


Knowledge gaps and opportunities for conservation with orchid collectors in Vietnam

Elizabeth Oneita Davis¹  | Adam Graves¹ | Heinfried Block¹ | Christy Powell¹ | Trung Tien Cao²

¹San Diego Zoo Wildlife Alliance, Escondido, California, USA

²Institute for Ecology and Conservation of Nature, Vinh University, Vinh, Vietnam

Correspondence

Elizabeth Oneita Davis, San Diego Zoo Wildlife Alliance, 15600 San Pasqual Valley Road, Escondido, CA, USA.
Email: edavis@sdzwa.org

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Abstract

Unsustainable harvesting of orchid species is a critical, global threat to orchid diversity and abundance, fueled by domestic and global demand. However, drivers of demand continue to be under-explored, despite opportunities for proactive engagement and/or behavior change strategies with and/or directed at orchid collectors. In this study, we surveyed self-identified Vietnamese orchid collectors, some of whom were also known to engage in wild harvesting of endangered species, to understand sociological dimensions including motivations, knowledge, attitudes, behaviors, and conservation ethos. We found that knowledge about domestic and international regulations was low, and that orchid collectors were likely to believe that Vietnam has plenty of orchids left in the wild. Orchid collectors were highly willing to share their expertise and collections with international NGOs, and receive advice on propagation of orchid species. Through Bayesian logistic regression, we found no statistically significant influence of demographic attributes on the behavior of harvesting from the wild; however, having access to propagation equipment and supplies increased the likelihood of wild harvest. Accurate knowledge (awareness) is a key first step in the behavior change process. We suggest the implementation of awareness-raising campaigns targeted at Vietnamese orchid collectors, which communicate domestic and international restrictions about orchid harvest and trade, as well as the known status of orchid species in the wild. Additionally, we suggest that an opportunity exists to recruit Vietnamese orchid collectors into a formal network for knowledge-sharing and the co-creation of sustainable guidelines around keeping and propagating orchids.

Abstract in Vietnamese is available with online material.

KEYWORDS

awareness-raising, behavior change, New Environmental Paradigm, *Paphiopedilum* spp., wild harvest

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1 | INTRODUCTION

Illegal and/or unsustainable trade in wildlife (IUWT) is a major threat to global biodiversity, resulting in the imbalance of natural ecological systems, loss of sustenance for local communities, and the loss of cultural heritage (e.g., 't Sas-Rolfes et al., 2019; Massé & Margulies, 2020). While IUWT affects all areas of the globe, it is an especially major threat in Southeast Asia, a historically highly biodiverse region which has suffered rapid and extensive losses in wildlife (e.g., Blair et al., 2017; Phelps & Webb, 2015; Rasphone et al., 2019). One understudied and highly affected family is *Orchidaceae* (orchids), which has many Critically Endangered species located throughout Southeast Asia (Phelps & Webb, 2015; Zizka et al., 2021), including *Paphiopedilum* (slipper orchids), a highly desired orchid genus (e.g., Hinsley & Roberts, 2018). International and domestic trade in orchids is known to occur throughout the region (Bullough et al., 2021; Hinsley et al., 2016; Liu et al., 2020; Phelps & Webb, 2015). In Vietnam, this trade is known to occur in large quantities, with several kilograms of orchids harvested and traded at a time (Bullough et al., 2021). Trade occurs despite strict laws by the Government of Vietnam that prohibit the harvest and trade of any orchid species (most recently, Decree No. 35/2019/ND-CP and Law No. 16/2017/QH14 on Forestry), as well as strict CITES regulations that prohibit trade of orchids out of the country (Bullough et al., 2021; Gale et al., 2019). Compounded by habitat fragmentation and climate change, this represents a severe threat to orchids and the potential loss of a cherished object of ornamentation in Vietnamese society (Bullough et al., 2021; Davis, E.O., Cao, T.T., *pers. obs.*). Furthermore, the trade in Vietnam has been identified as one with “few barriers to participation in trade and low enforcement,” meaning that the trade is likely to continue if interventions are not strengthened, and/or put in place (Bullough et al., 2021).

