 incorporating genetic analyses or not were added through an open-ended field. Genetic analyses can
362 help assess the risk of hybridization, conservation unity, determining whether populations can be mixed
363 (n=6), clarifying taxonomy (n=2), determining population characteristics (n=1), assessing the suitability
364 and modality of translocations (n=1), or because it is a strategy for conserving genetic diversity (n=1).
365 Genetic analyses were not included for several reasons: they are costly (n=16), not necessary for the
366 project (n=6), the species is not rare (n=1), there is no partnership (n=4), it takes too long to carry out
367 (n=4), respondents do not have the required expertise (n=5), and it is difficult to establish a partnership
368 with university research (n=2). While 16 respondents said that genetic analyses are too costly, one
369 indicated that lack of budget is not the problem and another one that no one is willing to pay for it.

370

371 **3.4 How is the current practice of translocation understood by respondents?**

372 Respondents were asked to give the definition of translocation as they perceive the current practice.
373 Translocations are primarily viewed (Q2) as mitigation of impacts during development projects (19.7%)
374 and as a rescue of individuals (18.7%), regardless of the respondent's profile. For respondents
375 favourable to translocation, this action is viewed as a way to improve the conservation status of a
376 population (13.6%) or a species (13.5%), while for respondents unfavourable to translocation,
377 translocation rather appeared as a reorganisation of nature in favour of human activities (15.4%) (Figure
378 3A).

379



380

381 Figure 3: A. Percentage of responses for each possibility in the question about the respondents'
 382 perception of the current practice of translocation. B. Percentage of responses for each possibility in the
 383 question about possible alternatives to translocation according to the respondent perception of
 384 translocation. Each respondent is worth 1, and each of her/his responses is worth $1/N_r$ with N the number
 385 of responses of respondent r.

386

387 They had to identify a possible alternative to translocation in the case of land-use planning. Not
 388 surprisingly, respondents thought that total avoidance was preferable (40%), followed by impact
 389 reduction (31%) (Figure 3B). However, development companies and environmental consultancies,
 390 which are primarily faced with mitigation-driven translocations, stand out, with only 32% of responses
 391 in avoidance and 30% and 39% in impact reduction, respectively. Among the proposed offsets methods,
 392 16% of respondents believe that appropriate management of a population of the impacted species is
 393 preferable. This is followed by financing a knowledge project on the species (6%), *ex-situ* cultivation

394 (5%), and offset banking (2%). A few groups stand out: respondents in environmental consultancies
395 rank impact reduction as the preferred alternative (39%) ahead of impact avoidance (32%), and
396 respondents working in development companies often chose the *ex-situ* culture (20% against 6% for
397 the total).

398

399

400 **4. DISCUSSION**

401 **4.1 Actors are divided on plant translocations**

402 From the survey, we could define three types of attitudes toward translocations, and we found that
403 favourable and unfavourable opinions were balanced among respondents. Regarding the perception of
404 the very principle of translocation, the two dominant responses are that it is considered as mitigation of
405 impacts of land use projects and as a rescue of individuals, regardless of the positive or negative opinion
406 of the respondents. The other responses depend on the main opinion on translocations; unfavourable
407 respondents mostly think it is a reorganisation of nature in favour of human activities, while favourable
408 respondents mostly perceive it as an improvement in the conservation status of the population or
409 species. Unfavourable respondents are usually opposed to the mitigation hierarchy. These respondents
410 may have been involved in failed translocations, or they may have experienced or participated in a
411 translocation project with a poor quality protocol. Julien et al. (2022a) highlighted that mitigation
412 translocation protocols under French legislation are of poor quality; information on biology or ecology
413 is poorly filled in and genetic issues are never addressed (see also Ducrettet et al., 2023). This pattern
414 is different from the study of Doyle et al. (2024), which appears to show greater support for
415 translocations. Our primary hypothesis was that this difference in the perception of the very principle
416 of translocations may reflect that favourable respondents were mainly working on conservation-driven
417 translocations while unfavourable respondents were working on mitigation-driven translocations.
418 However, our survey does not allow us to confirm this hypothesis, especially since the working
419 organizations do not reflect this distribution between the main opinions on translocations. Moreover,
420 the perception of the potential originality of populations does not seem to influence the opinion of
421 conservation actors on translocations, contrary to what was shown in the case of *Arenaria grandiflora*
422 (Maurice et al., 2013).

423 Interestingly, our study showed that respondents' opinion was not strongly influenced by their
424 professional activity, although those working in local authorities and administration tended to be more
425 favourable to translocations. Thus, being a researcher, working in a non-profit organisation, or being
426 responsible for a natural area does not prejudge attitudes toward translocation. However, the level of
427 knowledge does not seem to influence criteria used during translocation according to the respondents.
428 Plant translocations involve a diversity of actors and need an interdisciplinary approach because
429 biological and technical factors are not the only ones to influence the outcome of translocations
430 (Reading et al., 2002). Coordination between stakeholders (Clark and Westrum, 1989), consideration
431 of social aspects (Reading et al., 1997), and compliance with the legal framework (Morris, 1986) should
432 also be considered in determining the outcomes of a translocation operation.

433

434 **4.2 Different perceptions among clusters on genetic analyses**

435 As observed for management actions performed for *in situ* plant conservation (Ducrettet et al.,
436 2023), there is a discrepancy between the perception of genetic analyses and their integration in
437 translocation projects in practice. Indeed 77% of the respondents acknowledged the importance of
438 genetic diversity for long-term population persistence, but only 15% of the respondents involved in a
439 translocation project considered genetic analyses prior to the translocation. Translocations result in
440 populations with new demographic and genetic characteristics, whether by introduction, reintroduction
441 or reinforcement. These new values will determine the fate of the population created. Therefore, the
442 integration of demo-genetic processes guides, for example, the qualitative and quantitative choice of
443 source individuals to promote the viability of the population (see, for example, Kirchner et al., 2006;
444 Van Rossum et al., 2020). Respondents working in conservatories, natural areas, and academic research
445 have a better appreciation of the relevance of the genetic analyses for conservation measures than other
446 respondents, a tendency already found in a similar study in New Zealand (Taylor et al., 2017). Finally,
447 arguments invoked against genetic analyses are similar to those stated in studies performed in other
448 countries: *i.e.*, lack of training of managers in conservation genetics, of appreciation of the benefit of
449 its integration, of funding or the duration of the analyses (Vernessi and Bruford 2009; Pierson et al.,
450 2016; Taylor et al., 2017; Cook and Sgrò 2018; Sandström et al., 2019). In almost half of the cases, the

