

The impact of the “World’s 25 Most Endangered Primates” list on scientific publications and media

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Abstract

Assessing the impact of conservation campaigns is of critical importance to optimise the use of limited resources. Lists of threatened species are often employed as media outreach tools, but their usefulness is rarely tested. We investigated whether the inclusion of a species in the list “World’s 25 Most Endangered Primates”, published biannually by the International Primatological Society, the International Union for Conservation of Nature’s Species Survival Commission Primate Specialist Group, and Conservation International from 2000, had an effect both on scientific publications and on the general public. We analysed a database of 40 million articles from major scientific publishers (Elsevier, Springer, Nature, Plos, Pubmed, Biomed Central) finding an increase in the number of papers mentioning a species after its inclusion in the list. We also analysed media penetration (data from Google News), and online interest (data from Google Blogs and Twitter), collecting daily data for one month before and one after the official launch of the 2014-2016 list (24th November 2015). The results show a short spike of interest on Google News and Twitter but no long term effect, indicating a limited effect on the general public. Our results are important for the understanding of the impact of current conservation campaigns and to provide strategies for future campaigns.

Keywords: Primate conservation; conservation outreach; bibliometric analysis; digital media; social media.

1 Introduction

Large volumes of data, freely and easily accessible, provide a cost-effective way of analysing trends and attitudes across a broad spectrum of the public opinion (see Anderegg & Goldsmith, 2014; Cha & Stow, 2015; Proulx, Massicotte, & Pépino, 2014; Soriano-Redondo, Bearhop, Lock, Votier, & Hilton, 2017). The developing field of culturomics examines large online databases of word frequencies that can then be used to understand or predict broad cultural trends (Michel et al., 2011), for example the dynamics of emotional expression in centuries of printed books or newspapers (Acerbi, Lampos, Garnett, & Bentley, 2013; Iliev, Hoover, Dehghani, & Axelrod, 2016). Another example is Google Flu Trends, which utilises internet search data to track and plan responses to flu outbreaks (Dugas et al., 2013). Predictions from online data are clearly far from perfect (despite historical accu-

13 racy, in 2013, Google Flu Trends did not accurately predict peak levels of flu in the
14 US (Butler, 2013), but online tools may have less biases than traditional methods
15 (Soriano-Redondo et al., 2017) and are especially effective if triangulated with other
16 tools (Proulx et al., 2014).

17 The use of digital resources is growing in conservation research (Cha & Stow, 2015;
18 Proulx et al., 2014). A number of studies have started to use online sources to
19 examine trends in public interest in environmental issues (Ficetola, 2013; McCallum
20 & Bury, 2013; Soriano-Redondo et al., 2017), and monitor ecosystem services and
21 trade (Galaz et al., 2010; Ladle et al., 2016). Proulx et al. (2014), for example,
22 tracked biological processes and distribution, e.g. pollen and spread of invasive
23 species, and the relationship with public interest. Furthermore, online tools have
24 been used to measure public interest (Nekaris, Campbell, Coggins, Rode, & Nijman,
25 2013) and potential changes in opinion following key media events including ‘climate
26 gate’ and the death of Cecil the Lion (Anderegg & Goldsmith, 2014; Carpenter &
27 Konisky, 2017; Cha & Stow, 2015). The potential for digital data to assist with
28 understanding support, or a lack thereof, for conservation initiatives has not been
29 yet fully explored (Ladle et al., 2016; Soriano-Redondo et al., 2017)

30 Since 2000, the International Union for Conservation of Nature’s Species Survival
31 Commission (IUCN SSC) Primate Specialist Group, the International Primatologi-
32 cal Society, and Conservation International have biennially published the “World’s
33 25 Most Endangered Primates” (also known as “Top 25 list” or “Primates in Peril”;
34 hereinafter referred to as “Top 25”). This report highlights twenty-five of the most
35 threatened primate species with the aim of attracting attention and action from
36 the scientific community, relevant governments, and the public. As such, inclusion
37 in the list is not based on the actual conservation status of the primate species,
38 but most are also officially classified as ‘threatened’. The list is produced by the
39 world’s leading primatologists and field researchers who have first-hand knowledge

40 of the ongoing evolution of threats to primate species; more than 250 experts have
41 been involved in compiling the last five iterations of the publication. The number
42 of species included in this list is evenly distributed between 4 geographical regions
43 (Neotropics, Africa, Madagascar and Asia). Whilst the potential to increase scien-
44 tific interest and raise the profile of these animals is clear, the actual impact of the
45 Top 25 has never been tested.

