

1 **Public engagement promotes consumer choice in favour of sustainable palm oil**

2 Laura Hobbs, Josie Phillips, Amy Staff, Amber Goss, Laura Fogg-Rogers and Farnon
3 Ellwood. University of the West of England.

4

5 Accepted manuscript, Journal of Palm Oil Research. 2021.

6

7 **Abstract**

8 Despite the superior productivity, utility and economic benefits of palm oil compared with
9 other oil crops, the palm oil industry often receives negative publicity for its environmental
10 impact and there is widespread confusion over the perception of palm oil. The fact is that it is
11 difficult to avoid palm oil consumption, and consumer boycotts will do little to resolve the
12 social and environmental issues associated with oil palm agriculture. Instead, greater
13 awareness of the importance of certified sustainable palm oil (CSPO) is needed. We used a
14 mixed-methods survey to explore public awareness of palm oil, and understand the factors
15 influencing sustainable consumer choice. Our survey, conducted in the Rainforest Biome of
16 the world-renowned Eden Project in the United Kingdom, a nation with relatively high
17 environmental awareness, revealed that public awareness of palm oil was generally low and
18 that consumers had poor knowledge of CSPO. We identified that the most significant barriers
19 preventing consumer choice for CSPO products were unclear labelling, product availability
20 and cost. We recommend that the palm oil industry focus on enhancing sustainability,
21 promoting the benefits and increasing the visibility of CSPO in supply chains and final
22 products, rather than waiting for consumer choice alone to drive change.

23 **Keywords:** oil palm, public awareness, public perception, consumer habits, sustainability

24

25 **Introduction**

26 We are living through the sixth mass extinction and human activities are destroying
27 biodiversity at a rate significant enough for the Anthropocene to have been named after us
28 (Pievani, 2014). Highly respected global institutions such as the United Nations (UN) and the
29 European Parliament have declared a Climate and Ecological Emergency (European
30 Parliament, 2019; UN Environment Programme, 2021), with public belief in the climate
31 emergency at 81% in the UK (Flynn *et al.*, 2021). The rapid expansion of the palm oil
32 industry has had major negative consequences for the environment, yet the industry supports
33 the livelihoods of millions of people globally (Padfield *et al.*, 2019). To resolve this palm oil
34 paradox, the industry must adopt and develop sustainable practices underpinning the
35 protection of land for biodiversity, ecosystem function, carbon capture and future crop
36 production (Meijaard *et al.*, 2018; Corciolani *et al.*, 2019).

37 For more than two decades academic research has considered the impact and
38 opportunities of the palm oil industry (Padfield *et al.* 2019), yet the public's perception of
39 palm oil has been influenced largely by the media (Yan, 2017; Jackson *et al.*, 2019). In 2018,
40 the Christmas advertisement of a UK-based supermarket chain was not approved for
41 broadcast by the non-governmental organisation (NGO) Clearcast because it was deemed too
42 political. The advertisement, originally produced by Greenpeace, featured an animated
43 orangutan (*Pongo spp.*) named "Rang-tan" and the impact of oil palm expansion on its
44 rainforest habitat. The supermarket chain had intended to use the advertisement to promote
45 their decision to remove palm oil and its derivatives from their own-brand products. The
46 embargo generated major publicity and discussion on social media, as well as a petition
47 against Clearcast's decision (Mundy, 2018a). The negative response was such that Clearcast
48 took steps to protect its staff from the backlash, including permanent removal of some social

49 media presence (Mundy, 2018b). Celebrities and politicians used their social media platforms
50 to call attention to palm oil and the retailer’s boycott of its use (Sweney, 2018). In the week
51 following the release of the controversial “Rang-tan” advert [11th – 17th November 2018]
52 input of the search terms “palm oil” and “sustainable palm oil” into the Google Search engine
53 peaked in the UK (Mundy, 2018a). However, for every 100 searches using the term “palm
54 oil”, there were just six for “sustainable palm oil” (data extracted using Google Trends,
55 2019), suggesting that the spark in media attention did little to raise public awareness of
56 sustainable palm oil, as Greenpeace had originally intended (Greenpeace, 2020).

57 A major challenge for producers is the perception that palm oil is an ‘environmentally
58 damaging’ source of vegetable oil (e.g. Ostfeld *et al.*, 2019; Borrello *et al.*, 2019; Guadalupe
59 *et al.*, 2019). More than 85% of the world’s palm oil is produced in Indonesia and Malaysia;
60 the industry’s expansion in these countries has caused irreparable damage to Southeast Asia’s
61 primary tropical rainforest through habitat clearance (Murphy, 2014), and has reduced their
62 carbon storage potential (Guillaume *et al.*, 2018). As production continues to expand in
63 regions of Africa and South America we are likely to see further environmental damage
64 (Ocampo-Peñuela *et al.*, 2018), with further loss in forest cover destroying biodiversity and
65 undermining our ability to mitigate climate change (Guillaume *et al.*, 2018).

66 Oil palm expansion undoubtedly threatens biodiversity, but it has not been the sole
67 driver of biodiversity loss in the tropics (Russell, 2018; Myzabella *et al.*, 2019). For example,
68 fibre plantations for pulp and paper production, illegal logging and hunting have all
69 contributed to habitat and species decline (Sodhi *et al.*, 2004; Meijaard *et al.*, 2011; Abood *et*
70 *al.*, 2015; Jackson *et al.*, 2019). Similarly, the production of palm oil alternatives, which have
71 lower yields per unit area, can be more environmentally damaging than that of palm oil
72 (Foster *et al.*, 2011; Parsons *et al.*, 2020). Shifts in consumer choice to palm oil alternatives
73 would therefore not necessitate a better outcome for biodiversity (Foster *et al.*, 2011;

74 Meijaard *et al.*, 2018; Jackson *et al.*, 2019). Moreover, consumer boycotts of palm oil can
75 have significant negative socioeconomic impacts in palm oil producing regions including the
76 loss of employment and out-competition of smallholders by larger concessions (Lee *et al.*,
77 2014).

