FOLIA OECOLOGICA – vol. 51, no. 1 (2024), doi: 10.2478/foecol-2024-0007

Applying threat analysis approach in a small forest urban park (Northern Italy): local expert-based assessment to prioritize the management actions

Short communication

Pietro Giovacchini[1], Lorenzo Borghi[2], Davide Tartari[2], Francesca Cucci[2], Andrea Caldarelli[2], Massimo Tassinari[2], Pietro Melandri[2], Marco Dinetti[3], Corrado Battisti[4]*, Letizia Marsili[1]

[1]Department of Physical Science, Earth and Environment, Università degli Studi di Siena, Via P.A. Mattioli, 4, 53100 Siena, Italy
[2]"Giardino delle Capinere" and Wild Avifauna Rehabilitation Center, Lipu, Ferrara, Italy
[3]Lipu settore ecologia urbana, Via Pasubio 3/b, 43122 Parma, Italy
[4]'Torre Flavia' LTER (Long Term Ecological Research) Station, Protected Areas Service, Città Metropolitana di Roma Capitale, Viale G. Ribotta 41, 00144 Rome, Italy

Abstract

Giovacchini, P., Borghi, L., Tartari, D., Cucci, F., Caldarelli, A., Tassinari, M., Melandri, P., Dinetti, M., Battisti, C., Marsili, L., 2024. Applying threat analysis approach in a small forest urban park (Northern Italy): local expert-based assessment to prioritize the management actions. *Folia Oecologica*, 51 (1): 66–74.

To overcome the human-induced threats impacting on ecosystems, managers should focus on priorities. Here, we applied the expert-based Threat Analysis (TAN) in a forest urban park (Northern Italy), involving experts which ranked local threats, from the more to less impacting and following the IUCN classification. We also evaluated the level of knowledge of operators about these threats. Experts identified five priority target-specific threats: Roads and Railroads; Invasive-Non Native/Alien species; Other Ecosystem modifications; Recreational Activities, and Storms and Flooding. Storms and Flooding and Invasive-Non Native/Alien species appeared the threats with significant highest magnitude. Knowledge of threats is comparable without significant difference among them. However, Storms and Flooding and Roads and Railroads are the threats having both the highest level of knowledge by experts and the highest magnitude. At the opposite, Mowing was the less known threat regarding its regime and showed the lowest magnitude. TAN approach should be routinely used to build conceptual frameworks, ranking threats from the more to less impacting, therefore optimizing the management effort and developing local projects.

Keywords

conceptual framework, IUCN, management actions, threats, urban park

Introduction

Conservation projects and actions can lead to effective results in countering human-induced threats to species and biological communities (Margolius and Salafsky, 1998; Salafsky et al., 2008). To evaluate the effectiveness of these actions, managers can use specific biological indicators to compare the changes that

*Corresponding author:
e-mail: c.battisti@cittametropolitanaroma.it

have occurred following your projects (Battisti, 2018). However, project effectiveness monitoring focused only on biological indicators may show some weaknesses, for example due to the long response times of species and communities. Indeed, the effects of conservation measures on biological targets are often observable on different spatial and temporal scales (Noss, 1990). To overcome these weaknesses, Salafsky et al. (2008) suggested that managers and professionals should also focus their monitoring on human-induced threats, shifting attention from the state of biological targets to the pressure induced by anthropic threats (DPSIR framework: Driving force-Pressure-State-Impact-Response; Maxim et al., 2009).

Using specific regimen attributes such as extent, intensity, duration, frequency (review in Battisti et al., 2016), each threat could be quantified following the disturbance ecology theory (Sousa, 1984; Pickett et al., 1989). In this procedure, the threat regime assessment is expert-based. Compared to biological monitoring, threat monitoring based on expert evaluation shows interesting strengths having available short times and reduced human, economic and technological resources. This fact is particularly strategic since time and economic resources are often scarce in conservation (Margoluis and Salafsky, 1998; Johnson et al., 2012).

