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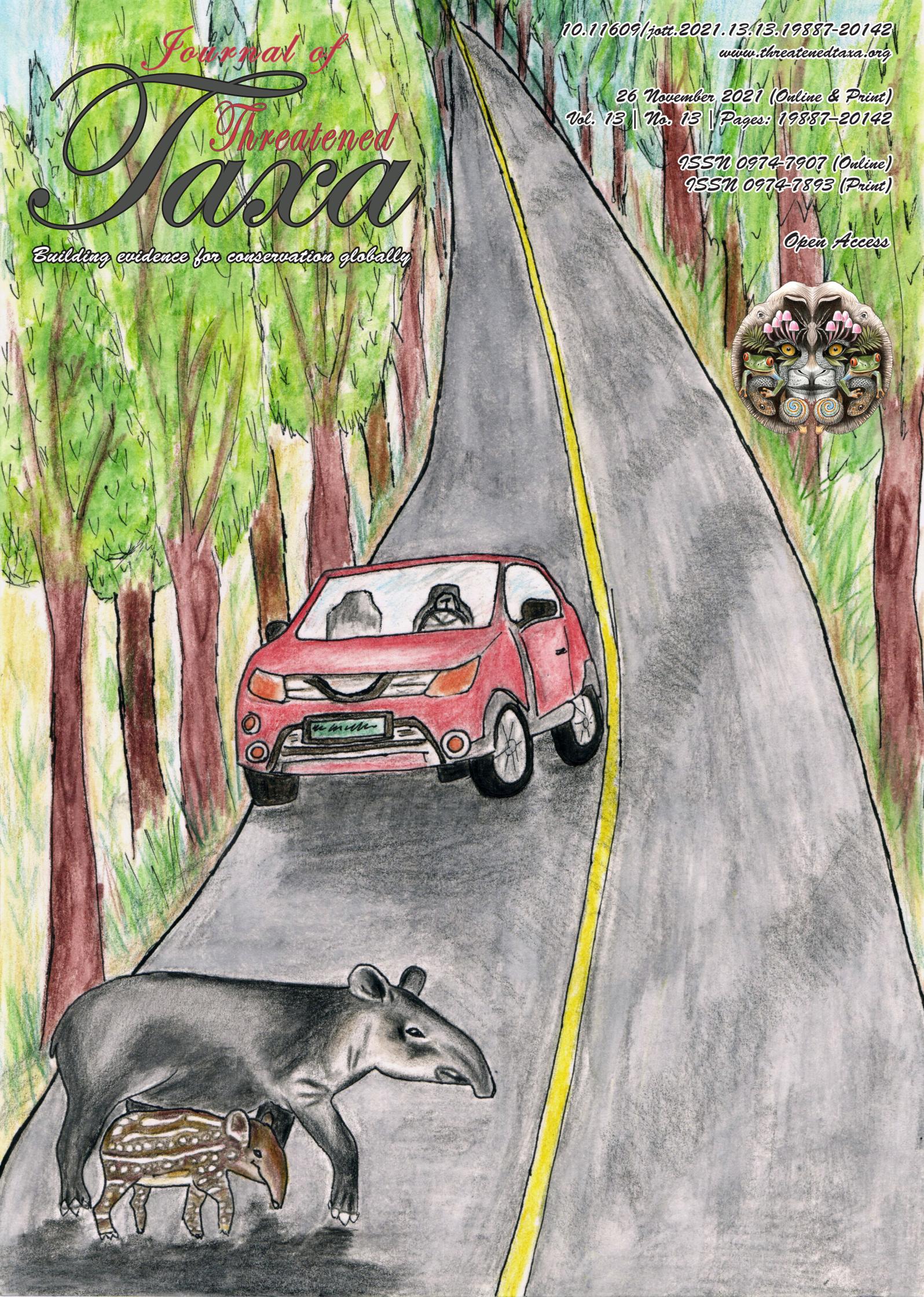
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Caption: Lowland Tapir *Tapirus terrestris* (Medium—watercolours on watercolour paper) © Aakanksha Komanduri.