46 The aim of this research is to evaluate the scientific output and media penetration
47 of the Top 25 list. We investigated whether the inclusion of a species in the list
48 had an influence on the number of peer-reviewed articles published on that species
49 in the following years. This is of vital importance as policy-makers and funding
50 agencies rely mostly on scientific reports. We also examined whether the list was an
51 effective communication tool for conservation, by analysing media output following
52 the publication of the Top 25 in 2014-2106.

53 **Material and methods**

54 **Scientific publications**

55 We tested the impact of the mention of a species on the Top 25 list on scientific
56 publications (see Table A1 in the Online Appendix for all species included, and the
57 year of their mentions). We have included in this analysis a total of 37 species that
58 were mentioned at least once in the Top 25 list from 2000-2002 to 2010-2012 (6 lists
59 overall of 25 primate species each). We excluded species that were mentioned in
60 the lists of 2012-2014 and 2014-2016 (as there is not enough post-mention data to
61 assess the impact). Each species was considered separately and included once in
62 the analysis.

63 We used 74 control primate species (see Table A2 in the Online Appendix) that

64 have never been mentioned in any of the Top 25 lists released to account for a
65 possible bias of an overall increase of publications through time. These control
66 species were chosen randomly, with the constraint of being evenly distributed in
67 the 4 biogeographical regions (Africa, Asia, Neotropics and Madagascar).

68 We extracted data from 40 million articles published from 1994 to 2014 in six
69 major scientific publishers (PLOS, BMC, Elsevier, Springer, Nature and High-
70 wire/Pubmed; see Table 1). The data were extracted from the publisher databases
71 using custom-written python interfaces to the API they provided. We extracted
72 all articles in which the Latin name of a species that was either included in the
73 Top 25 list (n=37 species) or of control species (n=74 species). We used the Latin
74 name for both Top 25 species and control species as the common name may have
75 changed over the years and scientific articles always list the Latin name when a
76 species is first mentioned. Data from the archives of these publishers were extracted
77 in February and March 2014.

78 We used a Bayesian structural time-series model that estimates the causal effect
79 of a designed intervention on a time series, given a baseline model of the expected
80 trend (Brodersen et al., 2015) in R software (R Core Team, 2014). For each species
81 (Top 25 and control) we compiled a count of the number of scientific articles per
82 year from 1994 to 2014. For species mentioned more than one time in the Top 25,
83 the intervention tested is the period of time from the first to the last mention in the
84 list. We used the average number of scientific publications of the control species
85 trend as baseline. We also ran the same analysis using only control species that
86 were classified as “threatened” (IUCN, 2017) as a control baseline (37 out of 74).
87 This allows us to account for the conservation status of control species which may
88 influence the number of publications.

89 One key assumptions of this analysis is that the set of control time series should be
90 predictive of the outcome time series in the pre-intervention period. In our case, it

is fair to assume that a general rise of publication as observed for control species is to be predicted for the species of the Top 25 before their mention in the list. A second assumption is that the control time series must not have been affected by the intervention (Brodersen et al., 2015). It is unlikely that the scientific publication on a control species, never included in a Top 25 list, would be affected by the release of a biennial Top 25 list.

