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# The role of BioBlitzes in citizen science: insights from participants and experts

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Beyond its primary role in generating scientific knowledge, citizen science also carries a potent educational dimension. An example of citizen science activities is BioBlitzes, which are collaborative events that bring together both experts and citizens, all united by a common mission: to register species observations within a defined geographical area during a predetermined time frame. In addition to comprehensively characterizing BioBlitz participants across sociodemographic, emotional, and cognitive domains, this study seeks to gain insights into the overall perceptions held by BioBlitz experts regarding these events and their participants. By considering both perspectives, we strive to achieve a more holistic understanding of BioBlitzes, elucidating their significance and impact on both the individuals participating and the broader scientific community involved. The analyzed sample corresponded to 96 participants and 11 experts. The evaluation made by the 96 participants was carried out by applying a pre-questionnaire and post-questionnaire, which allowed us to conclude that the participants, in the short term, acquired some knowledge during the event, but few emotional changes were detected. The evaluation made by the 11 experts was carried out in two online focus group sessions. It was concluded that there is a general opinion that citizens and experts learn during a BioBlitz and appreciate the social dimension of these experiences and that citizens leave the BioBlitz with more awareness of nature conservation issues.

## KEYWORDS

biodiversity monitoring, community effort, biological survey, iNaturalist, digital platforms, environmental education, science communication

## Introduction

Citizen science, often defined as the active participation of citizens in scientific research and environmental monitoring (Miller-Rushing et al., 2012), has emerged as an important tool in the realm of scientific investigation. Beyond its primary role in generating scientific knowledge, citizen science also carries a potent educational dimension (Phillips et al., 2019). At present, many citizens are actively engaged in a wide array of conservation projects, focusing on critical subjects such as invasive species, ecological restoration, and climate change, among others (Hurlbert and Liang, 2012; Crall et al., 2013; Huddart et al., 2016; Aceves-Bueno et al., 2017). Consequently, they wield the potential to significantly advance the field of science through multifaceted contributions encompassing data collection and analysis, fundraising endeavors, collaborative brainstorming, experiential learning, and even the creation of engaging games (Serrano et al., 2014; Roger and Klistormer, 2016). By

contributing to environmental monitoring, particularly biodiversity, not neglecting a strong educational component, citizen science plays a very relevant role in its conservation, as evidenced by numerous studies (Theobald et al., 2015; Kobori et al., 2016; Chandler et al., 2017).

An example of citizen science initiatives is BioBlitzes, which are dynamic and collaborative events that bring together both experts and citizens, all united by a common mission: to register species observations within a defined geographical area during a predetermined time frame (Roger and Klistorner, 2016; Parker et al., 2018; Postles and Bartlett, 2018). This engaging concept had its first event at Kenilworth Park and Water Gardens in Washington, United States, back in 1996, drawing the participation of scientists and wildlife experts and uncovering over 900 species (Baker et al., 2014; Parker et al., 2018; Fenster, 2023; Meeus et al., 2023). This event's objectives encompassed scientific research, conservation efforts, management strategies, education, public relations, and social engagement (Meeus et al., 2023). Since this first BioBlitz, the concept has been steadily gaining space, with enthusiasts from around the world organizing similar events (Palma et al., 2022; Meeus et al., 2023). Such endeavors may not only empower citizens to directly participate in scientific activities but also foster a deeper sense of environmental stewardship and a heightened understanding of the natural world (Leong and Kyle, 2014). In an age where environmental challenges are increasingly pressing, citizen science offers a collaborative and inclusive approach to scientific discovery and environmental protection (Fraisl et al., 2022).

One of the defining features of BioBlitzes is their versatility in terms of location—these events can happen in a wide range of settings, from rural landscapes to urban environments, solely on the premise that species will be identified and recorded (Baker et al., 2014; Roger and Klistorner, 2016; Parker et al., 2018). BioBlitzes are typically organized by a diverse range of institutions, including municipalities, museums, natural parks, environmental non-governmental organizations (NGOs), zoos, and other entities (Parker et al., 2018). The objectives behind these gatherings are as diverse as the species they register. Some focus on unearthing and studying rare or elusive species in specific places (Parker et al., 2018), while others aim to create comprehensive species lists for the area (Robinson et al., 2013). Importantly, many BioBlitzes are designed with a strong educational component in mind, often striving to engage the community in the registration and identification of species (Robinson et al., 2013). Indeed, these events can serve as an opportunity to introduce residents to the green spaces in the places they live, thus promoting a connection with biodiversity (Lundmark, 2003; Baker et al., 2014; Roger and Klistorner, 2016).

Therefore, these events may offer multifaceted benefits from providing data for scientists and researchers (Parker et al., 2018), engaging citizens in hands-on scientific exploration (Baker et al., 2014; O'Donnell and Brundage, 2023), and fostering an appreciation for the green spaces near communities (Roger and Klistorner, 2016). Moreover, they contribute to raising awareness about biodiversity conservation in general as well as promoting active participation in environmental stewardship (Lundmark, 2003). These periodic and seasonal events can be repeated throughout time and serve as ongoing monitoring tools for specific locations,

facilitating longitudinal ecological studies and assessments (Meeus et al., 2023).

Participants and experts can leverage internet applications to identify and record species during BioBlitzes, enhancing the overall process and harvesting the various objectives and advantages associated with such activities (Aristeidou et al., 2021). The involvement of participants in recording species through applications may make them more actively engaged and ensures that data become quickly and easily accessible. A prime example of such a digital tool is the "iNaturalist" application (<https://www.inaturalist.org>), a user-friendly platform that allows individuals to seamlessly capture photographs or even sounds of organisms directly through the application itself (Aristeidou et al., 2021). Once a user captures one or more images, the iNaturalist platform offers a potential identification for the observed organism using an automated identification tool trained on the database of "research-grade" observations (observations whose identification has already been validated by the community) (Wäldchen and Mäder, 2018). It not only aids in identifying the species but also automatically records crucial metadata, including the geographical location of the sighting, date, and time. The convenience and accuracy of this tool are further enhanced by the participation of the broader iNaturalist community. This means that users of the platform can lend their expertise by confirming or providing alternative identifications with a simple click, fostering a collaborative environment for species verification and data validation (Aristeidou et al., 2021).

Previous studies evaluated BioBlitz participants through questionnaires or interviews and showed that these events are a good way of communicating science and learning (Roger and Klistorner, 2016; Postles and Bartlett, 2018; Gass et al., 2021). In addition, Roger and Klistorner (2016) collected experts' opinions regarding this type of event. They considered that BioBlitzes are important for communicating science and a good method of learning about science, but that their scientific value is of less relevance. Furthermore, both participants and experts mentioned that they enjoy interacting with each other during these initiatives, and experts say that it is a good opportunity for them to learn how to communicate better with lay audiences.