451 expectation of the respondents is a discussion of the implications of the results for conservation issues,
452 and in less than one in five cases, a determination of the genotypes of the individuals to be translocated.
453

454 **4.3 What alternatives to translocation?**

455 Responding alternatives to translocations using the three steps of the mitigation hierarchy was probably
456 complex for respondents because translocations were originally considered in France as reduction or
457 offsetting measures. However, since 2018, a non-binding report guiding the project developers in
458 implementing the mitigation hierarchy defines translocation as an “accompanying” measure to the three
459 steps of the hierarchy (Cerema, 2018). Only those who do not see translocation as one of the steps in
460 the mitigation hierarchy, whatever it may be, could respond this question unambiguously. Otherwise,
461 we will never know if they proposed any of the steps as alternatives with translocation as one of them.

462 Furthermore, when choosing alternatives to translocation, we did not define what a
463 compensation bank is. This answer was rarely chosen by respondents because it is not a widespread
464 practice in France. A definition would therefore have been necessary to put all respondents at the same
465 level of knowledge.

466 The most often preferred alternatives to translocation follow the order of steps of the mitigation
467 hierarchy. If offsetting is always ranked last, the preference for avoidance and reduction steps differs
468 according to the work of the respondent: environmental consultancies rank reduction as the first
469 alternative to translocation ahead of impact avoidance. First, as mentioned above, this may be due to
470 uncertainty about how respondents place translocations in relation to the mitigation hierarchy. Second,
471 given the definitions of avoidance (not impacting all the protected species) and reduction (not impacting
472 certain protected species, *i.e.*, logically including the plant species for which an alternative to
473 translocation is sought) used, both avoidance and reduction can be seen as avoidance because the given
474 plant species is not impacted at all. Preferring general avoidance of impacts as an alternative to
475 translocation, the respondents are in line with the theoretical reglementary definition of the mitigation
476 hierarchy while, in practice, the step of avoidance is usually neglected (Clare et al., 2011; Bigard et al.,
477 2017; Phalan et al., 2018).

478 The fact that all the respondents, whatever their main opinion on translocations, give similar
479 responses to the question of alternatives to translocation confirms that translocation might be

480 denigrated, even by those favourable or undecided. One reason to dislike translocations is that it is a
481 risky conservation practice. While not included in our questionnaire, another reason can be the
482 reluctance to pay for translocations, often mentioned in other studies (Naidoo et al., 2006; Fenu et al.,
483 2019; Bradley et al., 2020).

484

485 **4.4 Perspectives**

486 Improving knowledge on translocations is crucial for informed decision-making and more effective
487 public policies. In response to increasing threats to biodiversity, especially flora, there is an urgent need
488 to enhance operational conservation practices like plant translocation. Recent findings in France
489 highlight significant potential improvements in mitigation translocation protocols by considering
490 species biology (Julien et al., 2022a), emphasizing the importance of systematic evaluation and shared
491 databases, such as TransLoc database, Trans-Planta, IDPlanT, Care Mediflora and ConservePlants
492 Database, for collective success (Albrecht et al., 2011; Godefroid and Vanderborght, 2011; Fenu et al.,
493 2017, Dalrymple et al., 2020; Abeli et al., 2021; Bellis, 2021; Doyle et al, 2023).

494 The relevance of translocations as conservation actions is regularly debated as this study shows
495 (187 Favourable, 17 Undecided and 182 Unfavourable), or even unvalidated for some specific examples
496 (Diallo et al., 2023). There is a mistrust of translocation, given the risks to the focal species and past
497 experiences with translocation that failed (Fahselt, 2007; Pérez et al., 2012; Julien et al., 2022a).

498 The poor feedback on translocations as identified by our respondents and the lack of
499 publications on translocation failures is regrettable, as this would be an important avenue for improving
500 translocation protocols (Godefroid et al., 2011). Setting up a list of “no-go” species that are
501 unacceptable to translocate in a mitigation context because they are too often linked to failure could
502 increase the overall acceptability of translocations. Identifying the species for which translocation is
503 systematically difficult or unsuccessful could be a lever to support the biodiversity conservation
504 argument in front of the other ones that currently most often define the public utility or legitimacy of
505 development projects. For conservation-driven translocations, limiting spending on measures that are
506 bound to fail would increase the legitimacy of public action and the very principle of translocation.
507 Translocations are only one conservation tool among others, to be used sparingly. As an emergency and

508 transitory solution, they will not be sufficient without systemic changes in our development and
509 consumption patterns.

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Supplementary documents

Supplementary document 1: Questionnaire in French

Introductory remarks: Que pensez-vous des translocations végétales ?

Vous avez déjà entendu parler des translocations végétales ? Vous pratiquez ? Ou bien vous êtes tout simplement curieux de découvrir ce qui se cache derrière ce terme ? Venez répondre à ce questionnaire et nous donner votre avis sur cette pratique.

Une translocation végétale, qu'est-ce que c'est ? C'est le déplacement volontaire de matériel végétal d'espèces sauvages (non cultivées) (graines, plants, plantules, etc.) d'un endroit à un autre. Le déplacement intentionnel peut avoir plusieurs motivations : expérimentales, légales dans le cadre de l'aménagement du territoire, conservatoires face aux menaces pesant sur l'espèce/la population.

Quel est l'objectif du questionnaire ? La translocation végétale soulève de nombreux questionnements. Nous souhaitons améliorer les connaissances scientifiques autour de cette pratique, notamment sur sa perception.

Comment partager votre opinion ? En répondant au questionnaire ci-dessous en ligne du 1er septembre au 30 novembre 2021 inclus.

