Received: 30 October 2023 | Revised: 27 July 2024 | Accepted: 30 September 2024

DOI: 10.1111/csp2.13265

RESEARCH NOTE

Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access

WILEY

Are local species prioritization lists sufficient for protecting endangered plants? Israeli red list as a test case

Merav Lebel Vine[1,2] | Margareta Walczak[2] | Gal Lebel Vine[2] | Ori Fragman-Sapir[3] | Hagar Leschner[4] | Yair Ur[5] | Mimi Ron[6] | Dar Ben-Natan[6] | Bar Shemesh[6] | Alon Singer[7] | Yuval Sapir[1]

[1]The Botanic Garden, School of Plant Sciences and Food Security, Faculty of Life Sciences, Tel Aviv University, Tel Avivs, Israel

[2]Science and Conservation Division, The Israel Nature Protection and National Parks Authority, Jerusalem, Israel

[3]Jerusalem Botanicl Gardens, The Hebrew University of jerusalem, Jerusalem, Israel

[4]The Herbarium, Hebrew University of Jerusalem, Jerusalem, Israel

[5]Moshav Amnon, Amnon, Israel

[6]Open Landscape Institute, The Steinhardt Museum of Natural History, Tel Aviv University, Tel Aviv, Israel

[7]Israel Plant Gene Bank, Agricultural Research Organization, Rishon LeZion, Israel

Correspondence

Merav Lebel Vine, The Botanicl Garden, School of Plant Sciences and Food Security, Faculty of Life Sciences, Tel Aviv University, 12 Klausner Street, Tel Aviv 6997801, Israel.

Email: meravlebel@gmail.com

Funding information

The Israel Nature Protection and National Parks Authority

Abstract

Conserving species from extinction requires risk assessment and ranking for conservation priorities. The IUCN criteria of extinction risk are currently accepted globally, but only a small fraction of species were evaluated. When assessing species' extinction risk, sufficient information, in particular rate of population decline, is often partial or missing. Here we utilized the red list of Israeli endangered plant species, which prioritizes them for conservation, and evaluated their local extinction risk using IUCN criteria for local assessment. We found a relatively high similarity between the Israeli red number value and the IUCN assessments. Most pronouncedly, the habitat vulnerability index, used in the Israeli method, is correlated with the IUCN parameter of extinction rate in the last decade. We conclude that in the case of Israel, prioritization ranking of endangered species based on locally available information is a powerful tool for conservation even when some species information is lacking, facilitating local decision-making. This finding may apply also to other countries using a local assessment system.

KEYWORDS

conservation, extinction rate, habitat vulnerability, IUCN red list

1 | INTRODUCTION

Global biodiversity is threatened by several human-induced processes, including habitat destruction, invasion of alien species, and climate perturbations (Butchart et al., 2010; Keil et al., 2015; Novacek, 2001). The immediate outcome is an increase in species extinction worldwide, at a rate exceeding the natural background extinction rate (Barnosky et al., 2011). This extinction affects ecosystem functioning and severely reduces ecological services (Keil et al., 2015). Therefore, great efforts are being made worldwide to conserve natural ecosystems and protect species from extinction (Balmford et al., 2005; Chandra & Idrisova, 2011; Goble & Scott, 2006). Preserving a species in its natural habitat (in-situ) is the preferred conservation strategy, and it may preserve the species as well as the ecosystem (Chandra & Idrisova, 2011; Heywood & Dulloo, 2005). However, when habitat loss or any other perturbation prevents in-situ conservation, other conservation methods should be applied ex-situ (IUCN/SSC, 2013; Manchikanti, 2016). Even when a plant population exists in its natural habitat, extinction may occur due to low genetic diversity and lack of gene flow, leading to reduced mate diversity and increased inbreeding depression, which leads to negative population dynamics and eventually to extinction (Aguilar et al., 2008; Frankham et al., 2014). In situ actions to preserve the ecosystem such as the establishment of protected areas and corridors, may be insufficient to compensate for population decrease, requiring additional conservation actions such as reintroduction of specific plant species (Guerrant & Kaye, 2007; IUCN/SSC, 2013; Kaye, 2009; Maschinski & Albrecht, 2017; Shemesh et al., 2018).

The first step of species conservation is defining which species is requiring conservation. While identifying ecosystems under risk and their prioritization is straightforward and has been done on multiple scales (Berg et al., 2014; Duraiappah et al., 2005; Etter et al., 2020), evaluating the conservation status and priority of an individual species requires further knowledge (Sapir et al., 2003). The categorization criteria of the International Union for the Conservation of Nature (IUCN) red list are accepted as the most comprehensive method to evaluate the global extinction risk of a species (Bachman et al., 2018; Betts et al., 2020; Keller & Bollmann, 2004; Rodrigues et al., 2006). The IUCN risk of extinction evaluation consists of five criteria: (1) reduction in population size; (2) reduction in geographical range; (3) small population in decline; (4) extremely small populations; and (5) quantitative analysis that indicates high probability of extinction. Defining the extinction risk category for a species only needs to match one criterion, but most assessments require knowledge on population decline rate in the last decade or an estimation on future decline (IUCN, 2012; IUCN Standards and Petitions Committee, 2019; Schatz, 2009).