Motivations for trading and consuming wildlife are complex and for many species, still unknown (Thomas-Walters et al., 2021). However, understanding motivations is critical for designing effective conservation interventions that have the strongest influence on individual behavior (Thomas-Walters et al., 2020). This is particularly pertinent for wildlife products—such as orchids—that can be used for a variety of purposes motivated by different factors, such as medicine, ornamentation, social capital generation, and so forth (Thomas-Walters et al., 2021). For example, motivations for using orchids for medicinal purposes could be addressed by behavior change campaigns designed to encourage non-wildlife-based alternatives; such a campaign would likely be less effective at reducing socially-oriented motivations, such as gifting orchids to friends and family. The specific motivations driving orchid collectors in Vietnam are understudied, and conservation interventions within Vietnam addressed at orchid harvest and purchase are few, if extant at all (The Authors, *pers. obs.*).

This study was initiated by personal observations of high-volume orchid trading occurring within a Vietnamese orchid hobbyist and trader Facebook group. Orchids were being offered for sale in bushels, including extremely rare and possibly Critically

Endangered species (The Authors, *pers. obs.*). The scale of trade, the low barriers of entry into the trade, and the trade chain have all been researched in Vietnam, as well as exploratory research into specific behaviors of orchid collectors, and motivations for illegally trading and purchasing orchids (Bullough et al., 2021). We aim here to build on the work of Bullough et al. (2021) by conducting a solely quantitative study that investigates different potential motivations for keeping orchids, and/or participating in behaviors that may be considered negative for orchid conservation in Vietnam (such as wild harvest of orchids), as well as the influence of other factors such as level of conservation ethos. To measure conservation ethos, we used an adapted version of the New Environmental Paradigm (NEP) scale. The questions of the NEP were designed and tested to have high internal reliability for measuring environmental ethos, with observed differences between those who could be labeled “environmentalists” and those who could not (Dunlap et al., 2000).

To successfully address IUWT, conservation scientists must understand the characteristics of the individuals whose behavior conservationists wish to change (Kanagavel et al., 2014). This study extends a foundation for understanding and engaging with orchid collectors in Vietnam, and for identifying opportunities to initiate positive conservation behavior change.

2 | METHODS

2.1 | Survey instrument

We designed the survey instrument based on previous surveys conducted into consumer characteristics and wildlife product use in Vietnam (Bullough et al., 2021; Davis et al., 2022), as well as the expert knowledge of the International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) Orchid Specialist Group. The survey began with a consent form that explained the survey, how the data would be used, and that the data would by default be anonymous, although we explained that we would provide an opportunity at the end for the respondents to voluntarily share their personal details to enter a drawing to obtain an orchid. Respondents were given the option to choose “Yes” if they wished to proceed with the survey, or “No” if they did not.

The survey began with a section on demographics, including a question asking whether the respondent had an orchid collection, as well as what types of orchids they have. This was followed by a brief section asking about knowledge (measured through “True/False”), for example, “*There are no international regulations for trading orchids.*”, and a section (Section 3) assessing respondent attitudes to certain statements (measured through a standard five-point Likert scale plus a “Don't know” option), such as “*I am proud that Vietnam has a diverse number of native orchid species growing in the forest.*” This was followed by a section (Section 4) assessing belief, again measured through a five-point Likert scale, with questions such as “*Cultivating orchids is not part of Vietnamese culture.*” The belief

section was followed by a section (Section 5) assessing knowledge and activity, for example, “I know how to collect orchid pollen,” again measured through a five-point Likert scale. Section 6 assessed the respondents' direct behavior through direct questioning, for example, “Have you ever harvested orchids from the wild?,” including specific questions related to harvesting and selling orchids, such as “Have you sold orchids internationally online?.” Section 7 asked about specific behaviors pertaining to the medicinal use of orchids, as harvesting/purchasing orchids for medicinal purposes has been documented elsewhere (e.g., Bashyal et al., 2023; Hinsley et al., 2018; Phelps et al., 2016). Section 8 was the NEP scale, with 13 questions each measured by a five-point Likert scale. Section 9 was an “extra” demographic question asking the respondents' monthly income; this was purposefully removed from the other demographic questions and placed at the end since it can be considered more sensitive than the other demographic questions. Finally, respondents were asked if they wanted to voluntarily share their address, phone number, or email to be entered into a drawing for a t-shirt and an orchid seedling grown sustainably at the San Diego Zoo.