Project managers and practitioners use the IUCN 'Threat Analysis' (hereafter, TAN) approach to make an expert assessment, assigning a standardized code to each threat. Furthermore, experts can assign a score that allows an assessment of the threat regime, namely: extent, intensity, and magnitude (Margoluis and Salafsky, 1998; Bauer et al., 2022). In this way it will be possible to obtain a ranking among the threats (from the most to the least impactful), defining the priorities among them (i.e., the threats that deserve to be resolved urgently), thus supporting the decision-making process (Salafsky et al., 2008). The quantification of threat regimes through scores can also be used to carry out before-after monitoring, to verify the effectiveness of the measures (Battisti et al., 2008). In this paper, first we carried out a TAN on a small urban park in Northern Italy.

In this work, we have identified a set of threats acting locally in a northern Italian urban park, structuring a conceptual framework, with driving forces-threats-targets as causal chains. This framework will be useful for defining specific conservation measures to be implemented to counter local threats. Through a panel of experts, we quantified the threats using the scores assigned to obtain a classification in extension, intensity, and magnitude (Salafsky et al., 2008). We also evaluated the level of knowledge of operators about these threats, comparing this level of awareness to the score in threat magnitude.

Methods

Study area

The Naturalistic Garden "Le Capinere" (11°36'53''E / 44°50'58''N) was in the city of Ferrara (Emilia-Romagna, Northern Italy) where the climate is wet-temperate, and the average temperature is 20 °C while during the year rainfall can peak 1,107 mm (https://it.climate-data.org/europa/italia/emilia-romagna/ferrara-3207/). The Garden was established in 1992 in the former Municipal Camping (10,000 m^2), in collaboration with the Municipality of Ferrara and the Lipu-BirdLife International (hereafter 'Lipu'). At first, in 1995, the most urgent environmental interventions were carried out following an award-winning project approved by the ERA (Emilia Romagna Region Award for the Environment), such as the intervention to make trees likely to fall safe, an artificial lake, and the re-proposition, in an urban forest ecosystem, of a part of the rural landscape with also the planting of trees (e.g., *Fraxinus excelsior*, *Quercus robur*, *Quercus ilex* and *Morus alba*) and the zoning of spaces according to their natural vocations of the individual areas. Sixty-nine species of birds have been found in the Garden, of which six (*Falco peregrinus, Egretta garzetta, Ardea alba, Nycticorax nycticorax, Alcedo atthis and Ficedula albicollis*) pursuant to Directive 147/09/CE. Now the management of the "Le Capinere" Naturalistic Garden - Lipu is still in collaboration with the Municipality of Ferrara, the Province of Ferrara and the Emilia Romagna Region and the Wild Bird Rehabilitation Center and the Wildlife Education Center (Lipu Ferrara, unpublished data).

The panel of experts

To carry out the assessment of the local threat regime, we selected six experts (two managers, two operators, and two volunteers) belonging to a local non-profit organization (Lipu-BirdLife International) for the TAN procedure.

All these experts participated in the operational selection phases of the conservation measures adopted. Each of them has a good knowledge of both the project site (ecological values and surrounding social context) and the local threats. This has proved to be useful to have all the evidence to carry out the naming of the threat, the evaluation of the magnitude, the classification into priorities.

Threat analysis

By "threat" we mean "any anthropic process that negatively affects specific components of biodiversity (species richness, habitat condition and area, ecosystem functioning) in a real local context" (Salafsky et al., 2008). In this work, for the study area, the set of threats defined a priori by a panel of experts in an urban park located in a city in northern Italy (Ferrara) was analysed.

Threat nomenclature was reported in 2022 using the IUCN unified classification of direct threats (Salafsky et al., 2008; reviewed in Battisti et al., 2016).

