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A CITIZEN SCIENCE PERSPECTIVE OF THE LANIIDAE IN ISRAEL

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Abstract.

Citizen Science (CS) is currently widely used to collect data to assess large geographical areas and is advantageous in that the observations are random and independent, which collectively offer a database that is eclectic and free of professional biases. We availed of such a BioGIS database of the Hebrew University in Jerusalem and evaluated the status of the True Shrike (Laniidae spp.) in Israel. We found that in the Red-backed Shrike (Lanius collurio) the annual population growth rate (λ) in the exponential model for the entire period was 0.02 over 46 years; for the Great Grey Shrike (L. excubitor aucheri) was 0.07 over 53 years; for Isabelline Shrike (L. isabellinus) was 0.04 over 17 years; for Masked Shrike (L. nubicus) was 0.101 over 49 years; for Lesser Grey Shrike (L. minor) was 0.02 over 38 years; and for Woodchat Shrike (L. senator) was 0.11 over 48 years. Except for the decline in the breeding population of the Red-backed Shrike in Northern Israel, the rest of the species appear to be stable. Our study underlines the importance of CS for collating scientific data by the general public.

Key words: *BioGIS; Laniidae; temporal; geographical; distribution; Israel*

The Laniidae (True Shrikes) are a family of small to medium-sized birds that have evolved the unique behavior of impaling their prey (Yosef and Pinshow 2005). An African origin is suspected for the monogeneric family (*Urolestes*, *Corvinella*, *Lanius*), whose diversification occurred rapidly with the development of savannahs and other grassland habitats in Africa and in which migration evolved multiple times (Fuchs et al. 2019). True Shrikes are found on all continents except Antarctica, Australia and South America. True Shrikes are currently in decline in most regions of its global distribution for various, partly species-specific reasons (Yosef 1994, Tryjanowski et al. 2006, Kvist 2011, Duchardt et al. 2023). Therefore, monitoring programs aimed at obtaining information about population changes in this systematic group are needed.

Citizen Science (CS) currently widely used to collect data to assess large geographical areas and unlimited topics that can be addressed, all with minimal resources from the researcher (Yosef and Tryjanowski 2022). The digitization of observations also enables the compilation of species-specific data from the various open access platforms (Dylewski et al. 2017). The advantage of Citizen Science is that they are random and independent observations, which collectively offer a database that is eclectic and free of professional biases (Parsons et al. 2018, Reif et al. 2022). However, it should be borne in mind that data of this type can be biased due to methodological limitations – and therefore often need to use non-standard analysis methods.

Israel, located at the intersection of the three continents of Africa, Asia and Europe, is a biodiversity hotspot because it is typically located at the extreme edge of an organism's distribution (Rankevich and Warburg 1983, Sternberg et al. 2015). In Israel, Laniidae (*Lanius* spp.) studies have so far been limited either to general reviews in encyclopedias (e.g., Shirihai 1996) or to migration studies (Tryjanowski and Yosef 2002, Yosef et al. 2002, Aloni et al. 2021). The temporal and geographical distribution of the Laniidae has not been analyzed previously and little is known about their population trends in the Middle East in general and Israel in particular. Therefore, we used the BioGIS platform to download data on all seven Laniidae species observed in Israel over the past 50 years.

The species observed so far in Israel are Great Grey Shrike (*L. excubitor*), Southern Grey Shrike (*L. excubitor aucheri*), Red-backed Shrike (*L. collurio*), Isabelline Shrike (*L. isabellinus*), Masked Shrike (*L. nubicus*), Lesser Grey Shrike (*L. minor*), and Woodchat Shrike (*L. sena-*

tor). Also observed sporadically and considered extremely rare are the Turkmenistan/Red-tailed Shrike *(L. phoenicuroides;* 9 records*),* Long-tailed/rufous-backed Shrike *(L. schach)* and the Desert Grey Shrike (*L. e. pallidirostris*) but owing to the low numbers of these species we have not included them in our study. One *L. phoenicuroides* was ringed at the IBRCE research station in Eilat (Demongin and Yosef 2009), and the most recent records being from 2018 and 2021 (Israbirding.com 2023). However, the report by Demongin and Yosef (2009) was later corrected to be *L. isabellinus* (Panov 2011, page 543; N. Lefranc' Pers. comm.).

Updated information can be accessed at the website of Israel Birding which also includes the records of the Israeli Rarities and Distribution Committee (https://www.israbirding.com/checklist/).

However, we also draw attention to the fact that the Great Grey Shrike (*L. excubitor*) was considered a Holarctic species with about 20 subspecies, and data was collected as such in all studies and observations in Israel until the species was split into the Northern Grey Shrike (including North America), and the Southern Grey Shrike (*L. meridionalis*)(Isenmann and Bouchett 1993, LeFranc and Worfolk 1997, del Hoyo et al. 2008, Clements 2000, Harris 2000, Dickinson 2003, Panov 2011 but see Olsson et al. 2010) and even published as such (Keynan and Yosefa, b). However, *Lanius meridionalis* is now considered a monotypic species and called the Iberian Grey Shrike (Lefranc 2022; this volume), while all other earlier subspecies of the "Southern Grey Shrike" are again, as in the 1960s, considered subspecies of the Great Grey Shrike *Lanius excubitor.* Therefore, due to the ongoing debate surrounding the phylogeny of the *L. excubitor* group (Olsson et al. 2010), we merged the observations of the Southern Grey Shrike and the Great Grey Shrike under the local subspecies *Lanius excubitor aucheri*. However, it is possible that some of the observations may be of *L. e. pallidirostris* (N. Lefranc, pers. comm.).