Scientific contributions and learning experiences of citizen volunteers with a small cat project in Sanjay Gandhi National Park, Mumbai, India

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Abstract: We conducted a project on small wild cats in Sanjay Gandhi National Park near Mumbai during 2017–2019 with the participation of 35 citizen volunteers. Volunteers underwent a training period after which they collected scat samples, placed camera traps and participated in data analysis. Volunteers answered a questionnaire to gauge the impact the program had in furthering their interests and knowledge. Nineteen participants responded to the feedback survey. Most indicated an increase in their knowledge of wildlife research, conservation issues and small wild cats. We discuss the value of research projects where citizens can actively participate and learn semi-technical skills.

Keywords: Citizen science, conservation, feedback survey, Rusty-spotted Cat.

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INTRODUCTION

Planning conservation for rare and cryptic species is contingent upon reliable and adequate data, which requires considerable funding and labour over long periods (Buxton et al. 2020). Moreover, especially in human-dominated and privately owned landscapes, ownership of issues related to conservation are crucial for successful outcomes (Cooper et al. 2007). In urban landscapes, although most citizens are aware of the general impacts of human spaces on wild habitats, they are perhaps not aware of how they can contribute towards conservation and generating information (Miller 2005; Bhardwaj & Kumar 2021). Involving citizens in collecting information for scientific endeavours in the field of biodiversity conservation is gaining popularity across the globe (Frigerio et al. 2018), including in India (Surve et al. 2015; Singh 2018; Mukherjee 2019; Srivathsa et al. 2020), especially as climate change and changing land regimes become major issues of concern.

Citizen science with respect to carnivore conservation in India has been conducted in various ways, from using citizen science based web portals and social media for accessing information (Srivathsa et al. 2020) to actively engaging citizens as volunteers on projects to collect primary data (Director & Chief Conservator of Forests et al. 2012; Surve et al. 2015).

Several models of citizen science exist, ranging from simple contributions by citizens to a total involvement by contributing, learning and collaborating (Wiggins & Crowston 2011; Shirk et al. 2012). Some authors stress on the importance of training citizen volunteers in science prior to field collection of data to increase reliability of data collected (Bonney et al. 2014; Frigerio et al. 2018). We employed both the investigative and educational approaches to citizen science (Wiggins & Crowston 2011) during our study.

STUDY AREA

The project was conducted in Sanjay Gandhi National Park (SGNP), a protected area of 103.68 km², situated between 19.14–19.35 N and 72.98–72.86 E across Thane and Mumbai districts of Maharashtra. It is a popular recreation site among the citizens of Mumbai and experiences a high volume of approximately two million visitors per year (Surve et al. 2015).

Situated at the centre of a bustling and burgeoning metropolis, it is often referred to as the 'green lungs' of the city and figures as a major spot of conflict for space (Munde & Limaye 2013; Surve et al. 2015; Phadke 2019). This protected area faces several threats, the major ones

being encroachment due to urbanisation and Leopard *Panthera pardus* incursions into residential complexes located close to the Park, perhaps in search of food (Director & Chief Conservator of Forests et al. 2012; Surve et al. 2015; Anthony 2020). This led to the formation of a popular citizen-based project 'Mumbaikars for SGNP' by the Maharashtra Forest Department, in which citizens together with ecologists and sociologists assist the forest department to gather information on the Leopard (Director & Chief Conservator of Forests et al. 2012; Surve et al. 2015). However, there are several small carnivores which co-exist with the Leopard, and very little is known about their distribution and status within the Park and surrounding areas. Among these is the Rusty-spotted Cat *Prionailurus rubiginosus*, the smallest cat in the world, with a geographical distribution restricted to India, Sri Lanka and Nepal (Mukherjee et al. 2016). It is listed under Schedule I of the Indian Wildlife Protection Act (1972), categorised as Near Threatened in the IUCN Red List (Mukherjee et al. 2016) and included as a species of conservation importance in the SGNP Management Plan for 2013–2023 (Munde & Limaye 2013). Most citizens of Mumbai are perhaps not aware of the species, of its presence in the Park and how science can contribute to its conservation.

We aimed to bridge the gap in information and awareness through a citizen science participatory project by training citizen volunteers in various aspects of small cat biology, techniques in researching them and issues related to the conservation of small wild cats. The project spanned a period of two years and five months, from March 2017 to September 2019, during which volunteers collected samples and generated data. We conducted a questionnaire survey to gauge the response of the volunteers to their experience in participating in the project. This paper discusses the results of the questionnaire survey.

