The Thrill of Discovery: Significant Nature Experiences Among Biodiversity Citizen Scientists

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Abstract

The important role of direct experience in nature has sparked an interest in studying people's significant experiences in nature, yet few studies have addressed the nature experiences of biodiversity citizen scientists. For organizations involved in organizing biodiversity citizen science projects, or interested in improving recruitment and retention in existing projects, insight into which experiences in nature are especially memorable and impactful for participants can be used for effective communication or project design. To address this lacuna, this paper reports a thematic analysis of 1,450 significant nature experiences reported by Dutch biodiversity citizen scientists.

Respondents narrate a wide variety of experiences, ranging from the general to the particular and from the extraordinary to the everyday appreciation of nature. Discovery, that is, encountering plants and animals the respondent has not seen before, appears to be a critical factor in shaping significant experiences of biodiversity citizen scientists. This thrill of discovery is experienced both in remote locations and close to home. This, along with the relative prominence of rare or unique species and a sense of surprise in reported experiences, indicates that many respondents are deeply impressed when nature managed to catch them off guard. In addition, we discuss the importance of learning both as a motivator for and result of nature engagement among biodiversity citizen scientists. Based on our findings, we formulate several points of attention for organizations aiming to recruit and retain committed citizen

scientists for monitoring biodiversity, and discuss fruitful steps for further research. Key Words: Volunteer biodiversity monitoring—Citizen science—Connection to nature—Wildlife encounters—Peak experience—Coding.

Introduction

Direct experience in nature is considered vital for building an affinity toward and emotional connection with nature, which in turn are linked to proenvironmental attitudes and behavior (Nisbet, Zelenski, & Murphy, 2009). However, this important role of direct experience in nature has sparked concern over an increasing deficit of such experiences (Louv, 2005; Miller, 2005). As this deficit worsens, nature organizations search for new ways to get people outside and engage them with nature.

Nature-based citizen science is increasingly identified as a promising way to invite people to (re)engage with nature. The involvement of citizen scientists, volunteers from outside the walls of academia, in monitoring plants and animals is increasingly recognized as vital for biodiversity conservation (Cooper, Dickinson, Phillips, & Bonney, 2007; Dickinson, Zuckerberg & Bonter, 2010). However, citizen science is about more than data; biodiversity citizen scientists voluntarily engage with nature, and this engagement is meaningful and impactful for participants beyond their scientific contributions (Lawrence, 2006). Schuttler, Sorensen, Jordan, Cooper, & Schwartz (2018) argue that nature-based citizen science may be one way to offer the nature experiences needed for an increasingly urbanized populace to build a connection and commitment to nature.

Considering the value of biodiversity citizen science for research, conservation, and nature engagement, it is important to gain more insight into biodiversity citizen scientists' nature experiences. Not only will this contribute to our understanding of these experiences, but it is also important information for project organizers. Insight

into which experiences in nature are especially memorable and impactful for participants can be used for effective communication or facilitation of specific experiences, and to improve recruitment and retention in new or existing projects.

This paper uses a large data set ($N=1,450$) of significant nature experiences reported by Dutch biodiversity citizen scientists to thematically analyze the character of these experiences. We first discuss previous studies on the meanings tied to significant nature experiences, and the specific experiences of biodiversity citizen scientists.

Meanings of nature engagement

Exposure to and engagement with nature have been linked to increased connectedness to nature, learning, inspiration, and several physical and psychological dimensions of well-being (Capaldi, Passmore, Nisbet, Zelenski & Dopko, 2015; MacKerron & Mourato, 2013; Russell et al., 2013). Scholarly attention has thus turned to studying people's everyday (Bell, Westley, Lovell, & Wheeler, 2018; Skår, 2010) transformative (Chawla, 2009), transcendent (Fredrickson & Anderson, 1999; Williams & Harvey, 2001), or peak (McDonald, Wearing, & Ponting, 2009; Naor & Mayseless, 2017) nature experiences.