Only a small fraction (8%) of the ~2.2 million described species have been evaluated for extinction status by the IUCN. Among plants, the fraction is higher (17%), and the estimated fraction of endangered plant species is 43% (IUCN, 2024). Assessment of endemic species is of great importance because their global distribution falls within a single country, where local conservation is also global (Gallagher et al., 2023). In many countries, however, a local system that uses categories other than the IUCN assessment is practiced to evaluate extinction risk, as in Peru, Chile, Ethiopia, Australia, New Zealand, Island, and Israel (Gallagher et al., 2023; Schatz, 2009).

Assessing species' extinction risk might be crucial for setting conservation priorities. Yet, the threat categories developed by the IUCN are not always sufficient to determine conservation priorities (IUCN, 2012; IUCN Standards and Petitions Committee, 2019; Mace & Lande, 1991). Moreover, for most IUCN evaluation criteria, a decline rate—either calculated or estimated—is needed, and these data are not always available. The absence of data and knowledge on distribution changes of many plant species limits the ability to create a conservation priority list. Efforts to estimate extinction risk (when data are insufficient), including, for example, machine-learning methods (Walker et al., 2020), are still not widely used and require validation.

To leverage the risk assessments for the prioritization list, additional information is needed, not necessarily related to the probability of extinction. While IUCN categories usually define the extinction risk globally, with some corrections applied for local assessment, prioritization at the local scale should take into account local circumstances and constraints and requires information that is not usually acquired when assessing extinction risk only (IUCN, 2012; Mace & Lande, 1991). Local assessments may include fine resolution data and be more accurate, based not only on population history (which is not always known), but also on analyzing the current situation and potential coming risks, connectivity of the local populations to the global population, genetic variation of peripheral population, and probability of success of local conservation actions. Hence, local prioritization may play an important role in conservation management, planning, and policy (Gauthier et al., 2010).

Few methods have been proposed to evaluate the priority of species for conservation locally, using spatial scale (rarity), habitat vulnerability, and feasibility of conservation as parameters (Brooks et al., 2006; Gauthier et al., 2010; Sapir et al., 2003; Wilson et al., 2009). To our best knowledge, there is no quantitative evaluation of the advantage (or disadvantage) of a local priority list, compared to a list based on extinction risk only. In many cases, local priority lists were interpreted into IUCN extinction risk categories without reevaluating using the IUCN system (BGCI, 2021).

In this work, we propose that comparing a list of evaluations based on IUCN extinction risk criteria and a local prioritization list can improve decision making for conservation, providing a tool to make a knowledge-based policy for conservation, even in cases with insufficient data. Here we utilized the Israeli list of endangered plant species as a case study, evaluated species' extinction risk (using IUCN categories with local applications), and compared it to their prioritization rank based on the method developed for Israeli flora (Sapir et al., 2003; Shmida et al., 2011; Shmida & Pollak, 2007).

The Israeli red list of endangered plant species is a list of plants ranked for prioritization of conservation. It is based on an evaluation of all rare plants of Israel, using "red number," an additive index developed for local evaluation (Sapir et al., 2003). Each rare plant species was scored for five parameters: (1) rarity; (2) vulnerability; (3) attractivity; (4) endemism; and (5) peripherality (Sapir et al., 2003). Briefly, rarity ranks species by their relative distribution, where the lowest number of sites (1 km^2) receives the highest rank. Vulnerability ranks the species according to the probability of the habitat extinction, or, if known, the rate of population decline. Attractivity ranks the species by their flower/inflorescence size, which corresponds to both illegal harvesting and public awareness. Endemism gives the highest rank to narrow-endemic species, and peripherality adds value to species on the margins of their global distribution.

The Israeli red list has been accepted by Israeli policymakers and is used by the Israeli Nature and Parks Authority (INPA). The red number priority ranking is used as the base to prioritize plant conservation actions because most of Israel's flora was not assessed for the IUCN criteria until this study. Two of the parameters of the Israeli red number are homologous to IUCN criteria: The first is the rarity parameter, which is equivalent to AOO and EOO (Area Of Occupancy and Extent Of Occupancy respectively). AOO and EOO are two alternative measurements to estimate the geographical distribution of a species, both can be used in the IUCN assessment to infer population decline in one criterion, and to evaluate population size in another criterion. The second is the vulnerability parameter, representing the estimated or calculated decline rate in population size between 1964 and 2006 (Shmida & Pollak, 2007), is equivalent to the population decline criterion in the IUCN system. IUCN criteria do not consider endemism, peripherality, or attractivity (IUCN Standards and Petitions Committee, 2019). In this work, we examined whether the above-mentioned differences drive differences between extinction risk (IUCN) and local prioritization ranking (the Israeli red number) and to what degree they affect selecting plants for conservation acts.