Respondents were assured that by default their responses were anonymous and that any data they shared would be confidential. Even where they voluntarily provided contact details, their contact details would not be accessed by anyone outside of the core project team of the lead author EOD and author TTC. The Google Form data was only accessible for download by the lead author, who placed the downloaded file into a secure, password-protected, cloud-based folder. Ethical approval for the project was granted by Miami Research Ethics and Integrity Office (MREI) (Protocol Number #04266e).

2.2 | Sampling strategy

We intended to only target the orchid collectors who were members of the Facebook group we had first identified. We shared the survey online, via Google Forms, in this group. We posted the survey once at the beginning of the project (August 2022), and again a few weeks later to try to generate more responses. Once no more new responses were received, we closed the survey and randomly selected participants to receive t-shirts and sustainably grown orchid seedlings.

2.3 | Data analysis

We created an aggregated NEP score for each respondent by first transforming the given response to a numeric between 0 and 5 (0: Don't know; 1: Strongly disagree; 2: Disagree; 3: Neither agree nor disagree; 4: Agree; 5: Strongly agree) and simultaneously recoding all questions on to the same scale (e.g., changing “5—Strongly agree” responses to “1—Strongly disagree” for “The balance of nature is strong enough to cope with the impacts of modern industrial nations,” to align with the scalar level of “Plants and animals have as much right as humans to exist,” where “5—Strongly agree”

indicates high environmental awareness). We then averaged the score for each respondent, to calculate their overall NEP score.

We coded the Likert scale as standard, apart from “Don't knows” which were coded as “3—Neither agree nor disagree” for questions where “Don't know” was a neutral response, for example, “Orchids have medicinal value.” Every question had between 12% and 77% “don't knows” (an average across all questions of 42%, nearly half of the sample).

Confidence intervals were calculated for relevant questions using the *gmodels* package in R (R Core Team, 2023; Warnes et al., 2022). We conducted Bayesian logistic regression to assess the effects of demographics, attitudes, beliefs, behavioral intentions, past behavior, and NEP score on the behavior “harvesting from the wild.” We used the *brms* package in R (Bürkner, 2017). Predictors were chosen from the dataset based on expert opinion by the author team over which of the predictors we investigated may have had the most impact, and/or would give us the most practical information for a conservation intervention. From there, we ran univariate models on each predictor and the dependent variable (a binary “0:1” with “1” being yes and “0” being no, for harvesting from the wild). Predictors that were significant in the univariate models were included in a combined model. Ultimately, the only predictors that were statistically significant were sex, age, the belief “I have access to propagation equipment and supplies,” and the behavior of having bought orchids internationally.

3 | RESULTS

3.1 | Demographics

A total of 40 individuals responded to the survey. Gender was slightly unbalanced, with women comprising 47.5% of the sample.

The average age for respondents was 32 (median 31). 65% of the respondents were from Nghe An Province in north-central Vietnam, and 50% of the respondents lived in a city. 52.5% had a university level education, and 67.5% of the sample stated that they had no religion. 40% of orchid keepers stated that they earned between 0 and 10 million dong (~\$426 USD) a month (see Table 1, Table S1 for a breakdown of the other categories). 37.5% of orchid keepers stated that they had only used Western medicine in the past 12 months (see Table 2, Table S1 for a breakdown of the other categories).

Over half of the orchid keepers stated that they only have orchids found in Vietnam (57.5%). The other 42.5% of the sample had orchids from a diversity of areas (or didn't know where they came from, 7.5% of the sample) (Table 1).