Qui peut répondre ? Nous nous adressons aux personnes intéressées par la protection de la nature, que ce soit par leur métier ou pour des raisons d'intérêt personnel.

Combien de temps faut-il pour remplir le questionnaire ? Ce questionnaire devrait vous prendre environ 15 minutes, en fonction de votre implication dans le domaine.

Qui sommes-nous ? Nous sommes 3 doctorants, nos thèses s'intéressent aux translocations végétales sous différents aspects.

Mohamed Diallo, "Evaluation interdisciplinaire des translocations végétales à des fins conservatoires". ESE (Ecologie Systématique et Evolution), Paris-Saclay, sous la direction de Bruno Colas (professeur à AgroParistech) et Anne-charlotte Vaissière (Economiste-écologue au CNRS)

Juliette Ducretet, "Renforcement des populations comme source de sauvetage évolutif". ISEM (Institut des Sciences de l'Évolution de Montpellier) UMR 5554, sous la direction de Eric Imbert (Maître de conférences à l'université de Montpellier) et Sandrine Maurice (Maitresse de conférences à l'université de Montpellier)

Margaux Julien, "Translocations végétales : bilan des connaissances, optimisation et expérimentations". CEFÉ (Centre d'Ecologie Fonctionnelle et Evolutive) UMR 5175 et Ecotonia, sous la direction de Bertrand Schatz (directeur de recherche au CNRS, CEFÉ) et Bruno Colas (professeur à AgroParistech). N'hésitez pas à diffuser largement ce questionnaire.

Nous vous remercions pour votre collaboration !

Q1	<p>Quel est votre niveau de connaissances sur les translocations végétales ?</p> <p>R1 J'en ai entendu parler</p> <p>R2 Je n'en ai jamais entendu parler</p> <p>R3 Je suis ponctuellement impliqué(e) dans des projets de translocation</p> <p>R4 Je suis régulièrement impliqué(e) dans des projets de translocation</p>
Q2	<p>Selon vous, dans la pratique actuelle, à quoi s'apparentent les translocations ? (5 réponses max) (Cocher les cases correspondantes)</p> <p>R1 Sauvegarde des individus</p> <p>R2 Atténuation des impacts lors de projets d'aménagement</p> <p>R3 Adaptation face au changement climatique</p> <p>R4 Colonisation de nouveaux espaces</p> <p>R5 Remplacement d'une espèce par une autre</p> <p>R6 Déplacement des individus présents sur un site d'intérêt à usage humain.</p> <p>R7 Réorganisation de la nature en faveur des activités humaines</p> <p>R8 Création d'une nouvelle population viable</p> <p>R9 Amélioration du statut de conservation de l'espèce</p> <p>R10 Amélioration du statut de conservation d'une population</p> <p>R11 Aucune de ces propositions</p>
Q3	<p>Questions éthiques sur les translocations (Notez de 1 – pas éthique à 10 - éthique)</p>
Q3.1	<p>La translocation des espèces communes vous paraît...</p>
Q3.2	<p>La translocation des espèces rares ou menacées vous paraît...</p>
Q3.3	<p>La translocation des espèces protégées par un statut légal vous paraît...</p>
Q3.4	<p>La translocation des espèces dont les retours d'expériences sont globalement négatifs vous paraît...</p>
Q4	<p>Avez-vous déjà été impliqué dans un projet de translocation végétale ? R1 Oui/ R2 Non</p>
Q5	<p>Connaissez-vous un ou plusieurs cas de translocation végétale ? R1 Oui / R2 Non</p>
Q6	<p>Comment l'avez-vous appris ? (Cocher oui ou non)</p> <p>R1 Presse locale</p> <p>R2 Presse spécialisée</p> <p>R3 Association naturaliste</p> <p>R4 Affichage à la mairie</p> <p>R5 Bouche à oreille</p> <p>R6 Réseaux sociaux</p>
Q7	<p>Selon vous, à quel point les critères ci-dessous devraient être pris en compte dans la mise en œuvre des opérations de translocation ? (0 ce critère ne devrait jamais être pris en compte, 10 ce critère devrait systématiquement pris en compte ou absence d'opinion)</p>
Q7.1	<p>On déplace des plantes venant d'une grande population.</p>
Q7.2	<p>L'espèce a déjà été observée dans le passé sur le site d'accueil.</p>
Q7.3	<p>Le site d'accueil choisi a déjà des individus de la même espèce.</p>
Q7.4	<p>Le site d'accueil choisi a beaucoup d'individus de la même espèce.</p>
Q7.5	<p>Le site d'accueil choisi est le plus proche géographiquement du site d'origine</p>
Q7.6	<p>Le site d'accueil choisi a l'habitat le plus similaire au site d'origine.</p>
Q7.7	<p>Il faut limiter le mélange de plantes provenant de sites d'origines différents.</p>

