

CONTRIBUTED PAPERS

Prevalence and perspectives of illegal trade in cacti and succulent plants in the collector community

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Abstract

Although illegal wildlife trade (IWT) represents a serious threat to biodiversity, research into the prevalence of illegal plant collection and trade remains scarce. Because cacti and succulents are heavily threatened by overcollection for often illegal, international ornamental trade, we surveyed 441 members of the cacti and succulent hobbyist collector community with a mixed quantitative and qualitative approach. We sought to understand collector perspectives on the Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES) and on the threats IWT poses to cactus and succulent conservation. Most respondents (74% of 401 respondents) stated that illegal collection in cacti and succulents represents a “very serious problem” and that the problem of wild plant collection is increasing (72% of 319 respondents). Most forms of illegal collection and trade were seen as very unacceptable by respondents. Self-reported non-compliance with CITES rules was uncommon (11.2% of 418 respondents); it remains a persistent problem in parts of the cacti and succulent hobbyist community. People engaging in rule breaking, such as transporting plants without required CITES documents, generally did so knowingly. Although 60.6% of 381 respondents regarded CITES as a very important tool for conservation, sentiment toward CITES and its efficacy in helping species conservation was mixed. Collectors in our survey saw themselves as potentially playing important roles in cactus and succulent conservation, but this potential resource remains largely untapped. Our results suggest the need for enhanced consultation with stakeholders in CITES decision-making. For challenging subjects like IWT, developing evidence-based responses demands deep interdisciplinary engagement, including assessing the conservation impact of species listings on CITES appendices.

KEYWORDS

CITES, collection, conservation social science, illegal behavior, illegal wildlife trade

Resumen

Aunque el mercado ilegal de especies (MIE) representa una amenaza seria para la biodiversidad, son escasas las investigaciones sobre la prevalencia del intercambio y la colecta ilegal de plantas. Ya que las cactáceas y suculentas están amenazadas seriamente por la sobrecolecta, generalmente para el mercado ornamental internacional e ilegal, encuestamos mediante una estrategia cualitativa y cuantitativa a 441 miembros de la comunidad de aficionados a coleccionar estas plantas. Buscamos entender las perspectivas que tienen los coleccionistas sobre la Convención sobre el Comercio Internacional de Fauna y Flora

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Silvestres (CITES) y sobre las amenazas que el MIE representa para la conservación de las cactáceas y las suculentas. La mayoría de los respondientes (74% de 401) mencionaron que la recolección ilegal de estas plantas representa un “problema muy serio” y que el problema de la recolección de plantas silvestres está en aumento (72% de 319 respondientes). Casi todas las formas de mercado y colecta ilegal fueron consideradas como inaceptables por los respondientes. El no cumplimiento autoreportado de las reglas de la CITES no fue recurrente (11.2% de 418 respondientes), pero permanece como un problema persistente en algunos sectores de la comunidad de aficionados a la colección de estas plantas. Las personas que rompieron las reglas, como con el transporte de plantas sin los documentos CITES requeridos, en su mayoría lo hicieron conscientemente. Aunque el 60.6% de los 381 respondientes consideraron la CITES como una herramienta muy importante para la conservación, los sentimientos hacia ella y su eficiencia en el apoyo a la conservación de especies fueron encontrados. Los coleccionistas de nuestra encuesta se reconocieron como actores potencialmente importantes en la conservación de las cactáceas y las suculentas, pero este recurso potencial permanece desaprovechado en su mayoría. Nuestros resultados sugieren que es necesaria una consulta reforzada con los actores en las decisiones de la CITES. Para temas exigentes como el MIE, el desarrollo de respuestas basadas en evidencias demanda una participación interdisciplinaria profunda, incluyendo la evaluación del impacto de conservación que tienen los listados de especies en los apéndices de CITES. Prevalencia y perspectivas del mercado ilegal de cactáceas y plantas suculentas en la comunidad de coleccionistas.

PALABRAS CLAVE

ciencias sociales de la conservación, CITES, colección, comportamiento ilegal, mercado ilegal de especies

【摘要】

虽然野生动植物非法贸易对生物多样性构成了严重威胁,但对植物非法采集与贸易普遍性的研究仍然很缺乏。由于仙人掌和多肉植物受到了过度采集的严重威胁,且通常是由于观赏目的的非法国际贸易,因此,本研究利用定量和定性混合方法调查了441名仙人掌和多肉植物爱好者收藏家社群的成员。我们试图了解收藏者对《濒危野生动植物种国际贸易公约》(CITES)的看法,以及野生动植物非法贸易对仙人掌和多肉植物保护构成的威胁。大多数受访者(401名受访者中的74%)表示,非法采集仙人掌和多肉植物是一个“非常严重的问题”,且野生植物采集的问题正日益严峻(319名受访者中的72%)。大多数形式的非法采集和贸易都被受访者认为是非常不可接受的。自我报告的违反CITES条例的情况并不常见(418名受访者中的11.2%),但仍是仙人掌和多肉植物爱好者群体中持续存在的问题。违反条例的人一般都是在知情的情况下进行操作的,例如在不具备必需的CITES文件的情况下运输植物。尽管381名受访者中有60.6%认为CITES是一项非常重要的保护工具,但人们对CITES及其在帮助物种保护方面有效性的看法却十分复杂。在我们的调查中,采集者认为他们在仙人掌和多肉植物的保护中可能发挥着重要作用,但这种潜在资源在很大程度上还没有被开发。我们的结果表明,在CITES决策中需要加强与利益相关者的协商。对于像野生动植物非法贸易这样具有挑战性的问题,制定以证据为基础的对策需要深入的跨学科交流,包括评估列入CITES附录对物种保护的影响。【翻译:胡怡思,审校:聂永刚】

关键词: 非法野生动物贸易, CITES, 非法行为, 保护社会科学, 收集

INTRODUCTION

Illegal wildlife trade (IWT) represents a significant driver of biodiversity declines worldwide, and wealthy countries in the Global North represent major consumers of wildlife products (Duffy, 2022; t' Sas-Rolfes et al., 2019). Illegal trade in plants makes up a major proportion of global IWT by volume and

economic value, with plants representing 14.3% of all wildlife seizure incidents in the UN Office on Drugs and Crime World WISE Database (UNODC, 2020). Illegal trade affects a great variety of endangered plant species (Margulies et al., 2019). Accordingly, plants comprise 85% of all species listed on the appendices of the Convention on International Trade of Endangered Species in Wild Fauna and Flora (CITES) (CITES, 2022).

Among plant species traded internationally for ornamental collection, cacti and succulents are some of the most heavily threatened by overcollection, much of which is illegal (Goettsch et al., 2015). The entire Cactaceae family and seeds of all Mexican species are listed on CITES Appendix *SII*; 32 species and 6 genera were listed on Appendix *SI* at the time of publication. For some rare species of cacti, collection pressure can be so great that they are critically threatened with extinction in the wild (IUCN, 2022; Sajeve et al., 2007). The Global Cactus Assessment for the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species (IUCN Red List) found that 31% of species are threatened with extinction, and 47% are affected by harvesting for horticulture and private ornamental collections (Goettsch et al., 2015). Other succulents, such as conophytum, lithops, and cycads, are also at great risk from illegal trade. Accordingly, cycads are considered the most endangered taxonomic group on the planet (Brummitt et al., 2015; Cousins & Witkowski, 2017). As of 2022, 97% of 111 assessed species of *Conophytum* were categorized as threatened and 45% were assessed as critically endangered on the red list; a primary driver of these declines is poaching for the international ornamental market (IUCN, 2022).

Interdisciplinary research combining biodiversity conservation, human geography, criminology, and the wider social sciences is needed to assess the scope, severity, and spatial structure of illegal plant trades and how illicit supply chains and their financing operate (Magliocca et al., 2021; Novoa et al., 2017; Whitehead et al., 2021). This includes using mixed-method research approaches combining qualitative and quantitative methods to characterize actor behavior and perspectives, as well as severity of conservation threats. Qualitative research on illegal plant trades drawing on the fields of human geography and anthropology can reveal specific motivations of those engaged in illegal collection and trade, as well as what drives consumer demand for species (Margulies, 2020). Explicitly spatial studies of plant poaching can determine geographic hotspots of illegal plant harvesting and help agencies better respond to criminal activity (Kurland et al., 2018). Conservation studies of illegal horticultural trade characterize the scale and scope of threats and their significance for conservation outcomes (Hinsley et al., 2018; Novoa et al., 2017). Finally, criminological studies detail, for instance, the organizational characteristics and supply chain connections of illegal plant trades (Lavorgna & Sajeve, 2021; Lavorgna et al., 2020) and the platforms that enable those trades (Perdue, 2021). In this context, data needed to inform evidence-based responses to IWT are missing on the actors involved in illegal plant trade, trade financing, actor's general understanding of international trade regulations, their awareness of the illegality of their actions, and justifications for their illegal activities (UNODC, 2020).

