International Research Journal of Advanced Science
Vol 2(1), 2021: 10–16

Species composition and diversity: baseline for tree conservation at Laguna State Polytechnic University, San Pablo, Philippines

Ericson Coracero[1*], Harvey Urriza[2], Parker Gino Foster[2]

[1]Department of Forestry and Environmental Sciences, Aurora State College of Technology, Baler, Aurora, Philippines
[2]College of Teacher Education, Laguna State Polytechnic University San Pablo City, Laguna, Philippines

Received: 03 February 2021
Accepted: 27 February 2021
Published: 05 March 2021

Copyright©2021 The Author(s)

ABSTRACT

The establishment and maintenance of urban forests are one of the most brilliant solutions in addressing biodiversity loss. Tree species help in providing green spaces in urban and populated areas. Assessing the tree diversity of an area can yield vital baseline information for the conservation and protection of the area. The assessment of trees in Laguna State Polytechnic University San Pablo City Campus showed a very low diversity (Shannon = 1.705). A total of 15 morphospecies with 295 individuals were found. The campus was found to be dominated by an invasive alien species, Swietenia macrophylla King with 131 individuals. Despite the dominance of an invasive species, the area was still home to 9 indigenous and endemic species, and 11 threatened species posing the need for conservation and protection of the area. Conservation and protection measures include improvement of diversity, addressing invasion, and protecting the ecologically important species.

Keywords Urban forest, Tree diversity, LSPU San Pablo, Native species, Species conservation

Corresponding Author: Ericson Coracero, E-mail: ericsoncoracero@ascot.edu.ph, : https://orcid.org/0000-0002-2569-3179

1. Introduction

Forest is defined as the "land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ which does not include land that is predominantly under agricultural or urban land use" [1]. Forest provides different services which include sustaining of water supply and rainfall [2], food security and nutrition [3], climate control and biodiversity conservation [4], and many more. Unfortunately, the world forest cover has been continuously decreasing wherein statistics showed that 178 million hectares were reduced from 1990 to 2020 leaving only 4.06 billion hectares [5]. In the Philippines, the same situation has been happening to make the forest cover decreased from 17.2 M hectares in 1934 to 6.8 million hectares in 2010 [6]. Improper ways and malpractices in forest management such as excessive land-use conversion and deforestation for urbanization are one cause of forest cover declination [7].

Urbanization is an inevitable process of shifting of population and the people's way of living from rural to urban style [8]. This is why the concept of urban forestry – the art and science of managing trees and forest resources within and for the community – was introduced [9]. Urban forest, by definition, is comprised of the tree species within cities or urban areas growing in green spaces [10]. This type of forest is important in maintaining the basics of ecological and environmental functioning in urban areas vital in animal and human survival [11]. In the United States of America, the tree cover in urban areas is estimated at 35% in 2012 but with a continuous decrease of about 4 million urban trees per year [12]. In the Philippines, there were limited studies on the scope of its urban forests except for its capital, Manila. It is a highly urbanized city with several green spaces that are also rich in histories such as Rizal Park, Paco Park, and Arroceros Forest Park (AFP). AFP is considered the last lung of Manila which provides free recreational activities and experiences to residents and tourists [13]. As the last greenest space in Manila, assessing its environmental and ecological status (i.e., biodiversity) is a commendable thing to do.

Biodiversity refers to the variety of life forms that can be found on Earth including plants and animals [14]. Trees are considered a major component of the ecosystem that serves as a habitat for wildlife [15]. Assessing tree diversity is a useful tool in the management and conservation of an area [16]. The present study on the diversity of trees in Laguna State Polytechnic University – San Pablo Campus is a pioneer in the area. The results obtained in the study will be a good baseline for drafting conservation and management strategies to fight complete diversity loss.

The study generally aimed to assess the composition, abundance, and diversity of tree species in Laguna State Polytechnic University San Pablo City Campus (LSPU-SPCC), Laguna, Philippines. Specifically, the research aimed to inventory the tree species within the campus, identify the most abundant species, compute for the diversity indices, assess the ecological status of trees in terms of endemism, indigeneity, invasiveness, and conservation status, and suggest possible conservation and protection measures for the management of remaining tree species in the area.

