Collaboration for Environmental Evidence

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Systematic Review Protocol

Title
How effective are perches in promoting bird-mediated seed dispersal for natural forest regeneration? A systematic review protocol.

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Background
Forest landscape restoration (FLR), often through tree planting, is one of the conservation priorities in many global and national initiatives for carbon offsetting as part of climate change mitigation strategies and biodiversity conservation. However, active efforts to meet FLR objectives entail substantial costs for the procurement of planting stocks and require an experienced workforce for planting and nurturing growing tree seedlings. Alternatively, forest restoration projects can be more cost-effective and potentially may have greater biodiversity gain through accelerating natural forest regeneration. The use of perches is one of the strategies under Assisted Natural Regeneration (ANR) and is used to attract avian seed dispersers to degraded habitats for increased tree seed supply and seedling establishment. The purpose of this meta-analysis is to determine the effectiveness of artificial and natural perches that have been used in promoting natural forest regeneration. Specifically, we will evaluate their effectiveness in driving seed richness, seed density, seedling richness, and seedling density. The stakeholders are individuals, organizations, and institutions that are involved in forest landscape restoration. The results will synthesize available evidence on the topic, identify knowledge gaps we urgently need filling to upscale the strategy, and inform their use in concert with other ANR strategies.

Theory of change or causal model
Birds have been shown to improve forest regeneration through increasing abundance and diversity of the seed rain in degraded areas, which can positively influence seed germination and seedling establishment. However, birds are generally hesitant to visit degraded sites, because of increased risks from predation, harsher conditions, and lack of resources. To accelerate natural forest regeneration, birds can be attracted to these habitats through the use of artificial perches, applied nucleation, and planting of fruit trees. The principle behind these methods is to attract birds into the matrix through provision of food and/or perching sites.

Stakeholder engagement
We created a stakeholder survey to seek insights and suggestions for the meta-analysis. This was disseminated through email to experts in the field of forestry, ornithology, restoration ecology, and other relevant fields. To date, we have received nine responses from participants who were affiliated

with different universities (based in UK, Thailand, Philippines) and environmental conservation organizations (BirdLife International, Instituto Claravis, Royal Society for the Protection of Birds). They found the research questions relevant and have suggested sub-topics to explore, including the dispersal distance of seeds from the forest. They have also suggested including ‘forest*’ (locator), ‘scrub*’ (intervention), and ‘regenerat*’ (outcome) as part of the search terms, which we have accepted and incorporated. The main interest in this topic is in the effectiveness of perches to increase bird-mediated seed dispersal to degraded landscapes. The audiences of the meta-analysis are the researchers and practitioners of forest landscape restoration.

Objectives and review question

The primary objective is to answer the question "How effective are natural and artificial perches in promoting bird-mediated seed dispersal and seedling establishment in degraded/matrix habitats?". Additionally, we aim to determine the influence of potential modifiers by asking the question, "How do landscape features and human disturbances alter the effectiveness of natural and artificial perches?"

Definitions of the question components

We defined the components of the question using the PICO model. Population (P): Degraded areas near a forest Intervention (I): Artificial perches (e.g., wooden posts, wires) and natural perches (e.g., single trees, shrubs) Comparator (C): Same site before and after intervention (temporal) or similar/adjacent site with and without intervention (spatial) Outcome (O): Seed richness, seed density, seedling richness, seedling density Moderator: Matrix type (e.g., agriculture, grassland, regenerating landscape), distance of perch to forest edge, Human Footprint Index, and soil moisture index

Search strategy

We will search for literatures (e.g., articles, books, theses, institutional reports) through several databases and solicited calls for relevant papers. A total of eight databases, which include an organizational library and a web-based search engine, will be searched using the refined search string in English (Supplementary Material 1). Review articles will not be included because meta-analyses require raw data, but we will be including the references used by Guidetti et al. (2016) in their review paper. No period will be excluded. Based on the elements of the question, we identified key terms that refer to the population, intervention, and outcome. These were combined using ‘OR’ within each element and with ‘AND’ across to form the search string, such that an article will be returned if it referred to birds (and its synonyms), a type of perch, and a term about seed dispersal outcomes. Lastly, we added a location term to limit the habitat type to forests, too.

Bibliographic databases

The final search string was as follows: (bird* OR avian OR aves OR disperse*) AND (palm* OR fruit* OR perch* OR "artificial perch*" OR roost* OR nucleation* OR nuclei OR "tree isl*" OR "woodland isl*" OR "habitat isl*" OR "remnant tree*" OR "isolated tree*" OR "single tree*" OR shrub* OR wire* OR post* OR scrub*) AND ("seed dispers*" OR "seed rain*" OR seedling* OR regenerat*) AND forest*. This was formatted for Web of Science (WOS) initially, and it was adjusted accordingly to the syntax of other databases (Supplementary Material 1). The search will only be done in English, which also includes literature with English abstracts and full texts in other languages. We expect to find most studies from the WOS Core collection and Scopus based on our initial scoping. Using the proposed search string, all ten articles in the benchmarking list were found in the former database, but one was missed in the Scopus search due to the lack of abstract. We included SciELO Citation Index to find regional studies from Latin America, Spain, Portugal, the Caribbean and South Africa, as well as ProQuest Natural Science Collection, and CAB Abstracts for theses, reports, and conference proceedings that may not have been published and indexed.

