# Invasive plant management: a systematic review protocol

Philip A. Martin[1,2], Gorm Shackleford[1,2], William J. Sutherland[1,2]

1. Conservation Science Group, Department of Zoology, University of Cambridge. 2. BioRISC St Catharine's College, Cambridge CB2 1RL, UK

## Abstract

### Background

TBA

### Methods

TBA

### Keywords

biosecurity; evidence-based conservation; invasive plant management; invasive species management; meta-analysis; subject-wide evidence synthesis; systematic map; systematic review

## Background

Biosecurity and the UK Biological Strategy: https://www.gov.uk/government/publications/biological-security-strategy

Invasive species (as part of biosecurity)

Invasive plants: impacts and control measures (with an emphasis on the UK/Europe?)

[...]

Individual invasive plant species have already been the subject of several systematic reviews (e.g., bracken (*Pteridium aquilinum*) [1], cordgrass (*Spartina* spp.) [2], Japanese knotweed (*Fallopia japonica*) [3], ragwort (*Senecio* spp.) [4], and rhododendron (*Rhododendron ponticum*) [5]). However, all of these reviews are now over 10 years old and are in need of updating. Moreover, we think it would be ideal if there were a general protocol that could be used for systematic reviews of any species of invasive plant, using a common set of methods and metadata, for the following reasons.

Firstly, the number of publications about individual species of invasive plant is likely to be relatively small, compared to the number of publications in a typical systematic review in *Environmental Evidence*. For example, our scoping searches for Himalayan balsam (*Impatiens glandulifera*) and its synonyms produced less than 300 search results. This is <1% of the workload for a typical systematic review, with approximately 12,000 search results [6]. At present, we have funding for several person-years of work on invasive plants, and this should give us time for several systematic reviews of an average size, which take about one person-year of work [6]. However, this process will be more efficient if we can reuse the same protocol for multiple systematic reviews.

Secondly, many interventions are likely to be identical for different species. For example, cutting and applying herbicide are interventions that were included in all of the above systematic reviews of invasive plants. By developing a general protocol, we will reduce the duplication of effort, and we will also work towards developing a database of systematic reviews with comparable data and metadata. In time, this will allow us to ask and answer larger-scale questions about invasive plants in general (e.g., "What are the effects of mowing on invasive plants?"), by combining data from multiple reviews. This will also allow us (or other groups) to add new reviews of invasive plants in the future, as new funding becomes available, while maintaining the compatibility of new and old reviews. A systematic map protocol was recently published in *Environmental Evidence* [8] with the similar goal of developing a general protocol for systematically mapping studies about any crop species. Whether it is possible to develop a general protocol that can be reused for multiple species has not yet been tested, but we will be able to test this protocol for multiple species of invasive plants, and we will publish a revised protocol if need be.

# Stakeholder engagement

- Should we ask David if he can get feedback from invasive experts?
- Or Kevin Smith or someone else in the building?
- Or GISD?
- Other ideas?
- Reserve managers or policy makers that express an interest in this sort of evidence?
- We should also mention the BioRISC project and Conservation Evidence here.

Should we suggest that our stakeholders are primarily in the UK/EU?

# Objective of the review

Primary questions:

1. What is the effect of different methods for controlling invasive plant species on the abundance of the target species?
2. What is the effect of these different methods on non-target species abundance and diversity?
3. What is the effect of different methods on ecosystem services?

# Methods

These methods are based on ROSES (RepOrting standards for Systematic Evidence Synthesis) [9], and a ROSES checklist has been completed (Additional file 1).

## Searches

### Search strategy

Our search strategy is designed to retrieve all the publications on invasive plant species of interest. We will search for publications in five bibliographic databases that were identified as relevant by the review team and our stakeholder group. In addition to published, peer-reviewed literature we will also search for unpublished research to reduce any effects of publication bias. We will also ask our expert panel to share any unpublished articles that they know of with us.