Cactus and succulent collecting today is a global phenomenon. In Europe and North America, large collector communities are organized through formal associations like the Cactus and Succulent Society of America (CSSA) or the British Cactus and Succulent Society (BCSS). Collectors are passionate about plants, but this passion can lead to engagement in illicit (as pertains to social norms) and illegal (as pertains

to the law) behavior to obtain desirable species (Magliocca et al., 2021). Although such societies express clear conservation goals, instances of even well-respected leaders within these societies engaging in illegal activities indicate conflicts persist within collector communities over the importance of obeying international trade conventions (e.g., Jordaan, 2021). This suggests perspectives on illicit versus illegal behaviors in collector communities are worthy of investigation (i.e., whether collectors understand what constitutes illegal vs. legal behavior and whether those activities align with perceived social norms of acceptability). We sought to investigate the prevalence of illegal and illicit behaviors related to collection and trade of cacti and succulent plants within collector hobbyist communities and collector perspectives on such behaviors and to consider the potential role of collectors in protecting these species.

Our specific objectives were to establish collector perspectives first on illicit and illegal activities and the general threat posed by IWT to cactus and succulent conservation. Our second objective was to investigate the general familiarity with and perspectives on CITES regulations as the main framework governing the trade in endangered flora, not least to obtain a better understanding of why adherence to international trade regulations may not be consistent or legitimized within collector communities. Our third objective was to determine the views of the collector communities regarding how these plant species can best be protected and what role the community might play in these activities. We therefore contextualized illegal behaviors within collector communities and considered interventions and outline opportunities to improve conservation outcomes.

METHODS

Survey design and dissemination

From 20 February to 20 May 2020, we conducted an online survey through Qualtrics (Qualtrics, Provo, Utah [<https://www.qualtrics.com>]) of cactus and succulent collector communities in accordance with Institutional Review Board approvals from the University of Alabama (under protocol 19-10-2891). The survey was composed of 48 multiple-choice and open questions and was designed for use on multiple devices (Appendix *S1*). Because online survey respondents are self-selecting and must have internet access, online survey samples might not represent the wider collecting community. However, we used this approach because anonymous online surveys provide extra protection for respondents and have been used successfully in studies of illegal behavior among horticultural collectors (Hinsley et al., 2017). Furthermore, the collecting community is widely dispersed, making face-to-face surveys difficult to implement at this scale (Wardropper et al., 2021). Rather than an indiscriminate online sampling, which can lead to problems associated with bogus answers and participation by nontarget populations, we targeted formal U.S. and U.K. collector associations recognized as trade hubs and centers of demand (Arroyo-Quiroz & Wyatt, 2019). Their executive leadership and individual chapter leaders were used as gatekeepers. In

response to wide interest from continental Europe, and given the popularity and historical importance of cactus and succulent collecting in German- and Czech-speaking countries (Robbins, 2003), we made corresponding survey translations available from 1 April to 20 May 2020.

Data collection

We received 464 responses. Excluding incomplete ($n = 20$) surveys and surveys from participants under the age of 18 ($n = 1$) and those not assenting to participation ($n = 1$) or not currently growing any cacti or succulents ($n = 1$), the remaining 441 survey responses were included in all analyses unless otherwise stated.

Qualitative data analyses

We used qualitative data analysis (QDA) to meet our research objectives. Such analyses of stakeholder perceptions, opinions, and perspectives on conservation policy and management efforts are increasingly recognized as vital to improving the conservation social sciences and practical conservation outcomes (Bennett, 2016; Bennett et al., 2017). We employed QDA to analyze the open-text responses to 2 optional questions: “Would you like to share any personal opinions about the effectiveness or role of CITES in protecting endangered or threatened cactus and succulent plants, or how it might be improved?” ($n = 135$ responses) and “Based on your personal experiences, would you prefer all cactus and succulent species be removed from CITES listing?” ($n = 119$). Because responses to both included comments with overlapping and adjacent themes, we analyzed them jointly to better reflect individuals’ holistic opinions in a single text data set combining all 211 responses that referenced CITES, trade, or conservation of cactus and succulent plants.

Manual sentiment analyses

We conducted manual sentiment analyses of open-text responses focusing on the tone of responses in relation to CITES, coding responses as negative (-1); neutral, no tone, ambiguous, or mixed (0); or positive ($+1$) following the sentiment analysis method described by Feldman (2013). Sentiment analysis is instructive for broadly determining respondent’s general sentiments toward a particular issue. Each person’s responses to the 2 open-text questions were merged into 1 response to obtain the proportional sentiment of respondents. We included only the 125 statements containing a specific opinion about CITES or international trade regulations.

Conservatively, only statements by respondents suggesting that CITES was ineffective at stopping illegal trade or unsuccessfully supported plant conservation were coded as negative. J.M. and F.M. coded 20% of the sample ($n = 26$). We tested intercoder reliability (ICR) of the samples based on Krippendorff’s Alpha (KALPHA) with the KALPHA macro in SPSS27

(De Swert, 2012; Hayes & Krippendorff, 2007; Krippendorff, 2011). Because the resulting ICR score ($\kappa = 0.88$, $n = 26$) was above the accepted 0.80 threshold (De Swert, 2012), F.M. coded all remaining responses.

Inductive thematic coding

We conducted content analyses of open-text responses with an inductive thematic coding process similar to Massé and Margulies (2020) to interrogate collectors’ thoughts regarding CITES ($n = 86$) and cactus and succulent conservation and trade ($n = 127$). An inductive coding approach allows thematic codes to emerge through the data rather than through pre-defined categories (Corbin & Strauss, 2008). To explore the overall diversity of opinions, we did not merge any statements unless an individual repeated the same statement in 2 open-text responses. We developed 2 separate code books (Tables 1 & 2): one responding to the question, “Why is CITES ineffective in protecting endangered or threatened cactus and succulent plants?” and the second to the question, “What are the opportunities for improving the management of cactus and succulent conservation and trade?” These were not questions participants were asked directly; instead, they were developed post hoc in response to the data to structure our thematic coding analyses.

To generate code books, J.M., F.M., and A.M. separately developed coding categories for a 10% sample from each data set. Codes and their definitions were discussed and refined in additional rounds of coding until thematic saturation was reached (Charmaz, 2006). Coding of open-text responses aimed to preserve the complexity and layers of meaning embedded in responses, which required permitting statements to receive multiple codes. This made the traditional use of KALPHA inappropriate (De Swert, 2012; Hayes & Krippendorff, 2007). Thus, we used R code produced by Wilckens (2021) to calculate the recently developed multivalued coding statistic α (KALPHA-multi) (Krippendorff, 2021) to assess ICR.

Two authors coded $\sim 20\%$ of samples from both data sets to test ICR with α (Krippendorff, 2021). This produced a multivalued ICR score above the 0.70 minimum threshold recommended by Krippendorff (2021) for both databases on CITES effectiveness (Table 1) ($\alpha = 0.81$, $n = 17$) and on improving conservation outcomes (Table 2) ($\alpha = 0.76$, $n = 23$). F.M. then coded all remaining responses. To our knowledge, this is the first application of α for QDA in the conservation social sciences.

Direct and indirect questions about CITES noncompliance

We asked respondents direct questions about their involvement in 3 behaviors that are illegal without appropriate CITES paperwork: personally transporting plants across international borders, shipping (e.g., mailing) plants across international borders, and buying wild-collected plants. In line with previous studies investigating IWT (e.g., Hinsley et al., 2016), we then

TABLE 1 Codebook developed to categorize themes in cactus and succulent collector responses ($n = 86$) to a survey on cactus and succulent trade regulation, conservation, and illegal wildlife trade framed through the question: “Why is CITES ineffective in protecting endangered or threatened cactus and succulent plants?”

Code and response frequency (n)	Definition	Example quotation
1. Lack of knowledge (5)	Refer to a deficit of knowledge, lack of education, or limited access to information regarding CITES regulations specifically, as well as pertaining cactus and succulent conservation and ethical plant sourcing more broadly.	“My understanding is that most (if not all) of the plant import inspectors in the United Kingdom do not understand and fail to correctly identify cactus and succulents.”—Respondent 110
2. Does not address other primary threats to species loss (29)	Suggest CITES overemphasizes international trade as a threat to species and thus does not sufficiently address other drivers that threaten the sustainability of cactus and succulent species in the wild. May indicate that they think other threats are more important. The threat of (legal) habitat loss due to development is a common example.	“Far more damage is done by farming, goats, habitat loss by industrial and commercial development, the local population, and government indifference to their own flora and fauna.”—Respondent 137
3. Poorly administered (13)	Alluding to bureaucracy or red tape hindering CITES effectiveness. This also includes responses that refer to CITES being out-of-date or too complex. May refer to the ineffectiveness of the administration/administrators of CITES indirectly. For example, by critiquing the influence/actions of national governments (e.g., greenwashing) or the role of public servants.	“CITES is not up to date and needs to be modernized to recognize the legal propagation of many species.”—Respondent 100
4. Insufficient deterrence and enforcement mechanisms (26)	Suggest that CITES does not make wild collecting or other illegal or sensitive behaviors risky/unprofitable enough. May state specific reasons for this ineffectiveness at preventing/detering poaching and illegal trade. Examples may include a lack of sufficiently harsh penalties for perpetrators, poor enforcement/policing, or limited attempts to lower demand. Responses may refer to variability in the successful implementation of CITES globally suggesting that some actors are able to get round the rules, that is, because of corruption or bribery.	“There are many cases I know of that CITES [sic] is not properly enforced and it is not protecting the species it aims to. I have heard very few cases when law enforcement has stopped wild collecting of CITES plants.”—Respondent 403
5. Restrictions hindering legal trade and conservation (43)	Indicating that CITES restrictions negatively affect or insufficiently facilitate legal/sustainable trade or conservation of seeds and plants. May suggest that CITES encourages illegal collection and trade by stimulating a demand for illegal products by highlighting rare and endangered species, or insufficiently addressing demand through inappropriate trade restrictions.	“Wild plants that are endangered should remain on the CITES list; however, by including cultivated plants, the value of those plants skyrockets, which gives people with criminal intentions an incentive to poach them.”—Respondent 55
6. Other (4)	Do not fall under the above categories and not widespread enough to warrant a separate code.	“Of the many commercial nurseries in Europe very few are registered with CITES and as a consequence from my understanding very few CITES certificates are being sent with plants purchased.”—Respondent 19