2. Materials and method

2.1. Study site

The study was conducted within the premise of the 6-ha campus of LSPU in San Pablo, Laguna, the Philippines located at 14.08°N, 121.31°E. LSPU is a university system that aims to promote integrity, professionalism, and innovation while providing quality education and service to the community [17].

2.2. Tree inventory

The entire LSPU-SPCC was surveyed in December 2018. Tree species with a diameter of at least 10 cm and a height of more than 5 meters were inventoried. These species were recorded and identified on the ground.

2.3. Diversity indices computation

Components of a community like taxa and trophic levels can be described and compared through the computation of different diversity indices [18]. Diversity indices are mathematical functions of the combination of evenness and richness of species [19]. In this study, diversity indices were computed using the Paleontological Statistics Software Package for Education and Data Analysis (PAST v.3.14). The following are the diversity indices and parameters obtained from the software [20]:

• Number of taxa (S). It is the total number of species.
• Total number of individuals (n)
• Evenness Index. It is the measure of the community's evenness from 0 to 1.
• Shannon index (entropy). A diversity index, taking into account the number of individuals as well as the number of taxa. Varies from 0 for communities with only a single taxon to high values for communities with many taxa, each with few individuals.

Diversity indices were then interpreted using the Fernando Biodiversity Scale, given in Table 1.

2.4. Ecological status assessment

The ecological status looked upon in this study was based on endemism, indigeneity, invasiveness, and conservation

Table 1 Fernando biodiversity scale [21].

Relative Values	Shannon index (H')	Evenness Index (E)
Very high	3.5 and above	0.75 – 1.00
High	3.0 – 3.49	0.5 – 0.74
Moderate	2.5 – 2.99	0.25 – 0.49
Low	2.0 – 2.49	0.15 – 0.24
Very low	1.9 and below	0.05 – 0.14

statuses of the tree species. Data on endemism and indigeneity were obtained from the Co's Digital Flora of the Philippines, a comprehensive website and database of plants that include but are not limited to the species' scientific name, family, distribution, endemism, and indigeneity [22]. The report of Joshi [23] provided the list of invasive species in the Philippines which was used in classifying the trees found on the campus. Lastly, the conservation statuses of trees were based on two lists: International Union for Conservation of Nature (IUCN) Red List that deals with the worldwide status of plants [24], and the national list of threatened species in the Philippines under DENR Administrative Order No. 2017-11 [25].

3. Results and discussion

3.1. Tree species composition and diversity

A total of 15 morpho-species of trees with 295 individuals belonging to 10 families, and 15 genera were recorded, presented in Table 2. Among these families, Meliaceae appeared to be the most specious and abundant families having 3 species and 156 individuals. The population of trees in this family is equivalent to 52.88% of all individuals found within the area. Moreover, the most abundant species also belongs to the same family. *Swietenia macrophylla* King or Big-leaf Mahogany had 131 individuals equivalent to 44.41% of the total population of all species (Figure 1). *S. macrophylla* is an introduced species to the Philippines [22]. According to Mukaromah et.al [26], it has high allelopathic potential or the potential to produce chemicals that can affect the growth and development of other organisms. Also, it was found that its leaves exhibit allelopathic activity that inhibits the growth of the species under its canopy where its leaves fall. Therefore, this species may have prevented other species from growing making it the most abundant species compared to other species in LSPU-SPCC.

Table 2 Taxonomic list of tree species found within LSPU-SPCC.

Tree No.	Family	Scientific Name	Common Name	Count
1	Anacardiaceae	*Mangifera indica* L.	Mangga	77
2	Annonaceae	*Annona muricata* L.	Guyabano	3
3	Arecaceae	*Cocos nucifera* L.	Niyog	3
4	Burseraceae	*Canarium ovatum* Engl.	Pili	4
5	Combretaceae	*Terminalia catappa* L.	Talisai	8
6	Fabaceae	*Samanea saman* (Jacq.) Merr.	Rain Tree	24
7	Fabaceae	*Tamarindus indica* L.	Sampalok	3
8	Fabaceae	*Pterocarpus indicus* Willd. forma *indicus*	Smooth Narra	4
9	Meliaceae	*Swietenia macrophylla* King	Big-leaf Mahogany	131
10	Meliaceae	*Lansium domesticum* Correa	Lanzones	22
11	Meliaceae	*Sandoricum koetjape* (Burm. F.) Merr.	Santol	3
12	Moraceae	*Artocarpus heterophyllus* Lam.	Nangka	5
13	Moraceae	*Ficus nota* (Blanco) Merr.	Tibig	2
14	Myrtaceae	*Psidium guajava* L.	Bayabas	4
15	Phyllanthaceae	*Antidesma bunius* (L.) Spreng.	Bignai	2