The aim of this study is to model population trends of the six most commonly observed and reported Laniidae species in Israel.

Methods

Data collection

The data were downloaded from the BioGIS (2023) website operated by the Hebrew University in Jerusalem in collaboration with the Israel Nature and Parks Authority (INPA) and the Israel Ministry of Environment. This is a moderated database where each observation is reviewed by an academic team before being included and made available to the public for free and is open access. The database currently contains more than 2.5 million records from 6,269 species. We downloaded the data for the Laniidae on August 5, 2023.

In order to verify the conservation status of each of the species in Israel, we accessed the Israel Nature Risk Assessment Project (INRAP); https://redlist.parks.org.il/en/aves/detail/Lanius/, downloaded 20 December 2023. However, although this is the latest data available for Israel, its most recent update was 1 January 2011, i.e., almost 13 years ago. Additional information was collated from Shirihai (1996), Lefranc and Worfolk (1997), Harris (2000), Panov (2011), Lefranc (2022).

Information supplied pertaining to breeding or migration is based on published peer-reviewed papers only and not on compilations of sporadic or random observations (e.g., Paz 1987, Shirihai 1996).

Data processing

Individuals are not marked for individual identification, and we were unable to control for the effect of reporting the same individual multiple times in a year. Therefore, in order to minimize the likelihood of population overestimation, we combined observations into temporal-spatial groups. To do this, we divided Israel, the West Bank and the Gaza Strip into 5/5 km squares, thus obtaining 1255 grid cells (see: Hadad et al. 2023). Next, we assigned each observation to specific grid cells separately for each of the 45 study years, assuming that two or more reported individuals within a distance of no more than 500 m were sightings of the same individual. This procedure controlled to some extent the effect of bird observation randomness that is typical in citizen science data (cf. Reif et al. 2022).

Statistical analysis

To evaluate the trend analysis, we used generalized additive mixed models (GAMM), where the number of individuals in the given grid cells (y_{gr}) was considered as the additive effect of the year and those grid cells. In our modelling framework, we used the 'year' as a fixed factor (*f(year)*) and the grid cells as a random factor. The model was considered using the Poisson distribution. The model was considered in two variants: spline s and linear l. The differences between the two models were tested using likelihood ratio tests. The visualization of the trend was based on the *ptrend* algorithm included in the *Poptrend* library for R (Knape 2016).

In addition, we also calculated the annual population growth rate (λ) as an exponential model showing the statistical growth of the population per year (Mils 2013).

$n_{y2} = n_{y1} \times \lambda^{(y2-y1)}$

where: n_{y2} means number of individuals in year 2, while n_{y1} means the number of individuals in the year preceding $n_{y2.}$

Results & Discussion

In Israel, the longest data series is for *L. excubitor* (53 years Table 1), while the shortest is for *L. isabellinus* (17 years).

Table 1. Time series, linear and smooth population changes recorded for six *Lanius* spp. in Israel.

Species	Years	Linear estimated percent population change (95% CL)	Smooth estimated percent population change (95% CL)	Tau (p)
L. collurio	1977 - 2023	-16 (-70 – 165)	-60% (-96 – 422)	0.391 (0.0001)
L. excubitor	1970 - 2023	-9.8 (-51 – 105)	-17 (-90 – 575)	0.434 (<0.0001)
L. isabellinus	2005 - 2022	54 (-38 – 292)	3.4 (-69 – 296)	0.041 (0.847)
L. nubicus	1974 - 2023	42 (-47 – 299)	42 (-47 – 290)	0.485 (<0.0001)
L. minor	1985 - 2023	-52 (-83 - 17)	21 (-93 – 2082)	0.284 (0.024)
L. senator	1975 - 2023	21 (-34 – 134)	28 (-94 – 2683)	1.582 0.001)

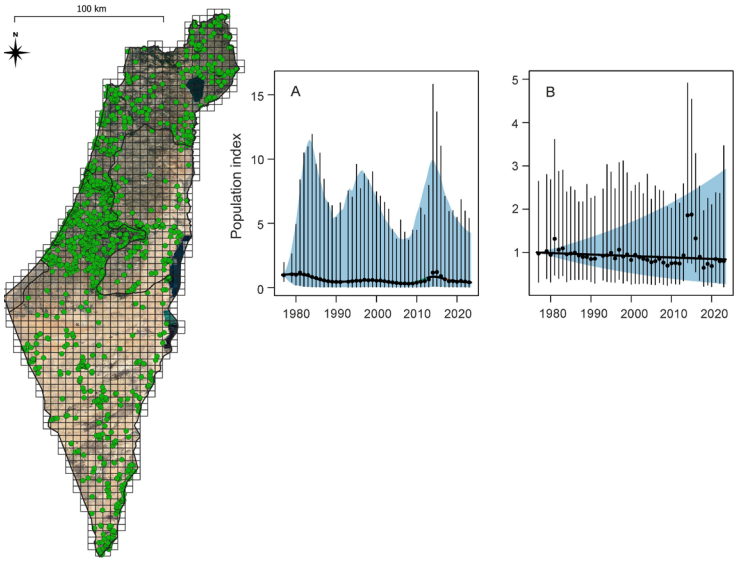

Fig. 1. Annual population trends for *Lanius collurio* in Israel based on GAMM with (A) smooth fit and (B) loglinear fit. Error bars show the standard error around the yearly estimates; black lines show trend fitted to the yearly point estimates, blue area represents 95% CL for the smooth fit. Map with dots showing the observation during 46 years of observations.