As BioBlitzes are events with activities for all ages, where there is socializing and learning, participants typically cover all age groups (Postles and Bartlett, 2018) and are accompanied by family members (Leong and Kyle, 2014). It was argued that participants acquire new skills during BioBlitzes (Postles and Bartlett, 2018) and that they can learn about research techniques in the field (Roger and Klistorner, 2016). That is, in addition to learning about species, they also acquire knowledge about the various research techniques that experts use for environmental studies. Furthermore, other researchers concluded that BioBlitzes provide participants with the possibility of contributing to science and that they feel that they have contributed (Leong and Kyle, 2014; Gass et al., 2021). In some research studies, it has been found that participants derive enjoyment from being in natural settings, as highlighted by studies conducted by Roger and Klistorner (2016) and Gass et al. (2021). These findings underscore the positive inclination of individuals in spending time in natural environments.

Considering what endures after a BioBlitz, some studies mention that participants often express a desire to take positive actions, such



FIGURE 1

Study area in the metropolitan region of Lisbon, including the locations of the six BioBlitzes (1: Urban Park, Quinta de Recreio do Marquês de Pombal; 2: Coast Area of Oeiras; 3: Urban Park, Serra de Carnaxide; 4: Garden, Fundação Calouste Gulbenkian; 5: Urban Area, ISCTE; and 6: Urban Park, Parque da Paz) located in three different municipalities of the region.

as engaging in wildlife-friendly gardening, volunteering for various environmental initiatives, contributing to environmental organizations, or making positive contributions to society (Leong and Kyle, 2014; Postles and Bartlett, 2018). Additionally, research indicates that participants tend to advocate for biodiversity conservation and develop a positive attachment to the location where the BioBlitz occurred (Leong and Kyle, 2014; Gass et al., 2021). Furthermore, findings by Pollock et al. (2015) highlighted that participants believe in the potential for changes in their thoughts and behaviors, especially in their perspectives on biodiversity.

In other studies, it was found that participants like being in natural settings (Roger and Klistorner, 2016; Gass et al., 2021) and that most participants in these events are interested in learning more (Postles and Bartlett, 2018).

All studies mentioned above focused on evaluating participants/experts during one or more BioBlitzes. Only the study by Gass et al. (2021) concluded that the iNaturalist application is what makes the event a valuable experience. Aristeidou et al. (2021) went further and focused on evaluating the content, activity rate, duration, and frequency with which citizens used the application after having participated in at least one BioBlitz. After the event, they also found that most participants used the application for 1 or 2 days and never used it again. Therefore, they concluded that participants should be encouraged to continue using the application after the event.

Our study seeks to offer a thorough understanding of the experience of BioBlitz participants by delving into three domains: sociodemographic, emotional, and cognitive. Additionally, we aim to explore the overarching perceptions held by BioBlitz experts concerning these events and their participants. By considering both participant and expert perspectives, we strive to capture a more holistic view of BioBlitzes, understanding their significance and impact on individuals and the scientific community alike. Through this study, we aspire to enhance our understanding of the pivotal role of BioBlitzes as citizen science events.

## Methods

Six BioBlitzes were analyzed in this study which took place in different locations in the Lisbon region (Portugal). They were organized by municipalities or institutions in partnership with the Portuguese platform BioDiversity4All. All these locations were defined by these entities and were not chosen specifically for this study (Figure 1).

BioDiversity4All is a Portuguese online platform dedicated to biodiversity recording to involve citizens in scientific endeavors and enhance their knowledge in this field. It was initially launched in 2010, and as of November 2023, it has accumulated about 1,500,000 observations spanning 19,507 species. Since 2018, it has become connected with the international platform iNaturalist, serving as the Portuguese node for this project. BioDiversity4All was the co-organizing entity for the studied BioBlitzes, and the registration platform was iNaturalist, which is the application shared by both entities.

To address the main objective of this work, i.e., understanding the role of BioBlitzes in citizen science, two methodological approaches were adopted to characterize the participants of BioBlitzes and to understand the general perceptions that BioBlitz specialists have regarding these activities.

## Evaluation made by participants through questionnaires

To assess the participants of BioBlitzes, a quantitative approach was employed, involving the administration of both a pre-questionnaire (immediately before the BioBlitz) and a post-questionnaire (immediately after the BioBlitz). Although it is unlikely that a single participation has much effect on participants, it, nevertheless, seems important to understand the effects of each studied event. For example, it seems likely that a good experience from an emotional and cognitive perspective on a

BioBlitz is probably key to stimulating participation in future events and/or sharing positive comments with family and friends.

Participants were approached to fill in these questionnaires by the second and third authors of this study, who were not directly involved in the organization of the BioBlitzes. These researchers started with a brief explanation about the study and the request for the signing of the informed consent. They were present throughout these events, providing help and further explanations and making sure these were filled in independently by participants. Each of the six BioBlitzes was a single-day event, in which participants returned their questionnaires on paper to the two mentioned authors immediately before and after the BioBlitz.

The questionnaires aimed to assess participation in three domains: sociodemographic, emotional, and cognitive. The sociodemographic domain was exclusively assessed in the pre-questionnaire, providing information about the participants' age, gender, educational level, field of study, and place of residence. In the emotional domain, the goal was to gauge the significance of nature to participants, along with their motivation and interest in engaging in such events and changing their behaviors. In the cognitive domain, efforts were made to assess participants' knowledge and opportunities for learning (see [Supplementary Appendix SA1](#)).

The questionnaire consisted of closed-ended questions (in which participants could select one or more answers from the provided options) and open-ended questions (in which participants formulated their responses). For this questionnaire, an effort was made to include as many closed-ended questions as possible because they facilitate data analysis and require minimal effort on the part of participants. Since some questions could be considered intrusive, potentially leading to non-response or causing participants to abandon the questionnaire, the option "don't know/prefer not to answer" was included for all questions ([Jensen and Laurie, 2016](#)). For questions related to satisfaction and the rating of parameters, a Likert scale ranging from 1 to 5 was used, with 1 indicating "very dissatisfied" and 5 indicating "very satisfied" ([Nemoto and Beglar, 2014](#)).

This study was submitted and approved by the Ethics Committee of the Faculty of Sciences at the University of Lisbon. The questionnaire comprised 29 questions, with 18 in the pre-questionnaire and 11 in the post-questionnaire. Five questions were identical in both the pre-questionnaire and post-questionnaire, thus allowing for a direct comparison of participants' responses before and after their participation in a BioBlitz event.