LSPU-SPCC has a very low diversity as shown in the index values obtained (Table 3). Both of the values of the Shannon Index (1.705) and Evenness (0.367) fall in the very low category as affected by the individual count and its distribution to the species. Both of these indices rely on the species richness or count and the distribution of individuals among species [19]. As seen in the data, the number of individuals is very unevenly distributed from the tree with the highest

number of individuals (S. macrophylla = 131) to the least populated (A. bunius and F. nota = 2). The difference in their values is very high.

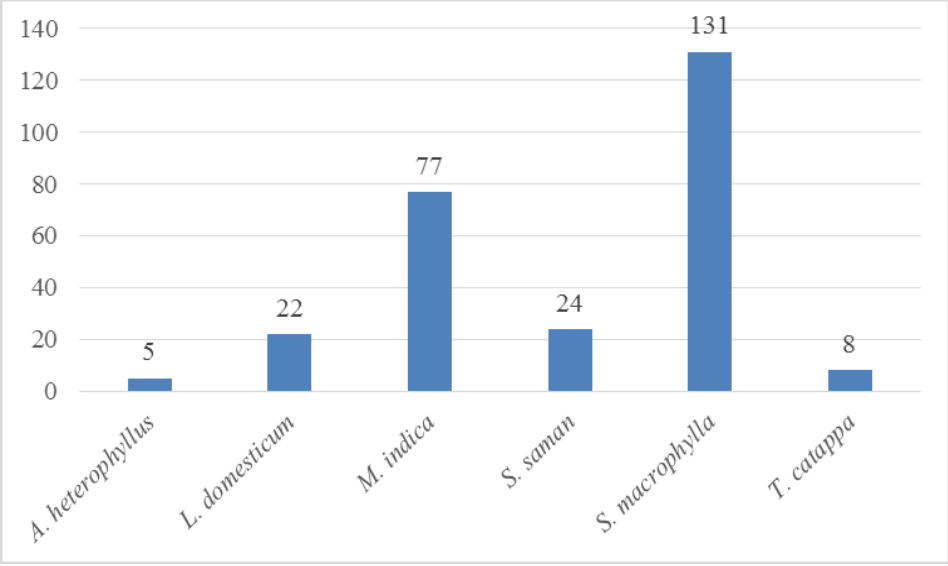

Figure 1 Top 6 species in terms of abundance.

Table 3 Computed diversity indices of LSPU-SPCC.

Parameters	Values
Taxa	15
Individuals	295
Evenness	0.367
Shannon	1.705

No online publications dealing with tree diversity in schools and universities in the Philippines were available online. Thus, no local comparisons can be made. Nevertheless, foreign studies particularly in Nigeria were available in this aspect. A study at the University of Ilorin revealed a moderate tree diversity (H' = 2.95, E = 0.3950) having 2468 individuals under 54 species [27]. Another study in Nigeria at the College of Forestry and Fisheries, University of Agriculture Makurdi, Benue State yielded high diversity (H' = 3.21, E = 0.88) with 177 individuals belonging to 39 species [28]. Lastly, the study conducted in Ekiti State University, Ado Ekiti also had a low to high tree diversity (H' = 1.088 to 2.274) with 838 individuals from 27 species [29]. These studies obtained generally higher tree diversity than that of LSPU San Pablo. One of the main reasons was the highly unbalanced distribution of individual count among species wherein the S. macrophylla had a very dominant individual count. Also, the low tree diversity in LSPU SPCC may have been a result of land conversion observed inside the campus for development purposes. As observed, trees were cut by the management for the construction of new buildings and establishments. These kinds of events sacrificed the tree diversity which has unfavorable effects on the environment wherein a study showed that 25% of the greenhouse gases released in the atmosphere are from cut down forests or deforestation [30]. Therefore, tree cutting greatly contributes to climate change.