Q7.8	Les plantes déplacées viennent d'un site où elles risquent fortement de disparaître.
Q7.9	Un site A et un site B ont des plantes de la même espèce. Les individus du site A n'ont pas la même forme de feuilles que les individus du site B. Il ne faut pas déplacer des plantes du site A sur le site B.
Q8	Dans combien de projets avez-vous été impliqué(e) ? R1 1 R2 entre 2 et 5 R3 plus de 5
Q9	Lors de la mise en place ou de l'évaluation des projets dans lesquels vous avez été impliquées ou eu connaissance, à quel point les critères suivants ont été pris en compte ? (0 pas du tout pris en compte, 10 très bien pris en compte)
Q9.1	Certains individus transférés viennent d'une population de grande taille.
Q9.2	L'espèce a déjà été observée sur le site d'accueil mais n'est plus présent.
Q9.3	La population présente sur le site d'accueil est de très grande taille.
Q9.4	Des individus de l'espèce transférée sont déjà présents sur le site d'accueil.
Q9.5	Le site d'accueil choisi est le site disponible le plus proche géographiquement du site d'origine.
Q9.6	Le site d'accueil choisi a un habitat similaire au site d'origine.
Q9.7	Il faut limiter le nombre de populations mélangées.
Q9.8	Les individus transférés viennent d'une population avec un risque d'extinction élevé.
Q9.9	Si deux populations présentent des variations observables (phénotype), ces deux populations ne doivent pas être mélangées.
Q10	Pour la translocation la plus récente, comment évaluez-vous les caractéristiques suivantes ? Echelle de 0 à 10 (0 pas du tout pris en compte, 10 très bien pris en compte) ou absence d'opinion
Q10.1	Le coût financier
Q10.2	La faisabilité
Q10.3	La connaissance de la biologie et l'écologie de l'espèce
Q10.4	Les chances que les individus transplantés survivent à la translocation
Q10.5	La disponibilité des retours d'expériences des translocations passées
Q10.6	Le temps passé à l'élaboration de la translocation
Q10.7	Le statut de la population après translocation
Q10.8	L'attractivité récréative du site après translocation
Q10.9	Le choix de la période de translocation
Q10.10	Le protocole de translocation
Q10.11	La pertinence des critères de sélection du site d'accueil
Q11	Pour la translocation la plus récente, une population témoin a-t-elle été mise en place ? R1 Yes/ R2 No
Q12	Avez-vous déjà intégré des analyses génétiques dans vos projets de translocation ? R1 Yes/ R2No
Q13	Pourquoi ? Expression libre
Q14	Vous voulez solliciter un expert pour réaliser des analyses génétiques. Qu'attendez-vous de l'expert ? R1 Qu'il détermine les génotypes des individus à transloquer R2 Qu'il analyse les données brutes

	<p>R3 Qu'il échange avec vous sur les implications des résultats dans votre problématique de conservation</p> <p>R4 Ne se prononce pas</p>
Q15	Avez-vous en tête une structure / personne qui pourrait vous aider, si oui laquelle ?
Q16	<p>A quel point vous sentez-vous à l'aise avec les analyses de diversité génétique utilisées en biologie de la conservation ?</p> <p>R1 Estimer le flux de gènes, la connectivité entre les populations</p> <p>R2 Estimer le nombre d'individus qui participent à la reproduction</p> <p>R3 Déterminer la structure de la population</p> <p>R4 Identifier les menaces sur les populations</p> <p>R5 Déterminer la délimitation taxonomique</p>
Q17	<p>Pensez-vous que les translocations devraient être :</p> <p>R1 Utilisées comme actuellement</p> <p>R2 Davantage utilisées</p> <p>R3 Moins utilisées</p> <p>R4 Jamais utilisées</p> <p>R5 Ne sait pas</p>
Q18	Quel est votre avis sur les affirmations suivantes ? (0 pas du tout d'accord, 10 tout à fait d'accord ou absence d'opinion)
Q18.1	La translocation est un bon outil de conservation.
Q18.2	Les translocations conduisent généralement à des échecs.
Q18.3	La persistance d'une population dépend en partie de sa diversité génétique.
Q18.4	Les analyses de diversité génétique sont trop longues par rapport aux informations qu'elles apportent.
Q18.5	Les analyses de diversité génétique sont trop coûteuses financièrement par rapport aux informations qu'elles apportent.
Q18.6	Les translocations sont des opérations trop coûteuses financièrement
Q18.7	Une translocation sur un terrain augmenterait sa valeur financière.
Q19	<p>Classez de 1 à 7 ces critères permettant d'estimer le succès d'une translocation en fonction de leur pertinence selon vous (1 étant le plus pertinent et 7 le moins pertinent).</p> <p>R1 Le nombre d'individus présents</p> <p>R2 Le nombre d'individus au stade de floraison</p> <p>R3 Le nombre d'individus au stade de fructification</p> <p>R4 La diversité génétique</p> <p>R5 Le nombre de nouveaux individus</p> <p>R6 La résilience de la population (retour rapide à la normale après une perturbation)</p> <p>R7 L'établissement d'une nouvelle génération</p>
Q20	D'après vous, quel(s) critère(s) non listé(s) précédemment et permettant de mesurer le succès d'une translocation serai(en)t pertinent(s) ? Expression libre
Q21	<p>Lors de projets d'aménagements, quelles alternatives vous semblent préférables aux translocations végétales ?</p> <p>R1 Eviter tous les sites à espèce(s) protégée(s) du projet</p> <p>R2 Réduire les impacts en évitant certains sites à espèces protégées</p> <p>R3 Compenser en réalisant une culture ex-situ</p> <p>R4 Compenser en mettant en place une action de gestion pour favoriser d'autres populations de la même espèce</p> <p>R5 Compenser en finançant une action de connaissance sur la même espèce</p> <p>R6 Compenser en contribuant financièrement à une banque de compensation</p>

Caractéristiques du répondant	
Q22	Etes-vous membre du CNPN ou d'un CSRPN ? R1 Oui/ R2 Non
Q23	Niveau d'études supérieures R1 Absence de diplôme R2 Baccalauréat R3 BTS, Licence R4 Master, ingénieur R 5 Doctorat ou plus
Q24	Tranche d'âge R1 18-25 R2 26-35 R3 36-50 R4 51-60 R5 <60
Q25	Vous habitez... R1 Bordure de ville R2 Centre-ville R3 Village / Campagne R4 Ne souhaite pas répondre
Q26	Genre R1 Femme R2 Homme R3 Autre R4 Ne se prononce pas
Q27	Etes-vous adhérent(e) d'une association dans le domaine de l'écologie/l'environnement ? R1 Oui/ R2 Non
Q28	Dans quel organisme/structure travaillez-vous ? R1 Association naturaliste R2 Bureau d'études en environnement R3 CBN, CEN, aires naturelles R4 Collectivité territoriale R5 Entreprise d'aménagement du territoire / branche environnement d'une entreprise R6 Laboratoire de recherche / université R7 Etudiant en environnement R8 Service instructeur (DREAL, DDT, etc) R9 Autre (à préciser)
Q29	Entrez le numéro de département de votre résidence principale

Supplementary document 2: Survey in English

What do you think of plant translocations?

Have you ever heard of plant translocations? Do you practise? Or are you simply curious to find out what's behind the term? Take this quiz and tell us what you think about the practice.