3.2 | Knowledge

Respondents were asked two knowledge questions and asked to give a True/False response to each. For “All orchid species are protected

Types of orchids	Percent response
Found in Vietnam, not found in Vietnam but found elsewhere in Southeast Asia	7.5%
Don't know	7.5%
Found in Vietnam, not found in Vietnam, but found elsewhere in Southeast Asia, not found in Southeast Asia, but found elsewhere in Asia, Don't know	5%
Not found in Vietnam, but found elsewhere in Southeast Asia	5%
Found in Vietnam, don't know	2.5%
Found in Vietnam, not found in Vietnam, but found elsewhere in Southeast Asia, not found in Southeast Asia, but found elsewhere in Asia	2.5%
Found in Vietnam, not found in Vietnam, but found elsewhere in Southeast Asia, not found in Southeast Asia, but found elsewhere in Asia, North America, Asia Europe, Pacific Islands, Central/South America, Australia	2.5%
Found in Vietnam, not found in Vietnam, but found elsewhere in Southeast Asia, not found in Southeast Asia, but found elsewhere in Asia, Europe	2.5%
Found in Vietnam, not found in Vietnam, but found elsewhere in Southeast Asia, not found in Southeast Asia, but found elsewhere in Asia, Pacific Islands, Africa	2.5%
Found in Vietnam, Central/South America	2.5%
Not found in Southeast Asia, but found elsewhere in Asia	2.5%

TABLE 1 Percent of orchid keepers with orchids found from areas other than Vietnam ($n=40$).

by the Government of Vietnam and cannot be harvested from the wild” the majority of respondents answered incorrectly, with 67.5% choosing “false.” For “There are no international regulations for trading orchids” the majority of respondents answered incorrectly with 60% choosing “false.”

3.3 | Attitudes, beliefs, and knowledge

The most agreement was elicited by the statement “I am proud that Vietnam has a diverse number of native orchid species growing in the forest” (CI: 4.7, 4.5–4.8, SE: 0.08) (Table 2) while the most disagreement (with variability) was elicited by the statement “Orchids should not be protected by international regulatory bodies, such as CITES” (CI: 1.7, 1.3–2.2, SE: 0.22). Orchid collectors “agreed” to “strongly agreed” that they liked to show their orchids to other and were proud of their collections, and were willing to receive advice and share their expertise with conservation NGOs. Orchid collectors believed that orchids should be protected in the wild, but were neutral regarding questions related to wild harvest, such as “It's not ok to take orchids from the wild and keep them in my collection” (CI: 3.1, 2.8–3.5, SE: 0.17). Orchid collectors in our sample had low knowledge about sustainable propagation practices, such as collecting orchid seeds “I know how to collect orchid seeds;” (CI: 2.3, 1.7–2.9, SE: 0.31).

3.4 | Behavior

The majority of our sample had harvested orchids from the wild (75%), and purchased endemic orchids from a local trader (65%), primarily online (92%) (Table 3). About a third had purchased international orchids from local traders, and 12.5% had purchased international orchids online. About a third (35%) had sold orchids to other

collectors; 85% of these individuals had sold orchids within Vietnam, while 14% (two individuals) stated that they had sold orchids internationally online, had sold orchids internationally in-person, and had obtained a CITES permit.

A third of the sample stated that they grow their own orchids from seed (Table 3), 35% stated that they are members of other orchid collecting groups, and 20% had used orchids as medicine. Of the respondents who had used medicine, 37.5% (3 respondents) had used orchids as medicine in the past 12 months. Ailments treated were nervous breakdown, fatigue, clear heat, sore throat, fever, bone and joint disease, liver ailments, treatment of cough, bronchitis, skinny children (malnourishment), and arthritis. 12.5% of the sample had provided orchids to others to be used as medicine.

3.5 | New Environmental Paradigm Assessment

The average aggregated NEP score was 2.94 (SD: 0.99) (“Neither agree nor disagree,” or neutral). Overall, the sample tended toward “Neither agree nor disagree” in response. All respondents tended most toward “Disagree” for the question “Humans were meant to rule over the rest of nature” and most toward “Agree” for “If human actions continue on their present course, we will soon experience a major ecological catastrophe”.