applied unmatched count technique (UCT) questions to ask about participation in the 2 most active of these behaviors (shipping and transporting). A UCT aims to encourage truthful reporting of behaviors by obtaining sensitive information indirectly as a proportion of the sample reflecting prevalence of a specific behavior, making it usually impossible to link answers to specific individuals (Hinsley et al., 2019). We randomly assigned each respondent a list of either control or treatment statements. The control list contained 4 nonsensitive statements, (e.g., “I have traveled to 2 or more foreign countries to see cactus or succulent plants in habitat.”), and the treatment list included an additional sensitive statement (“I have personally sent or carried a cactus or succulent across an international border without obtaining required CITES paperwork [this includes Mexican cactus seeds].”).

The prevalence estimate for the UCT was calculated using the combinedListDirect function in the R package list (Blair & Imai, 2010) for specific questions corresponding to the UCT (i.e., a combination of the shipping and transporting direct questions). A more robust prevalence estimate was then calculated by combining answers from both methods (Aronow et al., 2015). No control for covariates was implemented because nonresponse on some demographic questions would have pushed the sample size too low. The combined analysis included 2 placebo tests to test for false-positive confessions in the direct questions and false-negative UCT answers (Aronow et al., 2015). No design effects were identified in either test (placebo test one: $p = 0.7$; placebo test 2: $p = 0.06$). As an indirect question, UCT estimates often have large standard errors, so we estimated significance at both 90% and 95% confidence levels.

TABLE 2 Codebook developed to categorize themes within cactus and succulent collector responses to a survey on cactus and succulent trade regulation, conservation, and illegal wildlife trade framed through the question: “What are the opportunities for improving the management of cactus and succulent conservation and trade?”

Code and response frequency (n)	Definition	Examples quotation
1. Education (25)	Advocate for education or information dissemination initiatives pertaining to CITES and the wider conservation of cactus and succulent species. Responses may include specific examples of knowledge building for targeted groups. Wider statements about knowledge and education are included. For instance, those that promote the clarification of CITES rules in general.	“I think it plays an important role, but more could be done to educate people about endangered species and the role of CITES and how to find out the rules etc. Also how to know if you are purchasing plants or seeds that could be wild collected.”—Respondent 58
2. Support ethical suppliers or traders (6)	Suggest improvements that help to promote or make ethical suppliers’ and traders’ practices easier. For example, through the creation of a trusted trader scheme. It also includes responses with suggestions to increase the number of nurseries that are CITES certified.	“I don’t know if a ‘trusted trader’ scheme could be introduced for nurseries which could be certified as not being involved in the harvesting of wild plants.”—Respondent 50
3. Need for more exceptions or exemptions (64)	State support for increasing the number of exceptions or exemptions in CITES regulations. These responses may refer to loosening regulations in general or specifically state a restriction that they believe should not exist. Frequently proposed exemptions relate to hybrids or cultivars, seed, propagated material, researchers/experts, nonendangered species, and plant rescue operations.	“All seeds produced in cultivation by an ethical grower or collected from habitat plants from Appendix SII should be traded freely. Growing from seeds is a practical conservation activity and does not appeal to the criminal plant smuggler because it is a lot of trouble for little financial reward”—Respondent 16
4. Promote or facilitate propagation (45)	Do not just want to allow the trade in propagated or cultivated wild plants through CITES (see code 3) but suggest that propagation should be actively promoted/facilitated. Examples include creating official breeding programs for endangered species or propagation to enable reintroductions. It will often be inferred that this improvement will help to lower demand for wild plants. Different methods of propagation may be mentioned including grafting, micropropagation and tissue culture, cuttings, or from seed.	“CITES could initiate a propagation program in the home countries of the plant with an online store to sell the propagated plants all over the world in the name of CITES. The profit could be used to support the protection of the habitats in the home countries of the plants.”—Respondent 117
5. Administrative restructuring of CITES (10)	Desire changes to how CITES is fundamentally administered. Examples may focus on reducing bureaucracy or red tape within CITES. More specific examples may refer to changing the financial costs associated with the current system or making it easier to get permits. More drastic proposals may suggest getting rid of CITES completely.	CITES needs to be made easier to access and use.”—Respondent 179
6. Greater collaboration (8)	Want increasing collaboration between relevant actors interested in the conservation of cactus and succulent plants. This could include greater collaboration between CITES and related conservation organizations, as well as collectors/hobbyists. Collaboration may be alluded to broadly or be discussed in terms of specific projects and practices that actors could work together or support; for example, CITES supporting plant rescue operations by hobbyists.	“It might be improved by actual cooperation between CITES and organizations/clubs governing cacti and succulent growers. There are many people who would be interested in making sure threatened plants still exist even if their habitat is destroyed.”—Respondent 86
7. Enhanced enforcement and regulations (22)	These responses want CITES to be more rigorously regulated and for in situ protection of cactus and succulent species to be improved. This could therefore refer to greater penalties for lawbreakers and increasing enforcement and policing capabilities. Other responses may advocate for more species to be listed on appendices.	“More significant penalties for poachers of plants, including jail time.”—Respondent 146
8. Other (11)	Responses that do not fall under the above categories but are not widespread enough to warrant a separate code.	“Much more monitoring is needed to assess the status of natural populations and possible declines due to international trade.”—Respondent 445

Because UCT prevalence estimates did not differ significantly from 0 at both 90% and 95% CIs, no further analyses were conducted on these data. Instead, we fitted model-averaged logistic regressions separately for the 3 separate direct questions about CITES noncompliance with the R package MuMIn (Bartón, 2020), with models with a $\Delta\text{AIC} < 4$ included in the final averaged models. To investigate characteristics associated with noncompliance, we included independent variables based on our knowledge of the market and the literature around IWT: gender, age, highest education level, collector type (amateur, serious hobbyist, professional), and a knowledge score combining the answers to 3 questions about self-reported awareness of CITES regulations (justification of inclusion for all covariates in Appendix S2).

RESULTS

Survey respondent characteristics

It took respondents a median time of 11.4 min to complete the survey. The majority of respondents described themselves as male (62%, $n = 437$), White (86%, $n = 432$), mature (72% >53 years of age, $n = 409$), and formally educated (67% earned a Bachelor's degree or above, $n = 439$) (Appendix S3). Responses came from 24 countries. Forty-four percent of respondents lived in the United States and 37% in the United Kingdom ($n = 439$). Roughly the same number of respondents kept plants in a collection and visited them in their habitat versus only keeping plants in a collection (45% and 50%, $n = 435$). Similarly, there was an even distribution between collectors who described themselves as more serious collectors whose primary hobby was collecting succulents (42%) compared with those who described the hobby as one of many they enjoyed (46%, $n = 435$). This is in contrast to the 8% of collectors who also responded that they worked professionally in the hobby (e.g., as a nursery grower). The majority (95%, $n = 436$) of survey respondents reported being members of a formal cactus and succulent society.

Collector perspectives on CITES rules and regulations

More than half (59%) of respondents ($n = 425$) were aware that the international transport of cactus plants requires CITES documents (Figure 1). Fewer were aware that other kinds of succulents (*Aloe*, *Pachypodium*, *Euphorbia*) require CITES paperwork too (<37%). Half of respondents (50.8%) were aware Mexican cactus seeds required CITES export permits for international transport or shipping.