MATERIALS AND METHODS

A call for volunteer participation on the project was advertised informally over social network platforms and through existing volunteer groups in SGNP. Those interested were inducted into the training program. In March and April 2017, four classroom and three practical training workshops, each lasting four to five hours, were held for volunteers in forest range offices and in the field in SGNP. Classroom training included basic lectures and discussions on cat behaviour, physiology and morphology, the importance of scat samples in

studying carnivore ecology, protocols for collecting scat and the rationale behind it, basics of molecular analysis of scat for species assignments, basics of geographic information system (GIS) applications and their importance in conservation and research, basics of study design for scat collection and camera trapping, habitat monitoring and the importance of collecting information on habitat variables. During practical field sessions, volunteers were taught how to locate scat with explanations related to carnivore behaviour, identify tracks and signs of various species, operate GPS units as well as Android applications of GPS on mobile phones, use the mobile phone application CanopyApp (Version 0.0.2, University of New Hampshire 2015) for monitoring canopy cover, operate and place camera traps, label samples and camera traps with explanations on the importance of good practices.

Volunteers were divided into three groups based on the location of their residence and proximity to each of the three forest ranges, which they later visited for collecting data. Each group had a team leader who monitored progress and report to the principal investigator (PI). Necessary permits were obtained from the forest department for each volunteer to enter the Park and access areas that are prohibited to tourists. These permits were always carried by the volunteers when they entered the Park for sampling. The groups self-organised into sub-groups and went on scat collection trips every weekend, either on one or both days, for seven months excluding the monsoon months from June to September. Volunteers uploaded all information on field work including date, time, name of the forest range visited, grid cell number, geo-coordinates, photographs of scat samples collected with their identity number and details to the Android based software EpiCollect5 (Aanensen 2009) in a format provided by the PIs. This enabled the PIs to access, download, monitor and check data online at any point of time.

A subset of the scat collecting team volunteered for camera trapping exercises. These consisted mainly of students who were interested in wildlife careers and received additional training. Volunteers interested in participating in further analysis of samples travelled to Sálím Ali Centre for Ornithology and Natural History, where they received training in genetic analysis for assigning scat to predator species, diet estimation through scat analysis, relevant statistics using the statistical package R (R Development Core Team 2014) and basic GIS tools for mapping.

At the end of the project, a feedback survey was conducted through an online questionnaire with options

for picking a score as well as descriptive comments sent to volunteers to seek their opinion on the training imparted, their expectations and if they were met through this project, and their overall experience during this duration (Appendix 1). The feedback was analysed through chi-square and paired Wilcoxon signed-rank tests.

RESULTS

A total of 35 citizens from various professions volunteered for the training sessions and project work of the SGNP Small Cat Project. While most volunteered for the scat collection trips, only three volunteered for camera trapping and two for further analysis in the laboratory. Volunteers collected 126 scat samples from the three Ranges of SGNP and set up camera traps in 39 locations for a total of 1,056 camera trap days.

One of the volunteers completed her Master's dissertation on the diet of the Rusty-spotted Cat based on scat collected (Gawari 2018). This was perhaps the first systematic analysis of the diet of the species. Another volunteer completed his internship with data collected on the project and participated in analysing camera trap data. The camera trapping exercise revealed the presence of 20 taxa, including domestic species such as goats, cattle, dogs and cats along with considerable movement of humans throughout the Park. It also generated information on the distribution of other wild carnivores, e.g., Ruddy Mongoose *Urva smithii*, Small Indian Civet *Viverricula indica* and Common Palm Civet *Paradoxurus hermaphroditus* within SGNP, which are often neglected in conservation schemes across the country, largely due to the lack of information on them.

A total of 19 participants from the SGNP Small Cat Project responded to the survey. Most participants (47%) were in the age group 20–25 years, followed by the age group 25–30 years (21%), and 16% of respondents being younger (15–20 years) or older (30–40 years). Most were students at the undergraduate level (58%) or postgraduate level (16%). Twenty-one percent of the participants defined themselves as persons whose primary occupations were in wildlife, environment or science-related professions. Only one participant was employed in a profession different from the above.