Richardson, Hallam, and Lumber (2015) specifically focused on the significant experiences people have in everyday nature. When asked to report "three good things in nature" every day for 5 consecutive days, their respondents noted many aspects of nearby mundane nature, including its sensations, growth and change, beauty, and active wildlife. Andrews (2018) found that her respondents reported a stronger sense of connectedness when directly present in nature and that they used language related to particular plants, animals, or natural phenomena when discussing a close relationship with nature. Several authors have focused on attachment to specific places and argued that direct presence and activities in, and experience with, a place contribute to a sense of attachment to it (Eisenhauer, Krannich, & Blahna, 2000; Ryan, 2005; Schroeder, 2007). Specifically focusing on significant wildlife encounters, Bell et al. (2018) found that these are characterized by qualities such as their unexpected or (conversely) their cyclical nature, or by a feeling of immersion. Curtin (2009, 2010) pointed at similar characteristics in her ethnographic analyses of wildlife tourists' nature experiences, although she also highlighted the significance of encountering new, rare, or large numbers of species.

The perspective of biodiversity citizen scientists

Previous studies have addressed biodiversity citizen scientists' key motivations, which may include protection of and connection with

nature (Ganzevoort, van den Born, Halffman, & Turnhout, 2017), learning about wildlife and nature (Domroese & Johnson, 2017), and sharing information and experiences with other people (Wright, Underhill, Keene, & Knight, 2015). However, while studying motivations for taking part in citizen science can aid in understanding which experiences are significant for participants, it is important for volunteer enthusiasm and retention that motivations are matched by actual experiences (Clary & Snyder, 1999; Wright et al., 2015).

A few studies have thus inquired into biodiversity citizen scientists' significant experiences. Bell et al. (2008), for instance, found that their respondents cherished the opportunity to learn about and be alone in nature but also the opportunity to share their experiences with others. Cosquer, Raymond, and Prevot-Julliard (2012) concluded from their study of garden butterfly recorders that participation became the starting point of an enduring habit of observing nature, in turn inspiring learning and reflection. Using an in-depth study of corncrake monitoring in Scotland, Lorimer (2008) highlighted several key experiences of participating field scientists (including volunteers), such as emotional highs and lows and honing the senses (p. 391).

Methodology

Participants

The data presented in this paper were collected as part of a larger online survey study ($N=2,193$) into Dutch volunteer biodiversity recorders (Ganzevoort et al., 2017). The goals of this study were to understand who is currently involved in biodiversity recording in the Netherlands (in terms of sociodemographics), the types of activities they undertake (including where, with whom, and taxonomic groups of interest), their motivations for monitoring, and their views on open data and data sharing. Data collection took place from September to October 2015. Biodiversity citizen scientists from across the Netherlands were recruited using online newsletters, e-mail lists, and social media of various Dutch nature and biodiversity organizations¹. Respondents all submitted biodiversity data into online repositories yet were otherwise highly diverse in terms of frequency of data submission, preferred taxa, and whether they acted independently or in consultation with a biodiversity organization.

¹These organizations included Sovon Dutch Centre for Field Ornithology; Reptile, Amphibian & Fish Conservation Netherlands (RAVON); Dutch Foundation for Botanical Research (FLORON); European Invertebrate Survey (EIS); Dutch Butterfly Conservation; The Dutch Mammal Society; Naturalis Biodiversity Center; and Waarneming.nl.

The question on significant nature experiences was optional, and we received 1,450 valid responses (66.1%). Mean respondent age of this group was 54.8 years ($n = 1,438$), men outnumbered women (71.9% to 28.1%), and respondents had been active as volunteer recorders for an average of 10.2 years. Respondents were highly educated, with 59.2% having completed higher education compared to 29.4% of the general population (Statistics Netherlands, 2018). These demographic characteristics were very similar to those of the larger survey sample², indicating that the decision to report a significant nature experience was not linked to these demographic characteristics.

Materials and analysis

After answering several questions about their monitoring activities, respondents were asked a few questions about their motivations and visions of nature. The first of these was an optional open question, asking respondents "What has been your most wonderful experience while monitoring?" We chose not to provide examples or suggested answer formats to our respondents (cf. Richardson et al., 2015) so as not to steer them toward specific types of experiences. Other questions on visions of nature and motivations came after this open question, also to prevent those answer categories from influencing the open responses.