Sentiment analysis suggests a predominance of negative and mixed sentiments toward CITES compared with positive sentiments (Table 3); 39% of responses specifically related to CITES or international trade regulations coded as negative and 45% as neutral, ambiguous, or mixed ($n = 125$). In contrast, responses to Likert-scale questions about CITES were positive; most respondents called CITES a “very impor-

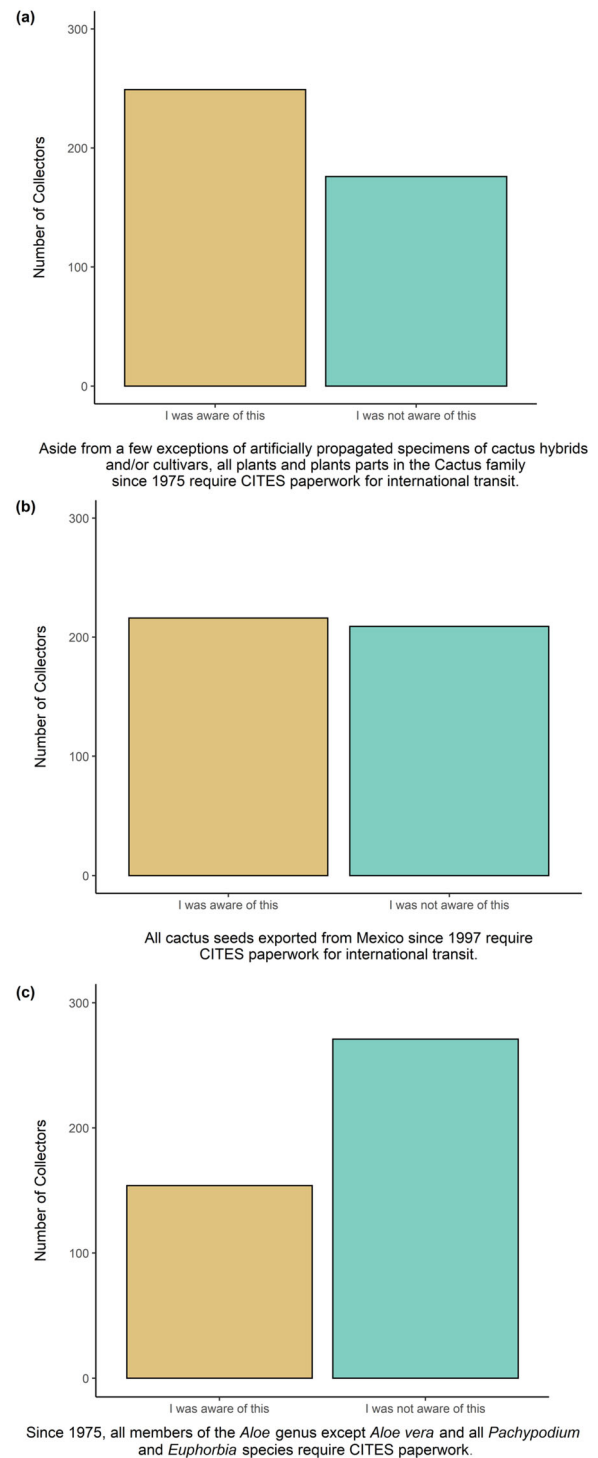


FIGURE 1 Awareness of surveyed ($n = 441$) cactus and succulent collectors of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) rules and regulations in relation to international trade in (a) cactus plants, (b) Mexican cactus seeds, and (c) other succulents

tant tool” (60.6%) or “somewhat important tool” (26.5%) for conserving cacti and succulents (Figure 2, $n = 381$). Similarly, 72% of respondents answered that CITES either “somewhat helps” or “helps a lot” in reducing illegal cactus and succulent trade ($n = 295$). These percentages excluded

TABLE 3 Summary results for sentiment analysis of cactus and succulent collectors' open-text responses related to CITES and CITES trade regulations in a survey on cactus and succulent trade regulation, conservation, and illegal wildlife trade ($n = 125$)

Code	Examples
-1: negative sentiment (49)	<p>"Cites in the main guarantees extinction"—Respondent 435</p> <p>"Unfortunately CITES is an administration with little to no knowledge behind it."—Respondent 111</p> <p>"The real problem is that CITES misses the point."—Respondent 337</p>
0: neutral, no tone or ambiguous or mixed sentiment (56)	<p>"I fully support CITES. However, by so stringently limiting international trade there is a lost opportunity to spread a species around the world which would ensure their future survival."—Respondent 232</p> <p>"CITES is great but it has many loopholes."—Respondent 313</p> <p>"CITES has good intentions, but it needs major revision."—respondent 403</p>
+1: positive sentiment (20)	<p>"I feel the CITES works really well in protecting and preserving all plants in the wild for future generations to enjoy and the well-being of the plants themselves."—Respondent 141</p> <p>"I think CITES is a valuable resource in preventing poaching."—Respondent 401</p>

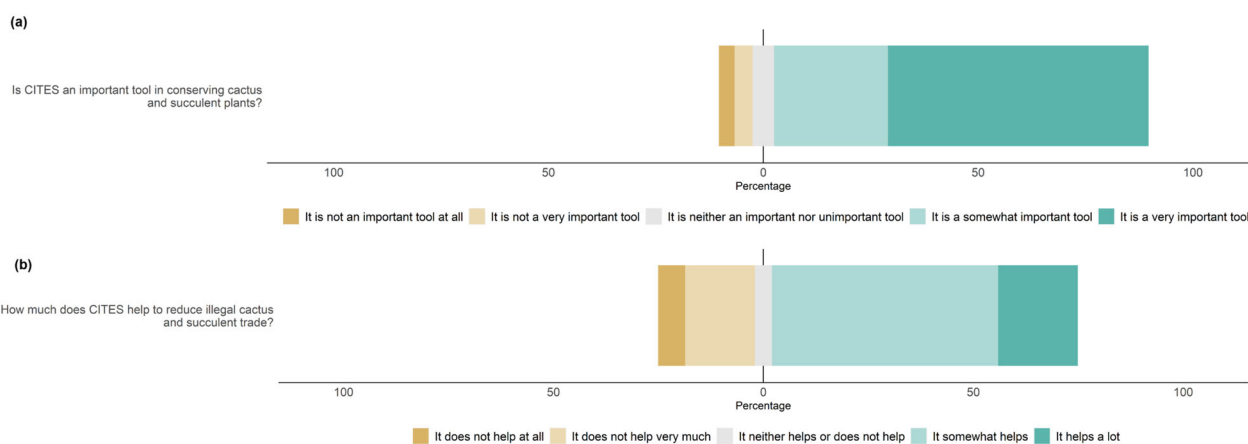


FIGURE 2 Cactus and succulent collector responses to survey questions on importance of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for conserving cactus and succulent plants ($n = 431$) and role of CITES in reducing illegal cactus and succulent trade ($n = 295$). Variations in sample size from the total survey data set ($n = 441$) relate to respondents who selected unsure as their answer, which is not considered a neutral response.

respondents answering “unsure,” which represents a nonneutral response.

The strongly negative opinions and perspectives about CITES were well characterized by respondent 16, who collected cacti consistently since childhood and identified it as his primary and serious hobby:

There is ample evidence that stripping habitats still happens in spite of CITES which is a bureaucratic failure when it comes to cacti. It should be easy to register as an ethical grower, producing artificially propagated plants from seeds and cuttings which can then be shipped anywhere without expensive paperwork. All seeds produced in cultivation by an ethical grower or collected from habitat plants from Appendix SII should be traded freely. Growing from seeds is a practical conservation activity and does not appeal to the criminal plant smuggler because it is a lot of trouble for little financial reward. CITES does not stop the commercial ille-

gal collecting of habitat plants for financial gain, especially involving the Far East.... It makes the harmless international trade in small quantities of nursery grown plants impossible to do legally, so encouraging smuggling which is then not monitored, resulting in habitat collected plants being traded (70, British, white, male).

Respondent 16's perspectives were shared by numerous collectors in their free-text responses (Tables 1 & 2). Respondent 16's opinions reflected Table 1's theme related to CITES hindering legal trades (code 5) and Table 2's theme regarding need for more exceptions and exemptions (code 3), both of which were the most frequently coded themes.