The most significant motivation for participating in the SGNP Small Cat Project was to learn more about wildlife science (90%), followed by the desire to broaden personal horizons and learn a new skill (74%) (Chi-square value= 18.15, df= 5, p value <0.05) (Figure 1). Sixty-



three percent of the participants stated that they were motivated by the need to understand conservation issues better. Many participants simultaneously expressed an interest in the three motivations listed above, while 47% of the participants also declared that a motivation was to obtain training and certification of wildlife research. Participants were least motivated by the access this project gave them to otherwise inaccessible parts of the National Park.

Most participants believed that there was a significant increase in their knowledge of wildlife research and science because of the program (paired Wilcoxon test, $V = 153$, $p\text{-value} = 0.0002244$), with most stating that their knowledge of wildlife was very low prior to the program (Figures 2, 3). They stated that through the project they gained information on the process of conducting research on small cats and other small carnivores and were made aware of modern techniques used in the field and laboratory as well as the ethics involved in data collection for research (Table 1).

When asked to rate their knowledge of conservation issues pertaining to Mumbai city, both before and after the program, participants stated that they felt significantly more aware after the program (paired Wilcoxon test, $V = 136$, $p\text{-value} = 0.0002804$). While almost all participants were moderately aware of

conservation issues around Mumbai, their knowledge of the nuances and complexities involved in science and conservation increased after their participation in the project (Table 1).

Participants stated that their knowledge of small cats and conservation issues pertaining to small cats was significantly greater after the project (paired Wilcoxon test, $V = 190$, $p\text{-value} = 0.0001044$). Prior to the project, most participants rated themselves as knowing nothing or little about small wild cats. Participants stated that they learnt about how small wild cats coexist with larger predators and how they also live in proximity to human settlements (Table 1).

DISCUSSION

During this project, we established that citizens in Mumbai were interested in exploring how wildlife research is conducted and that they wanted a stake in the process of doing research and conservation. In the past, the Mumbaikars for SGNP project involved citizen volunteers on some aspects of a study focussed on the Leopard and its prey species (Director & Chief Conservator of Forests et al. 2012; Surve et al. 2015). In the current project, we took this approach a step

Table 1. Comments received from volunteers on their overall experience of volunteering on the project.

Training Topic	Comments
Wildlife Research and Science	"The small cat survey was a unique project and I got the opportunity to learn certain nuances of camera trapping, reading animal tracks and signs and conservation genetics."
	"The entire process of mapping, finding out possible locations for looking up for scats and learning about how genetics can help in identifying species responsible for scat deposition was very much educational. This project helped me in developing an understanding of how Ecosystem services work."
	"I learned about how the work happens from collecting samples to lab. I hope someday I will be able to do it also and also the usage of different apps for making our data collection work easier."
	"Wildlife research is serious business. Zero tolerance for ethical mistakes like data manipulation, etc as it may completely change the outcome of a project."
	"I got to learn about method of scat collection and mapping the habitat and factors related to it."
	"I joined for a short period of time but I learnt how to identify basic mammal scats, spotting various animals not just small cats but other animals/birds in the park. Got exposure to various, wildlife population density measuring techniques, scat collection techniques, conducting transects etc. It was overall a complete experience with some phenomenal sights in the park."
	"Systematic approach towards assessment of population dynamics with supplementary behaviour study and optimum use of advanced technology."
	"It requires a lot of patience, deep understanding of the subject and that the efficient management of data and drawing conclusions forms the core of any research"
	"I learned about how to locate and collect carnivore scat in wild and upgraded my camera trapping techniques."
	"I learned about data collection, diet analysis using scat samples, mapping, data analysis, habitat and diet of small cats, interpretation and execution of research work in scientific manner, conservation issues regarding cats(both big and small)."
Conservation issues	"How to handle camera traps, what is meant by scat collection"
	"Through this program I learned about the proximity in which leopards, small cats & other wildlife are living to humans. It showed me with evidence as to how much we human are squeezing the forests of SGNP ". "I learnt the difficulty involved behind the scenes, the science of conservation and how a non-invasive method works."
Small cats	"I have learnt how small cats are co-existing with other larger carnivores of SGNP. Also how human settlements are indirectly helping to support the population of small cats."