Lanius collurio

In Israel, the Red-backed Shrike is a common passage migrant throughout the country in spring and fall migration, and a summer breeder on Mount Hermon and in the northern Golan Heights and Upper Galilee (Israel Nature Risk Assessment Project; INRAP 2023). Its status is "Vulnerable" (V) due to its small and declining breeding population. The current population is estimated to be less than 1,000 adults and the rate of decline is estimated to >10% over 3 generations (12 years). It was classified as "Near Threatened" (NT) in the previous edition of the Red Book (2002). The change in the species' threat category reflects ongoing declines in population size and range (INRAP 2023). This is a little-studied species in Israel with only two papers on migration (Tryjanowski and Yosef 2002, Markovets and Yosef 2010). It is not marked as breeding in most of the family specific Shrike books (Panov 2011, Lefranc 2023) except by Lefranc (1997), Yosef (2008, 2020), and Harris (2000). In Lefranc (1997, 2023) isolated breeding populations are noted in the text on Mt. Hermon but not on the map.

During the 46-year of study, 2,942 individuals were recorded (Fig. 1) in 454 (36.2%) of the grid cells. The mean number of individuals per year was 65.3 (95% CL: 23.5 – 107.19) and was 6.48 per grid cell (95% CL: 4.59 – 8.36). The fewest individuals were observed in 1977 and 1993 (in both cases only 1 individual), while the most individuals were recorded in 2014 (670). We found a linear trend in the number of reported individuals over the past 46 years (tau = 0.391, p = 0.0001). However trend population modeling based on GAMM with "smooth" fit (R^2 = 0.014, Fig. 1A) showed that in Israel between 1977 and 2023 the population decreased on average by -60% (95% CL -96% - 442%), while the model with "loglinear" (R^2 = 0.017, Fig. 1B) fit also showed a decrease in the population trend but only by -16% (95% CL -70% - 165%). The difference between two models was not significant (LSR test, L.ratio = 2.16, P < 0.141). Finally the annual population growth rate (λ) in the exponential model for the entire period = 0.02 (95% CL: -0.32 – 0.37). Although we have not separated the breeding and migration season observations, our data corroborate the conclusions of the INRPA