2 | METHODS

The red list of Israeli endangered plants comprises over 400 species (the list is updated every year, changing the accurate number of endangered species) (Sapir et al., 2003; Shmida et al., 2011; Shmida & Pollak, 2007). Previously, few species were assessed for their IUCN category of extinction risk (Sapir & Fragman-Sapir, 2017), but these are only a small fraction of the species, and this evaluation was limited to Mediterranean monocots. Moreover, most of these species are not listed in the Israeli red list because they are locally common and do not meet the threshold of rarity criterion (Sapir et al., 2003). We assessed 157 species from the Israeli RES list using IUCN criteria for local extinction risk (IUCN, 2012). These species assessed are those for which we had sufficient data from current (last ten years) surveys. At the time of the assessment, up-to-date surveys were available mostly for endemic or sub-endemic species. Hence, IUCN regional evaluations of these species are equivalent to global assessments.

For the assessment, we used updated data on population distribution. These data consist of both historic distribution and updated information gained through extensive surveys performed between 2013 and 2020 and included newly found populations, as well as data on populations validated as extinct. All the data were presented on a 1×1 kilometer grid, hereafter called sites, each site has a present/absence data and year of data collection. These data were used to calculate some of the variables that are essential for IUCN extinction risk assessment: AOO (the area within its "Extent Of Occurrence" which is occupied by a taxon, calculated using present data from past and current surveys) and EOO (the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of the present occurrence of a taxon), extinction rate during the last decade (percentage of extinct sites between 2010 and 2020, if available), and total extinction (percentage of extinct sites out of all sites). The latter was used as a quantitative evaluation of habitat loss with expert opinion to predict the possible rate of future extinction.

To compare categorization by extinction risk and prioritization, we tested for categorical association between the assignment of a plant to any of the IUCN categories and their ranking according to the red number, using χ^2 test and looking at Pearson residuals contribution to the significance of the association. For all plants assessed in both methods (IUCN extinction risk and Israeli red number), we performed a principal component analysis (PCA) in order to find the best explanatory variables for the assessments. The explanatory variables used for the PCA were the variables used to assess IUCN assessment and those used to calculate the red number, and are the following: $-$AOO (area of occupancy, the number of current sites; negative sign shows the parameter arow in

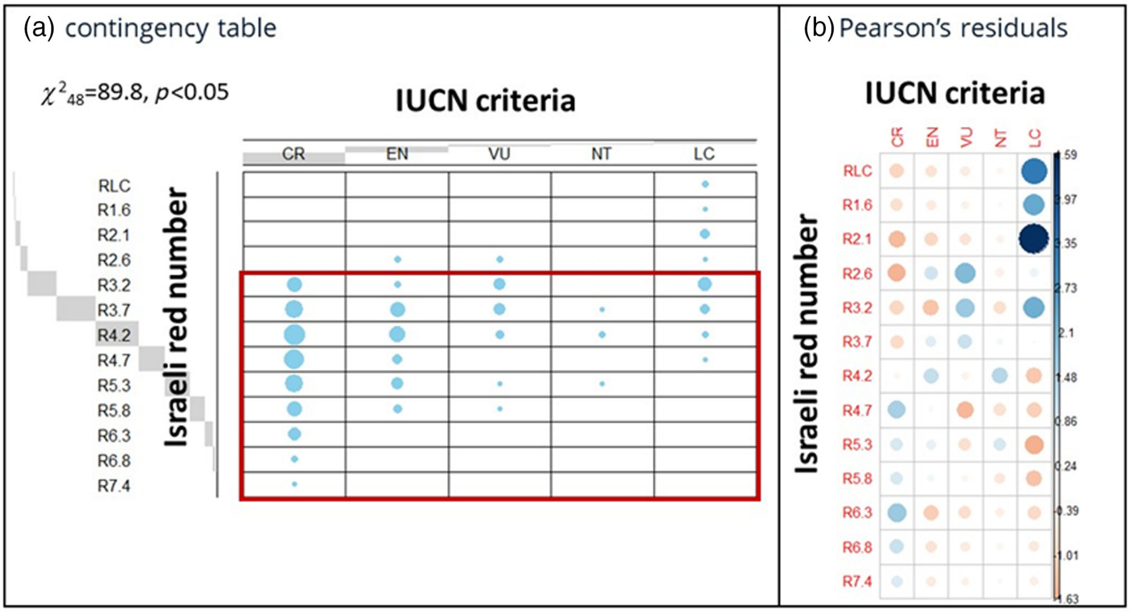

FIGURE 1 (a) Contingency table of IUCN categories and the Israeli red number for 157 plant species. Israeli red numbers range from 0 (LC) to 7.4, where species ranked >2.6 are included in the Israeli red list for conservation (marked in red frame in the table). Red number values are according to Shmida and Pollak. Sizes of the circles represent the number of species in each combination of the red number and IUCN category. (b) Pearson residuals contribution to the significance of the association. Blue circles denote positive contribution and red circles denote negative contribution. The size of the circles represents the contribution of each combination of red number and IUCN category to the association found.