The most common concerns expressed by survey respondents regarding CITES effectiveness (Table 1) involved restrictions hindering legal trade and species conservation ($n = 43$); CITES not addressing other primary threats to species loss ($n = 29$); and CITES being an insufficient deterrence and enforcement mechanism ($n = 26$). Respondent 414, who also

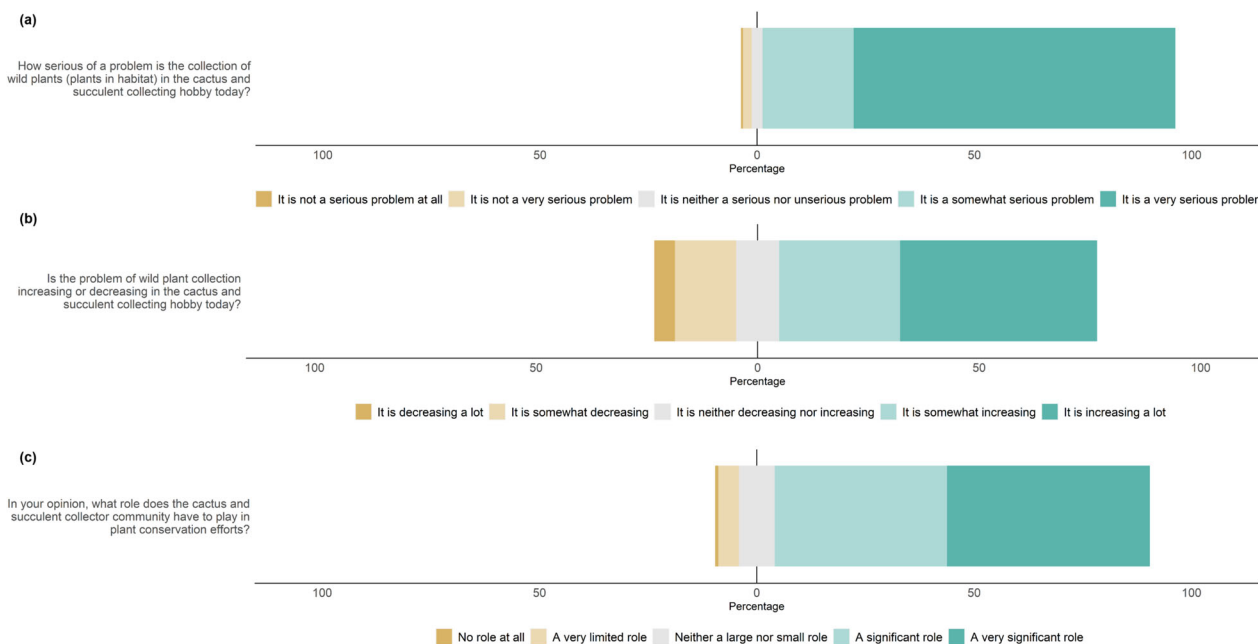


FIGURE 3 Cactus and succulent collector survey responses regarding (a) the severity of the problem of illegal wildlife trade within the cactus and succulent hobby ($n = 401$), (b) the degree to which the problem of illegal wildlife trade is increasing or decreasing in the hobby ($n = 319$), and (c) to what degree the collector community has a role to play in plant conservation efforts ($n = 401$). Variations in sample size from the total survey data set ($n = 441$) relate to respondents who selected unsure as their answer, which is not considered a neutral response.

agreed CITES was a “very important” tool for conservation, wrote: “Propagation of rare species should be promoted much more than now, this will stop the illegal collecting of plants in the wild. If you can buy such a plant legally, you will not buy it illegally” (68, Belgian, white, male). Poor administration ($n = 13$) and lack of collector knowledge about CITES ($n = 5$) were 2 other emergent codes.

Concerns about illegal trade and acceptability within collector communities

Despite concerns about CITES ineffectiveness (Table 1), most survey respondents recognized the wild collection of cacti and succulent plants was a “very serious problem” (74%, $n = 401$) and the problem of wild plant collection was increasing (71%, $n = 319$) (Figure 3). Most forms of wild collection were considered “very unacceptable” by respondents, regardless of whether the plants were considered threatened or not (Figure 4). Collectors did express that collecting wild seeds (43%, $n = 399$) was more acceptable than wild plants (8.5%, $n = 401$).

Our grouped direct question on illegal behavior (shipping or transporting plants or Mexican cactus seeds without paperwork) gave a prevalence estimate of 11.2% (SE 1.5, 95% confidence interval [CI]: 8.2 to 14.3) of respondents ($n = 418$), which was not significantly different from the UCT estimate of 12.4% (SE 10.7) at either 90% CI (−5.3 to 30.1) or 95% CI (−8.7 to 33.4). The combined analysis estimate was slightly higher, at 19.3% (SE 10.1, 90% CI: 2.7 to 35.9 and 95% CI: −0.5 to 39.1). With both the UCT and combined estimates resulting

in 95% CIs overlapping 0, we focused on the direct question estimates for the remainder of our analyses (Appendices S4 & S5).

When the direct questions were analyzed separately, 5.3% of 418 respondents ($n = 22$) reported having bought a plant without paperwork (13.2% [$n = 55$] selected maybe/unsure), 8.6% ($n = 36$) had transported a plant without paperwork (maybe/unsure 3.6%, $n = 15$), and 5.0% ($n = 21$) had shipped a plant without paperwork (maybe/unsure 1.9%, $n = 8$). Our multivariate analysis sample was smaller ($n = 385$) due to non-response to some demographic questions (e.g., age) or removal of response categories with very small numbers of responses (e.g., 6 people who answered “prefer not to say” for gender). People who reported different types of CITES noncompliance had different characteristics (Table 4). Younger people and men were more likely to report buying a plant without the required paperwork. Older people, professional growers, and respondents with higher self-reported CITES knowledge were more likely to report personally transporting a plant across an international border without paperwork. Finally, men and professional growers were more likely to report shipping a plant across an international border without paperwork. Men and serious hobbyists were more likely to personally transport a plant across an international border, whereas those with more CITES awareness were more likely to ship a plant internationally without paperwork (Table 4).

The majority of survey respondents (85%, $n = 441$) reported they saw the cactus and succulent collector community having “a significant role” or “a very significant role” in plant conservation efforts (Figure 3). Respondent 1 wrote:

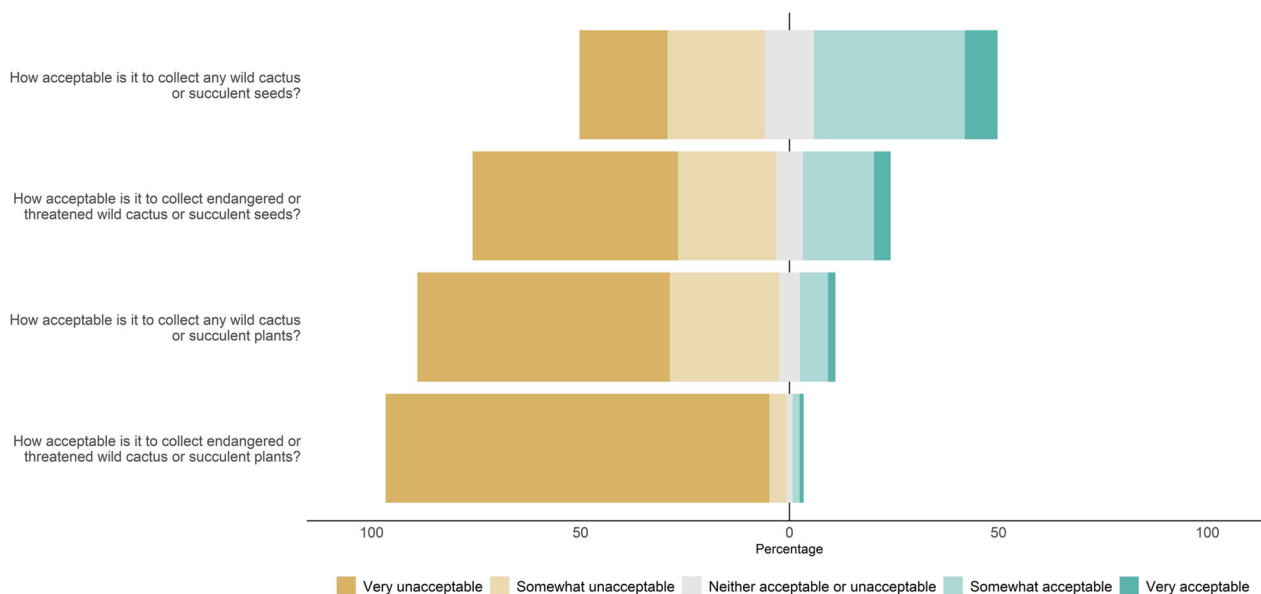


FIGURE 4 Cactus and succulent collector survey responses on the acceptability of various forms of wild cactus and succulent plant and seed collection. Respondents were asked to rate the acceptability of collecting any wild cactus and succulent seeds ($n = 399$), any wild cactus and succulent plants ($n = 401$), endangered or threatened cactus and succulent seeds ($n = 405$), and endangered or threatened plants ($n = 415$). Variations in sample size from the total survey data set ($n = 441$) relate to respondents who selected unsure as their answer, which is not considered a neutral response.

TABLE 4 Results of model-averaged logistic regressions of responses to direct questions, showing covariates associated with personal involvement in 3 types of CITES noncompliance: Buying, transporting or carrying, and shipping plants without the necessary CITES paperwork ($n = 385$)*

Covariate	Estimates for each direct question (SE)			
	Bought a plant without paperwork	Transported a plant without paperwork	Shipped a plant without paperwork	
Intercept	-2.13 (1.24)*	-5.86 (1.12)***	-6.11 (1.31)***	
Age	-0.04 (0.02)**	0.03 (0.01)**	0.01 (0.02)	
Education (ref: no higher education)	Undergraduate	NA	NA	
	Postgraduate	-0.61 (0.74)	NA	NA
Gender (ref: Female)	1.53 (0.78)**	0.84 (0.48)*	2.51 (1.05)**	
CITES reg. score	0.24 (0.23)	0.40 (0.17)**	0.40 (0.22)*	
Collector type (ref: amateur)	Serious hobbyist	-0.13 (0.58)	0.72 (0.43)*	0.18 (0.56)
	Professional	0.95 (0.75)	1.25 (0.62)**	2.12 (0.63)***

*Full model outputs in Appendix S5. Significance: $0.05 > *p < 0.1$; $0.01 > **p < 0.05$; $***p < 0.01$.