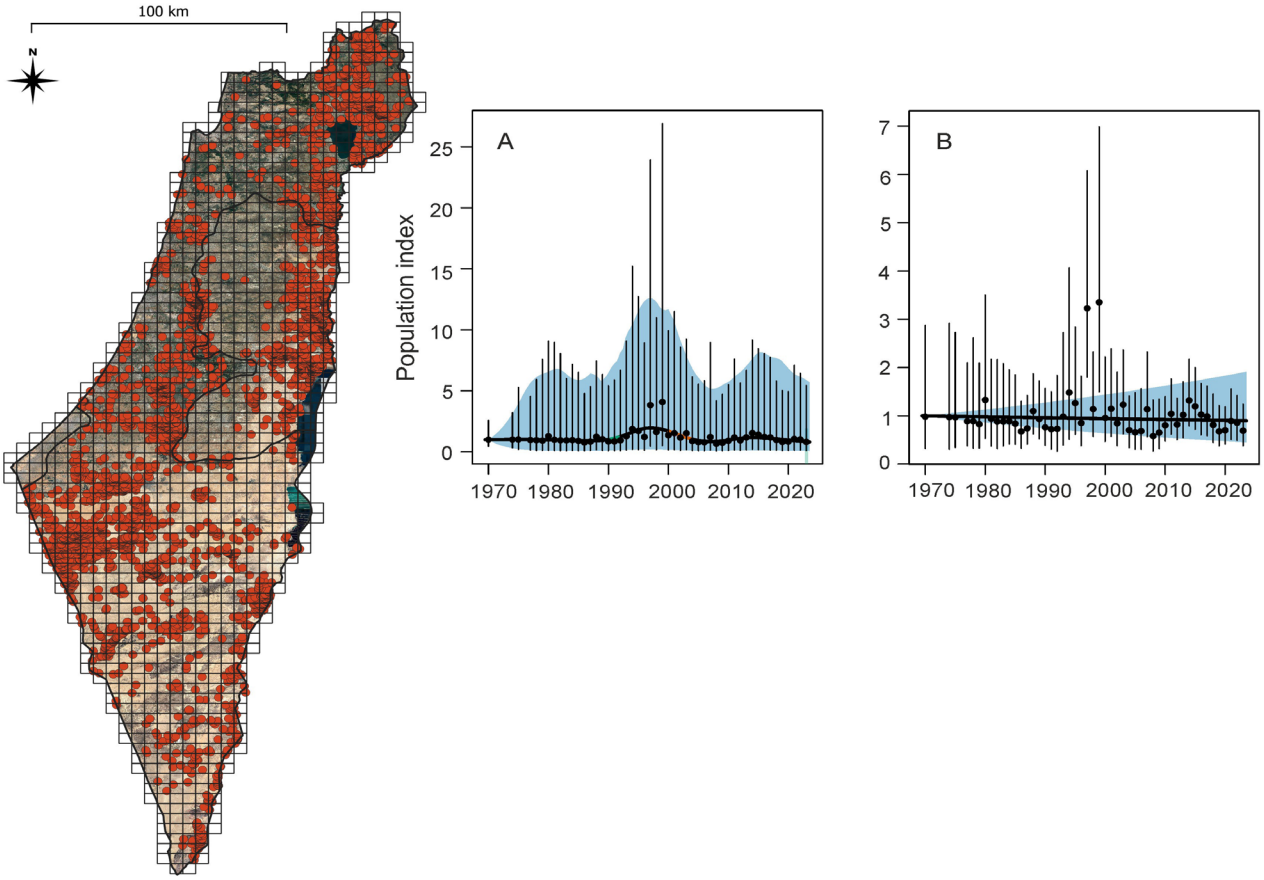

Fig. 2. Annual population trends for *Lanius excubitor aucheri* in Israel based on GAMM with (A) smooth fit and (B) loglinear fit. Error bars show the standard error around the yearly estimates; black lines show trend fitted to the yearly point estimates, blue area represents 95% CL for the smooth fit. Map with dots show the observation during all 53 years.

(2023) that the breeding population of the species in Israel is declining and justifies the risk assessment and the status "Vulnerable." INRPA believes that the main threat to Red-backed Shrikes in Israel is habitat modification due to development, afforestation and agriculture in the northern Golan Heights, as well as road construction and the development of ski runs and other facilities on Mount Hermon. In agricultural areas the species is likely to be affected by pesticides. However, no specific conservation measures have been taken for this species to date at the national level.

Lanius excubitor aucheri

In Israel the Levant (Great) Grey Shrike breeds throughout the country and is considered to be of "Least Concern" (INRPA 2023). In addition to the breeding population there is a hitherto unknown volume of the passage of migrants and also winter visitors (Shirihai 1996). Breeding in the species was studied in the desert regions of Sede Boqer (e.g., Yosef 1992, Yosef and Pinshow 1989, Degen et al. 1992) and Hatzeva (Keynan and Yosef 2010a, b).

As mentioned earlier, owing to the debate and uncertainty about the *Lanius excubitor*/*meridionalis* taxonomic status, we merged the observations of the Southern Grey Shrike (N = 36) and the Great Grey Shrike (N = 4,998) under the local subspecies, the Levant Grey Shrike *Lanius excubitor aucheri*.

Data for *L. e. aucheri* exists for the past 53 years, during which 5,034 individuals were recorded (Fig. 2) in 673 (53.6%) grid cells. The mean number of individuals per year was 100.6 (95% CL: 59.0 – 142.2) and 7.47 per grid cell (95% CL: 6.25 – 8.70). The fewest individuals were observed in 1970 - 1975 (in all cases only 2 individual), while the most individuals were recorded in 2014 (549). We found a linear trend in the number of reported individuals over the past 53 years (tau = 0.434, $p < 0.0001$). However trend population modeling based on GAMM with "smooth" fit ($R^2 = 0.057$, Fig. 2A) showed that in Israel between 1970 and 2023 the population decreased on average by -17% (95% CL -90% - 532%), while the model with "loglinear" (R2 = 0.035, Fig. 2B) fit showed an also decreased population trend but only by -9.8% (95% CL -51% - 105%). The difference between two models was not significant (LSR test, L.ratio = 0.192, $P < 0.661$). Finally the annual population growth rate (λ) in the exponential model for the entire period = 0.07 (95% CL: -0.11 – 0.28).