The 1,450 reported experiences were bundled and uploaded into the Atlas.ti software package for coding and analysis. While the literature reviewed in this paper suggests a broad array of significant experiences in nature, we did not develop a typology based on this literature for deductively coding the data set. Instead, the data set was coded inductively based on the experiences described, and the words used, by the respondents. Since categorizing each reported experience into

Fig. 1. Eight thematic categories of wonderful experiences while monitoring biodiversity. Numbers between parenthesis refer to the number of responses coded with that code.

only one category would not do justice to the richness of the data, we chose to allow multiple codes to each response when needed, although identical codes were not repeated within one response. As such, the total number of codes applied is greater than 1,450 (see Fig. 1).

To mitigate the issue of subjectivity, development of the code list and coding of the data set were carried out through constant collaboration in a team of three researchers. The second author started the coding process and developed an initial living document of codes developed bottom-up from the data. At several points during this process all three researchers met to discuss these initial codes, their content (what did and did not fall under that code), and whether certain codes might be subcodes that could be subsumed under a larger concept. After several of such group discussions and refinements to the document, at which point the first half of the data set had been coded, the third team member took over the coding process to further ensure that code identification and application were not strongly influenced by the perspective of one researcher. Like in the initial stages, during this second stage of the coding process the

²Demographics of the full survey sample: mean age 53.7 years, 75.4% male, active for 10.4 years, 61.7% completed higher education.

three-person team met up regularly to discuss any newly emergent codes and fine-tune the way codes had been applied in the first stage in light of new information.

When the entire data set had been coded, the first author and the third team member independently coded a random set of 50 responses, followed by all three researchers coding another random set of 50 responses to see where remaining disagreements or differences in interpretation occurred. These occurrences were discussed and resolved and used to complete the final code list of 35 codes. Finally, at the end of this process it was decided to not repeat identical codes within one response, as noted above; the first author thus finalized the coding process by removing duplicate codes from the same response.

Results

Because respondents were free to determine for themselves what constitutes a significant experience, reported experiences ran the gamut between a single specific moment and a type of experience, species, or environment. In addition, 59 respondents (4.1%) reported more than one significant experience (these counted as one response), and 37 responses (2.6%) could not be assigned any code. After coding was concluded, the 35 codes were grouped into eight thematic categories as shown in Fig. 1. These thematic categories are briefly discussed below; for an overview of each code's definition and example quotes, see Table 1. In the text below, the percentages in brackets indicate how often each code was applied.

Observing species

Since our respondents are all active as biodiversity recorders, and our question referred to experiences while monitoring, it is not surprising that the two most common codes by far concern aspects of species observation. Specifically, the most common type of significant experience reported (by 33.5% of respondents) is the discovery of a plant or animal new to the observer, or rediscovering one not seen for a long time. Discovery could refer to both rare and everyday species; it was the sense of personal discovery that makes the experience memorable. In addition, almost as many respondents (31.7%) refer to specific species in their reported experiences; these could be anything from kingfishers to leeches. Another significant dimension of species observation appears to be learning about biodiversity: Respondents mention learning about ecology and animal behavior among others (7.1%), as well as recognizing and correctly naming species (3.5%).

Special observations

We identified several recurring elements that make observations special. The most common of these is a description of specific

behavior of the animal in question (13.9%); the behavior itself did not have to be special or rare, but it is the behavior that makes the observation significant to the respondent (e.g., witnessing a bird chase its prey). Unsurprisingly, rare or unique observations are frequently identified as memorable experiences (10.6%). Another dimension of wonderful experiences while monitoring concerns extraordinary numbers of a species at one point in time (4.7%). Finally, quite a few respondents (2.6%) specifically note that they consider all living beings wonderful and special, or that their significant experiences do not concern "special" species or circumstances.

Context

The next theme centers on the context of the observation; how the observation could be characterized. Most frequently, respondents refer to circumstances that made the moment special, such as the time of day or the weather (8.1%). A few respondents (0.6%) also link this specifically to a sense of hardship that had to be endured to make the observation. Wonderful experiences while monitoring also include moments where observers experienced a direct encounter with wildlife, inspired by proximity or some form of interaction (5.8%). While interactions are considered special, so are moments where animals did not notice the observer and continued their behavior undisturbed (1.8%). Finally, some respondents liken their most significant experience to a quest (3.2%): the observation is special because the observer was specially looking for, or expecting, a certain plant or animal.