I would like to see CITES working alongside collectors to propagate and distribute plant material legally and safely... serious (expert) hobbyists, experienced commercial growers and botanical institutions should be granted permits to collect material that can then be used for propagation. This could be used for *ex-situ* conservation and to supply demand for new species/prevent illegal habitat stripping (35, British, white, male).

Seven themes (Table 2) described respondents' ideas for how to improve the management of cactus and succulent conservation and trade. The most common suggestions related to a

need for more exemptions and exceptions to current CITES regulations ($n = 64$); the need to promote or facilitate plant propagation ($n = 45$); greater focus on education about CITES ($n = 25$); enhanced enforcement and regulations in trade and conservation ($n = 22$); and improved administrative restructuring of CITES ($n = 10$). Other codes included support for greater collaboration among CITES, conservation groups, and collector communities or organizations ($n = 8$) and developing an ethical trader and grower program ($n = 6$). Combined, the most frequent suggestions from collectors related to making CITES more accommodating of the propagation, trade, and sale of artificially grown CITES-listed species to reduce demand for wild-harvested species of conservation interest.

DISCUSSION

Importance of interdisciplinary collaboration and listening to stakeholders

We combined research techniques not previously integrated in analysis of consumer behaviors and illicit activity with conservation impacts. In the context of topics as complex as IWT, such integration of methods and methodological perspectives is likely necessary (Fukushima et al., 2021; Whitehead et al., 2021). Social survey design is improved when interdisciplinary researchers collaborate from the outset rather than in a post hoc fashion (Bennett et al., 2017). We also demonstrated the value of KALPHA-multi (α) as a useful tool for ICR testing (Krippendorff, 2021). The α partially overcomes a long-standing problem in which scientists constrain complex social analyses of textual data to use mutually exclusive ICR tests as a quantitative metric of coding reliability. We are not suggesting α should replace more interpretive approaches to textual analysis (e.g., discourse analysis, ethnography), but it improves the capacity for testing code book quality while permitting more complex textual analyses than mutually exclusive ICR tests, such as KALPHA.

Closed survey responses suggest competing perspectives among collectors regarding challenges to cactus and succulent conservation, their trade, and illicit behavior, with QDA adding further important context. We therefore conducted integrated analyses of our survey findings in this discussion. We drew on specific phrases from survey respondents to present qualitative data alongside interpretation of that data.

Collectors concern for illegal trade and criticism of CITES

Respondents were reasonably familiar with the existence of CITES and the necessity of permits for at least some international trades in cactus and succulent plants (Figure 1). Most survey respondents thought CITES is a “very important tool” for conservation. Nonetheless, although most respondents agreed that CITES helps or “somewhat helps” to reduce IWT, there was also disagreement (Figure 2). 27% of respondents expressed uncertainty or doubts about the effectiveness of CITES as a regulatory convention, and open-text responses suggested that for at least some respondents this was due to lack of sufficient knowledge or technical understanding of CITES. Sentiment toward CITES in open-text responses skewed negative (Table 3), and open-text responses suggested that although many respondents saw CITES as important in principle, it was perceived variously as “flawed” (R363), “ineffective” (R142), or that it “has many loopholes” (R313). Many of the comments coded as mixed or ambiguous in the sentiment analyses (Table 3) were structured as support for CITES or that CITES has good intentions, but there are caveats, suggesting many respondents expressing mixed sentiments did so because they thought CITES was important in intent but flawed or in need of “major revision” in practice (R403).

The text-based responses were generally concerning, given most respondents believe illegal collection represents a “very serious problem” that is increasing in severity (Figure 3). What these responses and others like them share is a concern for illegal collection (R16 and R25, quoted above, “strongly disagreed” with the acceptability of taking plants from the wild and recognized illegal collection as a “somewhat serious problem”) coupled with frustration that CITES, in their opinion, is ineffective in reducing the presence of wild-collected plants in the international marketplace.

An important consideration is that open-ended responses in social surveys have lower response rates than closed-choice questions, and more negatively opinionated participants are more likely to respond than those with more moderate or positive perspectives (Poncheri et al., 2008). This may explain some of the discrepancy between open-text sentiment analysis results (Table 3) and Likert-scale responses regarding the importance of CITES (Figure 2). The high proportion of respondents who also responded “unsure” to questions about CITES’ effectiveness also suggests that, although some respondents hold very strong and negative opinions about CITES, there is also a large group of respondents who do not feel sufficiently knowledgeable about CITES to offer a firm opinion.

Our results suggest that despite being recognized as an important conservation tool, the legitimacy and efficacy of CITES is questioned within the surveyed collector community that drive demand in the specialist succulent ornamental plant trade. One likely reason is the problem of CITES failing to sufficiently consult or engage with stakeholders affected by trade regulations (Cooney et al., 2021; Duffy, 2013). This lack of consultation may erode collector trust in CITES and serve as justification for collectors to ignore trade regulations if they perceive them as deteriorating, rather than helping species conservation. In this light, it is promising to see the U.K.’s Department for Environment, Food and Rural Affairs (DEFRA) approaching the BCCS to join the CITES Sustainable Users Group (BCSS, 2021). Our concern echoes Cooney et al. (2021) and Wyatt (2021) calling for a reappraisal of CITES and its shortcomings to incorporate social science and economics research into determining CITES appendix listings and their potential impact on affected species.

Desire for pragmatic, market-oriented solutions to regulating species trade

One of the most common perspectives within our sample was what we characterized as a market pragmatist orientation toward species trade regulation and conservation efforts. It recognizes species as holding durable and resilient demand within a consumer base (i.e., Moreto & Lemieux, 2015) and a strong desire to obtain species, potentially threatening their conservation. This perspective is evidenced in the desire of collectors for CITES to regulate what they imagine as a sustainable international trade in artificially propagated plants and seeds, or sustainable harvest of wild seed stock (Table 1, code 5; Table 2, codes 3, 4). Many collectors expressed a desire for loosening regulations or wider

exemptions from CITES regulations, especially for the trade in seeds. Another common suggestion related to the idea of an ethical trader scheme, permitting either commercial nurseries or even individual consumers to become CITES certified to trade and sell artificially propagated plants more easily (Table 2, code 2). Since 1994 CITES has permitted nurseries to be registered for the export of artificially propagated Appendix SI plants, but it remains up to the individual Parties of CITES to implement such programs.

Rule breaking and collectors

Almost 90% of our sample did not report breaking CITES rules, suggesting noncompliance is not widespread among the surveyed hobbyist community. An important caveat is that historical, textual, and qualitative evidence (e.g., online forum discussions, ethnographic research by the first author, textual analysis of society journals) points to potentially higher rates of noncompliance by collectors across several Central and Eastern European countries compared with this study's surveyed population, but our limited sample was not sufficient to test this. Worryingly, high CITES-knowledge scores and the involvement of professionals in the most involved noncompliant activities (shipping and transporting) suggest that people break these rules knowingly. Similar themes are observed in the trade of horticultural orchids and antiquities, where deliberate noncompliance with trade laws is linked to conflict between formal regulations and an individual's belief in what is right (Hinsley et al., 2017; McKenzie & Yates, 2016). In our study's open-text answers, CITES was seen by many respondents as flawed, which could contribute to their justification of noncompliance if they see existing rules as ineffective to protect wild plants. Buying plants without paperwork was not linked to better CITES knowledge, and a higher proportion of respondents reported being unsure whether they had engaged in this behavior when shipping or transporting plants. This suggests some collectors may be unwitting participants in illegal trade, due to a lack of understanding of CITES rules or a lack of clarity from traders on the requirements for shipping a plant internationally. This is especially likely in more informal settings, such as online commerce or social media platforms, that have become increasingly important in horticultural plant trade (Lavorgna & Sajeva, 2021).

Blame for illegal trade in species

Open-text responses suggested that although surveyed collectors agreed illegal collection was a serious, increasing problem, several respondents blamed collectors in East Asia for this problem rather than European or North American collectors. This type of blame, as opposed to recognizing the problem as part of one's own community, is regularly seen in IWT studies (e.g., Mbanze et al., 2021). However, our results showed IWT is persistent in Western collecting communities. This is not to downplay concerns about IWT involving actors in East Asian countries, but rather that the problem is not isolated to

this world region, as recent incidents featured in popular news outlets demonstrate (e.g., Nuwer, 2021). Nonetheless, IWT in cactus and succulent plants remains a problem across Europe and the United States. This geographic displacement of blame parallels the narrative of the "Asian super consumer" as a bogeyman in popular IWT discourses (Margulies et al., 2019). We encourage leadership in cactus and succulent collecting societies to educate their membership about these problematic dynamics. At the same time, we recognize the important need for further research on the illegal trade in cactus and succulent species in East Asian countries.