PCA will indicates smaller AOO hence rarer), −EOO (extent of occupancy, the smallest range between the farthest sites; negative sign shows the parameter arow in PCA indicates smaller EOO hence smaller range), extinction rate in the last decade (percentage of extinct sites since 2010), total extinction (percentage of all extinct sites), endemism, vulnerability, and attractiveness criteria (Shmida & Pollak, 2007). All the analyses were done in R, using the package 'chisquare' (R Core Team, 2013).

3 | RESULTS

3.1 | Extinction risk assessment

Out of 434 plant species on the Israeli red list (as of 2021, when assessment was done), we assessed the local extinction risk according to the IUCN criteria for 157 species (see Appendix). This list includes all the endemic and sub-endemic species of Israel, as they were the first in the survey for updated distribution, as well as many species with a wider distribution for which data were available for accurate assessment. Among these species, 37 are endemic to Israel, 39 are sub-endemic, that is, endemic to Israel and a neighboring country, and 81 species have a wider distribution, assessed based on their distribution in Israel only. Of the 157 species assessed, 22 (14%) were assessed as Least Concerned (LC), 4 (2%) as Near Threatened (NT), 17 (11%) as Vulnerable (VU), 34 (22%) as Endangered (EN), and 80 (51%) as Critically Endangered (CR). See Table S1 for detailed assessments of all species. We did not assess extinct species from Israel in this study (see Sapir et al., 2003).

We found a significant association between the species rank according to the Israeli red number (Israeli red numbers range from 0 to 7.4, where species ranked >2.6 are included in the Israeli red list for conservation) and their IUCN categories ($\chi^2_{48} = 89.8$, $p < .05$; Figure 1a). When looking at Pearson residuals, the highest contribution to this association was by species assessed as LC in IUCN criteria, which were more likely to rank lower in their red number. Similarly, species assessed as CR in IUCN criteria were more likely to rank higher in their red number. These matches in the low and high ends determined the overall association between the assessments, while the intermediate values of red numbers and IUCN criteria of EN and VU did not match (Figure 1b).

The first two principal components in the PCA explained 27.8% and 20.9%, respectively, of the variation among species. PCA results revealed that habitat vulnerability is grouped in the same direction with extinction rate in the last decade and with total extinction rate, suggesting a positive correlation. These variables are the best explanatory factors for a large group of species evaluated