What is plant translocation? It's the deliberate movement of plant material of wild (uncultivated) species (seeds, seedlings, seedlings, etc.) from one place to another. Intentional movement can have several

motivations: experimental, legal as part of land-use planning, conservation in the face of threats to the species/population.

What is the purpose of the questionnaire? Plant translocation raises many questions. We want to improve scientific knowledge of this practice, particularly in terms of how it is perceived.

How can you share your opinion? By completing the questionnaire below online from 1st september to 30th november 2021

Who can respond? We are looking for people who are interested in protecting nature, whether through their job or for reasons of personal interest.

How long does it take to complete the questionnaire? The questionnaire should take about 15 minutes to complete, depending on your level of involvement in the field.

Who are we? We are 3 PhD students, and our theses focus on different aspects of plant translocations. Mohamed Diallo, "Interdisciplinary evaluation of plant translocations for conservation purposes". ESE (Ecologie Systématique et Evolution), Paris-Saclay, under the supervision of Bruno Colas (professor at AgroParistech) and Anne-charlotte Vaissière (economist-ecologist at the CNRS).

Juliette Ducretet, " Use of population genetics in in situ conservation". ISEM (Institut des Sciences de l'Évolution de Montpellier) UMR 5554, under the supervision of Eric Imbert (Senior Lecturer at the University of Montpellier) and Sandrine Maurice (Senior Lecturer at the University of Montpellier)

Margaux Julien, "Plant translocations: assessment knowledge, optimization and experimentation". CEFE (Centre d'Ecologie Fonctionnelle et Evolutive) UMR 5175 and Ecotonia, under the supervision of Bertrand Schatz (CNRS research director, CEFE) and Bruno Colas (professor at AgroParistech).

Please feel free to distribute this questionnaire widely.

Q1	<p>What is your level of knowledge about plant translocations?</p> <p>R1 I've heard about it</p> <p>R2 I have never heard about it</p> <p>R3 I am occasionally involved in translocation projects</p> <p>R4 I am regularly involved in translocation projects</p>
Q2	<p>What do you think translocations look like in current practice? (5 responses max) (Check or uncheck each response)</p> <p>R1 Saving individuals</p> <p>R2 Mitigation of impacts during development projects</p> <p>R3 Adaptation to climate change</p> <p>R4 Colonisation of new areas</p> <p>R5 Replacement of one species by another</p> <p>R6 Displacement of individuals present on a site of interest for human use</p> <p>R7 Reorganisation of nature in favour of human activities</p> <p>R8 Creation of a new viable population</p> <p>R9 Improvement of the conservation status of the new species</p> <p>R10 Improvement of the conservation status of a population</p> <p>R11 None of these proposals</p>
Q3	<p>Questions about ethics (scale from 1 - not ethical to 10 - ethical)</p>

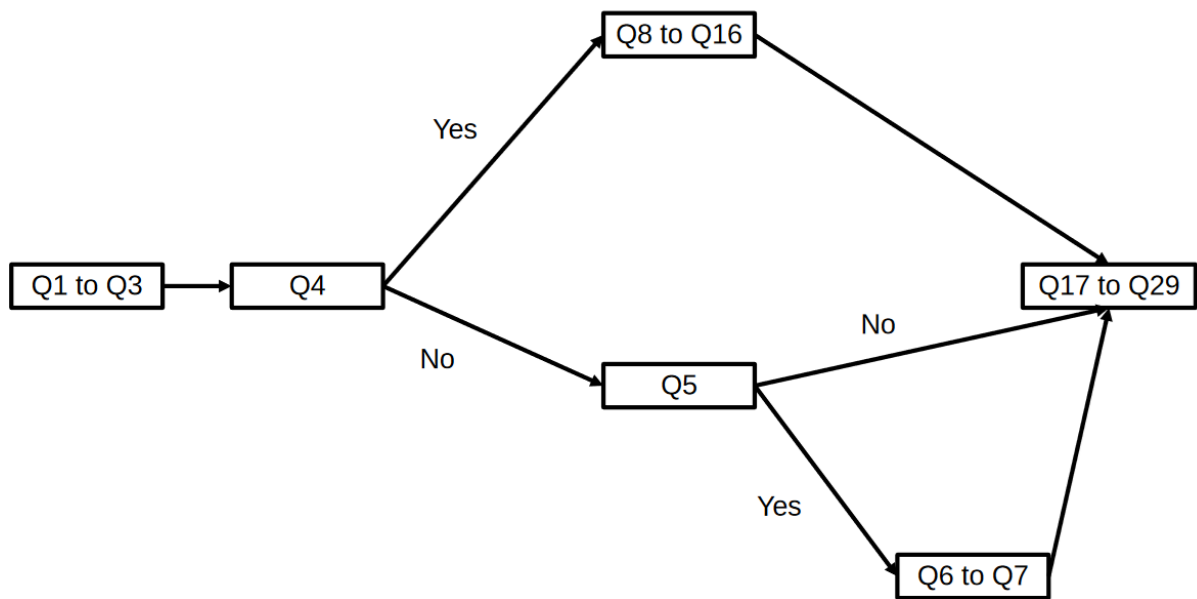
	Q3.1	The translocation of common species seems to you... –
	Q3.2	The translocation of rare or endangered species seems to you...
	Q3.3	The translocation of species protected by a legal status seems to you...
	Q3.4	The translocation of species for which the feedback are globally negative seems to you...
	Q4	Have you ever been involved in a plant translocation project? R1 Yes/ R2 No
	Q5	Do you know one or more cases of plant translocation? R1 Yes/ R2 No
	Q6	How did you learn about it? Check or uncheck each response R1 Local media R2 Specialised media R3 Naturalist association R4 Posting at the city hall R5 Word of mouth R6 Social media
	Q7	How much should the criteria be considered? Scale from 0 to 10 (0 strongly disagree to 10 strongly agree) or no opinion
	Q7.1	Plants are moved from a large population.
	Q7.2	The species has been observed in the past at the recipient site.
	Q7.3	The selected recipient site already has individuals of the same species.
	Q7.4	The chosen recipient site has many individuals of the same species.
	Q7.5	The chosen recipient site is the closest geographically to the original site
	Q7.6	The selected recipient site has the most similar habitat to the original site.
	Q7.7	Mixing of plants from different sites of origin should be limited.
	Q7.8	The displaced plants come from a site where they are at high risk of extinction.
	Q7.9	A site A and a site B have plants of the same species. Individuals from site A do not have the same leaf shape as individuals from site B. Do not move plants from site A to site B.
	Q8	How many projects have you been involved in? R1 1 R2 Between 2 and 5 R3 More than 5
	Q9	When setting up or evaluating the projects you were involved in or aware of, how well were the following criteria taken into account? (0 not taken into account at all, 10 very well taken into account)
	Q9.1	The translocated individuals come from a large population
	Q9.2	The species has been observed in the past at the recipient site
	Q9.3	Individuals of the same species already present at the recipient site
	Q9.4	Individuals of the same species are numerous at the recipient site
	Q9.5	The selected recipient site is the closest geographically to the site of origin
	Q9.6	The selected recipient site has the most similar habitat to the original site
	Q9.7	Mixing of plants from different source sites should be limited
	Q9.8	Plants are moved from a site where they are at high risk of extinction
	Q9.9	Mixing individuals with different phenotypes should be limited