Location

For some respondents, the location of an observation, or their monitoring in general, is just as significant (or even more so) than the plants or animals encountered. Observations in respondents' own gardens (3.2%) and in their own neighborhood or usual monitoring location (3.9%) stand out for some respondents. Another group of memorable observations, however, are those made when species were witnessed in their own habitat (2.6%). Finally, while a sense of discovery was most commonly linked to specific plants or animals, a few respondents (1.1%) also discuss the discovery of a new place: Monitoring wildlife sometimes brought a respondent to areas either new to them or with restricted access.

Nature characteristics

Several characteristics of nature, of specific species and/or natural landscapes in general, appear to make nature experiences significant. Over a hundred respondents (8.2%) refer to beauty, specifically to the

Table 1. Code Titles, Number and Percentage of Responses the Code Was Applied to, Code Descriptions, and Example Quotes for All 35 Codes

	COUNT	%	DESCRIPTION	EXAMPLE QUOTES
Observing species				
(Re)discovering species	486	33.5%	The observation is special because the respondent discovers a species or has never seen it before. This concerns a personal sense of discovery. Instances of rediscovery (not yearly repetition) are also included	"It's exciting to find a species that's new to me"
Species name	459	31.7%	The respondent names a specific species. This has to be more specific than classes (e.g., "bird")	"Seeing a beautiful kingfisher, or an osprey"
Learning	103	7.1%	The respondent makes clear he/she learns things, e.g., species names, behavior, ecology	"Nature is about learning how to observe"
Naming species	51	3.5%	The respondent notes that he/she can now recognize and/or name a specific species	"Naming species makes it even more fun, because then you understand better what exactly you're looking at"
Special observations				
Behavior	202	13.9%	The respondent notes or describes animal behavior; this behavior does not have to be explicitly referred to as extraordinary or special	"A fox walking through a flock of geese, and the geese barely responding, as in 'we can see you!'"
Rare/Unique	153	10.6%	The observation was special because it concerned a rare or unique species	"Discovering an extremely rare vagrant emperor"
Extraordinary numbers	68	4.7%	The observation was special due to the number of individual animals or plants witnessed at once. What counts as extraordinary depends on the circumstances and the respondent	"Discovering several hundred marsh valerians just at the edge of a ditch"
Not special	37	2.6%	The respondent explicitly notes that an observation or species does not have to be "special" to leave an impression, or that everything that lives is "special"	"Simple sightings of everyday species give me a rich feeling as well"
Context				
Circumstances	117	8.1%	The respondent makes clear that the circumstances (weather, time, temperature, etc.) contributed to making the observation special	"Singing nightingales on a beautiful summer evening at dusk on an otherwise empty heath"
Encounter	84	5.8%	The respondent experienced an encounter with an animal, either through proximity or the experience of an interaction	"Standing face to face with a roe deer, 5 meters between us"
Quest	46	3.2%	The respondent was expecting to find the plant or animal they observed or was explicitly looking for it	"When you find what you've been searching for (for so long)"
Undisturbed	26	1.8%	During the observation nature was not disturbed by the respondent's presence	"That I'm secluded so well that birds just go about their business without noticing that I'm there"
Hardship	9	0.6%	The respondent describes some form of hardship (cold, discomfort) they endured while in the field	"All my most wonderful experiences are under extreme circumstances, like long hikes in the pouring rain or extreme cold of -15°C"

(continued)