3.6 | Generalized linear model of predictors for harvesting from the wild

While the four predictors of sex, age, the belief “I have access to propagation equipment and supplies” and the past behavior of having bought orchids internationally were all shown to be significant in the univariate models, only “I have access to propagation equipment

TABLE 2 Confidence intervals for all attitude, belief, and knowledge questions, arranged in order of agreement, as measured by a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

Attitudes, beliefs, and knowledge of orchid collectors (n = 40)				
Question	Estimate	Lower Estimate	Higher Estimate	Standard Error (SE)
I am proud that Vietnam has a diverse number of native orchid species growing in the forest.	4.7	4.5	4.8	0.08
I like being able to show my orchids to friends and family.	4.4	4.2	4.7	0.13
I am proud of my orchid collection.	4.4	4.2	4.6	0.10
I would like to receive advice from international and local NGOs about propagation of orchid species.	4.2	3.9	4.6	0.18
I would be willing to share my expertise with international and local NGOs for conservation purposes (e.g., lab propagation of endangered orchid species)	4.2	3.8	4.6	0.20
Gifting orchids to others shows respect.	4	3.5	4.4	0.20
I would be willing to share my collection with international and local NGOs, for conservation purposes (e.g., research about orchid properties).	3.9	3.6	4.2	0.17
There are plenty of orchids left in the wild.	3.8	3.3	4.2	0.24
I am helping to conserve orchids by keeping them in my collection.	3.6	3.2	4	0.20
It's not ok to take orchids from the wild and keep them in my collection.	3.1	2.8	3.5	0.17
It's not ok to take orchids from the wild and sell them.	3.1	2.7	3.5	0.21
Cultivating orchids is not part of Vietnamese culture.	3.1	2.6	3.5	0.22
I can identify different species of orchids native to Vietnam.	3.1	2.5	3.7	0.29
I have access to propagation equipment and supplies.	3.1	2.5	3.6	0.29
Orchids have medicinal value	2.8	2.2	3.3	0.29
Harvesting orchids for their medicinal properties is OK.	2.7	2.2	3.3	0.26
At least 25% of my yearly income comes from selling orchids.	2.4	1.9	2.8	0.23
Orchids should not be protected in the wild by GVN.	2.4	1.9	2.8	0.24
I know how to collect orchid seeds.	2.3	1.7	2.9	0.31
Propagating orchids from seed is something I know how to do.	2.3	1.7	2.8	0.28
I know how to collect orchid pollen.	2.1	1.5	2.8	0.32
Orchids should not be protected by international regulatory bodies, such as CITES.	1.7	1.3	2.2	0.22

Note: The sample most strongly agreed with the attitude statement "I am proud that Vietnam has diverse number of native orchid species growing in the forest," and most strongly disagreed with the belief statement "Orchids should not be protected in the wild by international regulatory bodies, such as CITES."

and supplies" was significant in the multivariate generalized linear model ($p = 0.006$) (Table 4).

The odds of somebody harvesting from the wild and having access to propagation supplies is 2.36 times higher (beta estimate: 0.86, 0.23–1.62) than the odds of individuals harvesting from the wild who stated that they do not have access to propagation equipment (Table 4); that is, individuals who have propagation equipment are more likely to harvest orchids from the wild than those who do not.

4 | DISCUSSION

In this article, we present a quantitative perspective of orchid collectors in Vietnam, and attempt to identify characteristics

that define these individuals, as well as those characteristics that may influence "conservation negative" behaviors such as the wild harvest of orchids. We found that orchid collectors tended to be male, in their 30s, with a university education. More than half of orchid collectors only had orchids from Vietnam, and collectors with more species primarily had species that could also be considered comparatively "local," that is, from other parts of Southeast Asia and Asia. This emphasis on Asian species could be due to the high diversity of highly esthetic species already extant in Asia (e.g., Guo et al., 2015; Liu et al., 2015; Zizka et al., 2021). Collectors can (and do) collect directly from the wild, but they also have access to extensive, physical domestic markets with diverse, highly-valuable species (e.g., Gale et al., 2019; Phelps et al., 2014; Phelps & Webb, 2015). In support of this hypothesis, we found that most

orchid collectors had harvested from the wild and had purchased orchids from local traders, but only about a third of the sample had ever purchased international orchids locally, and only about 10% had purchased international orchids from international traders.