78 Communication campaigns and customer purchasing decisions frequently favour
79 products which are branded “palm oil free”, and perceived as healthier, more sustainable
80 options compared with those containing palm oil (Borrello *et al.*, 2019, Guadalupe *et al.*,
81 2019). However, this is not necessarily the case (Jackson *et al.*, 2019), and puts pressure on
82 the consumer to read product labels in order to detect palm oil and its derivatives. This
83 approach assumes a high level of awareness and time on behalf of the consumer, and also
84 depends on the availability of products. Whilst it is possible for consumers to identify and
85 purchase products containing certified sustainable palm oil (CSPO), cost is likely to be a
86 barrier preventing the purchase of CSPO or palm oil-free products given that they are often
87 more expensive (Ostfeld *et al.*, 2019).

88 There is evidently some way to go before the palm oil paradox is resolved, but the
89 industry has taken major steps to develop a code of conduct under the Roundtable on
90 Sustainable Palm Oil (RSPO) (Jackson *et al.*, 2019). The RSPO aims to establish a globally
91 sustainable palm oil industry, currently certifying ~20% of annually produced palm oil as
92 sustainable (RSPO, 2018a). Alongside stakeholders in the palm oil industry, the RSPO
93 develops and implements standards for sustainable production based on ethical, transparent
94 and legal operations, respect for human rights, support for smallholders, optimisation of
95 productivity, efficiency, positive impacts and resilience and protection, conservation and
96 enhancement of ecosystems and the environment (RSPO, 2018b). For example, Sime Darby,
97 an RSPO founding-member company, cancelled planned oil palm plantations in Cameroon as
98 establishment would have necessitated destruction of existing forest (Feintrenie, 2014).

99 While the majority of sustainable palm oil comes from Southeast Asia, RSPO
100 certification is on the rise in both South America and West Africa (RSPO, 2018a). Jackson *et*
101 *al.* (2019) surmised that palm oil could become the most environmentally, socially and
102 economically sustainable vegetable oil source through adherence to the RSPO principles and
103 criteria. Given the potential of a globally sustainable palm oil industry, it is essential that we
104 develop our understanding of the impact that palm oil research has on members of the public,
105 particularly in those nations where palm oil is produced and where it is consumed. The
106 reaction to “Rang-tan” demonstrated how quickly an environmental campaign, intended to
107 raise awareness of unsustainable agro-practices, can be ‘hijacked’ by misinformation and
108 bias. However, impacts and opportunities for the sustainable production of oil palm vary by
109 biogeographical region, and this requires clear communication to the public. A study by
110 Reardon *et al.* (2019) found that consumer views of palm oil are shaped by location and can
111 be impacted by campaigns and flows of information on palm oil. We therefore set out to
112 establish, by way of introduction, which countries generate the most oil palm publications,
113 before asking which research themes contribute most to those publications. We then ask,
114 what is the level of public knowledge of palm oil in a typical consumer country, and how can
115 consumers be encouraged to embrace sustainable palm oil?

116 **Methods**

117 **Literature search, selection criteria and data acquisition**

118 Google Scholar’s global database was searched in November 2019 for original peer-reviewed
119 research, review papers and scientific reports (excluding patents and citations) using the
120 search term [“palm oil” OR “oil palm”]. We confined the search dates between 2000, the year
121 in which Myers *et al.* (2000) identified biodiversity ‘hotspots’ threatened by severe habitat
122 loss and exploitation, and 2018, the last full year of data available at the time of searching.

123 Cited more than 12,000 times, Myers *et al.* (2000) were the first to associate deforestation
124 and biodiversity losses with agricultural expansion in the tropics. Our search returned 17,900
125 publications and consistent with Padfield *et al.* (2019), we found a near exponential increase
126 in the number of publications per year containing the terms “palm oil” or “oil palm”.

127 To address Question 1, we randomly selected a subset of 200 publications from
128 Google Scholar. This gave a reasonable sample size, whilst providing good resolution for
129 analysis. We assigned each publication to a biogeographical region based on the locality of
130 the research. These regions, all key areas of oil palm cultivation and palm oil production,
131 were Southeast Asia, South America, Africa or Global (where the publication took a global
132 perspective rather than being region specific). To answer Question 2, keywords were
133 extracted from the publications and used to align each publication to one of seven research
134 impact themes: (1) Greenhouse Gas (GHG) Emissions, (2) Biodiversity (3) Improving
135 Sustainability, (4) Biofuels, (5) Working Conditions and Livelihoods, (6) Production
136 Methods and Global Trends, and (7) Deforestation. Previous work has also identified these as
137 key themes within oil palm literature (Sheil *et al.* 2009).

138 **Questionnaires at the Eden Project**

139 To address Questions 3 and 4 we performed a mixed methods cross-sectional survey at the
140 Eden Project. This visitor attraction, educational charity and social enterprise is located in the
141 Southwest of England (Eden Project, 2019). Over one million people visit the Eden Project
142 annually (Eden Project, 2018), with peak visitor flow in July and August. The visitors include
143 education groups, local residents and tourists; 90% of visitors are from the UK, with 75%
144 visiting while on holiday (2019). During schooling periods, adult visitors predominate
145 alongside formal education school groups, whereas families with children predominate
146 during school holidays (Elworthy, 2016).

147 The Eden Project's main attraction is the Rainforest Biome, which houses the world's largest
148 indoor tropical rainforest. It was at the centre of this indoor rainforest that we designed and
149 built an exhibit on the story of oil palm and palm oil. Our exhibit comprises several full-size
150 oil palms with information displaying the story of the production, impact, opportunities and
151 sustainability of palm oil (*Figure 1*). The exhibit, which also features the RSPO logo, is in the
152 tropical crops section of the Rainforest Biome and all visitors have to pass this section of the
153 visitor attraction (although they do not have to read the exhibition materials). Using a
154 convenience sampling approach, we handed questionnaires to members of the public as they
155 passed the palm oil exhibition. A researcher handed out the paper questionnaires to
156 consenting participants in July and August 2018. Due to high temperatures in the Rainforest
157 Biome, the questionnaire was designed to take a maximum of five minutes to complete. As
158 no personal data were collected, participation and the return of a completed questionnaire
159 indicated consent for data collection. The questionnaire included open and closed questions
160 about self-rated knowledge of palm oil, awareness of the RSPO logo, awareness of products
161 containing palm oil, and attitudes towards sustainable palm oil consumption. Critically, we
162 collected our data before the surge of negative attention engulfed palm oil in November 2018
163 following the UK supermarket chain advertisement (Sweney, 2018).