Media penetration

The Top 25 list for 2014-2016 was decided on the 13th of August 2014 and officially released on the 24th November 2015. We tracked, starting approximately one month before the day of the official launch and for one month after (21/10/15 to the 28/12/15), the presence of a series of keywords (the title of the list itself and related keywords, e.g. “endangered primates”, “primates in peril”, “Top 25 primates”) and the scientific and common names of the 25 primate species included in the list, (e.g. Sumatran orangutans, *Pongo abelii* and red ruffed lemur, *Varecia rubra*, cf. Table A3 in the Online Appendix) on a daily basis. The two data (title/keywords and species names) are considered separately in the analysis. We assessed the penetration of the Top 25 in traditional media (tracked through Google News), and the interest of the general public, in social media (through Twitter) and blogs (through Google Blogs Search). Google News is a free news aggregator that selects syndicated web content such as online newspapers in one location for easy viewing. Twitter is a social network where users post messages that can be read by an unregistered person and it has more than 319 million monthly active users as of 2016. Google Blog Search is a service to search blogs content with an identical process to Google Search.

As in the previous analysis, we used a Bayesian time series analysis (Brodersen et al., 2015). In this analysis we did not consider any control species given that we

117 did not expect any general increasing trend as we did for the scientific publications.
118 We ran the analysis for a post intervention period both of one week and one month,
119 in order to examine the duration of the possible effect.
120 The data used in the analysis are available in an Open Science Framework repository
121 at <https://osf.io/e7ymv/s>

122 Results

123 Scientific publications

124 We found 4,545 scientific articles that contained at least once the Latin name of the
125 37 primate species that were included in one of the six Top 25 lists from 2000-2002
126 to 2010-2012. In addition, 13,656 scientific articles contained at least once the Latin
127 name of the 74 primate control species.

128 Twenty two out of 37 species (59%) had an increase in scientific publications fol-
129 lowing their inclusion in the Top 25 list (Figure 1). For 11 species there was no
130 identified effect, and 4 species had a decrease in publications following inclusion in
131 the Top 25 list. The four species with the most positive impact were the mountain
132 gorilla (*Gorilla beringei beringei*), the drill (*Mandrillus leucophaeus*), the golden
133 lion tamarin (*Leontopithecus rosalia*) and the black snub-nosed monkey (*Rhinop-*
134 *ithecus bieti*). The four species that suffered a decline in publication were the brown
135 spider monkey (*Ateles hybridus brunneus*), the Miller's langur (*Presbytis hosei cani-*
136 *crus*), Miss Waldron's red colobus (*Procolobus badius waldroni*) and the north-west
137 Bornean orangutan (*Pongo pygmaeus pygmaeus*). There were no significant differ-
138 ences between species mentioned once (n=21) or several times (n=16) in the Top 25
139 list (two-tailed Mann-Whitney U-test, U=173, p=0.8916; Figure A1 the in Online
140 Appendix).

141 When using only the control species that were classified as “threatened” (IUCN,
142 2017) as a baseline to control for publication bias the results were even stronger,
143 with 25 species out of 37 (67.6%) demonstrating an increase in publication rates
144 following their inclusion in the Top 25 list (Figure A2 in the Online Appendix).
145 Twelve species were not affected by their mention in the list and none suffered a
146 decrease in presences in scientific publications after inclusion on the Top 25 list.

147 **Media penetration**

148 **Google News**

149 During the pre-intervention period, we collected a total of 296 mentions of the Latin
150 name of the species included in the Top 25 list and 27 mentions of the title/keywords.
151 During the post-intervention period, Latin name of species in the Top 25 list were
152 mentioned 427 times and the keywords 161 times.

153 When considering a post period of one week, we found a net significant increase of
154 mentions of the common or Latin name of species included in the 2012-2014 Top 25
155 Most Endangered Primate list (Table 2). However, with a post-intervention period
156 of one month, although the intervention appears to have caused a positive effect,
157 this effect is not statistically significant (Figure 2).

158 When we considered the keywords associated with the Top 25 list we found that
159 there was a significant effect of the official launch on the use of these keywords in
160 Google News, both considering a post-intervention period of one week and of one
161 month (Table 3).