We found that orchid collectors did not have correct knowledge about the level of protection for orchid species in Vietnam; that is, the majority of respondents did not know that all species are protected and cannot be harvested from the wild. For the knowledge question “There are no international regulations for trading orchids,” the majority of the sample incorrectly stated “True.” It is possible that orchid collectors based their responses on their own experience selling orchids internationally (although only two of the collectors had ever done so), and/or observing other collectors selling and receiving orchids without any apparent penalties. Moreover, it is likely that awareness about local and international regulations is low in general among the Vietnamese public, as to our knowledge no educational campaigns nor behavior change campaigns have been implemented in Vietnam, focused on conserving orchids in the wild. This represents a comparatively “easy” opportunity for conservation organizations to intervene, as the threat of prosecution (even if realistically largely minimal

in Vietnam for orchid harvesting and trade (Bullough et al., 2021) might deter some orchid harvesters/traders.

The attitudes, beliefs, and knowledge of orchid collectors in our sample showed pride in Vietnam's diversity of orchids and the respondents' own orchid collections, as well as a willingness to work with conservation NGOs to share skills and knowledge. Orchid collectors in our sample did not appear to have high knowledge, nor easy access to, technical supplies, and technical expertise for orchid cultivation. This interaction could explain why harvesting from the wild was so common among orchid collectors; yet we also found an opposite effect in our linear model of access to propagation equipment and supplies being significantly more likely to result in wild orchid collection. Possibly this points to our statement being too general. “Propagation equipment and supplies” could encompass anything from a pair of scissors to a lab bench and agar media. Therefore, the individuals in our sample may have felt confident in keeping wild-harvested plants alive, but not confident in growing those plants from seed. Alternatively, individuals could be propagating orchids, but also supplementing from the wild to add to their own collection more rapidly and/or sell the orchids to others. One of the most desired genera, *Paphiopedilum*, takes upwards of 12 months to germinate, and takes about 5 years to flower. Consequently, it is easier and faster to harvest wild specimens. There is a small potential to encourage more adoption of sustainable propagation through teaching the skills that seem to be missing (as seen in our sample), and influencing a normative shift toward acceptance of the long timeframe for having a flowering orchid; however, Bullough et al. (2021) identified a strong desire in Vietnam for “authentic” wild-grown orchids, rather than propagated orchids. Conservation organizations should therefore prioritize messaging that shifts orchid collectors' attitudes toward acceptance of propagated individuals, which could link with awareness-raising messages about the rapid decline of species in Vietnam.

The effect of orchid collectors exhibiting pride and “passion” in viewing native orchids was also found by Bullough et al. (2021). This sentiment, coupled with the findings of this study of agreement among our sample with “There are plenty of orchids left in the wild,” as well as neutral attitudes toward wild collection, presents a potential opportunity for awareness-raising. While

TABLE 3 Stated behaviors of the sample ($n=101$).

Behavior	Orchid collectors (%)
Harvested orchids from the wild	75
Purchased endemic orchids from a local trader	65
• Purchased online	92
Purchased international orchids from a local trader	32.5
• Purchased online	92
Bought international orchids from international traders	12.5
Sold orchids to other orchid collectors	35
• Sold within Vietnam	85
• Sold internationally online + in-person + obtained CITES permit	14
Grow own orchids from seed	32.5
Member of other orchid collecting group	35
Used orchids as medicine	20

TABLE 4 Generalized linear model of predictors for harvesting orchids from the wild ($n=40$).