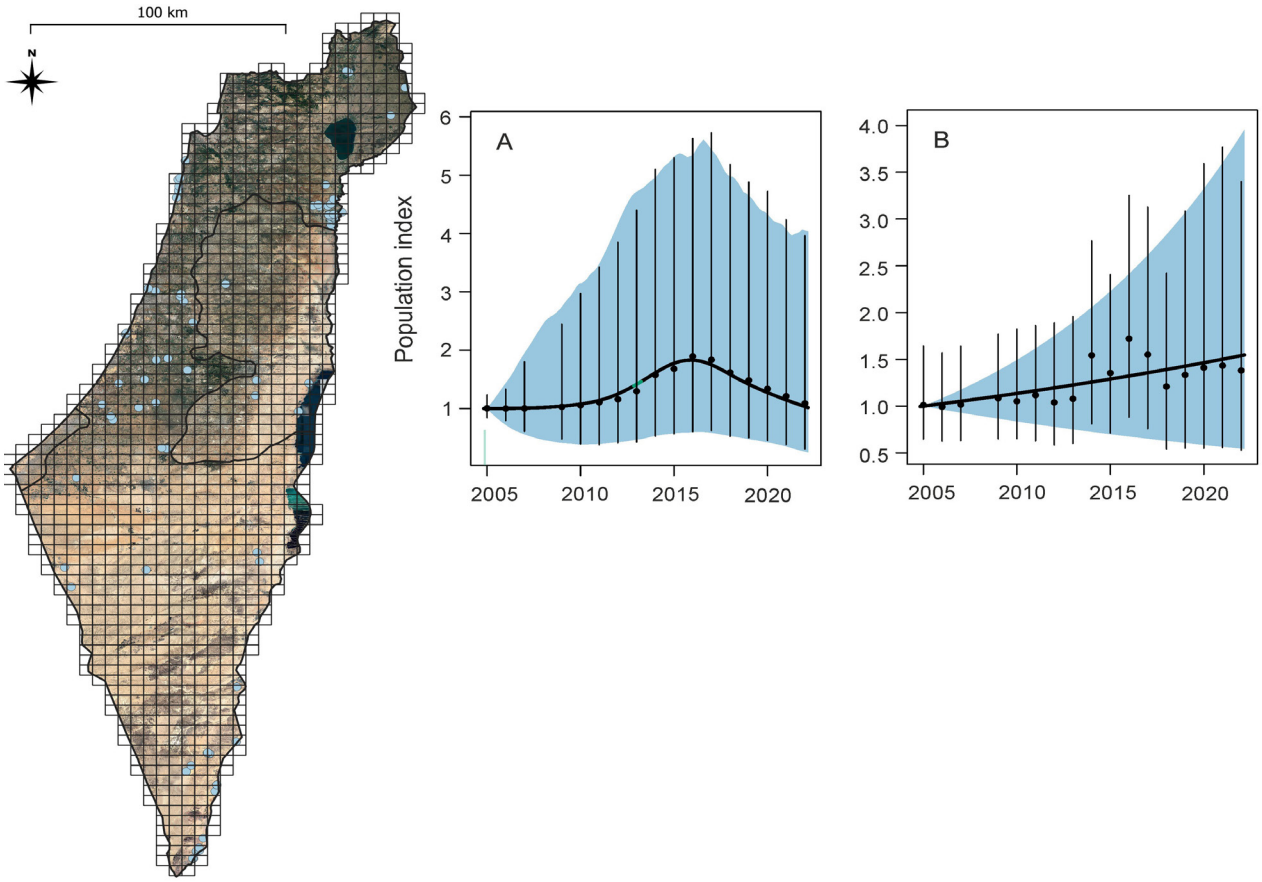

Fig. 3. Annual population trends for *Lanius isabellinus* in Israel based on GAMM with (A) smooth fit and (B) loglinear fit. Error bars show the standard error around the yearly estimates; black lines show trend fitted to the yearly point estimates, blue area represents 95% CL for the smooth fit. Map with dots showing the observation during the 17 years of observations.

Lanius isabellinus

Isabelline or Daurian Shrike is not included in Israel conservation status assessment (INRPA 2023). It is considered to be a passage migrant and winter visitor (Shirihai 1996).

Observations during the past 17 years include 109 individuals (Fig. 3) in 52 (4.1%) grid cells. The mean number of individuals per year was 6.41 (95% CL: 3.29 – 9.52) and 2.09 per grid cell (95% CL: 1.45 – 2.73). The fewest individuals were observed in 2005 – 2007 and 2020 (in all cases only 1 individual), while the most individuals were recorded in 2016 (18 individuals). We found no a linear trend in the number of reported individuals over the past 17 years (tau = 0.041, $p < 0.847$). However trend population modeling based on GAMM with "smooth" fit (R2 = 0.054, Fig. 3A) showed that in Israel between 2005 and 2022 the *L. isabellinus* population increased on average by 3.4% (95% CL -71% - 365%), while the model with" loglinear" (R2 = 0.056, Fig. 3B) fit showed an also increased population trend but by 54% (95% CL -39% - 271%). The difference between two models was not significant (LSR test, L.ratio = 0.001, $P < 0.999$). Finally the annual population growth rate (λ) in the exponential model for the entire period = 0.04 (95% CL: -0.39 – 0.48).