To validate the questionnaires, they were tested with a group of eight individuals working outside the environmental field and three experts working in the environmental field to assess their appropriateness. During this process, it was verified whether all the questions were understood, and the time of response to each part of the questionnaire was noted. This was done to eliminate potential interpretation errors and increase the questionnaire's reliability ([Synodinos, 2003](#)).

The first page included a brief explanation about the study, the anonymity and confidentiality of the questionnaire, instructions for completion, the estimated time required, and finally, informed consent for participation. All participants were requested to complete the questionnaires without assistance from other participants or individuals to ensure that the results were not influenced by external factors. The questionnaires were

distributed in paper format since this was considered a practical way to collect this information. This option was intended to avoid the overuse of mobile phones, which were already being used to run the application iNaturalist for species identification and registration.

## Evaluation made by experts through online focus groups

For the evaluation made by experts, the qualitative method online focus group (electronic focus group) was used to assess their perspectives through a set of questions. The experts were selected based on two criteria: they must have previously guided a BioBlitz and, in each discussion group, belong to different taxonomic groups. These experts did not necessarily participate in one of the six BioBlitzes used in the present study.

The technique known as a focus group, also referred to as a discussion group, is a group interview with a moderator that asks questions and aims to understand what the selected participants perceive about a particular topic [adapted from the work of [Schröderda and Klering \(2009\)](#)]. Since this study was conducted online, they are referred to as online focus groups or electronic focus groups ([Schröderda and Klering, 2009](#)). They are useful and recommended as a research method when one wants participants to express their ideas, concerns, experiences, or views on specific events ([Schröderda and Klering, 2009](#)). In addition, they can yield a lot of data and are relatively quick, easy, and cost-effective compared to other methods ([Rabiee, 2004](#); [Schröderda and Klering, 2009](#)). However, they can also have some disadvantages, such as the difficulty of analyzing data due to the social environment with many comments or the challenge of gathering a willing group of participants ([Schröderda and Klering, 2009](#)). These difficulties were mitigated by the fact that the first author specialized in BioBlitzes in Portugal, with the knowledge and personal contacts of experts in this field. This enabled an appropriate choice of experts and management of their participation during the online focus group sessions.

This study aimed to collect data on the general perceptions of experts about BioBlitzes, in which the questionnaire for the focus group sessions consisted of eight questions (see [Supplementary Appendix SA2](#)) designed to avoid simple "yes" or "no" answers. In addition to these, there were three additional questions in case there was extra time and/or if any question(s) did not generate discussion. Each session was planned to have a duration of 50 min (with extra 10 min for delays), and efforts were made to include an expert from each of the main groups of living organisms considered in these activities (e.g., birds, insects, and plants). All participants provided written informed consent for participation. These two focus groups were done remotely by using an Internet video call program, one with a group of six experts and another with a group of five experts ([Schröderda and Klering, 2009](#)).

## Data analysis

### Characterization of participants

Handling multiple responses: In the question about the participant's level of education, when a participant selected



multiple options, the highest level of education was chosen. Similarly, for the question about their field of study, if a participant selected multiple options, the area corresponding to their current profession, as indicated in the question about their current profession, was chosen. If a participant selected “other” in response to their field of study, the Portuguese Directorate-General for Higher Education website was consulted to determine the field associated with their profession.

**Location data categorization:** This information was categorized into “very close municipalities” (within a 10 km radius of the BioBlitz location), “nearby municipalities” (between 10 and 30 km from the BioBlitz location), and “more distant municipalities” (over 30 km from the BioBlitz). Google Earth Pro was used to obtain this information (Google, 2023).

**Analysis of knowledge acquisition:** This was assessed based on the difference in responses between the pre-questionnaire and post-questionnaire. Participants were categorized as having “acquired significant knowledge” (if they filled in 4–6 more fields in the post-questionnaire than in the pre-questionnaire and/or if the word count per field increased by 3–4 words in the post-questionnaire compared to the pre-questionnaire), “acquired some knowledge” (if they filled in 1–3 more fields in the post-questionnaire than in the pre-questionnaire and/or if the word count per field increased by 1–2 words), or “did not acquire knowledge” (if there was no increase in the number of words or if the species mentioned in the pre-questionnaire were the same as in the post-questionnaire). These three categories, as well as the number of fields and words in each, were defined according to the obtained data.

**Emotional domain analysis:** After carrying out a normality test of all emotional variables using the Shapiro–Wilk test ( $p < 0.05$ ), a non-parametric Wilcoxon matched-pairs test was conducted to determine whether differences in responses between the pre-questionnaire and post-questionnaire were statistically significant. The responses “don’t know/prefer not to answer” were excluded from this analysis. Additionally, correlation analysis between the variables “age,” “sex,” and “educational level” was related to the variable “satisfaction with the event.” Since these variables were not normal, a non-parametric Spearman correlation was used to assess these correlations.

**Handling incomplete responses:** In all questions, if a participant did not respond to a question or left it blank or wrote “-,” it was assumed as “don’t know/prefer not to answer.” If a participant responded to the “other. What?” option, a new response category was added.

**Software used for data analysis:** Data analysis was performed using Microsoft Excel (Microsoft, 2022) for most questions, except for questions related to the emotional domain, which were analyzed using IBM SPSS Statistics 28 (IBM, 2022).

## Online focus groups

For the evaluation made by experts using this method, a full transcription of both focus group sessions was carried out, and the participants’ interventions were anonymized. Following transcription, the text was organized according to a predefined list of key themes: the advantages and disadvantages of BioBlitzes for participants and experts; the motivation of experts in BioBlitzes;

and understanding whether experts consider BioBlitzes an effective data collection method (see [Supplementary Appendix SA2](#) for details) (Bryman, 2016; Braun et al., 2017). The cases of doubts in the classification of key themes were resolved in discussion between the three authors until reaching a consensus (Morgan, 1996).

## Results

### Analysis of BioBlitz events

The six BioBlitz events took place in three urban municipalities (Lisbon, Oeiras, and Almada) within the Lisbon metropolitan area (see [Figure 2](#) for details).

### Evaluation made by participants through questionnaires

For the evaluation made by the BioBlitz participants, a total of 107 questionnaires in paper format were obtained. However, as some participants did not properly complete all the questions, only 96 questionnaires were considered.