3.2. Species ecological status

A total of 9 (60% of the species) out of 15 species were found to be indigenous wherein one of those is endemic to the Philippines (Table 4). Indigenous or native species are those that are naturally occurring or originating in a specific place, country, or region [31]. While endemics are species that occur only in a specific area or region [32]. With that definition, Philippine endemics are the species that can only be found in the Philippines. Among the native species found within LSPU San Pablo Campus, C. ovatum (Pili) was the only Philippine endemic found. Pili trees found in the study site are large-diameter trees that can be a good source of regenerants.

Six (6) out of 15 species or equivalent to 40% of all species found were considered introduced or exotic to the Philippines (Table 5). Introduced species are those that are not naturally occurring in a specific geographic location but are brought out of their native habitat which commonly leads to invasion [33]. Invasion is caused by invasive species which persistently grow outside their native geographic location, being an introduced species, and proliferates in the area

[34]. As mentioned in the early pages, S. macrophylla is introduced and is the only invasive species found in the area but is the most abundant and populous among others.

Table 4 Taxonomic list of Philippine native and endemic species found in LSPU-SPCC.

Family	Scientific Name	Common Name	Native	Endemism
Arecaceae	*Cocos nucifera*	Niyog	Native	Non-endemic
Burseraceae	*Canarium ovatum*	Pili	Native	Endemic
Combretaceae	*Terminalia catappa*	Talisai	Native	Non-endemic
Fabaceae	*Pterocarpus indicus forma indicus*	Narra	Native	Non-endemic
Meliaceae	*Lansium domesticum*	Lanzones	Native	Non-endemic
Meliaceae	*Sandoricum koetjape*	Santol	Native	Non-endemic
Moraceae	*Artocarpus heterophyllus*	Nangka	Native	Non-endemic
Moraceae	*Ficus nota*	Tibig	Native	Non-endemic
Phyllanthaceae	*Antidesma bunius*	Bignai	Native	Non-endemic

Table 5 Taxonomic list of introduced and invasive tree species found in LSPU-SPCC.

Family	Scientific Name	Common Name	Native	Invasiveness
Anacardiaceae	*Mangifera indica*	Mangga	Introduced	Non-invasive
Annonaceae	*Annona muricata*	Guyabano	Introduced	Non-invasive
Fabaceae	*Samanea saman*	Acacia	Introduced	Non-invasive
Fabaceae	*Tamarindus indica*	Sampalok	Introduced	Non-invasive
Meliaceae	*Swietenia macrophylla*	Mahogany	Introduced	Invasive
Myrtaceae	*Psidium guajava*	Bayabas	Introduced	Non-invasive

The Philippines is home to several threatened species [35]. Threatened species are those that are at risk, from low to high depending on classification, of being extinct in the wild [36]. A total of 11 (73.33% of the total species) out of 15 species were found to be listed either in the DAO 2017-11 and/or IUCN Red List. Locally threatened species under DAO 2017-11 were only 2 namely, Pili and Narra which were classified as Other Threatened Species and Vulnerable, respectively. Internationally, there were 11 listed species in IUCN Red List wherein Narra (P. indicus) is the most critical being an Endangered species.

Table 6 Taxonomic list of threatened tree species found in LSPU-SPCC

Family	Scientific Name	Common Name	DAO 2017	IUCN Red List
Meliaceae	*Swietenia macrophylla*	Mahogany	-	VU
Annonaceae	*Annona muricata*	Guyabano	-	LC
Fabaceae	*Samanea saman*	Acacia	-	LC
Fabaceae	*Tamarindus indica*	Sampalok	-	LC
Myrtaceae	*Psidium guajava*	Bayabas	-	LC
Burseraceae	*Canarium ovatum*	Pili	OTS	LC
Combretaceae	*Terminalia catappa*	Talisai	-	LC
Meliaceae	*Sandoricum koetjape*	Santol	-	LC
Moraceae	*Ficus nota*	Tibig	-	LC
Fabaceae	*Pterocarpus indicus* forma *indicus*	Narra	VU	EN
Anacardiaceae	*Mangifera indica*	Mangga	-	DD

OTS – Other Threatened Species, DD – Data Deficient, LC – Least Concern, VU – Vulnerable, EN - Endangered