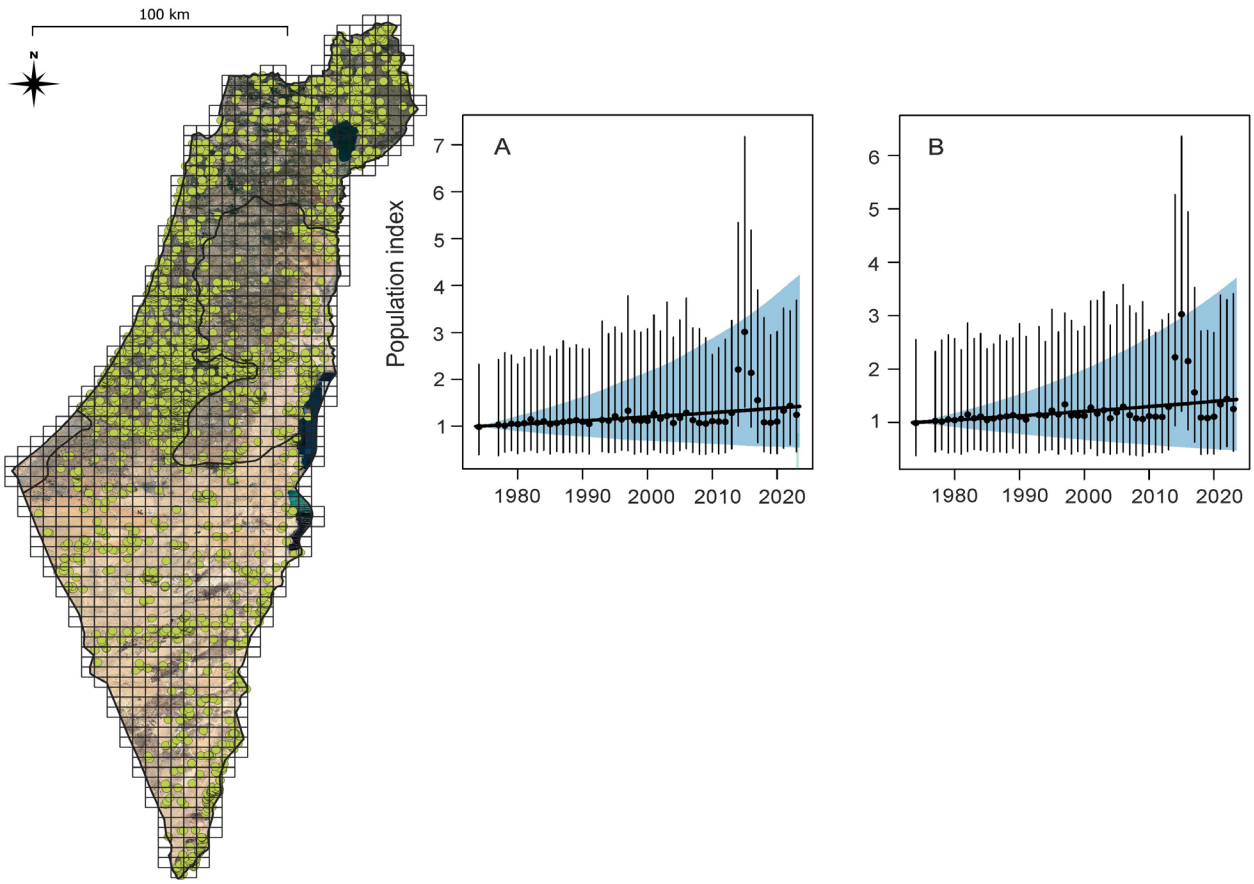

Fig. 4. Population trends for *Lanius nubicus* in Israel based on GAMM with (A) smooth fit and (B) loglinear fit. Error bars show the standard error around the yearly estimates; black lines show trend fitted to the yearly point estimates, blue area represents 95% CL for the smooth fit. Map with dots show the observations during the past 49 years.

Lanius nubicus

The Masked Shrike is considered to be of "Least Concern" in Israel with breeding in northern and central parts of the country (INRPA 2023), and passage migrant during the migration seasons (Shirihai 1996). The breeding biology of the species has not been studied in Israel, only migration strategies through ringing records (Yosef and Tryjanowski 2002, Aloni et al. 2021) and behavioral ecology (Yosef et al. 2012).

During the past 49 years, 4,260 individuals were recorded (Fig. 4) in 584 (46.5%) grid cells; the mean number of individuals per year was 90 (95% CL: 42.12 – 139.15) and 7.29 per grid cell (95% CL: 5.29 – 9.29). The fewest individuals were observed in 1974 and 1978 (in both cases only 1 individual), while the most individuals were recorded in 2015 (839 individual). We found a linear trend in the number of reported individuals over the past 49 years (tau = 0.485, $p < 0.001$). However trend population modeling based on GAMM with "smooth" fit (R2 = 0.042, Fig. 4A) showed that in Israel between 1974 and 2023 the *L. nubicus* population increased on average by 42% (95% CL -54% - 299%), while the model with" loglinear" (R2 = 0.066, Fig. 4B) fit showed an also increased population trend also by 42% (95% CL -48% - 261%). The difference between the two models were significant (LSR test, L.ratio = 10.39, P = 0.001). Finally the annual population growth rate (λ) in the exponential model for the entire period = 0.101 (95% CL: -0.85 – 0.62), indicating that on average the population of *L. nubicus* changed by 1% per year.