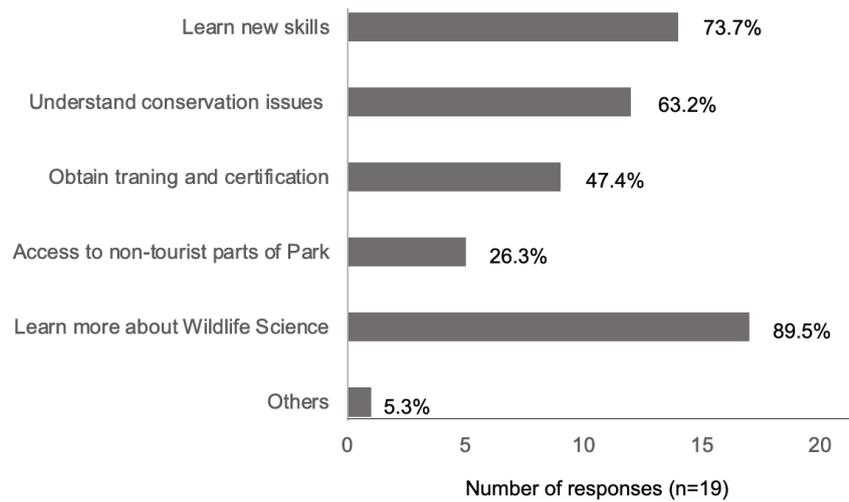


Figure 1. Responses of volunteers on their motivation to join the project.

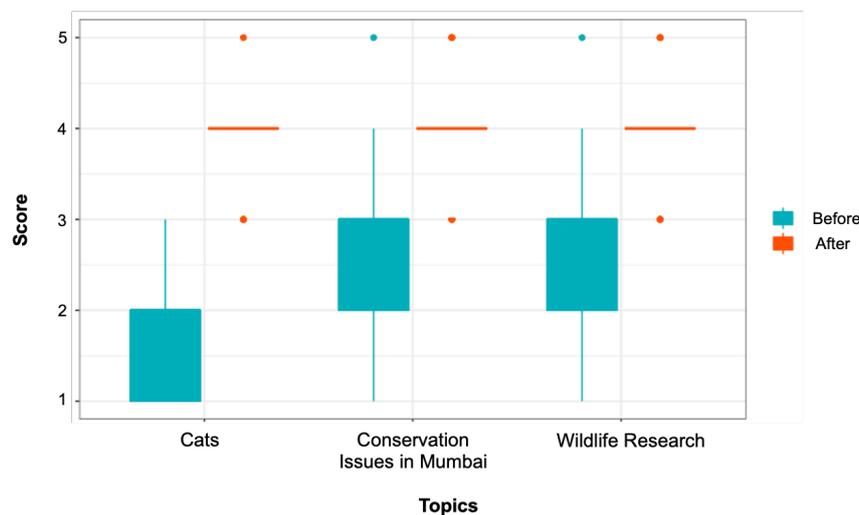


Figure 2. Responses of 19 volunteers on knowledge gained on various topics from participating in the project.

further by involving citizen volunteers in most aspects of the project and, providing them with some training in semi-technical skills. Moreover, this project was related to a small and little known carnivore, which could induce varied levels of interest among citizen volunteers. We were interested in knowing what motivated them to join the project and if and how the project helped them enhance their knowledge and meet their goals.

Understanding motivations of citizen participants to join science projects can help in refining the way in which citizen science projects are conducted to tailor them to specific needs and make them more popular (Schuttler et al. 2018). Our study had largely young, college going volunteers motivated to learn about wildlife science

and acquire new skills. Participants felt that the training and involvement in the project significantly increased their knowledge of small wild cats, techniques used to study them and conservation issues in Mumbai. Prior knowledge on these issues varied considerably among participants but most gave a high score of 4 for knowledge attained after participating in the project (Figure 2).