Web-based search engines
Searches will also be done on Google Scholar. We will use the following main search terms from population, intervention, and outcome components: Bird AND perch AND “seed dispersal”. Only the first 200 results, sorted by relevance, will be examined. In addition, to expand our search further, a public call for literature will be done through relevant mailing lists and social media (i.e., Facebook, Twitter).

Organisational websites
Conservation Evidence will be included in the search. We will search for studies using keyword "perch" under category "birds".

Comprehensiveness of the search
To ensure comprehensiveness of the search, the search string was optimized by testing it against ten benchmark articles (Supplementary Material 1) in the WOS Core Collection. We tested different search strings and checked whether the ten benchmark articles were included in the results and whether the results were generally relevant. The process was documented in the Supplementary Material 1. In addition, the search strategy and search strings were discussed and improved upon with the help of an information specialist (Julia Robinson from Newcastle University Library). Through this optimization process, we decided to include “disperse*” in the population term, because a paper in the benchmark list did not refer to birds specifically at the title, abstract, or keywords. For intervention, we added “roost*” to what Guidetti et al., (2016) used for artificial perches and also included terms for natural perches. We used “forest*” as the location term to exclude other habitats.

Search update
A search update will be performed every year, if resources allow, until the review is published.

Screening strategy
The screening of eligible studies will be done by the review team using a pre-defined inclusion/exclusion criterion. The review team will consist of the primary reviewer and two secondary reviewers. The former will be leading and conducting most of the screening process, while the latter will work on subsets of the literature searches for consistency checking. We will create the ROSES flow diagram to report the number of papers excluded at every stage of screening – title, abstract, full text. First, the library will be cleaned of duplicates using the tool in the software Rayyan (Ouzzani et al., 2016). Then, we will conduct title and abstract filtering using the eligibility criteria below as guide, retaining uncertain ones for the next step. Lastly, we will conduct full text filtering, primarily through reviewing the methods and results sections, as guided by the study inclusion criteria. We will provide a supplementary list of articles that were excluded at this stage with reasons for exclusion.

Eligibility criteria
We will review the collated studies obtained from the searches using the criteria set below. (1) Population: The site is a degraded site or matrix habitat near or adjacent a forest of any type; (2) Types of intervention: The study identified and collected data from perching sites for birds; (3) Types of comparator: The study compared a site with perch with a control site with similar conditions but without perch (paired design); (4) Types of outcome: The study reported means and standard deviation/error of seed richness, seed density, seedling richness, and seedling density. Studies must have data mostly contributed by birds, as justified by observations, previous literature, or pilot studies. We will exclude studies that used a combination of perches and another attractor (i.e., food, water) in the meta-analysis, but they will be listed separately for potential use in the discussion and interpretation of findings.

Consistency checking
For consistency checking of inclusion/exclusion decisions, we will randomly subset 10% of the total search and have them screened by the secondary reviewers at the title, abstract, and full-text stage. The results will be compared via Randolph's free-marginal multi-rater Kappa coefficient (Randolph, 2010). If kappa statistic is lower than 0.6, the eligibility criteria will be re-evaluated and readjusted. Conflicting decisions will be discussed with the team until a consensus is reached. This will be documented as supplementary material.

Reporting screening outcomes
We will create the ROSES flow diagram to report the number of papers excluded at every stage of screening – title and abstract, full text. In addition, we will also provide reasons for exclusion for full text articles that were rejected at the final stage.

Study validity assessment
We will assess study quality based on two criteria (Table 1). We used the Environmental-Risk of Bias Tool (Bilotta et al., 2014) but left out 'selection bias due to inadequate allocation concealment', because studies considered didn't involve allocation of interventions. We adapted Criteria 4 and 5 from the CEE Critical Appraisal Tool (Konno et al., 2021). Other criteria were not useful in our context, because of the paired sampling design in the studies considered and our interest in raw data. The method used to measure the effect of interest was important, hence the second criteria was included to appraise method validity. The best method (i.e., high validity) is observations of birds defecating seeds on the perches, because this allows us to ascertain that the seeds were bird-dispersed. However, we expect to find only a handful of studies with this standard due to resource constraints. We expect that the majority will have employed seed rain collection, which can produce varying data quality depending on the specificity of the sampling design, and these have been considered as high validity if it was designed to be bird-specific. The two criteria will be used to report the quality of studies included in the meta-analysis. Both overall risk of bias and method validity will be included as exploratory or sub-grouping variables in the meta-analysis to check the sensitivity of the results. The results and conclusion will be presented with consideration to the risk of bias and limitations among the collated evidence.