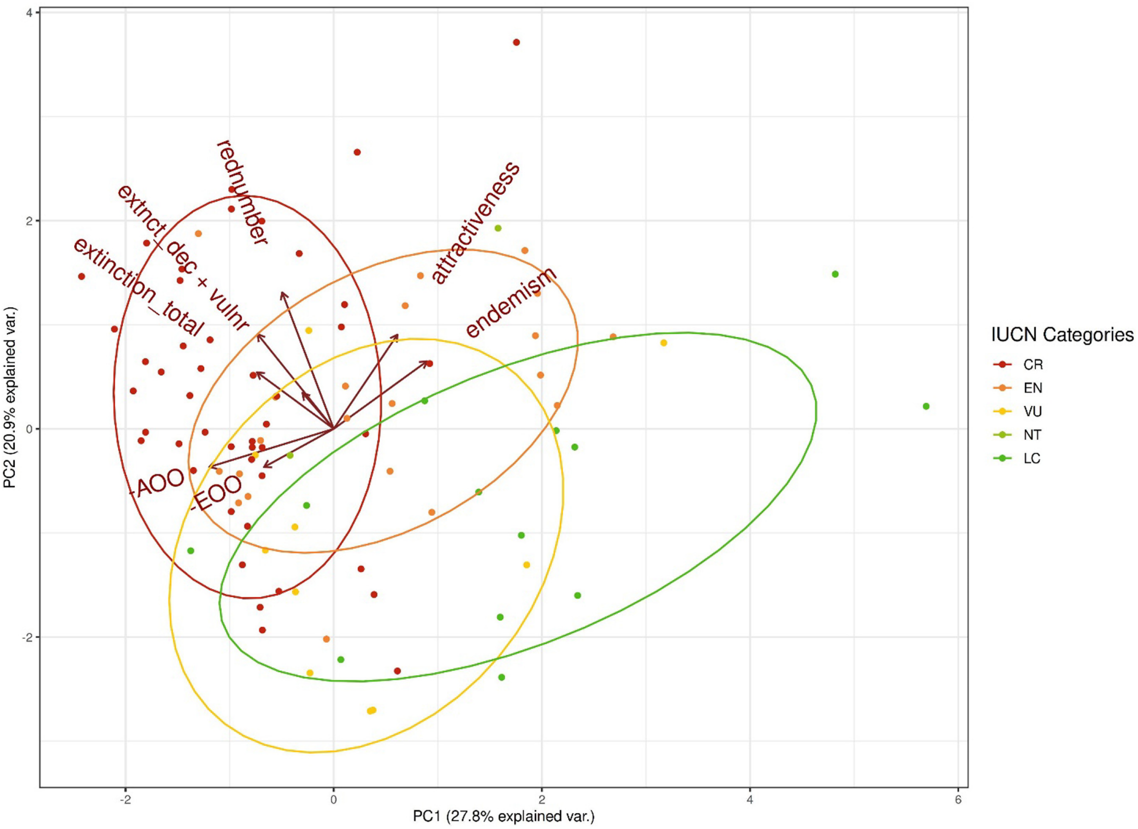

FIGURE 2 Ordination of 157 species assessed for Israeli red number and IUCN extinction risk categories. The species are colored by their category of risk (IUCN assessment): LC (least concern) in dark green, NT (near threatened) in light green, VU (vulnerable) in yellow, EN (endangered) in orange, and CR (critically) in red. The variables used in the ordination are the Israeli red number, −AOO (area of occupancy, the number of current sites; negative sign shows the arow indicates smaller AOO hence rarer), −EOO (extent of occupancy, the smallest range between the farthest sites; negative sign shows the arow indicates smaller EOO hence smaller range), extinction rate in the last decade (percentage of extinct sites since 2010), total extinction (percentage of all extinct sites), endemism, vulnerability, and attractiveness criteria.

as CR (Figure 2). Another group of species assessed as EN and CR are explained mostly by a small value of AOO and a small value of EOO. Assessment of species as EN is partially explained by endemism and attractiveness, but these criteria had a low contribution to loading on PC1 and PC2 (Figure 2).

4 | DISCUSSION

In this study, we aimed at testing the usefulness of local or regional prioritization lists of species for conservation when information for IUCN assessment is insufficient. We have utilized the Red List of Endangered Plants in Israel and reassessed these species using the IUCN criteria, based on updated information. We found that the Israeli local prioritization list is highly associated with the risk assessment using IUCN criteria on a local scale, even when different parameters were used for each assessment method. The two lists were similar in assessing both low-risk species and species under strong threat of extinction, but the intermediate values of the red number did not necessarily correspond with the intermediate IUCN ranks. Rather, species with high red numbers were ranked in the higher extinction category, and plants ranked with low red numbers were least concerned, according to IUCN criteria.

Among the 157 species in the Israeli red list assessed for IUCN criteria, 14 were assessed as LC by the IUCN method. Few of these species are endemic species to Israel, such as *Iris vartanii* Foster, *Cyperus sharonensis* Danin & Kukkonen, and *Ferula daninii* Zohary, and this increased their red number while their population sizes are relatively high and the extinction rate is low. Another possible explanation for this incongruence is other species that are extremely rare in Israel, but population sizes are large and stable, for example *Achillea falcata* L. and *Clinopodium graveolens* (M.Bieb.) Kuntze. Four species from the Israeli red list were assessed as NT because their population size is stable, despite being endemic to Israel

(*Vicia cypria* Kotschy, *Erodium subintegrifolium* Eig, and *Limonium galilaeum* Domina, Danin & Raimondo), or relatively rare (*Avena clauda* Durie). Overall, this suggests that endemism is not a factor affecting the extinction rate.

This test case of the Israeli red list indicates that extinction risk alone might not be sufficient for conservation strategy. Endemism, for example, is a very important factor to prioritize species for conservation acts in Israel, as well as the rarity of the species in Israel, even if the population is stable and large. This reflects the local conservation policy that highlights the importance of conserving local populations, as is also the case with endemic species in Italy (Orsenigo et al., 2018). Attempts to prioritize conservation based on extinction risk in Greece used phylogenetic diversity and evolutionary distinctiveness (Kougioumoutzis et al., 2021). Another example is Sardinia, where priority is given to species growing in an area rich with endemic species, where IUCN criteria are insufficient for creating an operative prioritization list (Bacchetta et al., 2012). Other factors for evaluation mentioned in the literature include cultural value on the plant, economic value, ecological services, and the cost and effectiveness of conservation actions needed (Berg et al., 2014).

The examples above of local priority lists take into consideration parameters beyond the parameters of the IUCN. The common to all the above-mentioned lists is that extinction risk by itself seemed insufficient for prioritization for conservation. The need for a list that takes into account local decision-making parameters can partially explain why many countries choose to assess their flora in a local system other than the IUCN method (Gallagher et al., 2023; Schatz, 2009). Another reason might be that IUCN assessments, if done comprehensively and following all the required instructions, are time-consuming and resource-intensive, leading to cost-effective methods to accelerate the extinction risk assessment process (Bachman et al., 2018; Le Breton et al., 2019; Verspagen & Erkens, 2023).

