Inadequacies in establishing CITES trade bans

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is the principal mechanism for ensuring sustainability in the international trade of wildlife, including plant and animal specimens (both living and dead) as well as parts and derivatives thereof. Fifty-seven proposals have been submitted to amend the CITES appendices (which offer various levels of protection; www.cites.org/eng/app/index.php) at its eighteenth Conference of the Parties (CoP18; 23 May to 3 June 2019 in Colombo, Sri Lanka). Among these, 17 proposals aim to prohibit international commercial trade by including species in Appendix I, and involve taxa ranging from the riverside swallowtail butterfly (*Parides burchellanus*) to the African elephant (*Loxodonta africana*; Figure 1).

Listing species in Appendix I is intuitively positive for many actors, including some policy makers and conservation NGOs. Perceived benefits encompass increased conservation attention to species, funding opportunities, and stronger legislation and enforcement action. Many animal welfare organizations and other lobbying groups vociferously campaign for Appendix I listings and celebrate them as conservation victories (eg Humane Society International 2010).

Decisions to amend the appendices may take place without debate. In September 2016, at CoP17 in Johannesburg, South Africa, debate on listing proposals involving charismatic megafauna lasted several days, while decisions on 11 other proposals were made rapidly in 32 minutes toward the end of the final day. This meant there was very little time to discuss the merits of these proposals and one result was the immediate transfer of Cuban land snails (*Polymita* spp) from Appendix II to I without debate.

Despite celebration by some actors, listing species in Appendix I actually highlights conservation failure, indicating that a species is threatened with extinction and is negatively affected (actually or potentially) by trade. Currently, proponents of Appendix I listings must demonstrate only this threat; they do not have to produce an evidence-based assessment of the likely consequences of the listing. The effect of Appendix I listings is difficult to predict, cannot be assumed to be positive, and depends on how consumers and producers react. Examples of adverse impacts exist, such as price hikes leading to increased poaching and local extinctions (eg black rhinoceros *Diceros bicornis*; Leader-Williams 2003), while illegal trade may continue, sometimes at high levels, or even increase (UNODC 2016; Hinsley *et al*. 2018).

Figure 1. A proposal has been submitted to transfer populations of the African elephant (*Loxodonta africana*) from CITES Appendix II to I at CoP18.

Predicting and mitigating against unintended consequences requires an understanding of the social–ecological systems within which exploitation and consumption occur (Larrosa *et al*. 2016), and the economics of supply and demand (Hall *et al*. 2008). This includes the nature of the demand (eg price elasticity) and consumers (eg consumer preferences). A review of the 17 proposals mentioned above reveals that they failed to consider relevant markets in any detail, with one exception (the African elephant proposal). This is concerning because it implies that policy is being made without an evidence-based understanding of probable consequences. For example, where demand is inelastic (that is, the quantity of a product consumed changes little with a proportionate increase in price), prohibiting international trade may be ineffective because demand is likely to persist, incentivizing traders to supply markets illegally (Challender and MacMillan 2014). Behavior change campaigns to reduce demand could be implemented to coincide with bans, but currently there is weak evidence that demand reduction interventions for wildlife products are effective (Veríssimo and Wan 2018).

CITES listing decisions also fail to adequately consider the role of international trade in the local economies of source countries for traded wildlife, despite the requirement to do so (Res Conf 9.24, Rev CoP17). Twelve of the 17 proposals refer to local use and/or captive breeding of species but do not discuss the potential impacts of the proposals on local communities (eg loss of use, income, or livelihoods) or means of mitigation. This is despite some proposals emphasizing extensive local collection efforts (eg Indian star tortoise *Geochelone elegans*) and high incentives for collectors (eg black-lipped lizard *Calotes nigrilabris*). Even if there are no concerns about impacts on poor or marginalized people, understanding the response of harvesters is vital to predicting the likely effectiveness of the proposals. Moreover, of the 23 species subject to proposed Appendix I listings, and based on a review of the proposals, 17 do not have in situ management measures in place. Although each situation is context specific, a more appropriate first measure for these species could be the development of conservation programs in partnership with local communities, as opposed to the "blunt instrument" approach of an international trade ban.