3.3. Possible conservation measures

Based on the results of the study the following measures are recommended:

a. The area was found to have a low tree diversity. In that essence, the administration of the university must have a program on enhancing the green space inside the campus to improve diversity. This program can be through the establishment of a nursery with some Philippine native species to bring back the natural ecosystem composition.

b. Invasion of Mahogany in the area must be addressed appropriately. As invasive species pose harm to biodiversity, the occurrence of other invasive species must be prevented from entering the ecosystem, and if it is not prevented, gradual eradication of the species must be done [37].

c. Presence of endangered and endemic species poses the need to conserve the said species in the area [38]. These species are really important in maintaining biodiversity and battling against climate change [39, 40]. One good way is through educating the people on the importance of these species (Gonzales, 2020). To educate the people on the campus, the administration can put a tag in every tree individual stating it's common, scientific, and family names, conservation and residency statuses, and uses.

4. Conclusion

LSPU-SPCC is an area with low tree diversity dominated by invasive species of Swietenia macrophylla (Mahogany) but is home to certain ecologically important species including threatened, endemic, and native tree species. Certain conservation and protection measures must be done to address the situation in the area.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgement

The authors would like to thank LSPU San Pablo City Administration for allowing the students to conduct this study.

References

[1] FAO (2010). Global forest resource assessment: terms and definitions. *Food and Agriculture Organization of the United Nations, Rome*, pp 27 pp.

[2] Ekhuemelo D, Amonum J, Usman I (2016). Importance of forest and trees in sustaining water supply and rainfall. *Nigeria Journal of Education, Health and Technology Research*, 8: 1-8.

[3] Powel B, Ickowitz A, McMullin S, Jamnadass R, Padoch C, Pinedo-Vasquez M, Sunderland T (2013). The role of forests, trees and wild biodiversity for nutrition-sensitive Food Systems and Landscapes. *Center for International Forestry Research*, 1-24.

[4] Torkar G, Verlic A, Vilhar U (2014). Importance of forest ecosystem services to secondary school students: a case from the north-west slovenia. *South-East Europeon Forestry*, 1: 35-43.

[5] FAO, UNEP (2020). The state of the world's forests 2020: forests, biodiversity and people. *Food and Agriculture Organization of the United State*.

[6] SEPO (2015). Philippine forests at a glance. *Philippines AG*, 1-15.

[7] Kelly P (1998). The politics of urbanrural relations: land use conversion in the Philippines. *Environment and Urbanization*, 1: 35-54.

[8] Sanyaolu P, Sanyaolu C (2018). URBANIZATION 1, https://doi.org/10.13140/RG.2.2.23495.96161.

[9] Konijnendijk van den Bosch C, Randrup T (2004). Urban forestry. *Encyclopedia of Forest Sciences, Landscape Planning*, pp 471-478.

[10] Nowak D (1994). Understanding the structure of urban forests. *Journal of Forestry*, 92: 42-46.

[11] Solomou A, Topalidou E, Germani R, Argiri A, Karetsos G (2019). Importance, utilization and health of urban forests: a review. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 1: 10-16.

[12] Nowak D, Greenfield E (2016). Urban forests. https://www.fs.fed.us/nrs/pubs/jrnl/2016/nrs_2016_nowak_002.pdf.

[13] Lagbas A (2019). Social valuation of regulating and cultural ecosystem services of Arroceros Forest Park: A man-made forest in the city of Manila, Philippines. *Journal of Urban Management*, 1: 159-177.

[14] Rawat U, Agarwal N (2015). Biodiversity: concept, threats and conservation. *Environment Conservation Journal*, 16: 19-28.

[15] Bütler R, Lachat T, Larrieu L, Paillet Y (2013). Habitat trees: key elements for forest biodiversity. Integrative approaches as an opportunity for the conservation of forest biodiversity. *European Forest Institute, Joensuu*, pp. 84-91.

[16] Naidu L (2015). Interactive dashboard for user activity using network flow data. https://rc.library.uta.edu/uta-ir/bitstream/handle/10106/25482/NAIDU-THESIS-2015.pdf?sequence=1&isAllowed=y.

[17] LSPU (2020). Laguna State Polytechnic University. https://lspu.edu.ph.