IUCN assessments, usually require species-specific data (Verspagen & Erkens, 2023). One of the Israeli red list unique criteria, namely, habitat vulnerability, was found to be associated with population decline. We conclude that habitat vulnerability can serve as a good indicator of species population decline. This may facilitate assessing species in other regions when information on population decline is lacking and collection of information is time-consuming. Habitat loss and degradation, as part of human-induced destruction, are the main reasons for species extinction (Butchart et al., 2010; Keil et al., 2015; Novacek, 2001; Orsenigo et al., 2018). The IUCN has developed a tool for assessing the risk of collapse at the ecosystem level (Keith et al., 2015; Rodríguez et al., 2015), but this tool does not include evaluation of specific habitats. When performing an IUCN risk assessment, it is possible to infer population decline from a reduction in habitat quality (IUCN Standards and Petitions Committee, 2019). That is why in local red lists that include calculated habitat loss as a major factor, as in the Israeli red list, local assessment can be a good representative for species extinction risk. On the other hand, some of the criteria for local prioritization in the Israeli red number may require reconsideration in the future, as the threats to plants change with time. For example, attractiveness is currently important for conservation because it increases public awareness and can serve to use endangered species as flagship species which, in turn, help to conserve their habitat (Clucas et al., 2008; Simberloff, 1998). Attractive species can also suffer from collection and harvesting, and that disturbance is addressed in the IUCN risk assessment when calculating species threats (locations) or calculating species generation length (IUCN Standards and Petitions Committee, 2019). In Israel, attractiveness was used as the major criterion for the initial list of species conservation acts (Paz, 1981; Sapir et al., 2003), because these species were massively collected in nature. Nowadays, thanks to successful educational campaigns, collecting ornamental attractive species in the wild has ceased (INPA, unpublished data), and the weight given to this criterion should be reconsidered.

To further assess the values of prioritization lists, compared to IUCN criteria, we suggest expanding this comparison by assessing the IUCN criteria for additional species of the Israeli flora, including un-evaluated plants from the red list and including common species. This will enable us to reassess the power of the correlation found here and to test whether species that are not under risk according to the Israeli red list are also exempted from the species in risk by IUCN criteria. It is essential to obtain the most current and accurate information on non-rare, non-endemic species of Israel and make a local IUCN extinction risk assessment based on quantitative data and analyses.

ACKNOWLEDGMENTS

The authors thank the Israeli Nature-Parks Authority (INPA) for the permission to use the dataset of plant observations and for financial and logistic support and A. Shmida and G. Pollak for advice and discussions. D. Kaplan and A. Perevolotzky provided many ideas and comments on early versions of the red list assessments. The authors also thank D. Allen and T. Bird for advice regarding the implementation of IUCN assessments for Israeli plants and the Deshe Institute of Open Landscape at the Steinhardt Museum of Natural History for gathering data in the field. Special thanks to many-to-count volunteer amateur botanists and nature lovers who have provided observations on plant distribution of endangered species since 1979.

DATA AVAILABILITY STATEMENT

All data are available in the Supporting Information.

ORCID

Yuval Sapir https://orcid.org/0000-0001-9685-8076

REFERENCES

Aguilar, R., Quesada, M., Ashworth, L., Herrerias-Diego, Y., & Lobo, J. (2008). Genetic consequences of habitat fragmentation in plant populations: Susceptible signals in plant traits and methodological approaches. *Molecular Ecology*, *17*, 5177–5188.

Bacchetta, G., Farris, E., & Pontecorvo, C. (2012). A new method to set conservation priorities in biodiversity hotspots. *Plant Biosystems*, *146*, 638–648.

Bachman, S. P., Nic Lughadha, E. M., & Rivers, M. C. (2018). Quantifying progress toward a conservation assessment for all plants. *Conservation Biology*, *32*, 516–524.

Balmford, A., Bennun, L., ten Brink, B., Cooper, D., Côté, I. M., Crane, P., Dobson, A., Dudley, N., Dutton, I., Green, R. E., Gregory, R. D., Harrison, J., Kennedy, E. T., Kremen, C., Leader-Williams, N., Lovejoy, T. E., Mace, G., May, R., Mayaux, P., … Walther, B. A. (2005). The convention on biological diversity's 2010 target. *Science*, *307*, 212–213.

Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O. U., Swartz, B., Quental, T. B., Marshall, C., McGuire, J. L., Lindsey, E. L., Maguire, K. C., Mersey, B., & Ferrer, E. A. (2011). Has the Earth's sixth mass extinction already arrived? *Nature*, *471*, 51–57.

Berg, C., Abdank, A., Isermann, M., Jansen, F., Timmermann, T., & Dengler, J. (2014). Red lists and conservation prioritization of plant communities - a methodological framework. *Applied Vegetation Science*, *17*, 504–515.

Betts, J., Young, R. P., Hilton-Taylor, C., Hoffmann, M., Rodríguez, J. P., Stuart, S. N., & Milner-Gulland, E. J. (2020). A framework for evaluating the impact of the IUCN red list of threatened species. *Conservation Biology*, *34*, 632–643.

