Peer Community In Ecology

Do look up: building a comprehensive view of population dynamics from small scale observation through citizen science

Aidan Jonathan Mark Hewison *based on peer reviews by* ***Todd Arnold*** *and 1 anonymous reviewer*

Chloé R. Nater, Francesco Frassinelli, James A. Martin, Erlend B. Nilsen (2024) Large-scale spatio-temporal variation in vital rates and population dynamics of an alpine bird. EcoEvoRxiv, ver. 4, peer-reviewed and recommended by Peer Community in Ecology. https://doi.org/10.32942/X2VP6J

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Population ecologists are in the business of decrypting the drivers of variation in the abundance of organisms across space and time (Begon et al. 1986). Comprehensive studies of wild vertebrate populations which provide the necessary information on variations in vital rates in relation to environmental conditions to construct informative models of large-scale population dynamics are rare, ostensibly because of the huge effort required to monitor individuals across ecological contexts and over generations. In this current aim, Nater et al. (2024) are leading the way forward by combining distance sampling data collected through a large-scale citizen science (Fraisl et al. 2022) programme in Norway with state-of-the-art modelling approaches to build a comprehensive overview of the population dynamics of willow ptarmigan. Their work enhances our fundamental understanding of this system and provides evidence-based tools to improve its management (Williams et al. 2002). Even better, they are working for the common good, by providing an open-source workflow that should enable ecologists and managers together to predict what will happen to their favourite model organism when the planet throws its next curve ball. In the case of the ptarmigan, for example, it seems that the impact of climate change on their population dynamics will differ across the species' distributional range, with a slower pace of life (sensu Stearns 1983) at higher latitudes and altitudes.

On a personal note, I have often mused whether citizen science, with its inherent limits and biases, was just another sticking plaster over the ever-deeper cuts in the research budgets to finance long-term ecological research. Here, Nater et al. are doing well to convince me that we would be foolish to ignore such opportunities, particularly when citizens are engaged, motivated, with an inherent capacity for the necessary discipline to employ common protocols in a standardised fashion. A key challenge for us professional ecologists is to inculcate the next generation of citizens with a sense of their opportunity to contribute to a better understanding of the natural world.

References:

Begon, Michael, John L Harper, and Colin R Townsend. 1986. Ecology: individuals, populations and communities. Blackwell Science.

Fraisl, Dilek, Gerid Hager, Baptiste Bedessem, Margaret Gold, Pen-Yuan Hsing, Finn Danielsen, Colleen B Hitchcock, et al. 2022. Citizen Science in Environmental and Ecological Sciences. Nature Reviews Methods Primers 2 (1): 64. https://doi.org/10.1038/s43586-022-00144-4

Chloé R. Nater, Francesco Frassinelli, James A. Martin, Erlend B. Nilsen (2024) Large-scale spatio-temporal variation in vital rates and population dynamics of an alpine bird. EcoEvoRxiv, ver.4 peer-reviewed and recommended by PCI Ecology https://doi.org/10.32942/X2VP6J

Stearns, S.C. 1983. The influence of size and phylogeny of covariation among life-history traits in the mammals. Oikos, 41, 173–187. https://doi.org/10.2307/3544261

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Reviews

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.32942/X2VP6J
Version of the preprint: 3

Authors' reply, 25 September 2024

Please find our detailed replies to comments by the recommender and the two reviewers in the attached pdf document.

We do not provide a tracked-changes version of the test, as this manuscript was written using Quarto. However, we used GitHub version control during writing and revising, and the change log in the form of GitHub commits can be found here: https://github.com/ErlendNilsen/OpenPop_Integrated_DistSamp/tree/MS_multiArea_application

Download author's reply

Decision by Aidan Jonathan Mark Hewison, posted 18 March 2024, validated 19 March 2024

This is an ambitious and rich manuscript which attempts to build a comprehensive overview of the population dynamics of willow ptarmigan across space and time using data collected through a large citizen science programme in Norway. The data are impressive, the analysis appear detailed and the conclusions will have a strong impact on both our fundamental understanding of this system and its management.