Out of the total of 96 participants, 59 were females, 35 were males, one was non-binary, and one did not reply. The majority belonged to the age group of 35–44 years, for males and females, and the age group with the fewest participants was the 55–64 years age group for both sexes ([Figure 3](#)). Most participants held a bachelor’s degree, followed by those with a master’s degree or postgraduate qualification ([Figure 3](#)) and backgrounds in life sciences, followed by social and behavioral sciences, and closely behind, health sciences ([Figure 3](#)). Concerning the profession of the participants, the majority worked in the service sector, and a few were retired ([Figure 3](#)). Considering gender, one person preferred not to answer and another person responded non-binary.

Almost half of the participants were from the same municipality where the BioBlitz was held, while less than 5% of participants traveled more than 30 km to attend these events ([Figure 4](#)). In all three municipalities evaluated, the majority of people belonged to the same municipality. This is an indication that participants tend to choose BioBlitz sites that are closer to the place where they live.

Most participants had never been in a BioBlitz before (74%), 16% of participants had attended only once, and only 7% had participated more than once. No participant attended more than 10 BioBlitzes, and 3% preferred not to answer.

Concerning the reasons of participation of people in the previous and present BioBlitzes, results indicate that participants greatly appreciate spending time in nature with family and/or friends while learning about species identification and something new about a geographical area ([Figure 5](#)).

This is consistent with the fact that most participants came to the BioBlitz accompanied by family members (50%), followed by participants who came with friends (26%). Only few people attended alone (17%), just six came with both family and friends (6%), and 1% did not respond. It should also be noted that 45% of participants became aware of the BioBlitz events through friends/



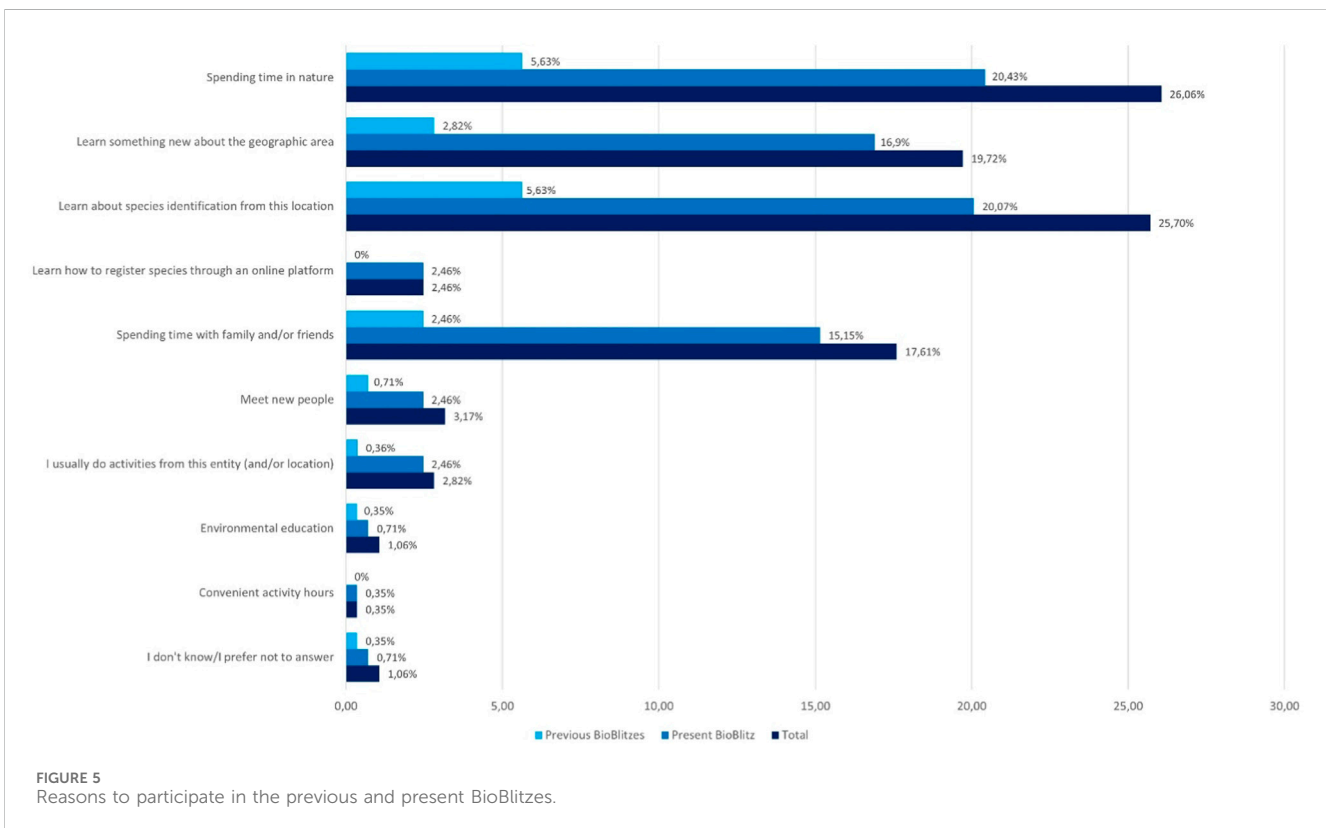
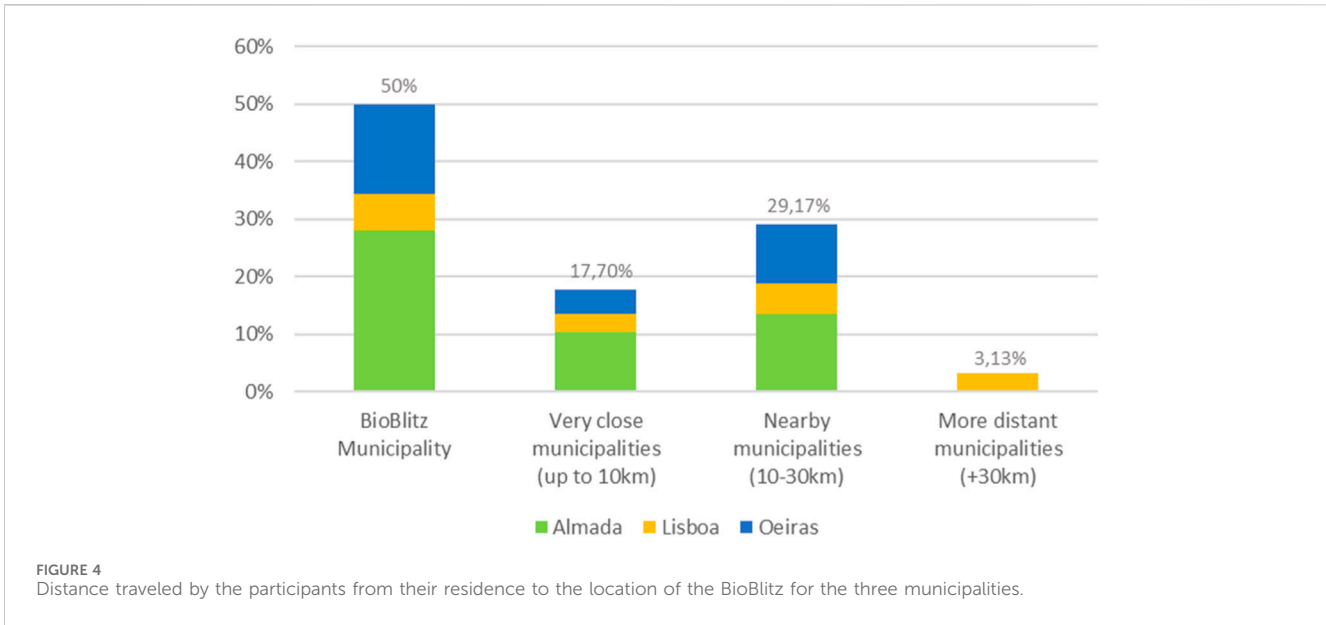
**FIGURE 2** Detailed information about the BioBlitzes (designation, date, duration, number of taxonomic groups evaluated, and number of species and observations recorded). Blue informational labels—Oeiras municipality; yellow informational labels—Lisbon municipality; and green informational labels—Almada municipality.