Q10	For the most recent translocation, how do you evaluate the following characteristics? Scale from 0 to 10 (0 was not considered at all to 10 was very well considered) or no opinion
Q10.1	Financial cost
Q10.2	Feasibility
Q10.3	Knowledge of the biology and ecology of the species
Q10.4	Chances of individuals surviving translocation
Q10.5	Availability of feedback from past translocations
Q10.6	Time spent on the development of the translocation
Q10.7	Status of the population after translocation
Q10.8	Recreational attractiveness of the site after translocation
Q10.9	Choice of translocation period
Q10.10	Translocation protocol
Q10.11	Appropriateness of recipient site selection criteria
Q11	Has a control population been established? R1 Yes/ R2 No
Q12	Have you ever incorporated genetic analysis into your translocation projects? R1 Yes/ R2No
Q13	Why? Open response
Q14	You want to hire an expert for genetic analysis. What do you expect from the expert? R1 Determine the genotypes of the individuals to be translocated R2 Analyse the raw data R3 Discuss with you the implications of the results for your problem R4 No opinion
Q15	Do you have a structure/person in mind that could help you, if so which one? Yes or no followed by an open response
Q16	How comfortable are you with genetic diversity analyses? R1 Estimate gene flow, connectivity between populations R2 Estimate the number of individuals participating in reproduction R3 Determine population structure R4 Identify threats to populations R5 Determine taxonomic delimitation
Q17	Do you think that translocations should be... R1 Used as currently R2 More used R3 Less used R4 Never used R5 Don't know
Q18	What is your opinion on the following statements? Scale from 0 to 10 (0 strongly disagree to 10 strongly agree) or no opinion
Q18.1	Translocation is a good conservation tool
Q18.2	Translocations generally lead to failure
Q18.3	The persistence of a population depends in part on its genetic diversity
Q18.4	Diversity analyses are too long compared to the information they provide
Q18.5	Diversity analyses are too costly compared to the information they provide
Q18.6	Translocations are too expensive financially
Q18.7	A translocation on my land would increase its financial value

Q19	Rank from 1 to 7 these criteria to estimate the success of a translocation R1 The number of individuals present R2 The number of individuals in flower R3 The number of individuals in fruit R4 The genetic diversity R5 The number of new individuals R6 Resilience (rapid return to normal after the disturbance) R7 The establishment of a new generation
Q20	What success criteria not listed above do you think would be relevant? Open answer
Q21	During development projects, what alternatives do you think are preferable to plant translocations? R1 Avoid all protected species sites in the project R2 Reduce impacts by avoiding certain sites with protected species R3 Offsets by performing an ex situ culture R4 Offsets by implementing a management action to favour other populations of the same species R5 Offsets by financing a knowledge action on the same species R6 Offsets by contributing financially to an offset bank
Respondent' characteristics	
Q22	Are you a member of a scientific committee (CNPQ or CSRPQ)? R1 Yes / R2 No
Q23	Level of higher education R1 No degree R2 Baccalaureate R3 BTS, Licence R4 Master, engineer R 5 PhD or more
Q24	Age group R1 <60 R2 18-25 R3 26-35 R4 36-50 R5 51-60
Q25	You live in... R1 City border R2 Downtown R3 Village / Countryside R4 Do not wish to respond
Q26	Genre R1 Female R2 Male R3 Other R4 No opinion
Q27	Are you a member of an association in the field of ecology/environment? R1 Yes / R2 No

Q28	<p>In which organization do you work?</p> <p>R1 Naturalist associations</p> <p>R2 Environmental consultancy</p> <p>R3 Conservatory and natural area</p> <p>R4 Territorial collectivity</p> <p>R5 Land management company / environmental branch of a company</p> <p>R6 Research laboratory / university</p> <p>R7 Environmental studies student</p> <p>R8 Regulators (DREAL, DDT, etc)</p> <p>R9 Other (please specify)</p>
Q29	<p>In which region/country do you live?</p>

Supplementary documents 3: Survey flow



Supplementary document 4: Method for identifying clusters of opinion on translocations