This work has been seen by two experts in the field who provide a consensus of opinion on its merit and weaknesses. While both reviewers appreciated the amount of work involved in accumulating and analyzing the data set, they also highlighted some issues that need to be addressed.

Indeed, from my own reading, I would like to emphasize the issue of integrating data from known fate animals. While this considerably enriches the information available for analysis, there is an obvious question of representativity in extrapolating these data from a single location to the entire spatial extent of the study. Given the strong spatial variation in environmental conditions across the wide latitudinal gradient, we need to be reassured that this is not a problem for model estimates and the authors' interpretations.

Concerning the impact of rodent abundance on ptarmigan recruitment, would it be possible to modify Fig. 5C, for example, explicitly plotting the X-Y relationship with all data points visible, to get a better handle on the effect size?

The results of the models appear to reveal that birds survived best in areas where recruitment was lowest which the authors interpret as evidence for an expected trade-off between survival and recruitment. I found this result striking and rather surprising, as at the population level, one would expect environmental conditions to drive positive covariation between vital rates. The interpretation of this result requires some attention, as life history trade-offs are expected at the individual level, and even then, are often confounded by individual variation in quality. I need convincing that these results can be seen as evidence for a life history trade-off.

Many thanks for this interesting contribution.

Mark Hewison

Reviewed by anonymous reviewer 1, 11 March 2024

In this study, the authors developed a multi-area integrated distance sampling model on willow ptarmigan in Norway. This modelling approach combines line transect data (citizen data) and radio-telemetry data to estimate spatio-temporal variation in vital rates (survival, recruitment), densities, population growth rates and the effect of small rodent occupancy on recruitment rates at several sites (41) across Norway.

I have enjoyed reading this manuscript. The paper is well-written, the citizen data collected at 41 areas across Norway is impressive, the modelling approach including multiple areas is novel, and the authors provide workflows that can be set up in a reproducible way by wildlife managers. I have really appreciated the figures (maps) showing the medians AND the uncertainty of demographic parameters at the different locations. Uncertainty is not always shown, and I think plotting maps with both median and uncertainty is very nice.

Here are some few comments and suggestions. I hope the authors will find them useful during the revision process.

Main comments:

(1) One of my main comments is about the use of radio-telemetry data that comes from one single area (Lierne municipality), whereas all line transect data come from 41 areas across Norway. This means that the demographic rates estimated within the multi-area integrated distance sampling model result from radio-telemetry data from one area + distance-sampling data from 41 areas.

o One key point of the paper is to explore and demonstrate spatio-temporal variation in demographic rates (including survival). But the telemetry data comes from one site only. Naively, one can think that if there are multiple data sources for one site (at Lierne with telemetry and distance sampling), whereas for other sites there are only distance-sampling data (with telemetry data coming from Lierne), most of the information on survival should be driven by telemetry data collected at Lierne. In other words, can telemetry data "constraint" or "drive" estimates of demographic parameters in one way or another? I guess so, as it is the philosophy of integrated population model: extract demographic information shared among different data sources. If Lierne is very different from other sites (ecological context, type of birds monitored, see my comment below), with demographic rates and their temporal variation differing a lot compared to other sites, how could telemetry data that is collected at Lierne impact (or not) estimates of demographic rates for all areas? I am not sure how this could be addressed. Of course, the best way would be to use telemetry data in all areas. In absence of data, maybe simulations could be useful to assess the sensitivity of demographic rates in all areas to telemetry data collected at Lierne.

o In the plots showing temporal variation in vital rates and detection probabilities, the opaque blue area marks the period of time for which line transect surveys have been conducted in the area. This means that for the rest of the period, in all areas except Lierne, estimates are only driven by shared variation among areas (random factors) and CMR resulting from telemetry in one site, is that correct? This is directly linked to the previous comment. I think it would strengthen the manuscript a lot if the authors could demonstrate how sensitive the results are to different telemetry data in Lierne.