**FIGURE 3** Sociodemographic characterization of the participants: age, gender, education (educational level and field of study), occupation, and employment.

acquaintances/family. Therefore, the results suggest that BioBlitzes tend to be social activities in which enjoying time with family and friends is an important factor.

The primary reason to choose a specific taxonomic group to attend was curiosity, learning, and interest (45%), followed by the availability to attend the event (23%); 20% chose 'do not know/



not answer’, and finally, 12% indicated the motivation to accompany family member(s) or minor(s).

Out of the total of 96 participants, the majority (67%) were very satisfied or satisfied (31%) with the event they took part in, with only 2% of the participants claiming to be very dissatisfied. Finally, no one selected the categories “neither dissatisfied nor satisfied” and “dissatisfied.” Five parameters of the level of satisfaction were analyzed through a Likert scale, and the

results obtained for all were high (more than 4) (Table 1). Despite this, the parameter that obtained the highest value was the researcher’s communication skills, while the aspect they liked the least was the timing of the activity. In addition, the correlational analysis between satisfaction with the event and with the main sociodemographic characteristics of participants showed that age ( $R_s = -0.113$ ;  $p = 0.302$ ) and sex ( $R_s = 0.001$ ;  $p = 0.996$ ) were not significant, but that the educational level

TABLE 1 Average value on the Likert scale (1–5) assigned to each analyzed parameter.

Parameter	Average value
Information transmitted	4,705 ± 0,596
Researchers' communication skills	4,789 ± 0,541
Location of the activity	4,621 ± 0,635
Activity time	4,468 ± 0,695
General organization	4,596 ± 0,607

( $R_s = 0.378$ ;  $p < 0.001$ ) was significant and directly proportional to this satisfaction level.

When asked about the positive aspects of participation in BioBlitzes, the most selected answer was to identify species and learn about them, followed by observing and/or hearing the species and having an expert share their knowledge during the visit. Additionally, responses highlighted the positive aspect of

connecting with nature, and finally, some participants mentioned that they enjoyed everything about the BioBlitz without mentioning specific reasons (Figure 6). Considering the negative aspects, most participants reported that they had nothing negative to note about the BioBlitz they participated in. Next, some participants expressed dissatisfaction because they expected to find more species than they observed. Some participants reported that the event was either too long or too short, and others noted that the weather conditions were not suitable. A few participants pointed out confusion, crowds, dispersion, and/or noise as the negative aspects of the BioBlitzes. Some participants mentioned personal injuries resulting from the activity, while others indicated there was either too much or too little information exchange. Finally, one response mentioned that the timing and day of the activity were not suitable, and another response highlighted an excessive emphasis on the phone application “iNaturalist” used during the BioBlitz (Figure 6).

The majority of participants (61%) have the intention to continue making records in the phone application “iNaturalist”. Only 7% the participants mentioned that they did not have the

