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COMMENTARY

Mapping illegal wildlife trade networks provides new opportunities for conservation actions

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Each year, millions of animals are captured, transported and sold – both legally and illegally. The overexploitation of commonly traded species is driving wild populations towards extinction, with consumer demand for rarer species resulting in a strengthening feedback loop between supply and demand (Tournan *et al*., 2012). The direct impact of the removal of traded species can also have indirect consequences on broader communities, such as when traded species also act as keystone species that underpin broader ecosystem functions (Broad, Mulliken & Roe, 2003; Marthy & Farine, 2018). Addressing the wildlife trade with conservation actions is extremely challenging. The trade of Red Siskin *Spinus cucullatus* exemplifies how many challenges are raised by the trade in even just a single species. However, by mapping the flow of this illegally traded endangered songbird, the study by Sanchez-Mercado *et al.* (2019) also reveals new opportunities to apply emerging techniques from the social network analysis toolbox that could help with directing novel conservation actions.

Sanchez-Mercado *et al.* (2019) combine on-the-ground interviews with online monitoring to identify those who are involved in the trade of Red Siskin, and apply social network analysis to identify the key actors in this trade. Their study reveals a trade network involving many types of people – including hobbyists, sustenance harvesters and professional traders – that together form a global network of trade. However, the primary focus of the study by Sanchez-Mercado *et al.* (2019) – to test whether the illegal bird trade coming from Venezuela is linked to more general illegal trade or remains more specialized – also sheds light on some potentially novel solutions. Their evidence for a specialized trade network structure, and their ability to identify the contribution of different parts of the trade network by following the flow of birds, suggests that there might be opportunities to apply knowledge from other disciplines to help develop new types of targeted interventions.

Recent developments in the study of human and animal social networks provide insights into possible conservation actions that could be directed at wildlife trade networks. For example, we now have a good understanding of how knowledge about novel information (Aplin *et al*., 2015) and imminent threats (Rosenthal *et al*., 2015) spread through animal social networks, and how social structure can lead to undemocratic outcomes in human social networks (Stewart *et al*., 2019). Such studies could provide the basis for identifying key points to infiltrate networks and establish targeted information campaigns. More direct conservation actions could involve the removal of a node, for example, via legal enforcement. Studies that have modelled the dynamics of social networks following the removal (Farine, 2019) and the introduction (Ilany & Akcay, 2016) of nodes in networks could help shed light on how wildlife trade networks might adapt to such interferences, and what factors make them resilient to the removal of key actors.

The quantitative data on the structure of a wildlife trade network provided by the study by Sanchez-Mercado *et al.* (2019) could also form the basis for researchers to study the emergence and maintenance of wildlife trade networks. Applying generative network models, such as stochastic actor-based models (Snijders, van de Bunt & Steglich, 2010), could deepen our understanding of the processes involved in the formation of trade networks. From such models, different types of interventions could be simulated, in much the same way as targeted vaccinations or culling programmes are simulated in other social networks. Sanchez-Mercado *et al.* (2019) identify one possible action – the engagement of Red Siskin breeders as a source of information for greater sustainable use of this endangered species. However, producing meaningful predictions of the efficacy of such an intervention and identifying the general applicability of different types of interventions across traded species require quantitative data from real wildlife trade networks. Sanchez-Mercado *et al.* (2019) showed that gaining the necessary information is possible by nurturing personal contacts in these networks, in their case through mutual contacts with harvesters of Red Siskin.

The wildlife trade is a widely pervasive and pressing conservation problem, and it can also pose a major risk to our own lives. Such threats are exemplified by several coronavirus and other major disease outbreaks over the past decades, as well the numerous cases of invasive species and spread of diseases that threaten food production systems. Addressing wildlife trade will, ultimately, require global action. In the meantime, by mapping the trade in one species – the Red Siskin – the results of Sanchez-Mercado *et al.* (2019) suggest that opportunities might exist to identify possible local interventions that could go some way to stemming the international flow of wildlife and their products.

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