Once the target-specific threats were named, we asked the experts the following questions: (i) What are the local threats acting on the small urban park that can be reduced (mitigating their impacts)? To answer this question, the experts analyzed all the factors and processes that act locally on a set of local ecological targets (list in Table 1). Subsequently, these factors/events were named and classified using the IUCN coded nomencla

Table 1. Matrix with threats (with IUCN code), effects and potential mechanisms and biological targets in the study area ("Le Capinere" urban park, Ferrara, Italy)

Threat	Effects	Potential mechanisms and targets
Road (Porta Catena's street) [4.1 - Roads and Railroads]	Accumulation of rubbish on the border of the "Giardino delle Capinere".	'Trap effect' on small mammals and invertebrates.
	Noise.	Interference on singing activity of nesting birds.
	Road-killing.	Direct impact on European green toad (*Bufotes viridis*), European hedgehog (*Erinaceus europaeus)*, Hare (*Lepus europaeus*), birds.
Alien/domesticated species (parakeets, tree species) [8.1 - Invasive-Non Native/Alien species/Diseases]	Feral cats.	Predation on European green toad (*Bufotes viridis*) and birds.
	Rose-ringed Parakeet (*Psittacula krameri*).	Direct competition for nesting-holes (in hole-nesting species, locally occurring: Scops-owl (*Otus scops*), Great Spotted Woodpecker (*Dendrocopos major*), Eurasian Green Woodpecker (*Picus viridis*), tits etc.
	Robinia sucker (*Robinia pseudoacacia*) and Ailanthus (*Ailanthus altissima)*.	Competition to native herbaceous vegetation/shrub/tree vegetation.
Grass mowing in the immediate surrounding [7.3 - Other Ecosystem modifications]		Direct (killing) and indirect (reduction in habitat suitability) impact on Hare (*Lepus europaeus*), Common Pheasant (*Phasianus colchicus*), European hedgehog (*Erinaceus europaeus*), European green toad (*Bufotes viridis*) and other open-habitat (crop land) and edge species.
Uncontrolled use by people [6.1 - Recreational Activities]	Annoying noises especially during the holidays beginning of the year, rubbish.	Wintering wild birds, irrecoverable birds in aviaries, animals being treated in the BirdLife International 'Wild Bird Rescue Centre'.
	Break in attempts and related damages.	Doors, gates, padlocks.
Extreme atmospheric/climate events [11.4 Storms and Flooding]	Severe thunderstorms can prevent the sewage system to work properly and cause the accumulation of foul-smelling waste.	Herbaceous vegetation and wild animals that feed on the ground.
	Severe thunderstorms can bring down trees or large branches and cause extensive damage.	Wooden or masonry structure (animal aviaries unrecoverable, inpatient aviaries for those under treatment, trails) and/or the animals themselves.
	Drought and related water strees.	Herbaceous vegetation, shrub and native tree.
	High temperatures and scarcity of rain for long periods can contribute to accumulation of botulinum toxin on the bottom of the pond.	Waterfowl.

ture (Battisti et al., 2016); (ii) What is their extent, severity, and magnitude? How are they ranked in order of priority? To answer this question, for each direct threat, the expert panel scored two attributes of the regime (extent and severity) using a scale from 1 (low) to 4 (high). Considering the different regimen attributes, extent, and severity (i.e., the perceived intensity of the targets) seem the easiest to calculate using an expert-based approach (Salafsky et al., 2008). "Extent" can be measured as the proportion of "area" that has been, is, or will be affected by the threat, relative to the total available land area. "Severity", as a proxy for the intensity of the threat on the targets: this constitutes an assessment of the past, present or future pressure, possibly caused by the threat event and which can affect the target by causing a specific potential or actual alteration, i.e., a negative impact on the target (see TNC, 2000). After this step, "Magnitude" is the sum of the two extent and severity scores, calculated for each threat. "Magnitude", as a compound variable, is a proxy for the pressure (and subsequent impact) of any threat on selected targets (Salafsky et al., 2008). Once experts have assigned a score to any threat attribute (extent, severity, and magnitude), their mean values (and standard deviation) are calculated. Finally, the experts sorted the threats in descending order (ranking) according to their magnitude values. Threats with the highest average value were prioritized; (iii) What is the level of local knowledge about the threat magnitude? To respond to this question, for each direct threat, the panel of experts assigned a score to the individual level of knowledge about each threat using a scale from 1 (low) to 4 (high).