	Cla/Mod	Mod/Cla	Global	p-value	v.test
Cluster 1, favourable					
Q5 – Ethical	92.23	95.19	50	1.35 ^{e-78}	18.77
Q6 – Ethical	93.60	86.10	44.56	2.68 ^{e-65}	17.07
Q48 – Agree	81.71	71.66	42.49	8.25 ^{e-31}	11.54
Q47 – More used	83.49	48.66	28.24	8.26 ^{e-19}	8.86
Q4 – Ethical	72.15	60.96	40.93	5.08 ^{e-15}	7.82
Q7 – Ethical	100.00	21.93	10.62	9.84 ^{e-15}	7.74
Q49 – NA	67.42	32.09	23.06	4.51 ^{e-05}	4.08
Q7 – Neutral	69.86	27.27	18.91	4.73 ^{e-05}	4.07
Q49 – Not agree	64.29	24.06	18.13	3.54 ^{e-03}	2.92
Q64 – Other	75.00	11.23	7.25	3.64 ^{e-03}	2.91
Q59 – Undergraduate	66.67	19.25	13.99	4.05 ^{e-03}	2.87
Q47 – Used as currently	62.54	21.39	16.84	2.15 ^{e-02}	2.30
Q60 – 18-25	66.67	12.83	9.33	2.29 ^{e-02}	2.27
Q64 – Environmental consultancy	38.55	17.11	21.50	4.28 ^{e-02}	-2.03
Q64 – Conservatory and natural area	37.66	15.51	19.94	3.51 ^{e-02}	-2.11
Q59 – Master, ingeneer	44.07	55.61	61.14	3.17 ^{e-02}	-2.15
Q60 – 26-35	37.86	20.86	26.68	1.23 ^{e-02}	-2.50
Q4 – Not ethical	25.86	8.02	15.03	1.68 ^{e-04}	-3.76
Q6 – NA	5.56	0.53	4.66	9.19 ^{e-05}	-3.91
Q4 – Neutral	32.82	22.99	33.94	1.04 ^{e-05}	-4.41
Q5 – NA	0	0	4.92	2.20 ^{e-06}	-4.73
Q48 – Neutral	29.27	19.25	31.87	2.17 ^{e-07}	-5.18
Q49 – Agree	22.43	12.83	27.72	1.24 ^{e-10}	-6.43
Q7 – Not ethical	32.29	38.50	57.77	7.28 ^{e-14}	-7.48
Q6 – Neutral	19.33	12.30	30.83	5.78 ^{e-15}	-7.81
Q48 – Not agree	9.52	4.28	21.76	1.94 ^{e-17}	-8.50
Q5 – Not ethical	2.86	1.07	18.13	2.79 ^{e-20}	-9.23
Q6 – Not ethical	2.60	1.07	19.95	6.42 ^{e-23}	-9.86
Q5 – Neutral	6.73	3.74	26.94	2.98 ^{e-26}	-10.60
Q47 – Less used	7.02	4.28	29.53	4.26 ^{e-29}	-11.20
Cluster 2 undecided					
Q6 – NA	88.89	94.12	4.66	3.06 ^{e-25}	10.38
Q5 – NA	84.21	94.12	4.92	1.93 ^{e-24}	10.20
Q4 – NA	35.90	82.35	10.10	5.81 ^{e-13}	7.20
Q7 – NA	20.41	58.82	12.69	4.75 ^{e-06}	4.58
Q65 – NA	23.81	29.41	5.44	1.28 ^{e-03}	3.22
Q47 – Don't know	9.18	52.94	25.39	1.48 ^{e-02}	2.44
Q48 – NA	20.00	17.65	3.88	2.59 ^{e-02}	2.23
Q48 – Agree	1.83	17.65	42.49	3.34 ^{e-02}	-2.13
Q5 – Not ethical	0	0	18.13	3.07 ^{e-02}	-2.16
Q47 – More used	0.92	5.88	28.24	2.80 ^{e-02}	-2.20
Q6 – Not ethical	0	0	19.95	2.08 ^{e-02}	-2.31
Q6 – Neutral	0.84	5.88	30.83	1.62 ^{e-02}	-2.40
Q4 – Ethical	1.27	11.76	40.93	1.03 ^{e-02}	-2.57
Q4 – Neutral	0.76	5.88	33.94	8.16 ^{e-03}	-2.65
Q5 – Neutral	0	0	26.94	4.21 ^{e-03}	-2.86
Q5 – Ethical	0.52	5.88	50.00	1.08 ^{e-04}	-3.97
Q6 – Ethical	0	0	44.56	3.29 ^{e-05}	-4.15
Cluster 3 unfavourable					
Q5 – Neutral	93.27	53.30	26.94	3.11 ^{e-31}	11.62
Q47 – Less used	87.72	54.94	29.53	1.10 ^{e-26}	10.69
Q6 – Not ethical	97.40	41.21	19.95	1.56 ^{e-26}	10.66
Q5 – Not ethical	97.14	37.36	18.13	1.84 ^{e-23}	9.98

Q6 – Neutral	79.83	52.20	30.83	2.61 ^e -18	8.73
Q48 – Not agree	86.90	40.11	21.76	1.80 ^e -17	8.51
Q7 – Not ethical	65.02	79.67	57.77	6.71 ^e -17	8.35
Q49 – Agree	71.03	41.76	27.72	5.35 ^e -09	5.84
Q4 – Neutral	66.41	47.80	33.94	5.52 ^e -08	5.43
Q48 – Neutral	64.23	43.41	31.87	4.50 ^e -06	4.59
Q4 – Not ethical	74.14	23.63	15.03	7.56 ^e -06	4.48
Q60 – 26-35	59.22	33.52	26.68	4.37 ^e -03	2.85
Q64 – Conservatory and natural area	59.74	25.27	19.95	1.41 ^e -02	2.46
Q59 – Master, ingeneer	51.27	66.48	61.14	4.27 ^e -02	2.03
Q64 – Student in environment	25.00	2.75	5.18	4.34 ^e -02	-2.02
Q48 – NA	20.00	1.65	3.89	3.31 ^e -02	-2.13
Q7 – NA	32.65	8.79	12.69	3.01 ^e -02	-2.17
Q49 – Not agree	34.29	13.19	18.13	1.74 ^e -02	-2.38
Q60 – 18-25	25.00	4.95	9.33	4.96 ^e -03	-2.81
Q5 – NA	15.79	1.65	4.92	4.49 ^e -03	-2.84
Q4 – NA	25.64	5.49	10.10	4.35 ^e -03	-2.85
Q64 – Other	21.43	3.30	7.25	4.33 ^e -03	-2.85
Q59 – Undergraduate	27.78	8.24	13.99	2.00 ^e -03	-3.09
Q7 – Neutral	28.77	11.54	18.91	4.42 ^e -04	-3.51
Q6 – NA	5.56	0.55	4.66	1.39 ^e -04	-3.81
Q49 – NA	26.97	13.19	23.06	1.15 ^e -05	-4.39
Q4 – Ethical	26.58	23.08	40.93	1.05 ^e -11	-6.80
Q7 – Ethical	0	0	10.62	5.33 ^e -13	-7.22
Q47 – More used	15.58	9.34	28.24	8.79 ^e -16	-8.04
Q48 – Agree	16.46	14.84	42.49	1.33 ^e -26	-10.67
Q6 – Ethical	6.40	6.04	44.56	6.13 ^e -53	-15.31
Q5 - Ethical	7.25	7.69	50.00	3.68 ^e -63	-16.78