164 **Statistical Analysis**

165 After testing data for normality, we used one sample Chi-Square (χ^2) tests to assess the
166 distribution of (a) the total number of publications by region ($n = 200$ for all samples across
167 Southeast Asia, South America, Africa or Global) and (b) publications by research theme. To
168 assess the distribution of research themes within each of the different equatorial regions we
169 used Chi-Square tests of independence (χ^2). All data collected from the Eden Project were
170 transcribed from the questionnaire into Excel v10. A Wilcoxon signed rank test (Z) was used
171 to compare pre- and post-exhibition self-rated knowledge of palm oil. A Spearman

172 correlation (r_s) was used to quantify the relationship between self-rated knowledge and
173 awareness of palm oil's use in consumable products, and a Mann-Whitney U test was used to
174 assess awareness of the RSPO logo based on self-rated knowledge. Content analysis based on
175 qualitative responses was used to identify the key factors that would encourage consumers to
176 purchase CSPO products. All statistical analyses were performed in IBM SPSS Statistics for
177 Windows Version 25.0 (IBM Corp, 2017).

178 **Results**

179 **Question 1. Which countries generate the most oil palm publications?**

180 Within the randomly selected subset of publications ($n = 200$), oil palm was the subject of a
181 significantly higher number of publications in Southeast Asia ($n = 88$) and Global ($n = 75$)
182 than in South America ($n = 19$) and Africa ($n = 18$) ($\chi^2 = 81.1$, $df = 3$, $p < 0.01$, *Figure 2*).

183 **Question 2. Which research themes contribute most to those publications?**

184 Key research themes were not distributed equally, with significantly more publications falling
185 into 'Production methods and global trends' ($n = 49$) and 'Working conditions and
186 livelihood' ($n = 46$) than would be expected for an equal distribution (25-30 publications per
187 theme) ($\chi^2 = 46.12$, $df = 6$, $p < 0.01$; *Figure 3*). Conversely, 'GHG emissions' ($n = 14$) and
188 'Deforestation' ($n = 10$) had significantly fewer (*Figure 3*). The under-representation of these
189 themes was also apparent in the distribution of publications by research theme within the four
190 geographical regions, where distribution was also significantly uneven ($\chi^2 = 0.008$, $df = 18$, p
191 < 0.05).

192 **Question 3: What is the level of knowledge of palm oil in a typical consumer country?**

193 We collected data from 397 respondents (89% between the ages of 25 – 64 years old) in July
194 and August 2018. The respondents assigned quantitative values to their knowledge of palm

195 oil from a pre- ($n = 395$) and post-exhibition ($n = 375$) perspective (no knowledge = 0, some
196 knowledge = 1, good knowledge = 2, expert knowledge = 3). Respondents generally rated
197 their pre-exhibition knowledge of palm oil as poor, with a mean ‘knowledge value’ of $0.95 (\pm$
198 $0.03)$. However, visiting the palm oil exhibition increased this to 1.83 ± 0.02 , a significant
199 positive impact ($Z = -16.13, p < 0.001$). *Figure 4* highlights this increase in cohort knowledge
200 and shows that all respondents felt they had at least some knowledge of palm oil after visiting
201 the exhibition. Complementary to this assessment, we asked respondents to indicate, from a
202 list of commercially available products, which items that they were unaware contained palm
203 oil prior to their visit. The greatest ‘unknowns’ were toothpaste, bread, detergent and
204 shampoo (*Figure 5*). When asked if they were aware of RSPO certification before their visit
205 to the Eden Project, more than 90% ($n = 387$) of respondents reported that they were not
206 (*Figure 6*). Even after passing through the exhibit containing the RSPO logo, more than 80%
207 of respondents ($n = 361$) were unable to name the RSPO when their logo’s identifying text
208 was removed (*Figure 6*).

209 To gauge the accuracy of the respondents’ self-assessment of their knowledge of palm
210 oil, we compared their self-rated pre-exhibition knowledge with their pre-exhibition
211 awareness of products containing palm oil. If their self-assessed knowledge was reasonably
212 accurate, we would expect to see a negative correlation between their self-rated knowledge
213 level, on a scale of 0-3, and the number of products that they were unaware contained palm
214 oil. Indeed, we found a significant negative correlation ($r_s = -0.371, p < 0.01$), indicating
215 reasonable efficacy of respondents’ self-assessment of their pre-visit knowledge levels.
216 Similarly, respondents who rated their pre-visit knowledge as ‘good’ were found to be
217 significantly more aware of the RSPO logo than those with ‘some’ knowledge ($U = 6854, p =$
218 $0.002, Figure 7$).

219 However, respondents' pre-visit knowledge of palm oil did not clearly align with pre-
220 visit awareness of RSPO certification. One respondent, who reported 'expert' level pre-visit
221 knowledge of palm oil, was not aware of RSPO certification, while ~4% of respondents who
222 claimed to have 'no knowledge' of palm oil, reported that they were aware of RSPO
223 certification. Generally, respondents performed poorly when asked to identify the RSPO logo
224 (*Figure 7*). Only 21% and 7% of respondents who rated their post-visit knowledge as 'good'
225 and 'expert' respectively were able to correctly name the RSPO logo, despite having some
226 pre-existing awareness of CSPO and having just visited an exhibition that featured the RSPO
227 logo.