To compare median values of threat Magnitude, due to not normal (asymmetric) distribution of data, we used the non parametric Kruskall-Wallis test (Dytham, 2011). We performed an Ordinary Least Squares regression between scored values in threat Magnitude and Knowledge. For statistical analyses, we used the PAST software (Hammer and Harper, 2001). Alpha was set at 0.05 level.

Results

The panel of experts identified the following local human-induced direct threats (classified following the IUCN Threat Nomenclature in Table 1): Roads and Railroads: locally represented by Road (Porta Catena's street); Invasive-Non Native/Alien species/Diseases, locally repre-

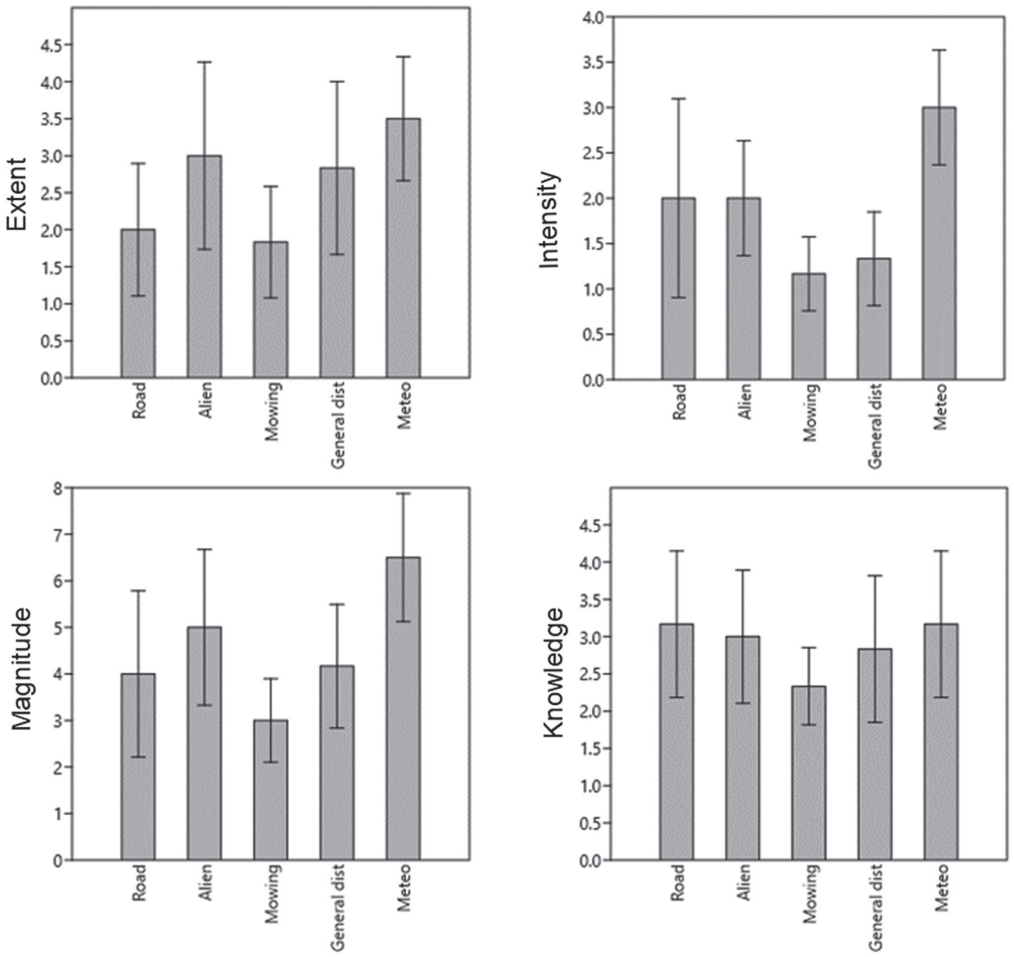

Fig. 1. Threat Analysis (TAN) procedure. Histograms reporting mean values (and ± standard deviation) in regime attributes (Area, Intensity, and Magnitude; see Methods for details) for the human-induced direct threats selected in the small urban park studied (Northern Italy).