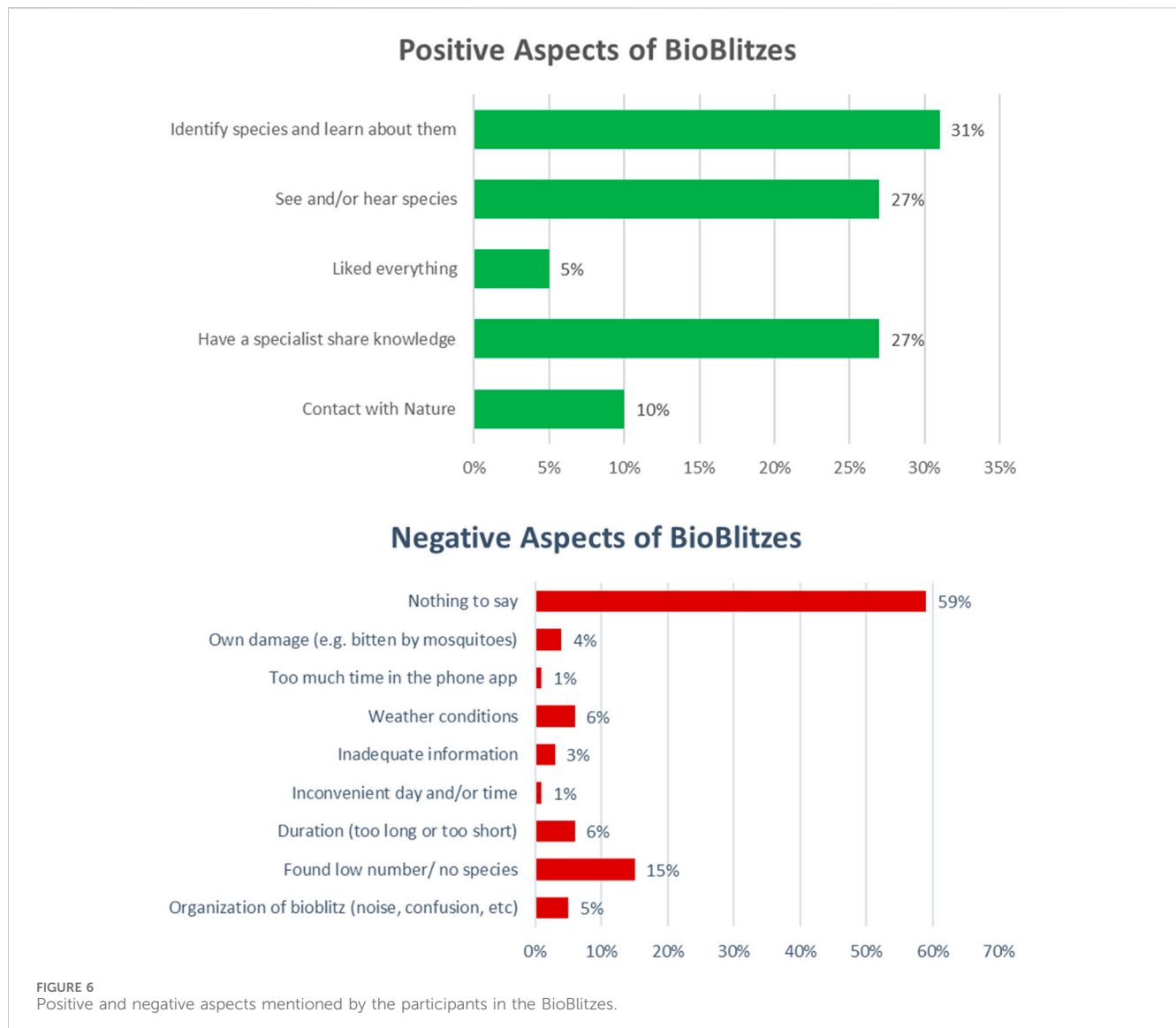




TABLE 2 Average values of the emotional parameters of the BioBlitz participants measured in pre-and post-questionnaires using the non-parametric Wilcoxon test.

Question	Assigned average value		Z	Wilcoxon test
	Pre-questionnaire	Post-questionnaire		
Nature has great importance in my life	4.82 ± 0.441	4.81 ± 0.393	-0.277	0.782
I enjoy learning about nature through these types of events	4.74 ± 0.441	4.78 ± 0.419	-0.775	0.439
I have an interest in the knowledge and observation of living beings	4.71 ± 0.484	4.74 ± 0.492	-0.832	0.405
I am concerned about the negative impacts of human actions on nature	4.92 ± 0.317	4.89 ± 0.310	-0.707	0.480
It is important to me to have a green space near my home	4.92 ± 0.277	4.87 ± 0.338	-1.414	0.157
I have a deep knowledge in the field of identifying living beings	3.06 ± 0.968	3.28 ± 0.995	-2.465	0.014*

\*Statistically significant— $p < 0.05$ .

intention to continue making records, and finally, 32% of the participants indicated that they were unsure whether they would continue using it and/or prefer not to respond.

Out of the total of 96 participants, 49% acquired some knowledge, 34% participants did not acquire knowledge, and only 17% acquired a significant amount of knowledge. Out of the participants, 5% already had a very high degree of knowledge on the topic before the BioBlitz began.

It was found that participants are especially concerned with the negative impacts of human actions on nature and attributed a high value to green spaces near their homes (Table 2). On the other hand, participants did not consider having a deep knowledge of species identification. This was the only parameter that had a significant change in responses between before and after the BioBlitz.

## Evaluation made by experts through online focus groups

As for the evaluation made by the experts, six specialists participated in one focus group and five specialists participated in another. Experts considered that participants learn and gain awareness about nature during their involvement in BioBlitzes. In addition, they still socialize with other people, while gaining knowledge of how specialists' fieldwork is carried out. On the other hand, they noted that one of the negative aspects for participants is the short duration of some BioBlitzes, which does not allow participants to learn how to use the phone application properly. It was suggested that there should be an initial phase (conducted before the activity) to teach participants the basic information of the identification and registration of species with the application. It was also mentioned that people may get the wrong impression that species identification is easy (Table 3).

The outcomes of BioBlitzes experts are highlighted as positive aspects, including the collection of new data in locations they usually do not visit, learning how to communicate science, and interacting with others. The latter point included replying to questions from participants and follow-up activities related to formal teaching (e.g., visits to schools). However, they also considered that these events may not be very challenging when conducted in less-natural and/or degraded environments. Some also emphasized that if they were to go to these places for research on their own, they would find more

species, as well as logistic difficulties in conducting BioBlitzes (Table 4).

In addition to the negative aspects mentioned by participants and experts, three specialists pointed out that BioBlitzes may have negative consequences for the environment. This is due to the potential disruption caused by using intrusive methods during the activity. Therefore, the experts suggested the possibility of establishing a set of basic rules or protective measures at the beginning of the activity to alert participants about what should not be done.

Experts participate in BioBlitzes to raise awareness, motivate and excite the participants ( $n = 5$ ), share knowledge ( $n = 4$ ), and discover the living organisms in the locations where BioBlitzes are conducted ( $n = 1$ ). One expert mentioned that their objective is for participants to 'learn while enjoying'. They also mentioned that what motivates participants is their desire and curiosity to learn more about their surroundings and the learning opportunity. Some parents also bring their children to instill an interest in the environment and nature. They find it challenging to assess whether participants truly learn from the BioBlitzes, but they found that participants usually leave these events satisfied.

In general, experts consider the data collected during BioBlitzes to be useful, with only one mentioning that the data are not useful and one expert expressing some indecision about their importance. However, all experts stated that they have used data from various citizen science platforms in their work, such as iNaturalist, which includes data from BioBlitzes. It was also mentioned that during these activities, they obtain records of new species in new geographic regions, that is, in regions that are generally not used for fieldwork. Furthermore, they also mentioned that they acquire more information about the geographic regions, temporal data, as these are recurring events over time, and cumulative data that may be very useful in the future. Moreover, they can obtain valuable data, at least as an initial sampling, to decide where to conduct further sampling and relevant data for municipal councils, as they have an interest in better understanding the biodiversity of their municipality. For experts who are environmental consultants, these data are useful in environmental consultancy, which consequently supports policy decisions, land planning, and the evaluation of ecosystem services.

From another perspective, the data collected in BioBlitzes may not be very useful because they often bring limited scientific novelty; it is infrequent that the data add new information or provide added

TABLE 3 Positive and negative aspects for BioBlitz participants from the perspective of experts.