Table 1. Continued

	COUNT	%	DESCRIPTION	EXAMPLE QUOTES
Location				
Own neighborhood	56	3.9%	The respondent made an observation either close to home or at their regular monitoring location	"The unexpected discovery of a neighbourhood chock-full of common swifts, a short distance from my home"
Own garden	46	3.2%	The observation was made in the respondent's own garden or at their own home	"The immense variety in your own garden continues to fascinate and amaze me"
Habitat	37	2.6%	The observation was made in the natural habitat of the plant or animal	"Realising you found a good indicator species, so you know the biotope is of a good quality"
Place discovery	16	1.1%	The respondent discovered/explored a new area while monitoring	"Entering a nature area at the crack of dawn, one where other people are not allowed to come"
Nature characteristics				
Beauty	119	8.2%	Species, habitats, landscapes or settings are described as beautiful (or with related terms)	"The beauty of the early hours of the morning"
Diversity	49	3.4%	The respondent refers to diversity in species, behavior, colors, or natural features	"The immense diversity of plants and animals, even in the city centre"
Yearly repetition	35	2.4%	The respondent notes yearly repetition or cycles in nature, such as the passing of the seasons	"The peacock butterfly who's waiting for me at the start of each monitoring season"
Nature engagement				
Enjoying nature	121	8.3%	The respondent refers to being in nature or enjoying nature or the landscape	"Enjoying all the little things in nature"
Connection to nature	53	3.7%	The respondent describes a deeper sense of connecting with nature, e.g., a sense of awe or oneness with nature	"Being completely immersed in nature time and time again"
Being outdoors	41	2.8%	The respondent refers to (the joy of) being outside, without explicitly linking this to nature	"Enjoying being outdoors during the different seasons"
Autonomous nature	20	1.4%	Nature is described in terms of being free, pristine, or autonomous	"Experiencing nature's parallel reality, which is not concerned with issues of the day"
Internal impact				
Surprise	190	13.1%	The observation, species, or situation came as a surprise or was unexpected	"It's the unexpected observations I enjoy most"
Relaxation	63	4.3%	The respondent experienced a sense of rest or relaxation while monitoring	"Being alone in nature, silence and peace"
Fun	47	3.2%	The observation, or the process leading to it, is described as fun or entertaining	"It's just fun to do"
Wonder	38	2.6%	The respondent reports a sense of wonder regarding species, behavior, nature, etc.	"Sometimes I'm amazed at what you come across"
Emotion	37	2.6%	The respondent explicitly describes an emotional state, such as happiness, sadness, feeling strongly moved or excited, or a sense of freedom	"The feeling of happiness when you see something special"

(continued)

Table 1. Continued

	COUNT	%	DESCRIPTION	EXAMPLE QUOTES
Tension	21	1.4%	An observation, situation, or experience was memorable because of a sense of tension involved	"It's often exciting, what you could run into"
Religious	5	0.3%	Experiences in nature are linked to a sense of religious or spiritual wonder, e.g., God or creation	"A sense of wonder about creation"
Health	3	0.2%	The respondent notes the health benefits of their monitoring activities	"Peace of mind combined with physical activity"
External impact				
Photography	76	5.2%	The respondent explicitly describes being able to take pictures of an observation or situation	"Taking a picture of a species that only briefly shows itself and moves quickly"
Science and conservation	60	4.1%	The respondent discusses contributing to science or nature conservation by submitting records	"These are protected animals who need help"
Sharing experiences	58	4.0%	Either the respondent was in the field with others, or they later shared their experience with others. This social aspect goes beyond sharing data	"Our daughter enthusiastically telling other people about the beautiful things one can see"

Note. Titles in bold refer to the thematic categories.

beauty of plants or animals, the natural environment, or the circumstances (e.g., sunlight). In addition, diversity in nature appears to be highly valued; our respondents describe diversity in colors, species, behavior, or in nature more generally (3.4%). Another quality that several respondents (2.4%) point out is a sense of yearly repetition in nature, such as the passing of the seasons or how spring signals the return of many species.

Nature engagement

Biodiversity monitoring is one form of nature engagement, and in describing their significant experiences our respondents refer to different ways of appreciating and engaging with nature. Some simply mention the joy of being outside, without specifically referring to nature (2.8%), while others (8.3%) mention being in nature, or enjoyment of the landscape or the natural surroundings. Several respondents explicitly mention experiencing a deeper feeling of connectedness to nature through a sense of awe or immersion (3.7%). Finally, a few respondents (1.4%) express an appreciation of nature being free or autonomous, not subject to human interference.

Internal impact

The seventh theme brings together ways in which monitoring biodiversity shapes respondents' emotional, spiritual, psychological, or physiological well-being. These include a sense of rest and relaxation while monitoring (4.3%), a sense of wonder regarding species,

behavior, or natural phenomena (2.6%), or being caught in a moment of tension (1.4%). A few respondents also touch upon nature stimulating a sense or religious or spiritual awe (0.3%) or the contribution of monitoring biodiversity to their physical health (0.2%). While specific experiences are sometimes wonderful simply because of the sense of fun or joy involved (3.2%), respondents also narrate a wide diversity of emotional responses, including happiness and excitement but also sadness or feeling moved (2.6%). By far the most common of these, however, is a sense of surprise (13.1%): When species or phenomena caught the observer off-guard, the resultant sense of surprise appears an important factor in making the experience significant.

