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## Coconut oil, conservation and the conscientious consumer

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No human activity has changed our world more than agriculture. Population growth and food, feed and biofuel requirements mean that crops and pasturelands now cover over 40% of the Earth's land [1] with negative impacts on our climate and biodiversity. Increasingly concerned consumers favor products with low environmental impacts. They are informed about products by producers, traders, governments and campaigning organizations—all having their own biases about impacts. The resulting narratives are often contradictory and confusing. We need transparent and objective measures that facilitate consumers to better weigh the consequences of their choices. Here we highlight the substantial environmental costs of the production of different vegetable oils to demonstrate biases in current perceptions, and to highlight the necessity and challenges of devising improved measures of impact.

We focus on vegetable oils because of the considerable societal debate about them. In these debates, oil palm *Elaeis guineensis* is especially highlighted as harmful [2], because it often replaces species-rich tropical forests [2]. Other oil crops such as rapeseed *Brassica* sp. or sunflower *Helianthus annuus* are grown primarily in temperate steppe and broadleaf forest biomes where the impacts provoke less concern [3]. Another tropical palm, the coconut *Cocos nucifera*, is often overlooked in environmental debates. Coconut is a popular product mostly used for oil, but also for copra, milk and water. A 2017 global survey found that 53% of consumers believe coconut oil has health benefits [4] and global media refer to a “coconut craze” [5]. Unlike oil palm, the impacts of coconut cultivation are, however, less often discussed, although this is changing.

Most of the global coconut cultivation (12.3 million ha, Data S1A) occurs in tropical island nations (Fig. 1), primarily in smallholdings under 4 ha [6]. In these island nations, species endemism and

richness typically exceed those of mainland nations by a factor of 9.5 and 8.1 for plants and vertebrates, respectively [7]. Most coconut growing countries were forested in the past, but in 2015 an average of just 11.2% of their land area remained under ‘primary’ forest (n=95, SD=17.7), with coconut expansion being the main driver of deforestation in some of them (Data S1A). The main biodiversity threats from coconut production stem from exacerbating the already high species extinction rates of unique communities. For example, coconut cultivation contributed to the extinction of the Solomon Islands’ Ontong Java flying fox *Pteropus howensis*, which has not been seen since 1945 but previously occurred on forested islands mostly converted to coconut [8]. The IUCN lists a further 66 species for which coconut production is among the main threats (Data S1B).

We used the number of threatened species per million tons of oil produced, to assess the environmental impacts from coconut and other oil crops. This measure indicated that coconut has greater relative impacts than, for example, oil palm (Figure 1, Table S1). If we consider impact by area rather than production—as is typically done—threatened species per hectare, oil palm (17 sp/mha) surpasses coconut (5.3 sp/mha) (Table S1).

Conservation narratives often focus on specific themes (e.g., tropical deforestation for oil palm or Amazonian cattle), but much goes unnoticed. For example, the olive *Olea europaea* harvest reportedly kills 2.6 million birds annually in Spanish Andalucía [9]. Olive production oil, however, rarely raises concerns among consumers and environmentalists. Conservation thus often appears to be impaired by shortsightedness and double standards, frequently driven by environmental campaign agendas. This is evident with respect to many crops sourced from the tropics [2]. Many

of us find it easier to see production impacts as something undesirable when happening far away, than near to home. Such biases are counterproductive to achieving conservation as it alienates potential allies and blinds us to opportunities [10].

Progress towards both the environmental and socio-economic objectives of sustainable development requires overcoming shortsightedness and double standards, and finding a much better understanding of the negative and positive impacts of all expanding crops. This demands an assessment of the opportunity costs of conservation (what could happen with land if it was not protected), and also of development (the cost of land being taken out of production and allocated to conservation). We should thus not only evaluate oil palm, coconut, soy and cattle production for their impacts in the tropics but similarly review land-uses and their products worldwide.

No single measure will be sufficient or perfect. In the measure we present (Figure 1), the IUCN coverage is incomplete for various taxonomic groups. It also focuses on what has happened in the past, rather than the marginal impacts of additional production, allocates all impacts to oil consumption, and cannot readily be applied to individual producers. Some oil crops, such as soy, olive and indeed coconut, are also used for purposes other than oil production, reaching different consumers. Furthermore, our measure relies on incomplete information about crop distribution, which remain poorly mapped at the global scale. Informed consumer choices require measures and standards that are equally applicable to producers in Borneo, Belgium and Barbados. These could build on the norms and criteria of good practice (e.g., Roundtables on Palm Oil and Soy), commitments from producers (e.g., “zero-deforestation”), and accessible datasets on global crop

coverage, landcover change and how production affects internationally agreed goals (e.g., Sustainable Development Goals or Convention on Biological Diversity).

It remains challenging to identify and weigh which species and environments have been or will be threatened by production of which products, and in which contexts, but such measures are needed. New measures can enable consumers to make better choices. While perfection may be unattainable, improvements over current practices are not.

### **Supplemental information**

Supplemental Information including methods, results and three tables can be found with this article online at <https://doi.org/XXX>.

**Declaration of Interest:** Authors declare no competing interests.

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**Author contributions:** E.M., D.S., and J.F.A. conceptualized this study and developed the initial manuscript, with D.J.B. and M.V. assisting in the acquisition, analysis, and interpretation of the data and further writing. J.F.A. and M.V. designed the graphics.