Table 2. Threat Analysis (TAN) procedure. Mean values (and ± standard deviation) in regime attributes (Area, Intensity and Magnitude; see Methods for details) for the human-induced direct threats selected in the small urban forest park studied (Ferrara, Northern Italy)

Threats	IUCN category	Area	Intensity	Magnitude	Knowledge
Road (Porta Catena's street)	4.1 Roads and Railroads	2.0 (±0.89)	2.0 (±1.09)	4.0 (±1.79)	3.17 (0.98)
Alien/domesticated species (parakeets, tree species)	8.1 Invasive-Non native/ Alien species/Diseases	3.0 (±1.26)	2.0 (±0.63)	5.0 (±1.67)	3.0 (0.09)
Grass mowing in the immediate surrounding	7.3 Other Ecosystem modifications	1.8 (±0.75)	1.1 (±0.40)	3.0 (±0.89)	2.33 (0.52)
Uncontrolled use by people	6.1 Recreational Activities	2.8 (±1.16)	1.3 (±0.51)	4.17 (±1.33)	2.83 (0.98)
Extreme atmospheric events	11.4 Storms and Flooding (climate change)	3.5 (±0.83)	3.0 (±0.63)	6.5 (±1.38)	3.17 (0.98)

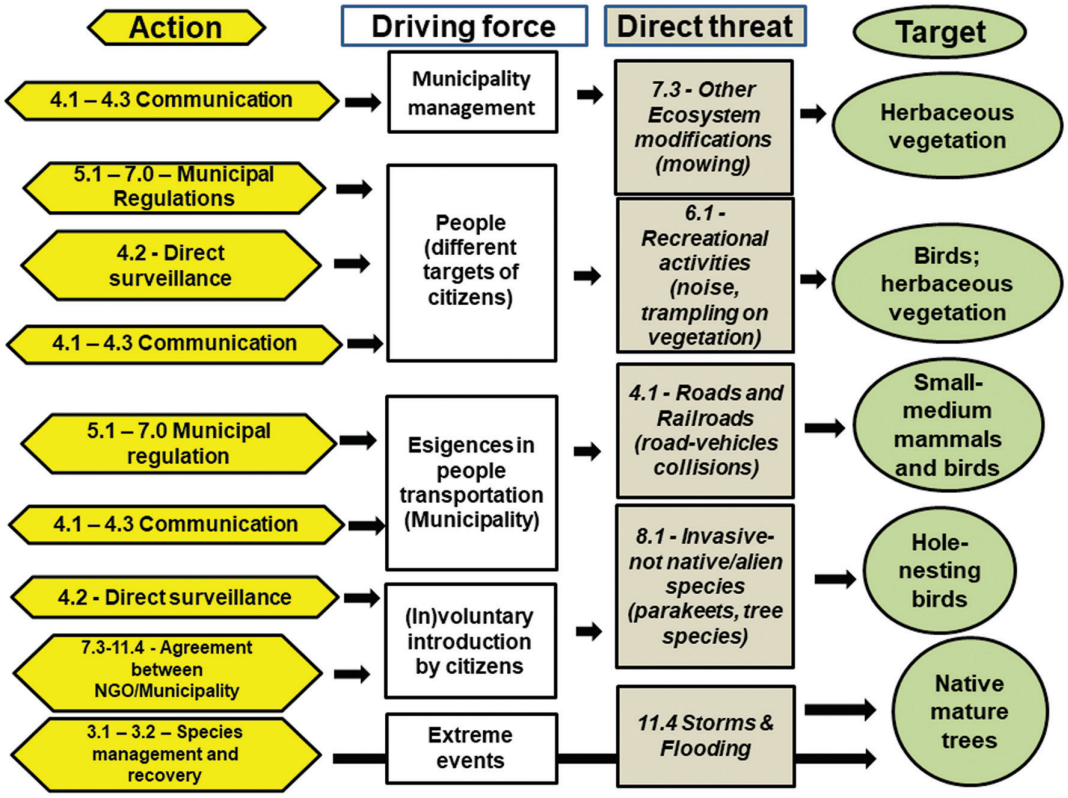

Fig. 2. Threat analysis (TAN) in the small urban park, with causal chain driving forces (social actors)-threats-targets. Actions (and their IUCN code) have been reported in exagons. IUCN nomenclature of threats follows Salafsky et al. (2008); review in Battisti et al. (2016).