External impact

The final three codes concern sharing the results of biodiversity monitoring. Nature photography is one way of doing so, and 76 respondents (5.2%) specifically mention taking pictures during their most significant experience. Secondly, several respondents (4.1%) refer to submitting their observational data and in doing so contributing to biodiversity research and/or nature conservation. Finally, beyond sharing data, some (4.0%) narrate how their most wonderful moments involved sharing their monitoring experiences with other people. This social component could involve biodiversity monitoring with other people but also sharing experiences through conversations or social media.

Methodological Reflection

While our results provide important insights into the significant nature experiences of biodiversity citizen scientists, some methodological notes are in order. For instance, while our coding process of constant collaboration between three researchers may lessen the issue of subjectivity compared to coding by one researcher, numerical data on consistency were not calculated. Despite the many steps taken to strengthen consistency, it is thus important to keep this issue in mind. Care must also be taken when making generalizations. Our large data set, embedded in a national study among biodiversity citizen scientists with diverse engagement patterns, may provide more opportunities for identifying broader trends than a study at a much smaller scale. However, with no population statistics to compare our sample with, we must be cautious with generalizing our findings to the larger volunteer base of the Netherlands or other countries.

In addition, Curtin (2009) cautions that “words can fall very short when talking about wildlife experiences” (p. 458), especially regarding spiritually significant experiences in nature (p. 468). This raises the methodological question of whether significant nature experiences can even be elicited using written or verbal methods. Since Curtin (2009) noted this difficulty in ethnographic interviews, it is likely that an open survey question presents further difficulties for respondents. As such, our results may underrepresent deeply moving experiences in favor of experiences that are easier to put into words, such as discovery and fun. However, one significant advantage of our approach is the opportunity to study experiences of a much wider group of respondents than would be possible using more ethnographic approaches.

Conclusions

Our study aimed to elicit significant nature experiences of biodiversity citizen scientists. Respondents narrated a wide variety of experiences, ranging from the general to the particular and from the extraordinary rare to the everyday appreciation of nature. These include witnessing rare species or undisturbed animals, or large numbers of plants or animals; noticing animal behavior; enjoying beauty and diversity in nature; experiencing feelings of fun, surprise, or relaxation; and feeling a sense of wonderment in, or deep connection to, nature. This paper addresses a lacuna in the literature, as few studies have specifically addressed the nature experiences of biodiversity citizen scientists.

While some authors have noted the significance of first-time sightings for wildlife enthusiasts (Curtin, 2010; Folmer, Haartsen, & Huigen, 2013), the dominance of discovery in our respondents' most wonderful experiences was notable. The ability to discover new

plants and animals, whether in remote locations or close to home, appears to be a critical factor in shaping significant experiences of biodiversity citizen scientists. This, along with the relative prominence of rare or unique species and a sense of surprise, indicates that many respondents are deeply impressed when nature managed to catch them off guard.

However, while the thrill of discovery and surprise clearly resonate strongly, the importance of everyday nature and “unremarkable” sightings must also be emphasized (Richardson et al., 2015). Our respondents mentioned not only rare species but also common plants and animals, and several respondents cited familiar areas such as their own gardens or regular monitoring trajectories. Even the most common garden bird or flower can be an exciting discovery, and terms like “mundane” and “unique” will be interpreted differently from person to person.

Another dimension that seems to be of specific importance to biodiversity citizen scientists is learning. Learning is frequently noted to be an important motivation for citizen science participation, including biodiversity monitoring (Bell et al., 2008; Domroese & Johnson, 2017; Ganzevoort et al., 2017) and was found to play an important role in motivating people to act for nature (Van den Born et al., 2017). Quite a few of our respondents specifically discussed their learning process, both regarding species names as well as behavior, biodiversity, and ecosystems. Cosquer et al. (2012, p. 4) argue that a positive feedback loop exists between knowledge about and attentiveness to nature: Paying attention to nature increases knowledge, increased knowledge inspires more attentiveness, and so on. Learning thus appears to be both a key motivator for, and an important experience in, biodiversity monitoring.