BGCI. (2021). *State of the world's trees*. BGCI.

Brooks, T. M., Mittermeier, R. A., Da Fonseca, G. A. B., Gerlach, J., Hoffmann, M., Lamoreux, J. F., Mittermeier, C. G., Pilgrim, J. D., & Rodrigues, A. S. L. (2006). Global biodiversity conservation priorities. *Science*, *313*, 58–61.

Butchart, S. H. M., Walpole, M., Collen, B., van Strien, A., Scharlemann, J. P. W., Almond, R. E. A., Baillie, J. E. M., Bomhard, B., Brown, C., Bruno, J., Carpenter, K. E., Carr, G. M., Chanson, J., Chenery, A. M., Csirke, J., Davidson, N. C., Dentener, F., Foster, M., Galli, A., … Watson, R. (2010). Global biodiversity: Indicators of recent declines. *Science*, *328*, 1164–1168.

Chandra, A., & Idrisova, A. (2011). Convention on biological diversity: A review of national challenges and opportunities for implementation. *Biodiversity and Conservation*, *20*, 3295–3316.

Clucas, B., McHugh, K., & Caro, T. (2008). Flagship species on covers of US conservation and nature magazines. *Biodiversity and Conservation*, *17*, 1517–1528.

Duraiappah, A., Kumar, N., & Tundi Shahid, A. (2005). *Ecosystems and human well-being: Biodiversity synthesis; a report of the millennium ecosystem assessment*. World Resources Institute.

Etter, A., Andrade, A., Nelson, C. R., Cortés, J., & Saavedra, K. (2020). Assessing restoration priorities for high-risk ecosystems: An application of the IUCN red list of ecosystems. *Land Use Policy*, *99*, 104874.

Frankham, R., Bradshaw, C. J. A., & Brook, B. W. (2014). Genetics in conservation management: Revised recommendations for the 50/500 rules, red list criteria and population viability analyses. *Biological Conservation*, *170*, 56–63.

Gallagher, R. V., Allen, S. P., Govaerts, R., Rivers, M. C., Allen, A. P., Keith, D. A., Merow, C., Maitner, B., Butt, N., Auld, T. D., Enquist, B. J., Eiserhardt, W. L., Wright, I. J., Mifsud, J. C. O., Espinosa-Ruiz, S., Possingham, H., & Adams, V. M. (2023). Global shortfalls in threat assessments for endemic flora by country. *Plants, People, Planet*, *5*, 885–898.

Gauthier, P., Debussche, M., & Thompson, J. D. (2010). Regional priority setting for rare species based on a method combining three criteria. *Biological Conservation*, *143*, 1501–1509.

Goble, D. D., & Scott, J. M. (2006). Evolution of at-risk species protection. In *The Endangered Species Act at Thirty* (pp. 6–23). Island Press, Washington, D.C.

Guerrant, E. O., & Kaye, T. N. (2007). Reintroduction of rare and endangered plants: Common factors, questions and approaches. *Australian Journal of Botany*, *55*, 362–370.

Heywood, V. H., & Dulloo, M. E. (2005). In situ conservation of wild plant species: A critical global review of good practices. *IPGRI Technical Bulletin*, *11*, 174.

IUCN. (2012). *Guidelines for application of IUCN red list criteria at regional and national levels*. IUCN.

IUCN. (2024). Table 1a: Number of species evaluated in relation to the overall number of described species, and number of threatened species by major groups of organisms. *IUCN Red List Summary Statistics*, 1.

IUCN Standards and Petitions Committee. (2019). *Guidelines for using the IUCN red list categories and criteria. Version 14*. Standards and Petitions Committee.

IUCN/SSC. (2013). *Guidelines for reintroductions and other conservation translocations*. IUCN Species Survival Commission.

Kaye, T. N. (2009). Toward successful reintroductions: The combined importance of species traits, site quality, and restoration technique. *Proceedings of the California Native Plant Society Conservation Conference*, 99–106.

Keil, P., Storch, D., & Jetz, W. (2015). On the decline of biodiversity due to area loss. *Nature Communications*, *6*, 8837.

Keith, D. A., Rodríguez, J. P., Brooks, T. M., Burgman, M. A., Barrow, E. G., Bland, L., Comer, P. J., Franklin, J., Link, J., McCarthy, M. A., Miller, R. M., Murray, N. J., Nel, J., Nicholson, E., Oliveira-Miranda, M. A., Regan, T. J., Rodríguez-Clark, K. M., Rouget, M., & Spalding, M. D. (2015). The IUCN red list of ecosystems: Motivations, challenges, and applications. *Conservation Letters*, *8*, 214–226.

Keller, V., & Bollmann, K. (2004). From red lists to species of conservation concern. *Conservation Biology*, *18*, 1636–1644.