Since the major focus of the project was gathering information on small wild cats in SGNP, the training was very specifically focussed on certain topics. Similar future projects involving citizen volunteers could incorporate a survey before the training to gauge the requirements of the group, and if possible, cater to different needs and

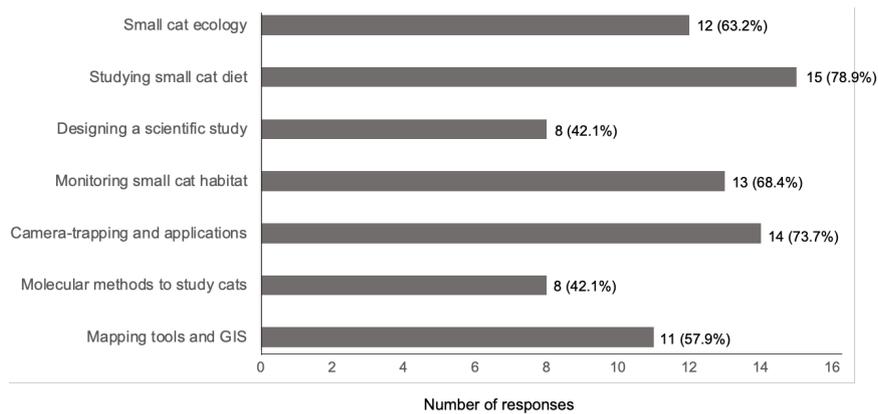


Figure 3. Responses of volunteers on knowledge gained on specific topics taught during classroom/discussion sessions.

offer options for participating in the project. For example, some participants were happy to volunteer for just the scat collection, and the training sessions for them could be focused on that topic. Targeted communication and training as a means of increasing motivation among volunteers was recognised elsewhere (Frigerio et al. 2018). As expected, fewer volunteers were interested in being involved in the more advanced and time intensive techniques such as molecular analysis of scat and GIS applications.

We observed that training using mobile phone apps gained much interest among volunteers, especially the younger ones, since these were more informal and less intimidating. Similarly, training in Forest Rest Houses and on field as opposed to traditional classrooms was also very popular with the younger age groups for the same reasons. Using a mobile app such as Epicollect5 enabled the investigators to check activity and data quality periodically and make course corrections through team leaders if any errors were found. Initially, there were several errors in data entry and recording, which were communicated to the volunteers, and necessary corrections were made. For example, uploading good pictures of scat on Epicollect5 following the protocols that were set with a ruler, GPS reading and the vial with date and id clearly visible enabled us to rectify errors made in recording identification of scat. Without these, the scat samples would have to be discarded, resulting in a waste of effort and samples, especially when studying a rare species. The usefulness of Epicollect5 as a user-friendly app for citizen science projects are acknowledged by other studies as well (Frigerio et al. 2018).

Due to the relatively short period of the study and a rapid enrolment of volunteers, we could not reach out to a wider set of citizens with more varied backgrounds

and age groups. Further, a relatively small proportion of volunteers responded to our questionnaire survey. Despite this, from the responses received, the project provided a platform for a few citizens to be trained in various aspects of small wild cat and small carnivore research. The project also provided an opportunity to learn new skills, especially for some volunteers who hope to build their careers in the field of wildlife research and conservation. This group of volunteers can form a pool of trained citizens who can be opted into various monitoring programs to aid Park management whenever required. However, such programs should be continued not just for additional information on rare species in and around the Park but also for increasing the pool of volunteers from various backgrounds, with refresher courses in training, to make a stronger impact on conservation.

Caveats

A major caveat in citizen science based studies is the quality and reliability of data because citizens may not be trained in collecting scientific information and would vary in their interest, motivations and knowledge levels (Lukyanenko et al. 2016). We tried to overcome this by using the Epicollect5 application to check for errors in reporting details of samples collected. Nevertheless, other probable issues such as failing to notice scat in the field when they were present could not be addressed and which may have reduced the number of samples obtained and hence data generated. Extending the duration of such projects to include a rigorous training period with intermittent checks and refresher sessions may produce better results.

Due to the nature of some of the training courses which required a certain level of educational background, we could not involve the locals who lived within the Park

in the project. Future projects could consider focussed training and partitioning the roles of volunteers based on other issues such as interest, language of instruction and education background to make the citizen science angle of the projects more inclusive and holistic. This would be especially beneficial since locals would have additional knowledge of the region and observation and detection abilities that even experts may lack (Lukyanenko et al. 2016; Tengö et al. 2021).

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