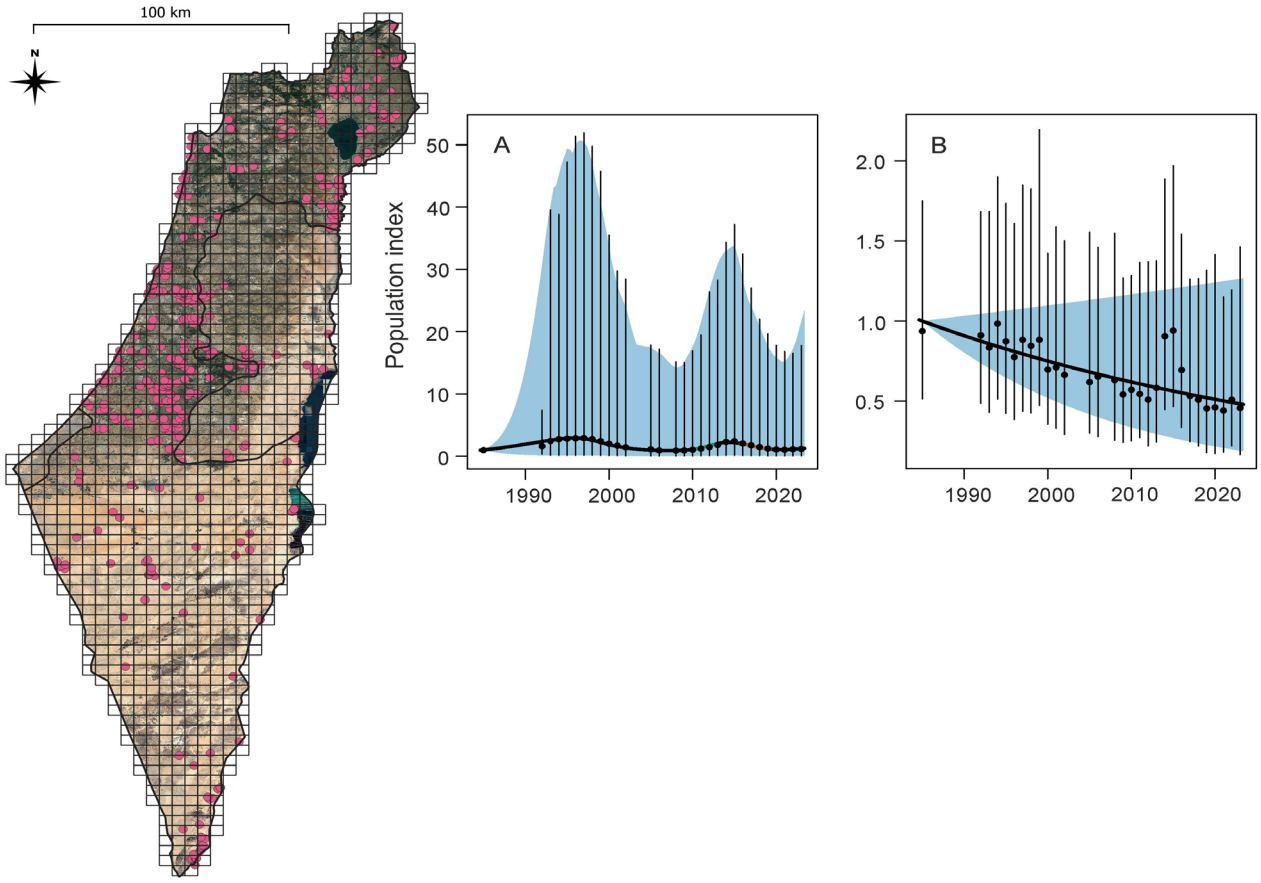

Fig. 5. Population trends for *Lanius minor* in Israel based on GAMM with (A) smooth fit and (B) loglinear fit. Error bars show the standard error around the yearly estimates; black lines show trend fitted to the yearly point estimates, blue area represents 95% CL for the smooth fit. Map with dots showing the observation during the 38 years of observations.

Lanius minor

In Israel the species is rarely observed, and is observed only on migration, hence no conservation status has been accorded (INRPA 2023). Some individuals may also summer but no breeding has been documented (Shirihai 1996).

The Lesser Grey Shrike was observed in Israel during past 38 years, in which 587 individuals were noted (Fig. 5) in 189 (15.1%) grid cells. The mean number of individuals per year was 19.56 (95% CL: 6.37 – 32.75) and 3.10 per grid cell (95% CL: 2.28 – 3.93). The fewest individuals were observed in 1985, 1996, 2001 and 2006-2008 (in all cases only 1 individual), while the most individuals were recorded in 2014 (155 individual). We found no linear trend in the number of reported individuals over the past 38 years (tau = 0.172, p =0.137). However trend population modeling based on GAMM with "smooth" fit (R2 = 0.034, Fig. 5A) showed that in Israel between 1985 and 2023 the *L. minor* population increased on average by 21% (95% CL -95% - 1432%), while the model with "loglinear" (R2 = 0.010, Fig. 5B) fit also showed an increase in the population trend by -52% (95% CL -80% - 19%). The difference between two models was not significant (LSR test, L.ratio = 0.950, P = 0.329). Finally the annual population growth rate (λ) in the exponential model for the entire period = 0.02 (95% CL: -0.32 – 0.37).