Supplementary document 5: Criteria to be considered for evaluation of translocation

134 respondents ranked the criteria of translocation success (Q55R1-Q55R7). The apparition of new individuals was considered the most relevant factor (sum=441, mean=3.32, Figure 4). The second factor was related to resistance to perturbation (resilience, *i.e.*, rapid return to normal after the disturbance; sum=461, mean=3.47; Figure 4). Genetic diversity (sum=561, mean=4.22), number of individuals (sum=574, mean=4.32) and the number of flowering plants (score=619, mean=4.65) were considered the least relevant (Figure 4).

The same analyses were performed considering the general opinion of the respondents on translocation. Favourable respondents ranked resilience as the most relevant criterion (sum=198, mean=3.09, n=64), while unfavourable ones chose new generation (sum=199, mean=3.11, n=64). The least relevant criterion is the number of flowering individuals, whether the respondent is favourable (sum=309, mean=4.82, n=64) or unfavourable (sum=287, mean=4.48, n=64) to translocations.

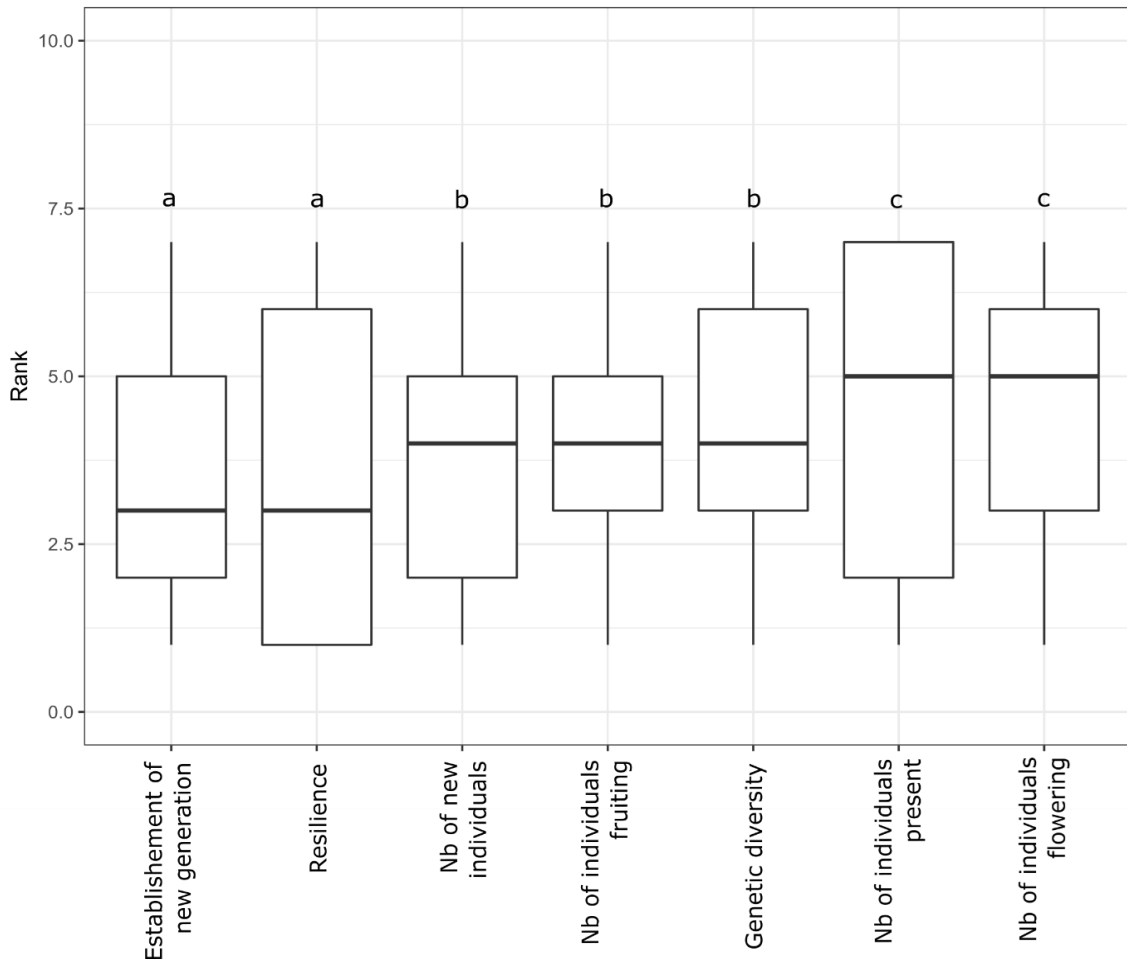


Figure 4: Boxplots of mean scores given to the different success criteria. The lower the rank, the more important the criterion is identified. The difference in ranking was tested using a Friedman test ($\chi^2=40.4$, $df=6$, $P<0.0001$). Letters above boxplots indicate significant differences between mean values using Conover post-hoc tests.

Finally, in addition to the listed criteria to be ranked, the respondents could give complementary criteria to evaluate the success of translocations (open responses to Q56, $n=252$). The respondents gave different criteria that could be grouped into indices at the community level (herbivory, interactions with other species; $n=82$), at the population level (dynamics, expansion, age/class structure; $n=78$), and finally at the individual level (survival, leaf area, health status; $n=38$). Few criteria linked to human perceptions (ecosystem services, public support; $n=10$) were given.

A few respondents refer to the management or absence of management of the translocated population ($n=11$), and comparing the translocated population with a control population ($n=5$) would be interesting.

Finally, a significant number (n=72) of respondents mentioned that monitoring should be done over the medium or long term.