162 **Google Blogs**

163 The Latin name of the species included in the Top 25 list and keywords relating to
164 the list were both mentioned only once during the pre-intervention period in Google
165 Blogs. During the post-intervention period, Latin name of species in the Top 25
166 list were mentioned 65 times, and the keywords 88 times.

167 We found that with both a short and long post-intervention period there was a
168 significant effect of the Top 25 list official launch on the mention of Latin and
169 common names of species (Table 2) on the use keywords (Table 3) included in this
170 list (Figure 2).

171 **Twitter**

172 Latin and common name of species were included in tweets 621 times during the
173 pre-intervention period. Keywords associated with the Top 25 list were sporadically
174 used in comparison, with a total of 33 tweets. For the post-intervention period, there
175 were 768 mentions in tweets including Latin or common names of species included
176 in the Top 25 list and 622 mentions of the Top 25 associated keywords.

177 Our analysis of the number of tweets and retweets following the Top 25 list launch
178 in 2015 yielded similar results to Google News (Figure 2). When considering the
179 species name there was an effect of the launch on mentions on twitter in the one
180 week-post intervention period, but no effect in the one month period (Table 2). The
181 analyses on keywords yield significant results for both period lengths (Table 3).

182 **Discussion**

183 We found that inclusion in the “World’s 25 Most Endangered Primates” list had a
184 positive effect on the number of scientific papers published on the featured primate

185 species. This is encouraging, and it suggests that the use of this type of report can
186 drive scientific interest for these threatened species (although see Jarić, Roberts,
187 Gessner, Solow, & Courchamp, 2017). Furthermore, as policy-makers and funding
188 agencies rely on scientific reports, this could have a direct positive impact on the
189 conservation of these primates. This result is, in some ways, unsurprising as some
190 of the scientists publishing on these species are going to be those who contribute
191 to the formulation of the Top 25 list. It is difficult to untangle the direction of
192 impact e.g., is inclusion driving publications or is the author's involvement with the
193 list driving inclusion? The lack of causal inference is a recognised limitation, also
194 with online data (Nghiem, Papworth, Lim, & Carrasco, 2016; Proulx et al., 2014)
195 and suggests the need for further research. In addition, few changes in taxonomy
196 occurred during the time period of the analysis (e.g. *Hapalemur simus* name was
197 changed to *Prolemur simus* in 2001, and this may have an impact on our results
198 (Correia et al., 2018). However, to the best of our knowledge, most scientific articles
199 used both terms for the species in questions.

200 Examination of media penetration highlighted a significant increase in news articles
201 focusing on species included in the Top 25 list, but this was not sustained for a
202 month after publication of the report. This has also been seen in other studies
203 where there tends to be a short term interest in the issue that is not sustained e.g.,
204 the killing of Cecil the lion (Carpenter & Konisky, 2017) or media events regarding
205 climate change (Anderegg & Goldsmith, 2014). The short spike of interest might
206 be due to high news turnover.

207 Interestingly, there was a significant increase in attention in Google Blogs for species
208 that had been included in the Top 25 list. This result may mostly be due to the
209 absence of any keywords and species name in the pre-period. Thus, even with a few
210 mentions in any blogs found in Google after the official launch, the analysis may
211 yield a significant effect of the intervention on the data collected. The sustained

212 interest, i.e., after one month, may also be a reflection of the longer timeframe
213 required to extract information from news sites, write and publish blogs. However,
214 it also suggests that direct engagement with key influencers and bloggers would
215 have potential to increase the reach of news regarding key conservation events.

216 A significant, but short-term, increase was also seen in the social media analysis.
217 Conservationists need to understand how to use social media effectively and engage
218 with their audience (Papworth et al., 2015). In its current form, the Top 25 list
219 is hardly an effective communication tool to the public. Simply releasing reports
220 or updates on to Twitter is not enough for a sustained impact and suggests there
221 is the need to intensify engagement and support with a social media friendly com-
222 munication tools, such as videos. For example, the publishing team could sustain
223 continued attention by presenting every month one of the species included in the
224 Top 25 list (which would approximatively cover the two-year period between the
225 launch of the next edition of the list).