Gender as a factor in illegal trade in cacti and succulent plants

With regard to young men in our sample being more likely to buy plants without paperwork, it is important to recognize that the cactus and succulent collecting community is generally male dominated (Appendix S3). But, like other forms of IWT (e.g., Sollund, 2020), it appears that it is more often men who engage in illegal trade of cacti and succulents. This may relate to heteromale notions of daring or adventure in breaking the law, especially where costs for doing so are perceived as low. Yet, the finding that younger men were more likely to purchase plants without paperwork may contradict common perspectives within the collector hobby that acquiring plants illegally is primarily the activity of an older generation that grew up taking part in this hobby before CITES implementation. This finding may also relate to different modes of acquisition; older respondents and professionals and those with greater knowledge of CITES were more likely to personally transport materials illegally, whereas younger people might purchase materials without necessary paperwork online. Attention to internet platforms in facilitating IWT is vital (Lavorgna et al., 2020). Nonetheless, our findings are a reminder that although the internet facilitates illegal trades, these actions still involve human actors with their own perspectives and desires, some of which may be mediated by forms of social difference such as gender, race, or class. The gendered dimensions of IWT in cacti and succulents provide evidence that more work is needed to theorize the role of gender in IWT generally, but specifically in relation to consumer profiles and perspectives of illicit actors (Agu & Gore, 2022; Dang Vu et al., 2018; Massé et al., 2021).

Collector role in conservation

Surveyed collectors see potential for their community to play an important role in plant conservation, but the persistence of illegal behavior within this community harms their capacity to be seen as legitimate conservation allies (Table 2, code 6; Figure 3). Despite evidence presented here on the presence of illegal behavior, we agree that engaging with this community could unlock a generally untapped pool of conservation advocates. Collectors demonstrated a concern for the long-term conservation of high-demand species while recognizing

the demand for many species in international markets. There are select case studies of market-oriented approaches to plant trade suggesting that making viable genetic material (e.g., artificial propagation and seed reproduction) available in commercial trades may reduce prices of desirable plant species and even limit the emergence of illegal trades involving wild-harvested species (e.g., Kay et al., 2011; Trueman et al., 2007). However, such approaches are still controversial within the conservation community, and there is mixed evidence of efficacy from other taxonomic groups (t Sas-Rolfes et al., 2019). More research and evidence are needed to assess if market-oriented solutions could reduce IWT in highly desired cacti and succulent plants and reduce demand for wild-harvested species through substitution of artificially propagated plants.

Our results suggest caution is warranted in presuming all collectors take species conservation seriously when weighed against their desires to collect coveted plants. At the same time, rather than characterize the cactus and succulent collecting community as a haven for actors who engage in illegal behavior, we are cautiously optimistic about leveraging this community's passion to conservation's benefit. Collectors frequently visit plants in their habitat ranges, and many maintain detailed records of species populations. Professional botanists, conservationists, and management authorities rarely have sufficient opportunities to visit species populations on a frequent basis for monitoring, or to search for unrecorded populations. Collectors, with appropriate training and supervision, could become an asset to species conservation monitoring programs or assist studies of species abundance and distribution. There are legitimate reasons many in conservation and law enforcement may be wary of engaging with collectors, given our results that a substantial percentage of collectors are knowingly engaging in illegal collection activities and trade. However, we believe there is a missed opportunity to develop engagement among the collector community, professionally trained scientific community, CITES, and conservation management authorities.

Study limitations

Given the study's focus on the U.K., U.S., and European-based collectors, our results should not be extrapolated to other geographic regions. Some forms of illegal trade in cactus and succulent plants point specifically to East Asia (including China, Japan, and South Korea) as a regional demand center for illegally traded succulents (Margulies, 2020). Consequently, an important future step will be a globally relevant survey tool to compare patterns and differences in collector practices and perspectives across geographic regions. Furthermore, 95% of survey respondents were members of formal grower societies, but widespread enthusiasm for cactus and succulent collection also exists outside these groups. Research is required to establish how the perspectives and activities of collectors outside formal societies compare with those within them. Finally, our UCT did not produce estimates significantly different from 0 or the direct question, potentially due to lower samples sizes (Hinsley et al.,

2018) or lack of sensitivity around CITES noncompliance questions (Hinsley et al., 2017). That illegal trade in wild cactus and succulent plants and especially in their seeds is not considered a socially sensitive behavior by many respondents suggests the need for future studies.

Our results showed sampled collectors most likely to engage in illegal behavior were generally familiar with CITES regulations. This suggests that rather than a problem of educating the collecting community about CITES, illegal behavior may persist because it is seen by those breaking the law as socially acceptable or even of conservation benefit. The most common critiques of CITES and suggestions for improving cactus and succulent conservation related to improving access and ease of international trade of artificially propagated plants and seed. Sampled collectors saw themselves as being able to provide such material, indicating they could play an important role in cactus and succulent conservation that to date has not been realized. We encourage conservation policy makers and CITES Parties to consider the importance of stakeholder consultation in assessing the impacts of CITES appendix listings on species conservation. Trying to reduce illegal trade within collecting communities alongside advocating for the collection of only legal, artificially propagated plants is vital. However, our data also point to opportunities to engage with actors that represent potential allies in protecting and monitoring threatened species and advocating for their conservation.

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REFERENCES

- Agu, H. U., & Gore, M. L. (Eds.). (2022). *Women and wildlife trafficking: Participants, perpetrators and victims*. Routledge.
- Arroyo-Quiroz, I., & Wyatt, T. (2019). Wildlife trafficking between the European Union and Mexico. *International Journal for Crime, Justice and Social Democracy*, 8(3), 23.
- Aronow, P. M., Coppock, A., Crawford, F. W., & Green, D. P. (2015). Combining list experiment and direct question estimates of sensitive behavior prevalence. *Journal of Survey Statistics and Methodology*, 3(1), 43–66.