228 **4. How can consumers be encouraged to embrace sustainable palm oil?**

229 After visiting the Eden Project's palm oil exhibition, 78% of respondents reported that they
230 were more likely or much more likely to buy certified sustainable palm oil products.
231 Respondents identified that the most important factors that would encourage them to buy
232 products containing CSPO were: (1) protection of primary rainforest (65%); (2) ensuring
233 workers get a fair price for the palm oil they sell (25%); and (3) improving biodiversity on
234 plantations (9%). Less than 1% of respondents stated that they 'would not buy a product
235 containing CSPO' (0.3%) ($n = 312$). We also assessed what factors may be preventing
236 respondents from purchasing CSPO products and found: (1) unclear labelling (33%), (2)
237 availability of products (24%) and (3) cost (23%) to be the most significant barriers ($n =$
238 312). Upon completion of the survey, respondents were asked to "tell us one fact about palm
239 oil that you learnt from your visit today". Content analysis of the responses ($n = 332$)
240 produced 409 individual items which were assigned across five categories: (1) the
241 pervasiveness of palm oil ($n = 125, 31%$); (2) purchasing/consumption and awareness of
242 sustainable palm oil ($n = 122, 30%$); (3) biodiversity/environmental issues ($n = 86, 21%$); (4)
243 production and yield ($n = 74, 18%$) and (5) other ($n = 2, 0.5%$).

244 **Discussion**

245 Our aim was to explore public awareness of palm oil and RSPO certification and to
246 understand how the palm oil industry can assist consumers in making informed and
247 sustainable choices. This is important, as gaining a better understanding of how to harness
248 consumer purchasing power will be key to driving sustainability further up the global agenda.
249 In line with Padfield *et al.* (2019), we found that the number of peer-reviewed palm oil
250 related publications has increased almost exponentially since the year 2000. With the
251 majority of these publications focussed on Southeast Asia, comparatively few focused on oil
252 palm agriculture in Africa and South America. This is perhaps not surprising given that
253 Southeast Asia's commercial oil palm cultivation boom began shortly after Malaysia's
254 independence more than 60 years ago (Murphy, 2014), whereas oil palm expansion in other
255 regions has largely taken place since 2000 (Carrere, 2013; Pardo Vargas *et al.*, 2015). Thus,
256 the disparity in the number of palm oil publications across production regions that we
257 observed was likely a fair representation of the distribution of global palm oil research within
258 the academic literature. While research conducted in Southeast Asia has been largely reactive
259 to oil palm expansion and its impacts, the likely gaps in knowledge arising from the gap in
260 research from other growing regions present an opportunity for proactive research and clear
261 communication of the benefits of sustainable palm oil. By applying knowledge gained
262 through oil palm development in Southeast Asia to other growing regions in West Africa and
263 South America, the global palm oil industry could vastly improve its sustainability. The
264 reaction to the "Rang-tan" campaign demonstrates how public outrage at unsustainable agro-
265 practices can spur consumer boycotting, but it also highlights the power of campaigning
266 through storytelling. For example, in order to address the negative association between palm
267 oil and the decline of the orangutan, there is an urgent need to deliver positive stories from
268 Southeast Asia. Furthermore, communication of positive and innovative research in areas of

269 new development, where there is still significant opportunity to develop truly sustainable
270 palm oil practices, is of the utmost importance. For example, a recent study in Colombia
271 showed that where oil palm plantations replaced pasture, carbon losses were reduced by 99.7
272 \pm 9.6% when compared to rainforest conversion (Quezada *et al.*, 2019), thereby increasing
273 the carbon sequestration potential of the landscape and sparing endemic-species-rich forest
274 ecosystems (Ocampo-Peñuela *et al.*, 2018; Prescott *et al.*, 2016).

275 Publications were assigned to research categories using a ‘best-fit’ method; much of
276 the research categorised showed some overlap between definitive themes. These overlaps
277 were most common for ecological and environmental categories where, for example, it would
278 have been feasible to assign a publication to either the Deforestation or Biodiversity category.
279 Nevertheless, we found ecological and environmental research (i.e. Biodiversity,
280 Deforestation and GHG emissions) to be under-represented in the literature compared with
281 publications that considered the social (i.e. Working conditions and livelihoods) and
282 economic (i.e. Production methods and global trends) impacts and opportunities of oil palm.
283 This suggests that more oil palm research has been conducted from an anthropocentric, rather
284 than an ecocentric perspective. Padfield *et al.* (2019) made similar observations, and noted
285 that peer-reviewed articles containing the terms “palm oil” or “oil palm” were heavily
286 weighted towards engineering and biofuel topics. Topics such as land use change and
287 biodiversity were far less common. Although landmark publications such as Myers *et al.*
288 (2000) have highlighted the ecological consequences of intense anthropogenic activity, oil
289 palm expansion has continued to drive deforestation and losses to biodiversity (Wilcove *et*
290 *al.*, 2013). Disparities in the distribution of publications by research theme may indicate that
291 the ecological and environmental impacts of the palm oil industry are less of a research
292 priority than social and economic impacts. However, given that research is underpinned by
293 funding availability, this could also suggest that funding, and especially industrial funding,

294 favours socio-economic (i.e. anthropocentric) over ecological and environmental (i.e.
295 ecocentric) research. This is concerning because as production expands in South America and
296 Africa, where much of the population lives below the poverty line (World Bank, 2019),
297 socio-economic research and development is likely to be prioritised over that of conservation
298 (Billé *et al.*, 2012).

299 Our study, in line with previous work by Padfield *et al.* (2019), revealed a substantial
300 volume of research into palm oil sustainability. Whilst this may highlight an historical
301 disregard of sustainability (Morgans *et al.*, 2018), it is potentially indicative of a shift in the
302 industry's priorities in favour of sustainable development (Padfield *et al.*, 2019). This is
303 evidenced by the fact that a non-trivial component (~20%) of palm oil produced globally is
304 now certified by the RSPO (Roundtable on Sustainable Palm Oil, 2018a). However, negative
305 media attention and product boycotting have often drawn attention away from the benefits of
306 CSPO and efforts to promote its production (Laurence *et al.*, 2010, Jackson *et al.* 2019). For
307 this reason, we designed the palm oil exhibition in the Rainforest Biome at the Eden Project
308 to provide the public with a balanced narrative of the scientific evidence on oil palm
309 agriculture.