226 The use of online data to examine the impact of a conservation intervention provides
227 important insights into scientific and public interest. This is necessary to drive
228 future communication in this area (Anderegg & Goldsmith, 2014; Nghiem et al.,
229 2016). However, there are limitations of this method which need to be taken into
230 account (Ladle et al., 2016). For example, the reliance on English speaking search
231 engines has the potential to skew the data as there are other online tools used
232 extensively in other countries; whilst Baidu has only a 6% global market share, it
233 has 70% of the market share in China (Statcounter, 2017). Conversely, a possible
234 limiting factor for the “World’s 25 Most Endangered Primates” diffusion is that its
235 global accessibility is limited by being available only in English.

236 In conclusion, the “World’s 25 Most Endangered Primates” publication appears to
237 fulfil its aim on attracting attention and action from the scientific community. It
238 has a positive impact on scientific publications and, by association, research into

239 these threatened species. Impact on governments is harder to ascertain and was
240 not the focus of this study. There seems to be little impact, however, on attracting
241 the attention of the general public. While other studies found that scientific and
242 general public seems usually aligned (Jarić et al., 2019), our results suggest that
243 broader public impact becomes a focus of the publishing team going forward.

244 Acknowledgements

245 This work has been funded by the Bristol Zoological Society and by the Margot
246 Marsh Biodiversity Foundation. We are grateful to Anna Egerton, Alexia Balat-
247 soukas, and Claire Drury for help in data collection, and to Anthony Rylands for
248 comments to the manuscript.

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Publishers name	Search type	Total articles searched	Top 25 species match	Control species match
PLOS	Full text	53,500	213	148
BMC	Full text	189,955	149	132
Elsevier	Full text	11,000,000	4,265	6,805
Springer	Keywords	5,000,000	66	36
Nature	Full text	500,000	211	259
HighWire/PubMed	Full text	23,000,000	2,565	6,276
Total		39,743,455	7,469	13,656

Table 1: **List of publishers used for the data mining analysis on scientific publication.** Search of the species name (either Top 25 species or control) was done either on the full text or on the keywords of scientific articles.

Media type	Post-intervention period	Absolute average effect	Absolute cumulative effect	Relative effect in %
News	month	3.5 [-3.5, 11]	121.5 [-122.6, 393]	40 [-40, 129]
	week	36 [24, 48]	291 [189, 381]	415 [269, 543]
Blogs	month	1.8 [1.7, 1.9]	64.0 [61.1, 67.0]	6342 [6058, 6639]
	week	7.1 [7, 7.2]	56.8 [56, 57.8]	24296 [23834, 24748]
Twitter	month	4 [-3.4, 11]	141 [-119.8, 399]	23 [-19, 64]
	week	17 [3.6, 29]	133 [28.5, 230]	93 [20, 160]

Table 2: **Latin and Common species names in media.** Causal impact analysis results for search of Latin and Common species included in the Top 25 list 2012-2014 on Google News, Google Blogs and Twitter with a pre-period before the official launch of one month and a post-intervention period after the official launch of either one month or one week. The absolute average effect is the estimated average causal effect across post-intervention period. The absolute cumulative effect is determined as the difference between the predicted and actual value, i.e., the additional publications following the inclusion in the Top 25 list. The relative effect shows the percentage of increase or decrease following the intervention from the predicted values. All effects are reported with their 95% CI.