In addition, quite a few respondents specifically referred to their contribution to science and conservation through submitting collected records. While the significant nature experiences of biodiversity citizen scientists might to some degree be comparable to those of other groups of nature enthusiasts (such as wildlife tourists), contributing to science and conservation may be one of the dimensions more unique to citizen science. The act of recording wildlife and submitting these records can be highly meaningful beyond the wildlife encounters themselves.

Implications and future research

While our results illustrate the diversity of what makes nature experiences wonderful, our analysis has identified some overarching patterns and points of attention for organizations aiming to recruit and retain committed biodiversity citizen scientists. Most striking is the experience of discovery, which was reported by a third of all

respondents. As such, nature organizations that work with volunteer recorders could facilitate discovery by providing information about species occurrence in different regions, as well as different methods of how to discover their presence. Notably, this should not be limited only to rare or flagship species, or special locations; everyday biodiversity close to people's homes may be just as significant in many cases, as long as a sense of discovery and surprise is nurtured.

This ties into the importance of learning as both a motivation for and benefit of participation in biodiversity citizen science. Learning was often mentioned as contributing to significant experiences, which indicates that stimulating volunteers' learning trajectories (e.g., through educational materials or fieldwork courses) may contribute to motivation fulfillment (Wright et al., 2015) by heightening the sense of significance in citizen scientists' nature experiences.

This interplay between experiences and motivations is not just of interest for practitioners but is also of scholarly interest. It should be noted, however, that we did not ask respondents whether their most wonderful experience was something they had specifically hoped for. Because the significance of an experience could be influenced by one's initial motivations or goals, incorporating this question would be an interesting next step.

Indeed, while the aim of this study was to elicit citizen scientists' experiences rather than motivations, previous studies on motivations of green volunteers provide some insights into how our experiential themes could be linked to different interests or behaviors (West & Pateman, 2016). For instance, among environmental volunteers both Ryan, Kaplan, and Grese (2001) and Asah and Blahna (2013) found that social and community-related motivations were important to ensure commitment. Biodiversity citizen scientists who emphasized social experiences in this study may be more committed to opportunities to connect with like-minded others (in person or online). These volunteers may consider other nature-based activities if they would offer social opportunities. This could contrast with those citizen scientists emphasizing diverse or specific species (Cole & Scott, 1999), undetected observation, or contributing to science and policy with their collected data.

As discussed above, we may also expect volunteers oriented toward a specific type of experience to value different modes of biodiversity citizen science (Measham & Barnett, 2008), such as invasive species programs for those interested in discovering new species or fulfilling a quest, or phenomenological projects for those valuing yearly repetitions in nature. Finally, one's most cherished experiences may influence how one deals with unpleasant circumstances (such as bad weather or harsh terrain). Those who simply want to be outside (Bruyere & Rappe, 2007, p. 513), relax, stay active (O'Brien,

Townsend, & Ebdon, 2010), have fun, or cherish everyday plants and animals may be more likely to avoid such challenging circumstances, whereas those whose key experiences are characterized by hardship, awe, or a deep connection to nature may enjoy the extra challenge (Lorimer, 2008). It should be restated, however, that using treasured experiences to predict behavior was not the aim of this study, and as such these potential implications should be considered invitations for future research.

Finally, we emphasize how the language used to communicate to volunteers should align with how they experience nature. Our findings match the observation by Buijs and Elands (2013) that lay representations of nature are oriented more toward individual animals or plants, rather than more abstract concepts such as "habitat" or "ecosystem." Especially with the current dominance of more instrumental and economic approaches to nature, for example, the discourse on ecosystem services, it is important to not lose sight of how people actually reflect on their engagement with nature (Chan et al., 2016). Project organizers or involved scientists ought to be careful with more abstract and detached terminology and favor more emotional and evocative descriptions of nature, as these may invite stronger connectedness and relationships with nature (Andrews, 2018).

Our findings, while an important first step, also serve as an invitation for further research on this topic. Future studies could extend a similar methodological approach to citizen scientists in different parts of the world, or to green volunteers more generally (e.g., nature restoration or educational activities in nature). Interviews or focus groups with biodiversity citizen scientists could also complement our results and would provide an opportunity to study some of the dimensions we identified in greater depth. Our work hopefully inspires further research into the significant nature experiences of biodiversity citizen scientists and the deeper meanings they attribute to their engagement with nature.

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