310 Our survey at the Eden Project provided a good insight into the public's awareness of
311 palm oil before the 'Rang-tan' advertising campaign went viral, and an opportunity to
312 understand the effectiveness of the exhibition as a platform for public engagement of a
313 complex socio-economic and environmental issue. Our results indicated that engagement
314 with the exhibit content had a significant and positive impact on respondents' knowledge of
315 palm oil and its products. Participants generally had poor knowledge of palm oil and its use
316 in consumer products, with less than 20% of respondents reporting to have had a 'good
317 knowledge' of palm oil before visiting the exhibition (*Figure 4*). This demonstrates that
318 despite an exponential increase in palm oil research, a disconnect remains between academic

319 research and public awareness of palm oil. Thus, exhibitions such as ours at the Eden Project
320 will become an increasingly important tool for addressing the challenge of convincing
321 consumers to buy CSPO (Laurance *et al.*, 2010). Awareness of palm oil in consumer products
322 varied by product type, and we found that respondents were most likely to be unaware that
323 personal care and household products such as toothpaste (70% unaware) and laundry
324 detergent (53% unaware) contained palm oil. Consumers were far less likely to be unaware of
325 palm oil's prevalence in food products such as margarine (18% unaware) and biscuits (27%
326 unaware), and this is likely to be a response to palm oil's portrayal in the media which has
327 frequently focused on demand from the food industry (Jackson *et al.* 2019). After visiting the
328 exhibit, none of the respondents reported 'no knowledge' of palm oil. Thus, our results
329 provide further evidence of the effectiveness of scientific exhibits for engaging consumers
330 and improving awareness of complex environmental issues.

331 A study by Ostfeld *et al.* (2019) revealed that recognition of the RSPO's logo was
332 effectively zero, and thus recommended that government policies should be amended to
333 require companies to source 100% CSPO instead of relying on consumers to demand and
334 purchase products containing CSPO. We similarly observed a near complete inability of
335 participants to name the RSPO logo, even after visiting the exhibition, which clearly displays
336 the RSPO logo. This suggests that simply displaying the RSPO 'ecologo' is not enough and
337 will not be sufficient to encourage a change in the buying habits of consumers. This can be
338 remedied, as other ecolabels are widely recognised, for example the Fairtrade logo was
339 recognised by 82% of shoppers in the UK (Ostfeld *et al.*, 2019). Though Fairtrade was
340 established over 25 years ago, its reputability has been underpinned by extensive outreach
341 work, advertising and marketing in the mainstream media (Fairtrade Foundation, 2019). At
342 present, the RSPO logo is rarely used as a consumer-facing label, thus may not be considered
343 an immediately applicable tool for engaging consumers (Ostfeld *et al.*, 2019). Therefore,

344 efforts from the RSPO and its member companies to increase visibility within the mainstream
345 media in countries that are major consumers of palm oil would likely pay dividends in terms
346 of public understanding, RSPO logo recognition and willingness to support CSPO.

347 Indeed, we found that the Eden Project’s palm oil exhibit had a major and positive
348 impact on the willingness of visitors to support CSPO, with 78% of respondents reporting
349 that they were more likely or much more likely to buy CSPO products after visiting the
350 exhibit. This clearly evidences the positive role that tourism attractions and botanical gardens
351 can play in raising awareness and changing attitudes towards environmental issues. There is
352 much evidence that tourists value the environment and with targeted, relevant
353 communications, could be encouraged towards more sustainable consumption behaviour
354 (Font and McCabe, 2017). While visitors to attractions such as the Eden Project could be
355 considered a key audience for CSPO products, efforts must also be made to ensure that
356 learning opportunities for improved awareness of CSPO as well as access to products are
357 available to audiences beyond those who would visit an educational charity and visitor
358 destination.

359 Despite finding that palm oil publications regarding ‘Biodiversity’ and
360 ‘Deforestation’ were under-represented in comparison with other themes in the literature,
361 when we asked visitors at the Eden Project what would encourage them to purchase CSPO,
362 ‘protection of primary rainforest’ was found to be of the highest priority (65%). When
363 respondents were asked to relay one fact about palm oil that they had learnt from their visit,
364 the ‘pervasiveness of palm oil’ (31%) as well as ‘awareness of sustainable palm oil’ (30%)
365 were most common responses. This contrasts with the broad unawareness of the presence of
366 palm oil in different product groups that respondents reported before visiting the exhibition.
367 Reported barriers to purchasing CSPO did not indicate a lack of interest in or willingness to
368 support CSPO; we identified that unclear labelling, lack of product availability and cost were

369 the key factors inhibiting consumer choice. The responses provided in our survey of
370 consumers were generally consistent with those reported from palm oil industry stakeholders
371 by Padfield *et al.* (2019). Though our respondents did not explicitly state that protecting
372 biodiversity was the most important factor that would encourage consumers to purchase
373 CSPO products, the protection of rainforest will certainly serve to protect biodiversity.
374 Together, this suggests that while consumers are concerned with the prevalence of palm oil in
375 products, the use of positive messages such as the protection of rainforest or fair prices for
376 workers will be key to encouraging consumers to make sustainable purchasing decisions
377 rather than boycotting palm oil altogether. This should alleviate fears from manufacturers and
378 retailers over drawing attention to the fact that they are using palm oil (Chaudhari and
379 Purkayastha, 2011; Ostfeld *et al.*, 2019), and provide direction for future marketing and
380 campaigning decisions. In addition, this finding can inform improvement of the RSPO's
381 operations. The roundtable has attracted criticism for ineffective monitoring and its failure to
382 halt the destruction of primary rainforest and provide beneficial ecological outcomes for its
383 approved members (Schouten and Glasbergen, 2011; Morgans *et al.*, 2018). Thus,
384 prioritization of rainforest conservation, paired with effective communication of this through
385 campaigns and exhibitions, may increase support and demand for certified palm oil.