Consistency checking
For consistency checking, 10% of the articles will be appraised by the two secondary reviewers, and disagreements will be discussed as a team.

Data extraction strategy
We will extract data from the accepted list of articles using a pre-designed datasheet with pre-coded options for certain fields (Supplementary Material 2). The data sheet was tested with the ten benchmark articles. The data will be taken from the text and tables. If the data is not readily available (i.e., in figures, transformed data), we will try to reach out to the corresponding author/s and ask for the raw data. Alternatively, if they do not respond, data reported in figures can be extracted using the metaDigitise package in R. The extracted data records will be reported as supplementary materials to the review. Some studies classified and reported seed rain data based on their dispersal modes. For such cases, we will only use those specific to animal or bird dispersal. We will exclude studies with missing or unextractable mean and/or variance data from the analysis.

Meta-data extraction and coding strategy
The metadata component of the data extraction will include details pertaining to the attributes of the study setting. The set-up fields refer to details on the methods, which include intervention type, perch height in meters, specific bird species included, specific tree species included, habitat type of the matrix, type of forest, number of samples, distance of perch to nearest forest in meters, length of

experiment in days, and method used in the study. On the other hand, the outcome fields contain information about the data being compared, namely type of outcome measured, unit of the mean values, mean value of the intervention, mean value of the control, type of variance measured, variance of the intervention, variance of the control, test statistics used for analysis, value of the statistical test used, p-value, confounding variable that may affect the results, and other general notes on data reliability, availability, limitations, and assumptions. These will be coded in the data sheet (Supplementary Material 2).

Consistency checking
For data extraction, the two secondary reviewers will independently extract data from all eligible studies. However, if the number of studies is large, only the primary reviewer will extract the data, which will subsequently be checked by the secondary reviewers. Discrepancies in the data coding will be discussed within the team.

Potential effect modifiers/reasons for heterogeneity
The effects of perches in the seed rain and seedling establishment may vary across studies due to differences in study methods and contexts. We will mainly consider distance of perch to forest patch and type of matrix as possible effect modifiers. The two modifiers were chosen because of their importance to facilitating movement of birds according to literature (Awade & Metzger, 2008; Eycott et al., 2012). In addition, we are also interested to examine Human Footprint Index (Keys et al., 2021) and soil moisture index.

Type of synthesis
Narrative and quantitative synthesis

Narrative synthesis methods
The narrative synthesis will report basic summary of the studies that have been conducted so far and data availability. Based on the representation in the meta-data of the studies, we can identify sub-topics and research gaps that warrant further research.

Quantitative synthesis methods
For data analysis, the effect size will be computed as the unbiased standardized mean difference Hedges' d (Hedges & Olkin, 1985). This metric has the following equation: d =(X^E- X^C)/(SD^E+ SD^C) J , representing the difference in the mean values of the two groups (X^E as for experimental and X^C for control group) standardized by the pooled standard deviation (SD) and includes a correction for small sample size (J) (Koricheva et al., 2013). Positive d values indicate higher seed richness, seed density, and seedling richness and density in areas with perches than in those without perches, and vice versa. The models will be constructed in a mixed-effects approach, which will include distance to forest and matrix type as fixed effects. Models will be evaluated based on AIC values. All computations will be done in R using the metafor package (Viechtbauer, 2010). Studies that included perches in different distances from the forest will be considered as distinct results if they have replicates. For example, a study that collected data from control sites and perches at three different distances away from the forest (e.g., 5m, 10m, 15m) will be treated as three distinct responses in the analyses. We will include the study identity as a random factor to account for potential dependence of results.

Qualitative synthesis methods
N/A

Other synthesis methods
N/A

Assessment of risk of publication bias
Small study effects, including publication bias, will be visually assessed using funnel plot (Sterne & Harbord, 2004). It will be symmetrical and funnel-shaped centred around the mean effect size when there are no such effects.

Knowledge gap identification strategy
The research gaps will be identified by analysing the representation of the meta-data, which can be visually shown as a table or figure.

Demonstrating procedural independence
Authors of research studies included in this review will not be involved in any decisions regarding their own work. Procedural independence is guaranteed as none of the authors has (co-)authored studies which could be included in this review.

Competing interests
The authors declare that they have no competing interests.

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Author's contributions
JLG, MS, and MP conceptualized the idea. JLG conducted the stakeholder survey and wrote the manuscript. MS and MP reviewed the survey form, protocol design, and the manuscript.

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