[18] Morris E, Caruso T, Buscot F, Fischer M, Hancock C, Maier T, Meiners T, Müller C, Obermaier E, Prati D, Socher S, Sonnemann I, Wäschke N, Wubet T, Wurst S, Rillig M (2014). Choosing and using diversity indices: Insights for ecological applications from the German Biodiversity Exploratories. *Ecology and Evolution*, pp 4.

[19] Colwell R (2009). Biodiversity: concepts, patterns and measurement. In: Simon A. Levin (Ed.), *The Prince-ton Guide to Ecology. Princeton: Princeton University Press*, pp 257–263.

[20] Hammer Ø (2018). Reference manual. https://folk.uio.no/ohammer/past/past3manual.pdf.

[21] Fernando E (1998). Forest formations and flora in the Philippines: Handout in FBS 21.

[22] Pelser P, Barcelona J, Nickrent D (2011). Co's Digital Flora of the Philippines. http://www.philippineplants.org.
[23] Joshi R (2016). Invasive alien species (IAS): Concerns and status in the Philippines.
[24] IUCN (2017). The IUCN redlist of threatened species. https://www.iucnredlist.org.
[25] DENR (2017). DAO 2017-11. https://www.philippineplants.org/dao-2017-11.pdf.
[26] Mukaromah A, Purwetsri Y, Fujii Y (2017). Determination of allelopathic potential in mahogany (Swietenia macrophylla King) leaf litter using sandwich method. *Indonesian Journal of Biotechnology*, 22: 93-101.
[27] Raji I, Babalola F (2018). Assessment of tree diversity and abundance in university of Ilorin campus: towards conservation. *Proceedings of 6th NSCB Biodiversity Conference*, pp 443 – 450.
[28] Amonum J, Jonathan B, Japeth H (2019). Structure and diversity of tree species at the college of forestry and fisheries, university of agriculture makurdi, benue State, Nigeria. *International Journal of Forestry and Horticulture*, 1: 20-27.
[29] Ayaji I, Kayode J, Ademiluyi B (2020). Study on urban trees in Ekiti State University, Ado Ekiti, Nigeria: 1. structure and composition. *Budapest International Research in Exact Sciences*, 2: 147-156.
[30] Bennett L (2017). Deforestation and climate change. *Climate Institute Publication, Washington DC*.
[31] Schwartz M (1997). Defining indigenous species: an introduction. In: Luken J.O., Thieret J.W. (eds) assessment and management of plant invasions. *Springer Series on Environmental Management. Springer, New York, NY*.
[32] Isik K (2011). Rare and endemic species: why are they prone to extinction. *Turkey Journal of Bot*any, 35: 411-417.
[33] Vitousek P, D'Antonio C, Loope L, Rejmanek M, Westbrooks R (1996). Introduced species: a significant component of human-caused global change. *New Zealand Journal of Ecology*, 21.
[34] Ricciardi A (2013). Invasive Species. Encyclopedia of sustainability science and technology. https://doi.org/10.1007/978-1-4614-5755-8_10.
[35] Fernando E, Co L, Lagunzad D, Gruezo W, Barcelona J, Madulid D, Lapis A, Texon G, Manila A, Zamora P (2008). Threatened plants of the Philippines: A preliminary assessment. *Asia life sciences*, 3: 1-5.
[36] Hilton-Taylor C (2000). 2000 IUCN red list of threatened species. *IUCN, Gland, Switzerland and Cambridge, UK*.
[37] Tobin P (2018). Managing invasive species. *F1000Research*, https://doi.org/10.12688/f1000research.15414.1.\
[38] Song Q, Wang B, Niu X (2016). Endangered and endemic species increase forest conservation values of species diversity based on the Shannon-Wiener index. *iForest - Biogeosciences and Forestry*, https://doi.org/10.3832/ifor1373-008.
[39] Coracero E, Malabrigo P (2020). Carbon storage potential of the tree species along the ultramafic forest in Sitio Dicasalarin, Barangay Zabali, Baler, Aurora, Philippines. *AIMS Environmental Science*, 6: 589-601.
[40] Gascon C, Brooks T, Contreras-MacBeath T, Heard N, Konstant W, Lamoreux J, Launay F, Maunder M, Mittermeier R, Molur S, Al Mubarak R, Parr M, Rhodin A, Rylands A, Soorae P, Sanderson J, Vié J (2015). The importance and benefits of species. *Current Biology*, 10: 431-438.