386 Awareness in botanical gardens and other relevant settings can have a measurable
387 impact on awareness and knowledge of palm oil and the issues surrounding it, but this is not
388 the only form of communication that is needed to effect change. Environmentalism is a fast-
389 moving field, with foci often changing with each new 'crisis' reported (Goldsmith and
390 Goldsmith, 2011). Longer-term engagement with relevant information is needed, particularly
391 in a time when 'fake news' and viral online content can rapidly disseminate facts and
392 information which may have a negative impact on the environment and wildlife, however
393 unintended (Clarke *et al.*, 2019). The role of scientists should be dualistic in nature, working

394 towards engaging the public in discussion while supporting the development and
395 implementation of sustainable practices. In the UK, the success of a collaborative approach is
396 demonstrated by Chester Zoo’s “Sustainable Palm Oil City” initiative, which has led to
397 Chester becoming the first sustainable palm oil city in the world. The campaign, alongside
398 increasing consumer awareness, assisted >50 organisations including manufacturers,
399 restaurants, cafes, and educational institutions to audit their supply chains and make a time-
400 bound commitment to using 100% RSPO certified palm oil (Chester Zoo, 2019a). Through
401 providing a toolkit, educational resources, and an incentive for local businesses, Chester Zoo
402 expanded its reach to new audiences (Ancrenaz *et al.*, 2018; Chester Zoo, 2019b). They also
403 addressed some of the key barriers to sustainable palm oil consumption identified by our
404 study, such as unclear labelling and lack of availability. Similar initiatives are now under
405 development in Bristol, Newquay, and Oxford (Bristol Zoo, 2018; Chester Zoo, 2019c).
406 Increasing public awareness is key to improving the reputation of sustainable palm oil, and
407 cross-organisational collaboration will allow stakeholders throughout the supply chain to feel
408 confident in promoting what has become an essential ingredient to 21st Century life.

409 **Conclusions**

410 Consumer awareness of palm oil and its prevalence in products remains low in the UK, as
411 does knowledge of CSPO, and the RSPO. However, consumers will support rather than
412 boycott products which protect rainforests, which should encourage manufacturers to
413 promote their use of CSPO. This will be important in driving change, but the palm oil
414 industry needs to do more to increase awareness of CSPO. Visitor attractions and educational
415 charities such as the Eden Project represent an effective opportunity to support public
416 engagement and raise awareness of the complex underlying issues and the viability of CSPO
417 as a solution. Public perception of the palm oil industry could be improved through further
418 outreach work and positive storytelling led by un-biased parties.

419 **References**

- 420 Abood, S A; Lee, J S H; Burivalova, Z; Garcia-Ulloa and Koh, J L P (2015). Relative
421 contributions of the logging, fibre, oil palm, and mining industries to forest loss in Indonesia.
422 *Conservation Letters*, 8: 58-67. <https://doi.org/10.1111/conl.12103>
- 423 Ancrenaz, M; Barton, C; Riger, P and Wich, S (2018). Building relationships: how zoos and
424 other partners can contribute to the conservation of wild orangutans *Pongo* spp. *International*
425 *Zoo Yearbook*, 52 (1), pp. 164-172.
- 426 Billé, R; Lapeyre, R and Pirard, R (2012). Biodiversity conservation and poverty alleviation:
427 a way out of the deadlock? *Surveys and Perspectives Integrating Environment & Society*,
428 5(1): 1-15.
- 429 Borrello, M; Annunziata, A and Vecchio, R (2019). Sustainability of palm oil: drivers of
430 consumers' preferences. *Sustainability*, 11: 4818. doi:10.3390/su11184818
- 431 Bristol Zoo (2018). *Palm Oil: Promoting sustainable palm oil*. [https://bristolzoo.org.uk/save-](https://bristolzoo.org.uk/save-wildlife/conservation-and-research/palm-oil-project)
432 [wildlife/conservation-and-research/palm-oil-project](https://bristolzoo.org.uk/save-wildlife/conservation-and-research/palm-oil-project)
- 433 Carrere, R (2013). *Oil palm in Africa: Past, Present and Future Scenarios*. World Rainforest
434 Movement, 79 pp.
- 435 Chaudhari, A and Purkayastha, D (2011). Greenpeace, Nestlé and the palm oil controversy:
436 Social media driving change? Report 911-010-1 IBS Center for Management Research, 24
437 pp.
- 438 Chester Zoo (2019a). *Chester Named World's First Sustainable Palm Oil City*.
439 [https://www.chesterzoo.org/whats-happening/zoo-news/2019/03/chester-named-worlds-first-](https://www.chesterzoo.org/whats-happening/zoo-news/2019/03/chester-named-worlds-first-sustainable-palm-oil-city)
440 [sustainable-palm-oil-city](https://www.chesterzoo.org/whats-happening/zoo-news/2019/03/chester-named-worlds-first-sustainable-palm-oil-city)

441 Chester Zoo (2019b). *Our Sustainable Palm Oil Challenge*.
442 <https://www.chesterzoo.org/what-you-can-do/our-campaigns/sustainable-palm-oil/>

443 Chester Zoo (2019c). *UK Cities and Towns Join Sustainable Palm Oil City Movement*.
444 [https://www.chesterzoo.org/news/uk-cities-and-towns-join-sustainable-palm-oil-city-](https://www.chesterzoo.org/news/uk-cities-and-towns-join-sustainable-palm-oil-city-movement/)
445 [movement/](https://www.chesterzoo.org/news/uk-cities-and-towns-join-sustainable-palm-oil-city-movement/)

446 Clarke, T A; Reuter, K E; LaFleur, M and Schaefer, M S (2019). A viral video and pet lemurs
447 on Twitter. *PLOS ONE*, 14(1): e0208577. <https://doi.org/10.1371/journal.pone.0208577>

448 Corciolani, M; Gistri, G and Pace, S (2019). Legitimacy struggles in palm oil controversies:
449 an institutional perspective. *Journal of Cleaner Production*, 212(1): 1117-1131.

