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Working

Statistical methods to analyze the persistence of threatened birds using citizen science data: A systematic review

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ABSTRACT

Abstract

Background

Due to certain risk factors such as climate change, habitat destruction, overhunting and pollution bird extinctions are now occurring at a rate that far exceeds their speciation rate. When a bird species is lost, the benefits it might have afforded are gone forever. There are no robust indicators of biodiversity conservation that can be used to complement existing national indicators of economic and social health. This study reviews the statistical methods that are used to model and evaluate the persistence or extinction risk of threatened bird species using citizen science data.

Methods

Adhering to PRISMA guidelines, this review systematically searched for relevant journal articles which were published between January 1900 and January 2019 in any of three databases (ProQuest Central, Scopus and Web of Science). Only the journal articles which used a statistical model, predictive model or trend analysis in analysing persistence or extinction risk (while considering risk factors) of threatened bird species developed using citizen science data were included in this study. The bird species that may be declining in population/range even in near threatened or least concern categories also included since these may be the next wave of species to be added to the endangered species lists. Citizen science data helps to increase the number of records and understanding of dynamics in declining bird species populations.

Results

This systematic review was able to identify 37 unique articles describing statistical models for this purpose. Generalised linear models and linear mixed/hierarchical models were the most popular methods used for analysis, followed by machine learning models. The review suggested several strategies to measure the persistence of threatened bird species, but there was no attempt to identify critical tipping points using methods such as change-point analysis.

Conclusion

Overall, it appears that the persistence of threatened bird species varies depending on various risk factors. Statistical models can provide a better understanding of the impact of these risk factors, which is expected to produce better immediate and long-term outcomes for the conservation of threatened birds. It is hoped that this review will identify the statistical methods which are most suitable for this purpose.

Define the review question

1 To identify suitable factors to explain and measure persistence or extinction risk of threatened birds using citizen science data.

Guideline

2 This systematic review was reported in accordance with the preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. The protocol for this review has been published in osf.io also in order to enhance the reproducibility of the

results. The protocol can be accessed respectively from: http://dx.doi.org/10.17605/OSF.IO/6VGUK .

Search

3 The study considered persistence or extinction risk of threatened birds conducted using citizen science data. To find the relevant research articles, an individualized search strategy was built for the Web of Science, Scopus and ProQuest Central databases. This literature search was limited to the journal articles which were published from January 1900 to January 2019.

Keywords for the search

4 It was decided to use individualized key words in the search strategy for the above mentioned databases, in order to extract more relevant articles.

Web of Science
(TS=("bird*") AND TS=("threatened" OR "endangered" or "vulnerable") AND TS=("citizen science") AND TS=("persistence" OR "extinction risk") AND TS=("statistic*" OR "statistical model*" OR quantitative OR "Models, Statistical" OR trend* OR "predictive model*")) AND LANGUAGE: (English)

Scopus
("bird*") AND ("threatened" OR "endangered" OR "vulnerable") AND ("citizen science") AND ("persistence" OR "extinction risk") AND ("statistic*" OR "statistical model*" OR "Models,Statistical" OR "trend*" OR "predictive model*") AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT TO (LANGUAGE , "English"))

ProQuest Central
((bird*) AND ((threatened) OR (endangered) OR (vulnerable)) AND (citizen science) AND ((persistence) OR (extinction risk)) AND ((statistic*) OR (statistical model*) OR (Models, Statistical) OR (trend*) OR (predictive model*))) AND la.exact("ENG") AND PEER(yes) AND stype.exact("Scholarly Journals")

Inclusion and exclusion criteria

5 To select articles better matched to the objective of this systematic review, four main inclusion criteria were developed. Articles were selected if
(i) the study focused on threatened bird species under IUCN red list assessment criteria, and, for bird species in near threatened or least concern categories that are declining in population/range, because these may be the next wave of species to be added to the endangered species lists;
(ii) citizen science data were used to conduct the study;
(iii) the study discussed persistence or extinction risk of threatened bird species;
(iv) the study needed to carry out a quantitative analysis using statistical modelling or predictive modelling or trend analysis.

Selection Process and Data Extraction

6 The articles which were found from the database search were uploaded to EndNote software and duplicates were removed by the first author. The other two authors were then given online access to view the results. The first two authors then independently screened the titles and abstracts against the inclusion criteria and shortlisted the most relevant articles. The articles which had been accepted by both reviewers were shortlisted and the articles which had questionable eligibility were directed to the third reviewer for resolution. This process shortlist the most relevant articles for a full text review. The first two authors will then carry out the full text review independently and identify whether the article is within the inclusion criteria or not. The articles which are then shortlisted from the full text review will then be eventually included in the review where the questionable articles were directed to the thrid author, for her decision.

Then in order to extract data from the selected papers we have maintained a well structured table which includes all the information about the paper from the author to statistical methods that they have used.

PRISMA flow diagram

7 Then the whole search process would be plotted in a well structured PRISMA flow diagram with the main reasons for rejections.

Quality assessment - Risk of Bias Assessment

8 There is no quality assessment checklist for journal articles in this area a new checklist named "Udani DM Checklist" was created, referring to the Downs and Black checklist (Black, N., 1998), in order to assess the quality of these 37 articles. This checklist consists of 22 items distributed among five sub scales, namely; reporting (9 items), external validity (4 items), internal validity - bias (4 items), internal validity - confounding (4 items) and power (1 item). The performance of the quality assessment items is assessed using "1" for compliance and "0" for non-compliance. The standard deviation for each item is calculated as a check of the discrimination capability for each item. The maximum score that a study can obtain is 22, with higher scores indicating better quality. In this review the Udani DM scores have been categorized as follows; low quality (10-13), fair quality (14-15), average quality (16-18) and high quality (19-22). Table S1 shows the 22

questions included in “Udani DM Checklist”.

Results

9 In order to present the results of the review that were generated by the previously prepared table in the data extraction stage, a taxanomy of statistical techniques were used.