Positive aspects	• Discovering and observing many species in both urban and more natural environments (n = 3).
	• Deepening their interest in science (n = 1).
	• Seeing how experts work during field trips (n = 2).
	• Engaging with topics they are not familiar with (n = 2).
	• Understanding the importance of citizens' roles in science (n = 1).
	• Becoming more environmentally aware (n = 2).
	• Interacting with others (socializing) (n = 2).
	• Learning more about activities carried out by various organizations (n = 1).
	• Teachers establishing contact with an expert (n = 1).
Negative aspects	• The short duration of the activity does not allow participants to learn how to use the application and acquire knowledge about other subjects (n = 1).
	• Experts and the use of the application during BioBlitzes may give the wrong impression that species identification is easy (n = 1).

TABLE 4 Positive and negative aspects for BioBlitz experts from their perspective.

Positive aspects	• Collecting new data in locations that experts wouldn't typically investigate (n = 2).
	• Confronting questions that make them think and reflect (n = 2).
	• Learning to communicate science and having to relearn how to convey information in common and easily accessible language for the general public (n = 4).
	• Interacting with others (socializing) (n = 2).
	• Serving as inspiration for classes (n = 1).
	• Recognition for their work, potentially being contacted to conduct activities (in schools) (n = 1).
	• Participants learn to use the application and provide information about what they have observed after the BioBlitz (n = 1).
Negative aspects	• If experts were to conduct research in these locations alone, they would find more species (n = 2).
	• Some BioBlitzes are conducted in unnatural and/or degraded environments, which makes them less challenging (n = 2).
	• Sometimes, specialists are asked to conduct a BioBlitz in a new location, and therefore, there is no opportunity for preparation for the activity (n = 1).
	• Not knowing the person contacting them from Biodiversity4All who will be meeting them on the day of the BioBlitz (n = 1).

value compared to existing knowledge. It was recognized by the experts that while BioBlitzes can be a source of inspiration and generate research directions, they may lack the methodological rigor and standardization necessary for more structured and scientific data collection.

## Discussion

One of the main aims of this study was to provide a characterization of participants of BioBlitz events in the Lisbon region (Portugal). There was a prevalence of female participants, and this gender distribution aligns with the findings of the Portuguese 2021 Census, which indicated a higher proportion of female residents in the Lisbon region (PORDATA, 2022). Furthermore, this study showed a predominant representation of participants within the age brackets of 35–44 years and 45–54 years, mirroring the demographic distribution of residents in the same age groups according to the census data. Despite the growth of scientific studies

in citizen science, inclusiveness and gender balance have not been thoroughly analyzed areas (Paleco et al., 2021).

It was also observed that many participants were well educated, holding a bachelor's, postgraduate, or master's degree. Although this prevalence of higher education among participants coincides with the educational landscape in the Lisbon Metropolitan Area, there is, nevertheless, a much higher percentage of participants with B.Sc. or above education degrees than the average of 26.6% of residents in this region (PORDATA, 2022). Therefore, it can be said that BioBlitzes mainly attract participants with university degrees. Additionally, a correlation was found between a higher educational level of participants and a higher satisfaction level with the BioBlitzes.

An aspect also highlighted by this study is the commonality of motivations among BioBlitz participants, with a substantial number expressing the desire to "spend time with family and/or friends." Additionally, a prevalent trend emerged, where participants mentioned joining BioBlitz events to accompany their children, thus fostering a sense of environmental awareness and learning

within the family unit. The Portuguese Census data, indicating an average age of 30.9 years for women having their first child (PORDATA, 2022), shed light on the correlation between the age group of 35–44 years and the high participation within this bracket. In essence, this study's findings are consistent with the trends of demographic data from the region emphasizing the interconnectedness between societal characteristics and participation patterns in BioBlitz activities. These environmental education events particularly appeal to families with children, offering them an opportunity to embark on a nature walk while concurrently acquiring knowledge. Other authors observed a similar trend, noting that many BioBlitz participants were accompanied by family members, a pattern substantiated in the present study (Leong and Kyle, 2014). Also, other authors researching what motivates visitors to zoos and aquariums found that learning about the natural world while spending a pleasant time with family and/or friends was an important factor (Ballantyne et al., 2011; Therkelsen and Lottrup, 2015; Ballantyne and Packer, 2016).

Furthermore, it was found that many participants have backgrounds in the fields of life sciences and social behavioral sciences. Therefore, the present study reinforces the notion that citizens participating in BioBlitzes are more familiar with the natural sciences and likely have a heightened interest in these subjects, thus reflecting a greater willingness to engage in scientific activities (Aristeidou et al., 2021; Meeus et al., 2023).

At the same time, this study also reinforces Gass et al.'s (2021) conclusion that the majority of BioBlitz participants had no previous experience with this type of event, establishing consistency in patterns even in different geographical contexts. This recurrence highlights the potential appeal and novelty of BioBlitz activities, attracting participants with diverse educational backgrounds to engage in scientific exploration and ecological observation (Leong and Kyle, 2014). On the other hand, it also poses a challenge of how to motivate citizens to participate in BioBlitzes more than once, which should be seen as a similar approach to retaining individuals in citizen science projects (West and Pateman, 2016).

Moreover, most participants live in the municipality where the BioBlitzes took place, with the large majority traveling less than 30 km to attend. This can be attributed to the local nature of event promotion, potentially leaving citizens residing farther unaware of it. Furthermore, the convenience and cost-effectiveness of local activities and/or the desire to explore green areas in the area where they live probably contributed to this preference for sites closer to home.

The primary motivations driving citizen participation in BioBlitzes encompass the desire to immerse themselves in nature, engage in local species identification, and gain insights into the geographical characteristics of the event location. These findings resonate with earlier research, where learning (Postles and Bartlett, 2018) and the pleasurable experience of spending time in nature (Roger and Klistorner, 2016) were identified as fundamental drivers for participants. This study also established that participants left the BioBlitz experience with a sense of satisfaction. This echoes the sentiment of previous studies, with many participants expressing that the BioBlitz was a good experience (Roger and Klistorner, 2016; Gass et al., 2021).

When it comes to participants' preferences for taxonomic groups, the timing of the event emerges as a key factor

influencing their choices. Birds, in particular, are frequently selected, drawing substantial interest and curiosity and contributing to the growing fascination with urban ornithology (Murgui and Hedblom, 2017). Participants often cite curiosity, a thirst for learning, and personal interest as the primary factors guiding their choice of a specific taxonomic group. These findings reinforce previous results that underscore citizens' participation in BioBlitzes as being motivated by a quest for knowledge (Postles and Bartlett, 2018).