450 Eden Project (2018). Eden Project Annual Review 2017/18. Available from
451 <https://www.edenproject.com/eden-story/about-us/annual-and-sustainability-reports>

452 Eden Project (2019). Admission. <https://www.edenproject.com/buy-tickets-0>

453 Elworthy, J (2016). Eden Project palm oil exhibit proposal to University of the West of
454 England (UWE). Unpublished market research data

455 European Parliament (2019). The European Parliament Declares Climate Emergency.
456 [https://www.europarl.europa.eu/news/en/press-room/20191121IPR67110/the-european-](https://www.europarl.europa.eu/news/en/press-room/20191121IPR67110/the-european-parliament-declares-climate-emergency)
457 [parliament-declares-climate-emergency](https://www.europarl.europa.eu/news/en/press-room/20191121IPR67110/the-european-parliament-declares-climate-emergency)

458 Fairtrade Foundation (2019). The history of Fairtrade. [https://www.fairtrade.org.uk/What-is-](https://www.fairtrade.org.uk/What-is-Fairtrade/The-impact-of-our-work/The-History-of-Fairtrade)
459 [Fairtrade/The-impact-of-our-work/The-History-of-Fairtrade](https://www.fairtrade.org.uk/What-is-Fairtrade/The-impact-of-our-work/The-History-of-Fairtrade)

460 Feintrenie, L (2014). Agro-industrial plantations in Central Africa, risks and opportunities.
461 *Biodiversity and Conservation*, 23(6): 1577–1589.

462 Flynn, C; Yamasumi, E; Fisher, S; Snow, D; Grant, Z; Kirby, M; Browning, P;
463 Rommerskirchen, M and Russell, R (2021). People's Climate Vote; Results. UNDP and
464 University of Oxford, 68 pp.

465 Font, X and McCabe, S (2017). Sustainability and marketing in tourism: its contexts,
466 paradoxes, approaches, challenges and potential. *Journal of Sustainable Tourism*, 25(7): 869-
467 883.

468 Foster, W A; Snaddon, J L; Turner, E C; Fayle, T M; Cockerill, T D; Ellwood, M D F; Broad,
469 G R; Chung, A Y C; Eggleton, P; Vun Khen, C and Yusah, K M (2011). Establishing the
470 evidence base for maintaining biodiversity and ecosystem function in the oil palm landscapes
471 of South East Asia. *Philosophical Transactions of the Royal Society B*, 366: 3277–3291.

472 Goldsmith, E B and Goldsmith, R E (2011). Social influence and sustainability in households.
473 *International Journal of Consumer Studies*, 35: 117–121.

474 Greenpeace (2020). *Palm Oil*. <https://www.greenpeace.org.uk/challenges/palm-oil/>

475 Guadalupe, G; Lerma-García, M; Fuentes, A; Barat, J; Bas, M and Fernández-Segovia,
476 I (2019). Presence of palm oil in foodstuffs: consumers' perception. *British Food Journal*,
477 121(9): 2148-2162. <https://doi.org/10.1108/BFJ-09-2018-0608>

478 Guillaume, T; Kotowska, M.M; Hertel, D; Knohl, A; Krashevskaya, V; Murtilaksono, K;
479 Scheu, S and Kuzyakov, Y (2018). Carbon costs and benefits of Indonesian rainforest
480 conversion to plantations. *Nature Communications* 9: 2388. [https://doi.org/10.1038/s41467-](https://doi.org/10.1038/s41467-018-04755-y)
481 [018-04755-y](https://doi.org/10.1038/s41467-018-04755-y)

482 Jackson, T A; Crawford, J W; Traeholt, C and Sanders, T A B (2019). Learning to love the
483 world's most hated crop. *Journal of Palm Oil Research*, 31(3): 331-347.

484 Laurance, W F; Koh, P K; Butler, R; Sodhi, N S; Bradshaw, C J; Neidel, D; Consunji, H and
485 Vega, J M (2010). Improving the performance of the roundtable on sustainable palm oil for
486 nature conservation. *Conservation Biology*, 24(2): 377-381.

487 Lee, J S H; Garcia-Ulloa, J; Ghazoul, G; Obidzinski, K and Pin Koh, L (2014) Modelling
488 environmental and socio-economic trade-offs associated with land-sparing and land-sharing
489 approaches to oil palm expansion. *Journal of Applied Ecology*, 51(5): 1366-1377.

490 Meijaard, E; Buchori, D; Hadiprakarsa, Y; Utami-Atmoko, S S; Nurchahyo, A; Tjiu, A;
491 Prasetyo, D; Nardiyono, Christie, L; Ancrenaz, M *et al.* (2011). Quantifying killing of
492 orangutans and human-orangutan conflict in Kalimantan, Indonesia *PLoS ONE* 6: e27491.
493 <https://doi.org/10.1371/journal.pone.0027491>

494 Meijaard, E; Garcia-Ulloa, J; Sheil, D; Wich, S A; Carlson, K M; Juffe-Bignoli, D; and
495 Brooks, T M (eds.) (2018). Oil palm and biodiversity. A situation analysis by the IUCN Oil
496 Palm Task Force. IUCN Oil Palm Task Force Gland, Switzerland: IUCN. xiii + 116pp.

497 Morgans, C; Meijaard, E; Santika, T; Law, E; Budiharta, S; Ancrenaz, M and Wilson, K
498 (2018). Evaluating the effectiveness of palm oil certification in delivering multiple
499 sustainability objectives. *Environmental Research Letters*. 13 (6), pp. 064032.

500 Mundy, C (2018a). Response to coverage of decision not to clear the Iceland ad.
501 [https://www.clearcast.co.uk/blog/clearcasts-md-responds-to-coverage-of-their-decision-not-](https://www.clearcast.co.uk/blog/clearcasts-md-responds-to-coverage-of-their-decision-not-to-clear-the-iceland-ad/)
502 [to-clear-the-iceland-ad/](https://www.clearcast.co.uk/blog/clearcasts-md-responds-to-coverage-of-their-decision-not-to-clear-the-iceland-ad/)

503 Mundy, C (2018b). Clearcast's MD speaks out on abuse directed at staff following Iceland
504 decision. [https://www.clearcast.co.uk/blog/clearcasts-md-speaks-out-on-abuse-following-](https://www.clearcast.co.uk/blog/clearcasts-md-speaks-out-on-abuse-following-iceland-decision/)
505 [iceland-decision/](https://www.clearcast.co.uk/blog/clearcasts-md-speaks-out-on-abuse-following-iceland-decision/)

506 Murphy, D J (2014). The future of oil palm as a major global crop: opportunities and
507 challenges. *Journal of Oil Palm Research*, 26(1): 1-24.