(2) In Lierne municipality, birds are equipped with VHF collars. I see that references to previous works are provided (Israelsen et al. 2020, Arnekleiv et al. 2022), but still, it could be helpful to provide a little bit of details about the study area (habitat type, hunting pressure, environmental conditions). I think this information is important to better understand to what extent the Lierne area can be representative of other areas (see also my comment above). Similarly, it could be helpful to have information on the birds equipped (sex, age). I guess individuals of different sexes/ages may have different vital rates, that can in turn influence demographic rates estimated for other areas?

(3) If I understood correctly, there is no sex effect in the model, assuming same vital rates for both sexes. Is that realistic biologically for that species? If so, it should be easy to add few sentences to clarify this. If not, it seems that line transect sampling allows collecting information on the sex of the individuals (L. 176), so maybe this information could be used in the model?

(4) Another major comment is about the uncertainty around estimated demographic rates. Some credible intervals (CRI) are very large. More precisely, I am wondering whether the model converges correctly and whether all demographic rates are actually estimable by the model. Here are few examples:

o By looking at the posterior distributions of survival and recruitment, for each area, each year: it seems that some parameters are hardly estimable (e.g. survival in 2021 for all areas).

o Similarly, CRI for the effect of rodent occupancy on recruitment rates are very large in some areas. Could the data points be added on the all the graphs (in addition to model prediction)? I have the feeling that there are very few data points for large rodent occupancy values.

o In Budal Fjellstyre or in Os Fjellstyre, the plot showing the average population density over time seems to indicate a population size equals to zero with a large CRI as well as for annual survival probability.

o Similarly, uncertainty around estimated proportions of variance explained by spatial, temporal and residual variation is very large for survival probabilities (figure 7).

Maybe the model is overparametrized? Maybe it is worth trying some more parsimonious models (e.g. remove time-dependent detection probability in some areas where it seems constant)? Maybe also some areas could be removed, in particular when the amount of collected data is low (e.g. Fjellstyre)? Maybe some key environmental drivers (e.g. weather covariates, hunting pressure) could be added in the model to “help” estimating demographic rates?

Minor suggestions:

· L. 63-64: there can be substantial amounts of variation in population dynamics and life history within a species (among populations), as shown in Nilsen et al. 2009 JAE on roe deer. Maybe also highlight that these differences can be driven by contrasting ecological contexts (hunting pressures, weather conditions, interspecific interactions, etc.)?

· L. 171: consist of -> consists of

· L. 210: from from: delete one “from”

· L. 303: proportion variance -> proportion of variance

· I am wondering whether estimates obtained at Lierne municipality (i.e. survival, recruitment, density, etc.) with the multi-area integrated distance sampling model match to estimates obtained in an earlier study (Nilsen and Nater 2024). Maybe clarify this point?

- L. 343: Estimates for population density are provided in all areas, which is very great. I am wondering whether age-specific densities (adults/juveniles) could be provided as well. This could be interesting in order to assess whether age structure varies among areas, and over years. In addition, I guess estimates of demographic rates are not only available at the area level, but also at the transect level, right? I think providing this information could be very interesting as well.
- L. 417: “variation in detection over time was modest”. From the “timeseries_pdetect.pdf” file, I would say that variation in detection is area-specific: detection seems constant over time in some areas, and highly variable in others. Maybe the range of values could be given (the lowest value reported and the highest one), just to given an idea to the readers? I guess the detection probability depends on how much the fieldworkers are trained (as well as the dogs!) (L. 170). Is the ID of the fieldworkers and the dogs known, and if so, can it explain spatio-temporal variation in detection probability? Along the same line, can spatio-temporal variation in detection probability be explained by varying environmental conditions?
- On the plots showing the detection probability over time for each site, maybe the first year with a detection of 1 can be removed?
- Difference in life histories among populations is mentioned at several places throughout the manuscript. Generation time is a relevant metric to range a population along the slow-fast continuum of life history variation. As the integrated model allows estimating demographic rates for multiple populations, I think generation times can easily be estimated for all populations, and then compared?
- L. 625: observed -> observer
- L. 654: may possible -> may be possible

Again, thanks for this manuscript. This is a very interesting study, and the analysis of large-scale citizen data offers exciting opportunities for wildlife management and conservation.

Reviewed by Todd Arnold, 16 March 2024

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