**Data and materials availability:** All data is available in the main text or the supplementary materials.

## Highlights

- Conscientious consumers seek sound guidance to reduce their impact.
- Coconut affects more species than other major oil crops per volume oil produced
- Our example of coconut oil shows the public discourse about crop impact is distorted.
- More transparent and objective measures of multiple concerns and impacts are needed.

**eTOC** Conscientious consumption of agricultural products is hindered by a lack of objective guidance and a distorted public discourse. Meijaard et al. use the environmental impacts of coconut production to illustrate the need for improved measures that facilitate fair and transparent comparisons among products.

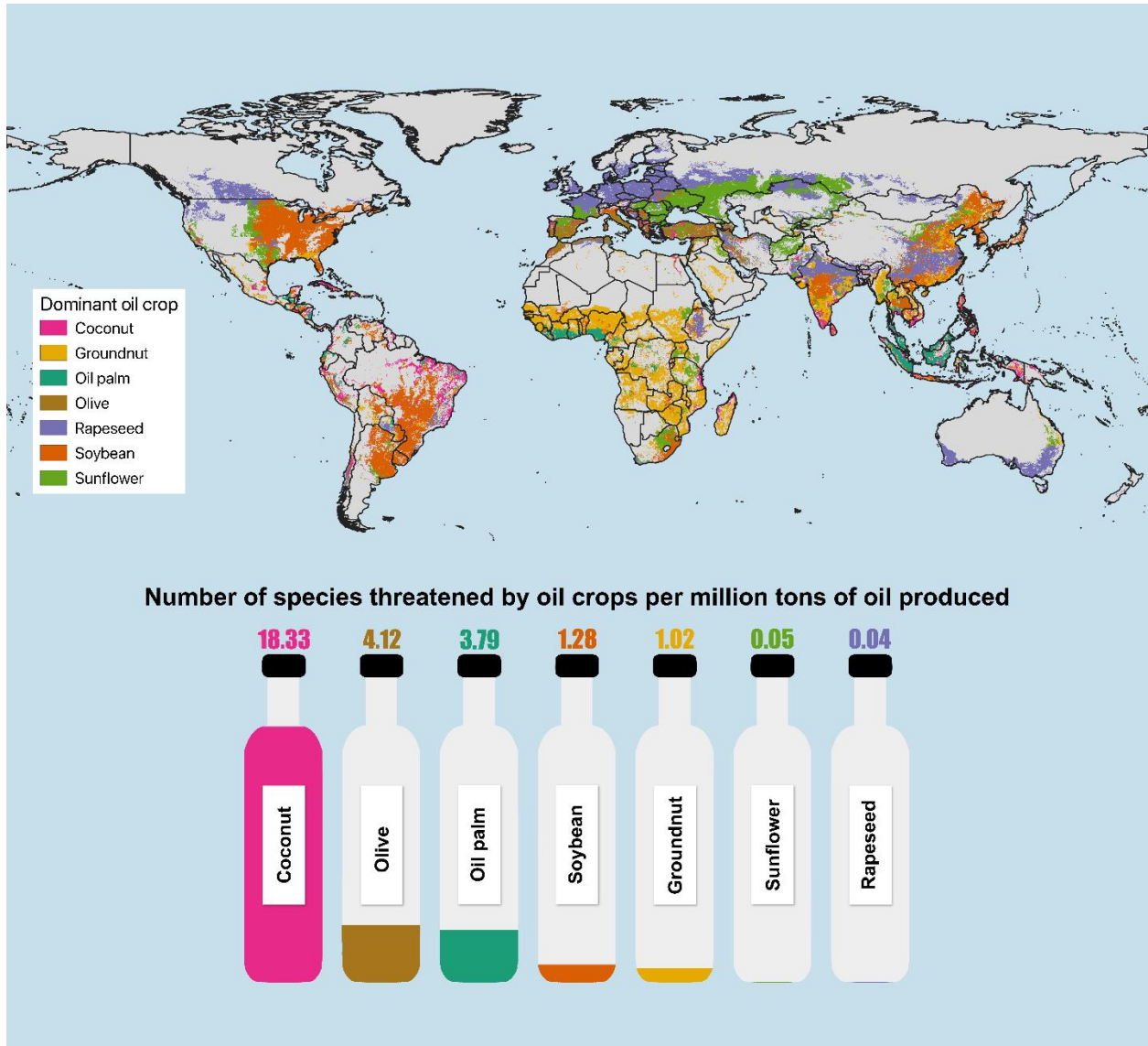
## Supplemental Materials

### **Data S1. Country-specific coconut production figures, land use, and impacts on species.**

A) Full list of countries with their 2017 coconut production volume and land area used for coconut production [S8], percentage primary forest cover [S9], and land area relative to the number of Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) plant and animal species per km<sup>2</sup> of land area of each country [S1] B) The species for which coconut production was identified in the IUCN Red List of Threatened Species to be an important threat. CR =



Critically Endangered, EN = Endangered, and VU = Vulnerable (S1). The final column summarizes key text in the species threats text that refer to coconut. Related to Figure 1.\



**Figure 1. Global map showing the dominant oil crops per grid-cell.**

The oil levels in the bottles represent the number of species threatened by each oil crop per million tons of oil produced (Table S1, for methods see Supplementary Materials). We note the threatened species coverage is incomplete for various taxonomic groups, such as invertebrates and plants.