While trade prohibitions have proven effective at reducing trade volumes for various species (Conrad 2012; Reino *et al*. 2017), difficulties in predicting their impacts complicate the application of the precautionary principle in CITES; it cannot be assumed that prohibiting international trade is the precautionary option (Cooney and Jepson 2006). Consequently, we argue that evaluation of CITES listing proposals should involve scenario analyses to explore feasible outcomes, explicitly considering market and socioeconomic factors, and highlighting areas of uncertainty.

The use of CITES Appendix I as a conservation tool will be most effective if proposals (1) are informed by knowledge of markets for the species and products concerned and socioeconomic factors associated with harvest and supply as well as biological and trade criteria, and (2) feature an evidence-based theory of change explaining how the listing decision is expected to contribute to improving the status of species. All Appendix I proposals should be given appropriate consideration in CITES meetings, so that Parties are confident that, if adopted, there is a high probability that they will be effective.

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Truffles on the move

Range shifts in the distribution of plant and animal species have been associated with climate change (Lenoir *et al.* 2008; Chen *et al.* 2011; Gottfried *et al.* 2012), and a temperature-induced northward movement of European fungal fruiting patterns has been evident since the mid-20th century (Kauserud *et al.* 2012; Boddy *et al.* 2014; Andrew *et al.* 2017). However, understanding the relationship between belowground processes and species occurrences, including the growth and abundance of hypogeous (underground) fungi, is still limited (Trappe and Claridge 2010).

Here, we report what we believe to be the first scientific discovery – detection, excavation, and identification – of Piedmont white truffles (*Tuber magnatum* Pico; hereafter PWT) north of the European Alps. Of the three main *Tuber* species, PWT is the most aromatic and valuable (Vita *et al.* 2018), often exceeding several thousand Euros per kilogram. Nevertheless, the life cycle of this ectomycorrhizal fungus remains enigmatic (Riccioni *et al.* 2016; Iotti *et al.* 2018). While the phylogeny of the genus *Tuber* indicates that the *magnatum* group belongs to the oldest lineage originating from an area that later became Europe (Jeandroz *et al.* 2008), Rubini *et al.* (2005) suggested that the geographic distribution of PWT tracks the postglacial expansion of its host plants (mostly hardwood trees such as oak [*Quercus* spp]) from a refugium in central Italy. Until now, observations of PWT fruiting have been restricted to a few natural habitats in northern Italy and parts of the Balkan Peninsula. Given that successful cultivation of PWTs has yet to be confirmed (Iotti *et al.* 2018), the iconic species seems particularly vulnerable to environmental changes, and predicted warming represents a substantial economic threat.

On different dates during six growing seasons between October 2012 and November 2018, 15 PWTs were detected by Giano, a trained truffle dog (breed name: Lagotto romagnolo), under a dominant beech (*Fagus sylvatica*) tree in the city of Geneva, Switzerland (Figure 1). No fruiting bodies were found in 2014. The spatial locations of the 15 PWTs – each weighing between 5 and 50 g – were mapped shortly after their excavation at soil depths from 8 to 40 cm; findings from a preliminary examination of spore size and fruiting body ornamentation were suggestive of *Tuber magnatum* (Figure 1). Subsequent laboratory analysis – including DNA extraction from samples of fresh gleba (spore-bearing tissue) of two PWTs from 2012 and 2018, as well as DNA sequencing of the fungal ITS region (internal transcribed spacer of the nuclear ribosomal DNA; Leuchtmann and Clémençon 2012) – revealed 100% accordance with *Tuber magnatum*. Genetic sequences have been deposited in the GenBank database (http://ncbi.nlm.nih.gov/genbank), which is hosted by the National Center for Biotechnology Information, under accession numbers MK5