sented by Alien/domesticated species (parakeets, tree species); Other Ecosystem modifications, locally represented by Grass mowing in the immediate surrounding; Recreational Activities, locally expressed by Uncontrolled use by people; Storms and Flooding, i.e., Extreme atmospheric events (Fig. 1). All these local threats show specific driving forces (Tables 1 and 2, Fig. 2).

After expert-based quantification, we showed as local threats differ significantly in magnitude among them ($H = 11.73$; $p = 0.017$; Kruskall-Wallis, test for equal medians), with highest magnitude showed by 11.4 Storms and Flooding and 8.1 - Invasive-Non Native/Alien species/ Diseases.

Knowledge of threats is comparable without significant difference among them ($H = 3.083$, $p = 0.471$). However, Storms and Flooding and Roads and Railroads are the threats having the highest level of knowledge by experts and, at the same time, they have been assessed

as threats having the highest magnitude. At the opposite, Mowing was the less known threat regarding its regime and showed the lowest magnitude. Regression between total scores assigned by experts both in magnitude and in knowledge showed a medium-low variance ($R^2 = 0.53$) but not significance ($r = 0.73$, $t = 1.85$, $p = 0.16$) Ordinary Least Squares Regression: K-M, 95% bootstrapped confidence intervals (N = 1,999).

Discussion

The panel of experts selected a set of main (direct and indirect) human-induced threats acting locally, using the TAN approach in a small forest urban park of Northern Italy.

Considering the judgment of the experts, the park is mainly affected by extreme climate events, which can be classified as an indirectly anthropogenic threat, as it is influenced by larger-scale climatic phenomena that have been occurring for some years in the Mediterranean ("Medicane"; Bakkensen, 2017) and which show heavy implications on biodiversity (e.g., Pinna et al., 2022). Regarding severe climate events, the city of Ferrara and all the North-Eastern Italy has suffered in recent years from extreme climate events (Brunetti et al., 2001; Straffelini and Tarolli, 2023).

The nature of extreme meteorological events, especially if markedly widespread on a scale, often makes it difficult to contain. In this regard, urban forest planners should adapt the urban forest to become more resilient in the face of such events (Marshman, 2018). Actions focused on the recovery of damaged plants can constitute further options useful for responding to a threat whose causes cannot be locally controlled. The staff managing the park should carry out a census of the tree species most susceptible to these impacts, as has already been done in other areas (e.g., Foran et al., 2015).

Alien species represent the direct anthropogenic threat that was prioritized. In lowland anthropized areas, simplified ecosystems are highly vulnerable to invasions by these species. In this sense, a large part of the Po Plain, where the city of Ferrara is located, is characterized by a high presence of non-native species, belonging to various animal and plant groups (Lurz et al., 2001; Castaldelli et al., 2013; Bianco, 2014; Verloove and Ardenghi, 2015; Falaschi et al., 2018). These species may act impacting on native vanishing fauna (e.g., Ferri et al., 2017).