508 Myers, N; Mittermeier, R; Mittermeier, C; da Fonseca, G and Kent, J (2000) Biodiversity
509 hotspots for conservation priorities. *Nature*, 403(6772): 853-858.

510 Myzabella, N; Fritschi, L; Merdith, N; El-Zaemey, S; Chih, H J and Reid, A (2019).
511 Occupational health and safety in the palm oil industry: A systematic review. *The*
512 *International Journal of Occupational and Environmental Medicine*, 10(4): 159-173.

513 Ocampo-Peñuela, N; Garcia-Ulloa, J; Ghazoul, J and Etter, A (2018). Quantifying impacts of
514 oil palm expansion on Colombia's threatened biodiversity. *Biological Conservation*, 224:
515 117-121.

516 Ostfeld, R; Howarth, D; Reiner, D and Krasny, P (2019). Peeling back the label-exploring
517 sustainable palm oil ecolabelling and consumption in the United Kingdom. *Environmental*
518 *Research Letters*, 14, 014001. doi: 10.1088/1748-9326/aaf0e4

519 Padfield, R; Hansen, S; Davies, Z G; Ehrensperger, A; Slade, E M; Evers, S;
520 Papargyropoulou, E; Bessou, C; Abdullah, N; Page, S *et al.* (2019). Co-producing a Research
521 Agenda for Sustainable Palm Oil. *Frontiers for Global Change*, 2, DOI:
522 10.3389/ffgc.2019.00013

523 Pardo Vargas, L E; Laurance, W F; Clements, G R and Edwards, W (2015). The impacts of
524 oil palm agriculture on Colombia's biodiversity: what we know and still need to know.
525 *Tropical Conservation Science*, 8(3): 828-845.

526 Parsons, S; Raikova, S and Chuck, C J (2020). The viability and desirability of replacing
527 palm oil. *Nature Sustainability*, 3: 412-418. doi:10.1038/s41893-020-0487-8

528 Pievani, T (2014). The sixth mass extinction: Anthropocene and the human impact on
529 biodiversity. *Rendiconti Lincei. Scienze Fisiche e Naturali*, 25: 85–93.
530 <https://doi.org/10.1007/s12210-013-0258-9>

531 Prescott, G; Gilroy, J; Haugaasen, T; Medina Uribe, C; Foster, W.A. and Edwards, D (2016).
532 Reducing the impacts of Neotropical oil palm development on functional
533 diversity. *Biological Conservation*. 197pp. 139-145.

534 Quezada, J; Etter, A; Ghazoul, J; Buttler, A and Guillaume, T (2019). Carbon neutral
535 expansion of oil palm plantations in the Neotropics. *Science Advances*. 5 (11), pp. eaaw4418.

536 Reardon, K; Padfield, R and Salim, H K (2019). Consumers don't see tigers dying in palm oil
537 plantations: a cross-cultural comparative study of UK, Malaysian and Singaporean consumer
538 views of palm oil. *Asian Geographer*. 36(2): 117-141. doi: 10.1080/10225706.2019.1621187

539 Roundtable on Sustainable Palm Oil (2018a). RSPO Impact Report 2018. Impacts and
540 Evaluation Division, RSPO Secretariat, Kuala Lumpur, Malaysia. 86 pp.

541 Roundtable on Sustainable Palm Oil (2018b). Principles and criteria for the production of
542 sustainable palm oil 2018. Roundtable on Sustainable Palm Oil, Kuala Lumpur, Malaysia.
543 137 pp.

544 Russell, M (2018). Palm Oil: Economic and environmental impacts. *European Parliamentary*
545 *Research Service*. [https://epthinktank.eu/2018/02/19/palm-oil-economic-and-environmental-](https://epthinktank.eu/2018/02/19/palm-oil-economic-and-environmental-impacts/)
546 [impacts/](https://epthinktank.eu/2018/02/19/palm-oil-economic-and-environmental-impacts/)

547 Schouten, G and Glasbergen, P (2011). Creating legitimacy in global private governance: The
548 case of the Roundtable on Sustainable Palm Oil. *Ecological Economics*. 70(11), pp. 1891-
549 1899.

550 Sheil, D; Casson, A; Meijaard, E; van Nordwijk, M; Gaskell, J; Sunderland-Groves, J; Werts,
551 K and Kanninen, M (2009) *The impacts and opportunities of oil palm in Southeast Asia:
552 What do we know and what do we need to know?* (51) Bogor, Indonesia: Centre for
553 International Forestry Research

554 Sodhi, N S; Koh, L P; Brook, B W and Ng, P K L (2004). Southeast Asian biodiversity: an
555 impending disaster. *Trends in Ecology & Evolution*, 19(12): 654-660.

556 Sweney, M (2018). Iceland to let loose animatronic orangutan after Christmas ad ban. The
557 Guardian. [https://www.theguardian.com/business/2018/nov/14/iceland-let-loose-animatronic-
558 orangutan-after-christmas-advert-ban-palm-oil](https://www.theguardian.com/business/2018/nov/14/iceland-let-loose-animatronic-orangutan-after-christmas-advert-ban-palm-oil)

559 UN Environment Programme. 2021. Facts about the Climate Emergency.
560 <https://www.unep.org/explore-topics/climate-change/facts-about-climate-emergency>

561 Wilcove, D S; Giam, X; Edwards, D P; Fisher, B and Koh, L P (2013) Navjot's nightmare
562 revisited: logging, agriculture and biodiversity in Southeast Asia. *Trends in Ecology and
563 Evolution*, 28(9): 531-540.

564 World Bank (2019). *Poverty and Inequality: Featured Indicators (Poverty headcount ratio at
565 national poverty lines)*. [http://datatopics.worldbank.org/world-development-
566 indicators/themes/poverty-and-inequality.html#featured-indicators_1](http://datatopics.worldbank.org/world-development-indicators/themes/poverty-and-inequality.html#featured-indicators_1)

567 Yan, N W (2017). A makeover for the world's most hated crop. *Nature*, 543: 306-308.
568 doi:10.1038/543306a

569

570 **Competing interests**

571 This work was conducted independently with all authors employed by an academic research
572 institution, and there are no conflicting interests to declare.