Media type	Post-intervention period	Absolute average effect	Absolute cumulative effect	Relative effect in %
News	month	3.8 [3.4, 4.2]	1133.2 [117.7, 148.2]	480 [424, 534]
	week	17 [16, 17]	134 [128, 139]	2100 [2015, 2182]
Blogs	month	2.5 [2.4, 2.5]	86.1 [83.2, 88.9]	4446 [4295, 4590]
	week	11 [11, 11]	86 [84, 87]	19152 [18901, 19379]
Twitter	month	17 [16, 17]	588 [568, 610]	1726 [1666, 1790]
	week	44 [43, 45]	350 [343, 358]	4486 [4394, 4587]

Table 3: **Top 25 related keywords in media.** Causal impact analysis results for search of keywords (e.g. top 25 primates, primate in peril) included in the Top 25 list 2012-2014 on Google News, Google Blogs and Twitter with a pre-period before the official launch of one month and a post-intervention period after the official launch of either one month or one week. The absolute average effect is the estimated average causal effect across post-intervention period. The absolute cumulative effect is determined as the difference between the predicted and actual value, i.e., the additional publications following the inclusion in the Top 25 list. The relative effect shows the percentage of increase or decrease following the intervention from the predicted values. All effects are reported with their 95% CI.

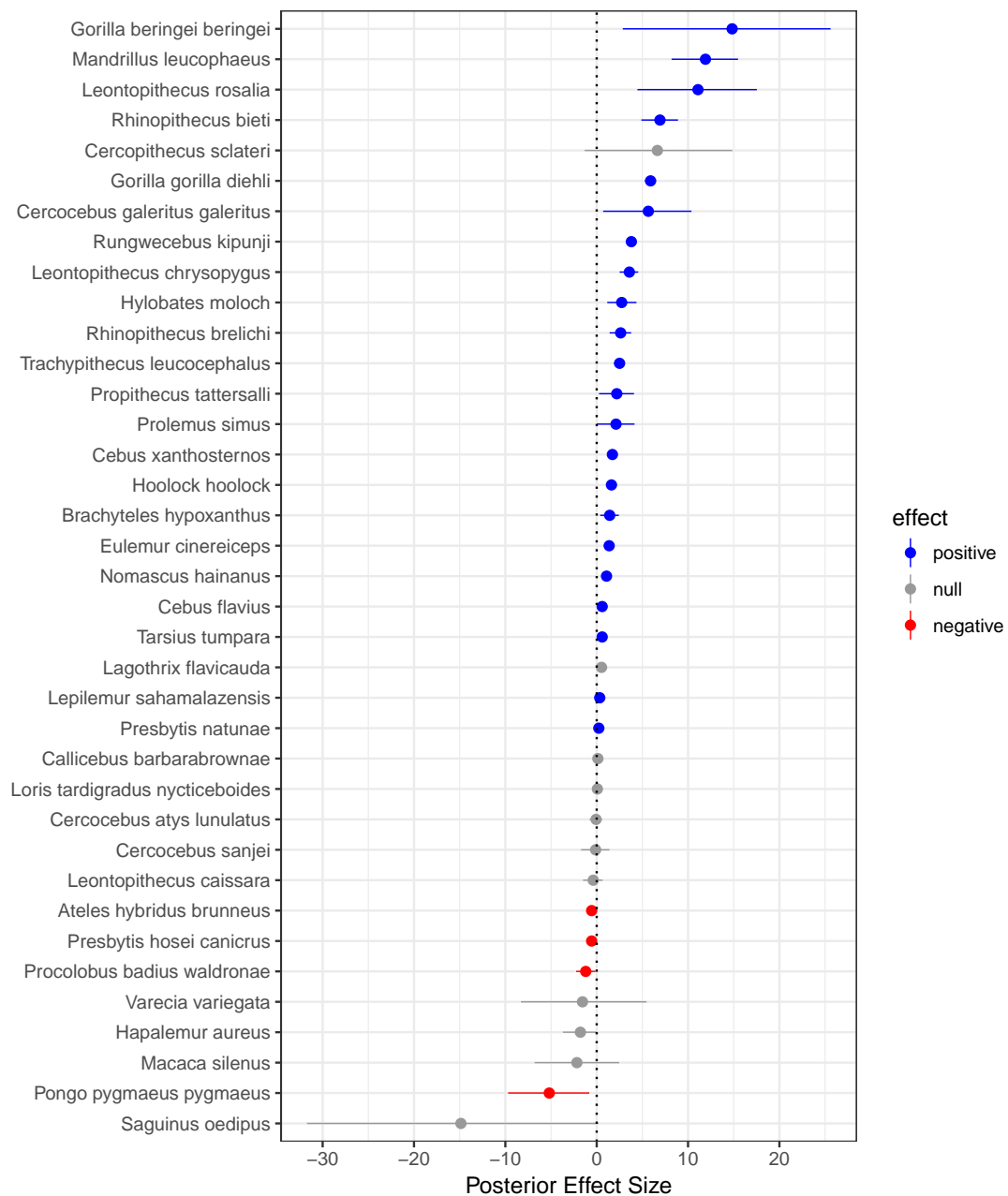


Figure 1: **Effect of Top 25 inclusion on scientific publications.** Posterior effect size of Causal Impact analysis for each Top 25 primate species included in the 6 Top 25 lists from 2000-2002 to 2010-2012 on scientific publications containing at least once their Latin names. Effect size containing only positive values are in blue, containing both positive and negative value are in grey and containing only negative value are in red. (No colour in print.)

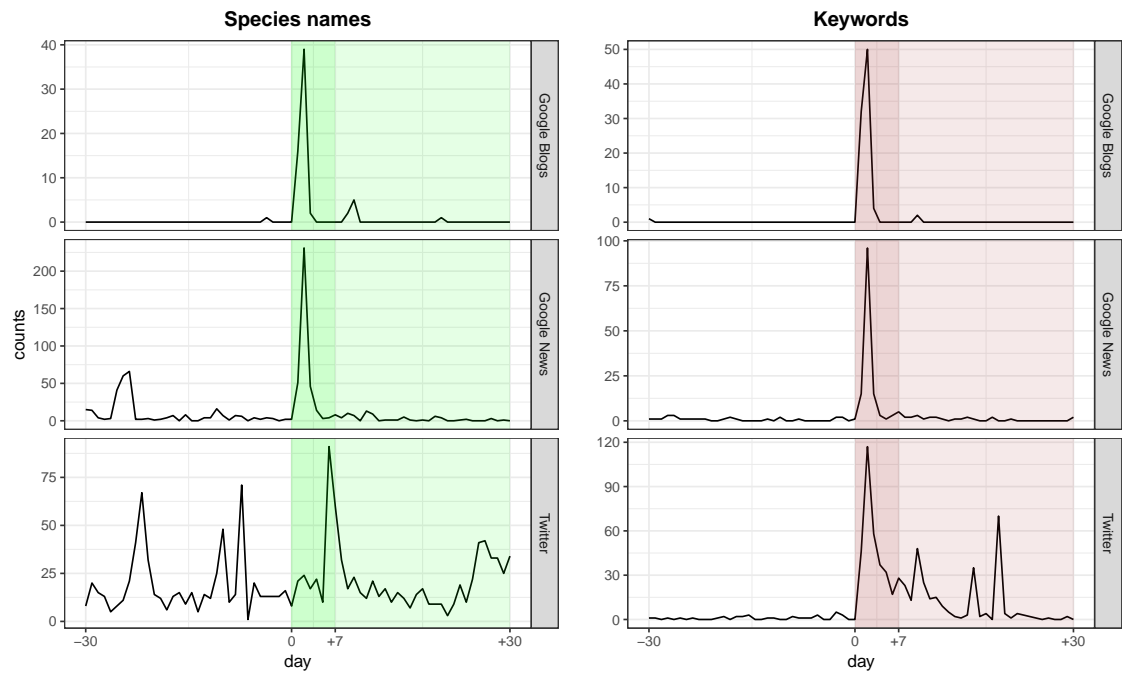


Figure 2: **Effect of Top 25 inclusion on media.** Counts of mentions on Google Blogs, Google News and Twitter of Latin name species and keywords related to the list one month before and one month after the official launch of the Top 25 list (24th of November 2015). The post-intervention period (following the launch) of one month and of one week are highlighted. (No colour in print.)