- Bartón, K. (2020). Multi-model inference (Package MuMIn: version 1.43. 17). <https://CRAN.R-project.org/package=MuMIn>
- Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, 30(3), 582–592.
- Bennett, N. J., Roth, R., Klain, S. C., Chan, K. M., Clark, D. A., Cullman, G., Epstein, G., Nelson, M. P., Stedman, R., Teel, T. L., Thomas, R. E., Wyborn, C., Curran, D., Greenberg, A., Sandlos, J., Verissimo, D., & Thomas, R. E. (2017). Mainstreaming the social sciences in conservation. *Conservation Biology*, 31, 56–66.
- Blair, G., & Imai, K. (2010). list: Statistical Methods for the Item Count Technique and List Experiment. <https://CRAN.R-project.org/package=list>
- Botanic Gardens Conservation International. (2021). *Plant poaching is on the rise. What can we do?* <https://www.bgci.org/news-events/plant-poaching-is-on-the-rise-what-can-we-do/>
- British Cactus and Succulent Society. (2021). *British cactus and succulent society*. eNews. <https://us13.campaign-archive.com/?u=6eae4ef84a62a7993da4bad4&cid=7adbe844dd>
- Brummitt, N. A., Bachman, S. P., Griffiths-Lee, J., Lutz, M., Moat, J. F., Farjon, A., & Nic Lughadha, E. M. (2015). Green plants in the red: A baseline global assessment for the IUCN Sampled Red List Index for Plants. *PLoS ONE*, 10(8), e0135152.
- Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Sage Publications.
- Christie, P., Oracio, E. G., & Eisma-Osorio, L. (2011). Impacts of the CITES listing of seahorses on the status of the species and on human well-being in the Philippines: A case study. FAO Fisheries and Aquaculture Circular. UN Food and Agriculture Organisation.
- Cooney, R., Challender, D. W. S., Broad, S., Roe, D., & Natusch, D. J. D. (2021). Think Before You Act: Improving the Conservation Outcomes of CITES Listing Decisions. *Frontiers in Ecology and Evolution*, 9:631556. <http://doi.org/10.3389/fevo.2021.631556>
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). (2022). *The CITES species*. <https://cites.org/eng/disc/species.php>
- Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Sage.
- Cousins, S. R., & Witkowski, E. T. F. (2017). African cycad ecology, ethnobotany and conservation: A synthesis. *The Botanical Review*, 83(2), 152–194.
- Dang Vu, H. N., & Nielsen, M. R. (2018). Understanding utilitarian and hedonic values determining the demand for rhino horn in Vietnam. *Human Dimensions of Wildlife*, 23(5), 417–432.
- De Swert, K. (2012). *Calculating inter-coder reliability in media content analysis using Krippendorff's Alpha*. Center for Politics and Communication.
- Duffy, R. (2013). Global environmental governance and north–south dynamics: The case of the CITES. *Environment and Planning C: Government and Policy*, 31(2), 222–239.
- Duffy, R. (2022). *Security and conservation: The politics of the illegal wildlife trade*. Yale University Press.
- Feldman, R. (2013). Techniques and applications for sentiment analysis. *Communications of the ACM*, 56(4), 82–89.
- Fukushima, C. S., Tricorache, P., Toomes, A., Stringham, O. C., Rivera-Téllez, E., Ripple, W. J., & Cardoso, P. (2021). Challenges and perspectives on tackling illegal or unsustainable wildlife trade. *Biological Conservation*, 263, 109342.
- Goetsch, B., Hilton-Taylor, C., Cruz-Piñón, G., Duffy, J. P., Frances, A., Hernández, H. M., & Gaston, K. J. (2015). High proportion of cactus species threatened with extinction. *Nature Plants*, 1(10), 1–7.
- Hayes, A. F., & Krippendorff, K. (2007). Answering the call for a standard reliability measure for coding data. *Communication Methods and Measures*, 1(1), 77–89.
- Hinsley, A., De Boer, H. J., Fay, M. F., Gale, S. W., Gardiner, L. M., Gunasekara, R. S., Kumar, P., Masters, S., Metusala, D., Roberts, D. L., Veldman, S., & Phelps, J. (2018). A review of the trade in orchids and its implications for conservation. *Botanical Journal of the Linnean Society*, 186(4), 435–455.
- Hinsley, A., Keane, A., St John, F. A., Ibbett, H., & Nuno, A. (2019). Asking sensitive questions using the unmatched count technique: Applications and guidelines for conservation. *Methods in Ecology and Evolution*, 10(3), 308–319.
- Hinsley, A., Nuno, A., Ridout, M., John, F. A. S., & Roberts, D. L. (2017). Estimating the extent of CITES noncompliance among traders and end-consumers; lessons from the global orchid trade. *Conservation Letters*, 10(5), 602–609.
- Hinsley, A., Lee, T. E., Harrison, J. R., & Roberts, D. L. (2016). Estimating the extent and structure of trade in horticultural orchids via social media. *Conservation Biology*, 30(5), 1038–1047.
- International Union for Conservation of Nature (IUCN). (2022). *The IUCN Red List of Threatened Species: Version 2022-1*. <https://www.iucnredlist.org>
- Jordaan, N. (2021). *American fined R500,000, banned from SA for 'stealing' protected plant*. TimesLive. <https://www.timeslive.co.za/news/south-africa/2020-04-01-american-fined-r500000-banned-from-sa-for-stealing-protected-plants/>
- Kay, J., Strader, A. A., Murphy, V., Nghiem-Phu, L., Calonje, M., & Griffith, M. P. (2011). Palma corcho: A case study in botanic garden conservation horticulture and economics. *HortTechnology*, 21(4), 474–481.
- Krippendorff, K. (2011). *Computing Krippendorff's alpha-reliability*. https://repository.upenn.edu/asc_papers/43
- Krippendorff, K. (2021). Multi-valued coding of predefined units. In K. Krippendorff (Ed.), *The reliability of generating data* (pp. 137–152). Chapman and Hall/CRC.
- Kurland, J., Pires, S. F., & Marteache, N. (2018). The spatial pattern of redwood burl poaching and implications for prevention. *Forest Policy and Economics*, 94, 46–54.
- Lavorgna, A., Middleton, S. E., Pickering, B., & Neumann, G. (2020). FloraGuard: Tackling the online illegal trade in endangered plants through a cross-disciplinary ICT-enabled methodology. *Journal of Contemporary Criminal Justice*, 36(3), 428–450.
- Lavorgna, A., Rutherford, C., Vaglica, V., Smith, M. J., & Sajeve, M. (2018). CITES, wild plants, and opportunities for crime. *European Journal on Criminal Policy and Research*, 24(3), 269–288.
- Lavorgna, A., & Sajeve, M. (2021). Studying illegal online trades in plants: Market characteristics, organisational and behavioural aspects, and policing challenges. *European Journal on Criminal Policy and Research*, 27(4), 451–470.
- Mackenzie, S., & Yates, D. (2016). Collectors on illicit collecting: Higher loyalties and other techniques of neutralization in the unlawful collecting of rare and precious orchids and antiquities. *Theoretical Criminology*, 20(3), 340–357.
- Magliocca, N., Torres, A., Margulies, J., McSweeney, K., Arroyo-Quiroz, I., Carter, N., & Tellman, E. (2021). Comparative analysis of illicit supply network structure and operations: Cocaine, wildlife, and sand. *Journal of Illicit Economics and Development*, 3(1), 50–73.
- Margulies, J. D. (2020). Korean ‘Housewives’ and ‘Hipsters’ are not driving a new illicit plant trade: Complicating consumer motivations behind an emergent wildlife trade in *Dudleya farinosa*. *Frontiers in Ecology and Evolution*, 367, 604921.
- Margulies, J. D., Bullough, L. A., Hinsley, A., Ingram, D. J., Cowell, C., Goetsch, B., Klitgård, B., Lavorgna, A., Sinovas, P., & Phelps, J. (2019). Illegal wildlife trade and the persistence of “plant blindness”. *Plants, People, Planet*, 1(3), 173–182.
- Margulies, J. D., Wong, R. W., & Duffy, R. (2019). The imaginary ‘Asian super consumer’: A critique of demand reduction campaigns for the illegal wildlife trade. *Geoforum*, 107, 216–219.
- Massé, F., Givá, N., & Lunstrum, E. (2021). A feminist political ecology of wildlife crime: The gendered dimensions of a poaching economy and its impacts in Southern Africa. *Geoforum*, 126, 205–214.
- Massé, F., & Margulies, J. D. (2020). The geopolitical ecology of conservation: The emergence of illegal wildlife trade as national security interest and the re-shaping of US foreign conservation assistance. *World Development*, 132, 104958.
- Mbanze, A. A., da Silva, C. V., Ribeiro, N. S., & Santos, J. L. (2021). Participation in illegal harvesting of natural resources and the perceived costs and benefits of living within a protected area. *Ecological Economics*, 179, 106825.
- Moreto, W. D., & Lemieux, A. M. (2015). From CRAVED to CAPTURED: Introducing a product-based framework to examine illegal wildlife markets. *European Journal on Criminal Policy and Research*, 21(3), 303–320.
- Novoa, A., Le Roux, J. J., Richardson, D. M., & Wilson, J. R. (2017). Level of environmental threat posed by horticultural trade in Cactaceae. *Conservation Biology*, 31(5), 1066–1075.
- Nuwer, R. (2021, May 20). Global cactus traffickers are cleaning out the deserts. *The New York Times*. <https://www.nytimes.com/2021/05/20/science/cactus-trafficking-chile.html>

- Perdue, R. T. (2021). Who needs the dark web? Exploring the trade in critically endangered plants on eBay. *American Journal of Criminal Justice*, 46(6), 1006–1017.
- Poncheri, R. M., Lindberg, J. T., Thompson, L. F., & Surface, E. A. (2008). A comment on employee surveys: Negativity bias in open-ended responses. *Organizational Research Methods*, 11(3), 614–630.
- Robbins, C. S. (Ed.). (2003). *Prickly trade: Trade and conservation of Chihuahuan desert cacti*. TRAFFIC North America, World Wildlife Fund.
- Sajeva, M., Carimi, F., & McGough, N. (2007). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and its role in conservation of cacti and other succulent plants. *Functional Ecosystems and Communities*, 1(2), 80–85.
- Smith, K. M., Zambrana-Torrel, C., White, A., Asmussen, M., Machalaba, C., Kennedy, S., Lopez, K., Wolf, T. M., Daszak, P., Travis, D. A., & Karesh, W. B. (2017). Summarizing US wildlife trade with an eye toward assessing the risk of infectious diseases introduction. *EcoHealth*, 14(1), 29–39.
- Sollund, R. (2020). Wildlife crime: A crime of hegemonic masculinity? *Social Sciences*, 9(93), 1–16.
- † Sas-Rolfes, M., Challender, D. W., Hinsley, A., Verissimo, D., & Milner-Gulland, E. J. (2019). Illegal wildlife trade: Scale, processes, and governance. *Annual Review of Environment and Resources*, 44, 201–228.
- Trueman, S. J., Pegg, G. S., & King, J. (2007). Domestication for conservation of an endangered species: The case of the Wollemi pine. *Tree and Forestry Science and Biotechnology*, 1, 1–10.
- United Nations Office on Drugs and Crime (UNODC). (2020). *World Wildlife Crime Report 2020: Trafficking in protected species*. https://www.unodc.org/documents/data-and-analysis/wildlife/2020/World_Wildlife_Report_2020_9July.pdf
- Version XM of Qualtrics. (2022). *Qualtrics*. Provo. <https://www.qualtrics.com>
- Wardropper, C. B., Dayer, A. A., Goebel, M. S., & Martin, V. Y. (2021). Conducting conservation social science surveys online. *Conservation Biology*, 35(5), 1650–1658.
- Whitehead, D., Cowell, C. R., Lavorgna, A., & Middleton, S. E. (2021). Countering plant crime online: Cross-disciplinary collaboration in the FloraGuard study. *Forensic Science International: Animals and Environments*, 1, 100007.
- Wilckens, M. (2021). Organizational Practices for the Aging Workforce: Conceptualization, Operationalization, Validation, and Application of the Later Life Workplace Index [Unpublished doctoral dissertation]. Leuphana Universität Lüneburg.
- Wyatt, T. (2021). *Is CITES protecting wildlife?: Assessing implementation and compliance*. Routledge.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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