Variables	Beta estimate	Mean central odds ratio estimate—HOW	95% credibility interval—HOW	p —HOW
Demographic, socioeconomic, and orchid collection characteristics				
Sex	-0.24 (-3.10, 2.74)	0.78	(0.05, 15.43)	0.86
Age	0.07 (-0.04, 0.21)	1.08	(0.96, 1.23)	0.23
Knowledge, beliefs, practices				
I have access to propagation equipment and supplies	0.86 (0.23, 1.62)	2.36	(1.26, 5.07)	0.006**
Bought international orchids	1.14 (-1.93, 4.72)	3.12	(0.15, 112.17)	0.48

Note: **Significant according to threshold level of $p=0.05$.

awareness-raising alone may not result in behavior change (e.g., Olmedo et al., 2018), it is possible that some orchid collectors may be more likely to change their behavior if a campaign is designed both to encourage the identified pride in having diverse orchid species, and the true information that orchid species are rapidly disappearing from Vietnam.

We found that nothing we measured (other than access to propagation equipment, as discussed above) significantly influenced whether an orchid collector would harvest wild orchids. While this is important information, we suggest follow-up studies of semi-structured interviews with orchid collectors and harvesters that specifically investigate other possible contributing factors unexplored in our study; for example, whether wild harvesters started collecting wild orchids with others (friends, family); whether they collect wild orchids opportunistically as part of other activities (e.g., rice cultivation), and etc.

Finally, using the NEP framework, we wanted to assess the level of “environmentalism” ethos within our sample. Our sample tended toward neutrality. Environmentalism ethos (or lack thereof) was not found to be significant in influencing the likelihood of harvesting from the wild. This is important as it affirms that generally raising conservation knowledge and cultivating positive conservation attitudes will be less effective at addressing specific behaviors—such as wild orchid harvest—than targeted educational and/or specifically behavior change focused interventions.

5 | CONCLUSIONS

In support of Bullough et al.'s (2021) findings, we found that orchid collectors in Vietnam tend to lack identifying characteristics and easily identifiable motivations for engaging in illegal and unsustainable behaviors, such as wild orchid collection. Like Bullough et al. (2021), we also identified interest among orchid collectors in working with conservation organizations. Indeed, one of the orchid collectors who won the prize to receive a sustainably-grown orchid called a member of our research team to emphasize his willingness to work together further (T. Cao, *pers. obs.*). Collaborative initiatives could include the co-design of codes of conduct related to collection and harvest (e.g., IUCN SSC Orchid Specialist Group, 2021; Wong & Liu, 2019), and co-design of guidelines for sustainable harvest around community partners' land (Ticktin et al., 2023). Since collecting orchids from the wild is illegal at a national level in Vietnam, the law would have to be revised to provide for decentralized determination of legal, sustainable harvest, for example, at the provincial and/or national park level. Co-designed sustainable harvest plans would likely find support at these levels, as there is recognition that the traditional model of persecution of offenders is unsustainable, and unachievable (Dabis, E.O., Cao, T.T., *pers. obs.*). Many opportunities exist for conservation organizations, local NGO partners, local communities, and orchid collectors to conserve orchids collaboratively and effectively in Vietnam. From the basis of this preliminary research,

we hope to inspire the creation and eventual implementation of such conservation interventions, which could serve as a model for other global regions affected by illegal and unsustainable orchid harvest and trade.

AUTHOR CONTRIBUTIONS

Elizabeth Oneita Davis: Conceptualization, methodology; validation, formal analysis, investigation, data curation, writing—original draft, writing—review and editing, visualization, supervision, funding acquisition, project administration. **Adam Graves:** Conceptualization, methodology, writing—review and editing. **Heinfried Block:** Conceptualization, methodology, resources. **Christy Powell:** Conceptualization, methodology. **Trung Tien Cao:** Supervision, project administration.

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CONFLICT OF INTEREST STATEMENT

The corresponding author confirms on behalf of all authors that there have been no involvements that might raise the question of bias in the work reported or in the conclusions, implications, or opinions stated.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The Editor-in-Chief has waived the required archiving due to privacy or ethical restrictions.

ORCID

Elizabeth Oneita Davis  <https://orcid.org/0000-0003-3446-4471>

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SUPPORTING INFORMATION

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

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