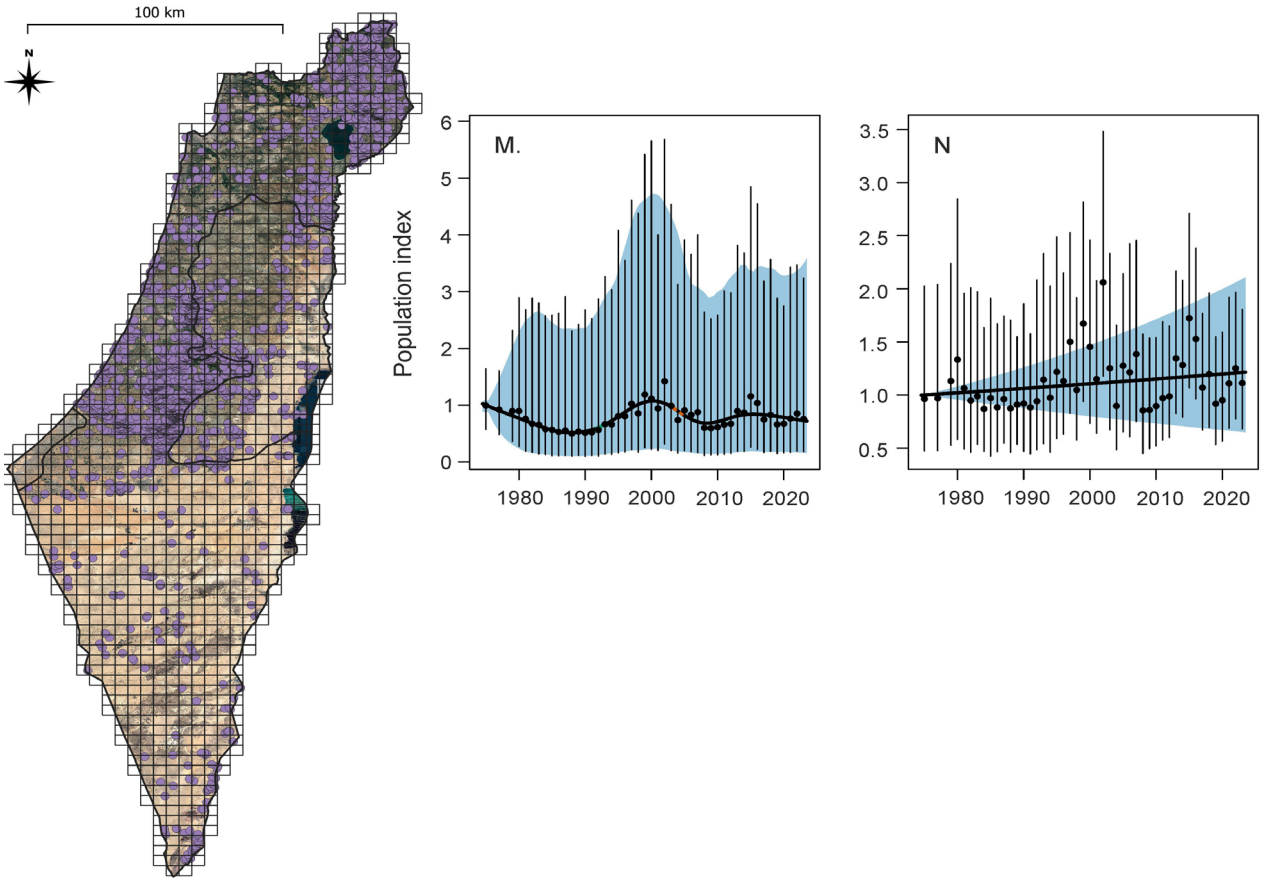

Fig. 6. Annual population trends for *Lanius senator* in Israel based on GAMM with (A) smooth fit and (B) loglinear fit. Error bars show the standard error around the yearly estimates; black lines show trend fitted to the yearly point estimates, blue area represents 95% CL for the smooth fit. Map with dots showing the observations during 48 years of study.

Lanius senator

The Woodchat Shrike is classified as of "Least concern" in Israel, as a summer breeder in northern and central Israel, and a migrant in the rest of the country (INRPA 2023). To date, the information about the breeding biology of the species is limited geographically (Inbar 1975, Shirihai 1996), and also the nominate subspecies on migration (Yosef and Tryjanowski 2000).

In the observations for the past 48 years, 3,853 individuals were recorded (Fig. 6) in 485 (38.7%) grid cells. The mean number of individuals per year was 81.9 (95% CL: 51.03 – 112.15) and 7.94 per grid cell (95% CL: 6.29 – 9.59). The fewest individuals were observed in 1975 and 1977 (in both cases only 1 individual), while the most individuals were recorded in 2015 (413 individual). We found a linear trend in the number of reported individuals over the past 49 years (tau = 0.582, $p < 0.001$). However trend population modeling based on GAMM with "smooth" fit (R2 = 0.019, Fig. 6A) showed that in Israel between 1974 and 2023 the *L. senator* population decreased on average by -27% (95% CL -82% - 231%), while the model with" loglinear" (R2 = 0.008, Fig. 6B) fit showed an also increased population trend also by 21% (95% CL -30% - 112%). The difference between two models was not significant (LSR test, L.ratio = 0.622, P = 0.430). Finally the annual population growth rate (λ) in the exponential model for the entire period = 0.11 (95% CL: -0.11 – 0.33). Our findings justify the Least Concern status for the species in Israel.

Methodological limitations and conclusions

However, it should be noted that our results may be biased. In particular, observations were assigned post-hoc to the grid cells. In addition, the method we use only allows, to a certain extent, multiple checks on the reporting of the same individual. Therefore, the estimate of the species population over the years may be over-estimated. It is therefore not surprising that the variability measures in our estimate are relatively large. However, by collecting data through citizen science, we were able to illustrate the situation of Lanidae population trends in Israel for the first time. Therefore, the presented picture of population changes should be considered as a first step in assessing population changes in this taxonomic group and planning

more targeted field research methods.Despite methodological limitations our data confirm the conclusions and thus the conservation status of each Laniidae species in Israel with those of the official Israeli assessment, last updated on 1 January 2011. The only other data for comparison is even older, Shirihai (1996), Further, our study supports the idea of Citizen Science, the collection of data by laymen which is verified by professionals and then made accessible for use by the general public and academics, including this and similar studies.

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