Specifically, the expert group locally considered as worthy of attention the local breeding colony of Rose-ringed parakeets (*Psittacula krameri*), nesting on the mature trees. The competition of these species during the reproductive period for cavities ecologically suitable for native hole-nesting birds (e.g., woodpeckers, tits, nutchatchs, starlings, owls) is known from literature (Strubbe and Matthysen, 2007; Dodaro and Battisti, 2014; Menchetti and Mori, 2014) and represents a cause for concern. Furthermore, parakeets show a very marked competitive behaviour (bullying; Le Louarn et al., 2016), also towards species of conservation interest (e.g., hawks; Battisti and Fraticelli, 2023). The management of the park in an ecological sense will have to take this threat into account as a priority: specifically, it may be necessary to define a control plan for this species and communication actions aimed at preventing parakeets from being released into the wild. Among the alien species, there are also recently introduced tree species, even unintentional ones (*Ailanthus altissima*, *Robinia pseudoacacia*) which can interfere with local plant successions (Halabuk and Gerhátová, 2011; Csiszár et al., 2020; Grigorescu et al., 2020; for Italy, see Montecchiari et al., 2020).

A targeted control of this vegetation with operational actions of eradication and replacement with hedges and rows of native species can be planned (e.g., Nunes, 2022). Finally, non-native species include feral cats that can pose a threat to many animal species, especially birds (Mori et al., 2019). Both in the case of non-native tree species and feral domesticated species, a control and eradication plan may be useful, as already implemented in other contexts (Sabo, 2000; Natoli et al., 2006; Liess and Drescher, 2008).

Note how the first two priority threats in the park can be interconnected. For example, it is known that invasions of non-native species can be facilitated by the occurrence of extreme climatic events (Diez et al., 2012).

Other threats are not a priority, but staff may still be able to take steps to mitigate them. The road adjacent to the urban park is at the origin of three impacting mechanisms (sensu Balmford et al., 2006): accumulation of rubbish, noise, and direct impact by motor vehicles. The presence of perimeter roads in natural areas causes a series of impacts that can generally be included in the category of road edge effect (Fuentes-Montemayor et al., 2009; review in Coffin, 2007). Each of these processes can impact specific components (e.g., rubbish can trap small mammals and invertebrates; Ferri et al., 2023; motor-vehicles can kill many amphibians, reptiles, small mammals, and birds by impact; Battisti et al., 2012; noise at roadsides can influence the presence of birds at roadsides; Pieretti and Farina, 2013).

Among the threats considered to be of minor magnitude was grass mowing in the immediate surroundings. This activity has been indicated as having an impact on different biological species (Vickery et al., 2000; Vickery et al., 2001; Humbert et al., 2009; Hyvönen and Huusela-Veistola, 2011). In this regard, the staff of the urban park should adopt some guidelines for grass management (e.g., Vickery et al., 2000).

Finally, the unmanaged people fruition by citizens can cause impact if not addressed (Giovacchini et al., 2022). The management effort, already started some years ago by the park staff, is aimed at defining a network of paths to prevent uncontrolled use (and therefore, trampling on the vegetation and general disturbance). However, the effects of uncontrolled use are little known to the group of experts as shown by the knowledge analysis.

It has been underlined how the expert-based threat analysis procedure can show some weaknesses: among these, the lack of analytical data that can influence the general judgment through bias related to subjectivity (see Johnson et al., 2012). However, the assessment was carried out by experts who have long demonstrated a high local knowledge of the threats and their regime.

However, the expert-based TAN approach may

show some strengths (Fazey et al., 2006). When budget and economic resources are scarce and threats are difficult to compare with each other, the use of an expert method can provide a preliminary assessment, useful for decision-making and planning strategies according to an order of priorities (Margoluis and Salafksy, 1998; Milatović et al., 2019).

Furthermore, the evaluation through scores assigned before and after a project can allow a comparison and an evaluation of their effectiveness, facilitating the process of adaptive management (McCarthy and Possingham, 2007).

Acknowledgements

The panel of experts was composed by: Lorenzo Borghi, Andrea Caldarelli, Francesca Cucci, Pietro Melandri, Davide Tartari and Massimo Tassinari. The first part of this project was supported by the Lipu-BirdIife International and University of Siena (Italy). All authors have read and agreed to the published version of the manuscript. Two anonymous reviewers and the Editor-in-Chief provided useful comments and suggestions which improved largely the first draft of the manuscript.

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Received October 20, 2023
Accepted November 29, 2023