Kougioumoutzis, K., Kokkoris, I. P., Panitsa, M., Strid, A., & Dimopoulos, P. (2021). Extinction risk assessment of the Greek endemic flora. *Biology (Basel)*, *10*, 1–22.

Le Breton, T. D., Zimmer, H. C., Gallagher, R. V., Cox, M., Allen, S., & Auld, T. D. (2019). Using IUCN criteria to perform rapid assessments of at-risk taxa. *Biodiversity and Conservation*, *28*, 863–883.

Mace, G. M., & Lande, R. (1991). Assessing extinction threats: Toward a reevaluation of IUCN threatened species categories. *Conservation Biology*, *5*, 148–157.

Manchikanti, P. (2016). 1. Nature conservation: Natural lands and biological diversity: B. Convention on biological diversity (CBD). *Yearbook of International Environmental Law*, *27*, 219–225.

Maschinski, J., & Albrecht, M. A. (2017). Center for plant conservation's best practice guidelines for the reintroduction of rare plants. *Plant Diversity*, *39*, 390–395.

Novacek, P. M. J. (2001). *The biodiversity crisis: Losing what counts*. New Press.

Orsenigo, S., Montagnani, C., Fenu, G., Gargano, D., Peruzzi, L., Abeli, T., Alessandrini, A., Bacchetta, G., Bartolucci, F., Bovio, M., Brullo, C., Brullo, S., Carta, A., Castello, M., Cogoni, D., Conti, F., Domina, G., Foggi, B., Gennai, M., … Rossi, G. (2018). Red listing plants under full national responsibility: Extinction risk and threats in the vascular flora endemic to Italy. *Biological Conservation*, *224*, 213–222.

Paz, U. (1981). *The nature reserves of Israel*. Nature Reserves Authorities.

R Core Team. (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Rodrigues, A. S. L., Pilgrim, J. D., Lamoreux, J. F., Hoffmann, M., & Brooks, T. M. (2006). The value of the IUCN red list for conservation. *Trends in Ecology & Evolution*, *21*, 71–76.

Rodríguez, J. P., Keith, D. A., Rodríguez-Clark, K. M., Murray, N. J., Nicholson, E., Regan, T. J., Miller, R. M., Barrow, E. G., Bland, L. M., Boe, K., Brooks, T. M., Oliveira-Miranda, M. A., Spalding, M., & Wit, P. (2015). A practical guide to the application of the IUCN red list of ecosystems criteria. *Philosophical Transactions of the Royal Society, B: Biological Sciences*, *370*, 20140003.

Sapir, Y., & Fragman-Sapir, O. (2017). *The IUCN Red Llist of Threatened Species, 2017*.

Sapir, Y., Shmida, A., & Fragman, O. (2003). Constructing red numbers for setting conservation priorities of endangered plant species: Israeli flora as a test case. *Journal for Nature Conservation*, *11*, 91–107.

Schatz, G. E. (2009). Plants on the IUCN red list: Setting priorities to inform conservation. *Trends in Plant Science*, *14*, 638–642.

Shemesh, H., Shani, G., Carmel, Y., Kent, R., & Sapir, Y. (2018). To mix or not to mix the sources of relocated plants? The case of the endangered Iris lortetii. *Journal for Nature Conservation*, *45*, 41–47.

Shmida, A., & Pollak, G. (2007). *The red data book: Endangered plants of Israel, part 1*. Nature and Parks Authority, Tel Aviv.

Shmida, A., Pollak, G., & Fragman-Sapir, O. (2011). *The red data book: Endangered plants of Israel, part 2*. Nature and Parks Authority, Tel Aviv.

Simberloff, D. (1998). Flagships, umbrellas and keystones. Is single-species management passé in the landscape era? *Biological Conservation*, *83*, 247–257.

Verspagen, N., & Erkens, R. H. J. (2023). A method for making red list assessments with herbarium data and distribution models for species-rich plant taxa: Lessons from the neotropical genus *Guatteria* (Annonaceae). *Plants, People, Planet*, *5*, 536–546.

Walker, B. E., Leão, T. C. C., Bachman, S. P., Bolam, F. C., & Nic Lughadha, E. (2020). Caution needed when predicting species threat status for conservation prioritization on a global scale. *Frontiers in Plant Science*, *11*, 1–4.

Wilson, K. A., Carwardine, J., & Possingham, H. P. (2009). Setting conservation priorities. *Annals of the New York Academy of Sciences*, *1162*, 237–264.

SUPPORTING INFORMATION

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

How to cite this article: Lebel Vine, M., Walczak, M., Lebel Vine, G., Fragman-Sapir, O., Leschner, H., Ur, Y., Ron, M., Ben-Natan, D., Shemesh, B., Singer, A., & Sapir, Y. (2024). Are local species prioritization lists sufficient for protecting endangered plants? Israeli red list as a test case. *Conservation Science and Practice*, *6*(12), e13265. https://doi.org/10.1111/csp2.13265