Beyond evaluating participant satisfaction, this study sought to delve into the positive aspects of BioBlitz experiences as perceived by participants. The exploration of these positive facets revealed significant themes, prominently including the enriching interaction with experts and the immersive connection with nature. Participants consistently mentioned the invaluable experience of engaging with experts as a major positive outcome of BioBlitz events. This interaction not only provided them with opportunities to glean insights from seasoned professionals but also fostered a dynamic learning environment. The findings echo the sentiments captured in Roger and Klistorner's (2016) study, where participants similarly expressed the significance of their interactions with experts during BioBlitz activities.

Additionally, participants emphasized the inherent value of being in direct contact with nature. The tangible and firsthand experience of exploring natural environments, identifying species, and contributing to biodiversity documentation emerged as key positive elements. Engaging with nature not only increased participants' knowledge of local ecosystems but also enhanced their appreciation for the intricate life network around them.

Although most participants did not highlight any negative aspects, some did mention challenges in finding or observing a limited number of species, particularly among those involved in the mammal group. Weather conditions and the duration of the event were also sometimes identified as drawbacks. Adjusting the duration of the activity for each taxonomic group could be considered to align with the effort required to observe species in those groups.

Other research also revealed that many participants expressed an intention to continue contributing records on the platform they utilized during the BioBlitz. The study by Gass et al. (2021) highlighted the significance of the iNaturalist application, deeming it a crucial factor in the BioBlitz experience. Consequently, the platform appears to be both attractive and indispensable in the context of BioBlitz events. However, a study conducted by Aristeidou et al. (2021) concluded that most participants tended to use the application for only 1 or 2 days, subsequently abandoning its use. Consequently, future investigations could explore whether participants follow through on their initial intentions to engage actively by consistently contributing records on the platform.

Participants demonstrated successful learning in the short term during the BioBlitzes, thus reinforcing findings from other studies (Leong and Kyle, 2014; Roger and Klistorner, 2016; Postles and Bartlett, 2018). These collectively affirm participants' perception of the BioBlitz as an effective method for gaining knowledge. Despite notable variations in participants' learning experiences, some authors mention that intentions to change behavior in support of

conservation were more difficult to achieve with these events (Roger and Klistorner, 2016; Postles and Bartlett, 2018; Gass et al., 2021).

Considering the analysis of the opinions of the BioBlitz experts, the primary findings reveal a greater emphasis on positive aspects rather than negatives. All highlighted learning and promoting environmental awareness as key benefits for BioBlitz participants, corroborating the findings of Roger and Klistorner (2016). Additionally, experts underscored the value of honing science communication skills and the advantage of citizens collecting new data both before and after the BioBlitz (Roger and Klistorner, 2016). Moreover, almost all experts mentioned the use of data collected in BioBlitzes for research and monitoring activities, whereas one mentioned that this was not the case. Although this was not consensual, a valid argument is that such collected data can, nevertheless, be used in the study of long-term trends and others that require longer time frames (Parker et al., 2018).

When probed about drawbacks, experts encountered challenges in responding and often added more positive dimensions. In general, the topics discussed by experts centered on the learning experiences for both citizens and experts as well as the awareness about biodiversity and the environment that experts could impart to participants—an objective they often mentioned as a motivation for participating in these events. Additionally, all experts said they have used BioBlitz data in their work, whether these were collected by themselves, a colleague, or citizens through a citizen science platform. This indicates that data collected in these events are valuable for the work of experts (Baker et al., 2014; Parker et al., 2018; Gliottini et al., 2023).

## Implications and recommendations

These findings carry significance for the effective planning and execution of future BioBlitzes as well as the continued engagement and satisfaction of participants. First, the identification of a predominantly female participant base, coupled with the prevalence of certain age groups, emphasizes the importance of tailoring BioBlitz activities to appeal to a wide range of demographics. Event organizers should consider this diversity when designing programs and activities to ensure inclusivity.

Moreover, since participants seem to have a higher educational background, organizers can leverage this information to create activities that cater to the knowledge and interests of participants with more modest education levels, thus promoting BioBlitzes as more inclusive events, for example, the organization of collaborative events in a nearby venue such as craft fairs, exhibitions, or sports activities. Establishing partnerships with local schools, sports clubs and cultural associations, scouts, and senior universities could also enhance a greater inclusion of underrepresented groups in these activities. The appeal of BioBlitzes as family-friendly activities also suggests the importance of incorporating elements that engage participants of all ages. Future events could include specific activities for children and teenagers, thus encouraging family attendance.

Since most of the participants of the BioBlitzes were residents, it makes sense to promote these events using information channels

such as local newspapers and businesses, cultural and sports associations, recreational organizations, and parish councils. To enhance accessibility for individuals living farther away, organizers can promote transportation to the sites of BioBlitzes and explore improved advertising strategies, leveraging online platforms and social media to broaden the reach of event announcements. The taxonomic group preferences of participants indicate the need for organizers to consider the convenience of timing and the inherent interest associated with specific groups. This knowledge can guide the scheduling and planning of future BioBlitz events. To further capitalize on the interest of participants in specific taxonomic groups, organizers can also design BioBlitz events with themes such as birdwatching, insect identification, or plant exploration. This approach allows participants to choose events more aligned with their interests.

Given the positive impact on participants' knowledge acquisition, organizers could prioritize educational components during BioBlitz events. This may involve collaborations with local schools or other educational institutions to promote learning about local biodiversity. Moreover, exploring medium-term learning with these events in future research could provide valuable insights into the sustained retention of acquired knowledge over an extended period.

An additional challenge that stems from the results of this study is how to motivate participants to come back after a first experience with BioBlitzes. One possibility would be a direct comparison of what species each participant identified in previous events or the suggestion of taking pictures of a visited site and then coming back to the same spots and seeing changes due to the time of the year and/or other factors. This could also involve post-event communication, periodic updates on recorded species, and incentives such as small gifts or tokens for continued participation, thus fostering an ongoing sense of community.

To conclude, this work provides information about participant demographics, motivations, and outcomes in BioBlitz events as well as the perspective of experts regarding these events. It identifies areas for improvement in event organization, promotional strategies, and the potential for sustained participant engagement. By incorporating implications and recommendations into the planning and execution of BioBlitz events, we hope to contribute to an enhancement of the overall experience for participants and experts, to promote biodiversity awareness, and for the success and sustainability of future BioBlitz initiatives.

## Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by the Science Ethics Committee—Faculty of Sciences of the University of Lisbon. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.



## Author contributions

PT: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, supervision, writing—original draft, and writing—review and editing. IE: formal analysis, investigation, software, and writing—original draft. BP: conceptualization, data curation, formal analysis, investigation, methodology, supervision, writing—original draft, and writing—review and editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fenvs.2024.1347428/full#supplementary-material>

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