### Search string

For each species, we will use its scientific name(s) and common name(s) as the search string, based on a standard list of taxonomic synonyms (CITATION). For example, for Himalayan balsam, we will search for '"Balsamina glandulifera" OR "Balsamina macrochila" OR "Balsamina roylei" OR "Impatiens glandulifera" OR "Impatiens candida" OR "Impatiens cornigera" OR "Impatiens glanduligera" OR "Impatiens macrochila" OR "Impatiens moschata" OR "Impatiens royleana" OR "Impatiens roylei" OR "Impatiens taprobanica" OR "Himalayan balsam" OR "policeman's helmet" OR "bobby tops" OR "copper tops" OR "gnome's hatstand" OR "kiss-me-on-the-mountain" OR "ornamental jewelweed"'. This search string should produce the most inclusive set of search results possible, because it will not use "AND" terms (e.g., '"Impatiens glandulifera" AND control'). However, because common names may represent common words or phrases they have the potential to increase the number of search results from irrelevant sources. To resolve this we will subject all keyword

searches to sensitivity tests and where the inclusion of a particular common name increases the number of papers returned by a search by >500 we will restrict the search for that name by adding "AND (control OR management)" for that name only. We will only use common names in English, unless the people working on an individual species are confident working in other languages (see below).

## Languages

We will review publications in English only, unless the people who are working on an individual species are confident working in other languages (at least two people, for consistency checking). However, we will provide a list of publications that were excluded because they were not in English (or these other languages). Therefore, it will be possible for other people to screen these publications without re-screening all of the search results.

## Bibliographic databases

Publications will be collated from the following databases:

- *Scopus*
- *Web of Science Core Collection*
- *OpenGrey* (http://www.opengrey.eu) - It would be useful to have something instead/in addition that is more generic as this source is EU only
- Agricola has been used by others (we used both Agricola and Agris for cassava, and they're a pain).

## Web-based Search engines

In addition to specialist bibliographic databases we also searched web-based search engines. We limited our searches to the first 500 results from the following sources:
- Google Scholar (https://www.scholar.google.com)
- Google (https://www.google.com)

## Organizational websites

We do not plan to specifically search any organizational websites. However, any relevant publications on organizational websites that are found using web-based search engines will be examined in detail.

## Estimating the comprehensiveness of the search

Because we will use search strings with high specificity (search strings that do not use "AND" terms), it will not be possible for us to estimate the comprehensiveness of the search for most species. However, if an older systematic review is available for an individual species (CITATIONS), then we will compare our search results with the publications included in that systematic review, to estimate the comprehensiveness of our search.

## Search update

We will provide dates on which initial searches were carried out for each database as well as the exact search terms used.

Following the initial collation of evidence we will continually update each systematic review on the website [www.metadataset.com](http://www.metadataset.com) as new relevant evidence becomes available. To our knowledge, this will constitute the first 'living' systematic review in ecology and conservation.

To ensure the evidence-base for each systematic review is up-to-date, we will carry out searches using the same key words as used in previous searches. Any new literature that we identify will be screened using the methodology presented in this protocol and, when relevant studies are identified we will extract appropriate data to allow the evidence base to be updated. At present we envisage carrying out these searches once a month.

# Article screening and study inclusion criteria

## Screening strategy

We will screen publications in two stages: (1) using titles and abstracts and (2) using full texts. At each stage we will decide whether to include or exclude a publication based on the eligibility criteria we set out below. At each stage we will record the number of publications included/excluded, and we will provide a list of the full texts that were included, together with reasons for their exclusion and a ROSES flow diagram. We will only include publications that are written in English. We acknowledge that this is a shortcoming, however, we do not have the resources needed to work in other languages, especially regarding checking of consistency. We will provide a list of publications that have been excluded because they are not in English.

- Need to work out what to do when there is doubt about inclusion at the title/abstract screening stage - I assume that we include things
- Need to work out if we use 'snow-balling' to find other relevant literature that we might have missed in the keyword searches - I think that we should.

## Consistency checking

To check for consistency a random sample of 10% of titles/abstracts will be screened by two people. Based on our scoping searches we expect between 100 and 5,000 non-duplicated search results for each species, thus constituting 10-500 titles/abstracts that will be screened by two people. Any disagreements between the two people will be discussed, and eligibility criteria will be revised to show how disagreements were resolved. Kappa scores will be calculated to test agreement between the two people. If Kappa scores are below 0.6,

another 1% of titles/abstracts will be screened by the same two people. Disagreements will be discussed and resolved again, Kappa scores recalculated, and the process repeated until Kappa scores are greater than 0.6.

Following this, a random sample of 10% of the publications that meet inclusion criteria based on their titles/abstracts will be screened by two people. This process will mirror that detailed above for title/abstract screening. Once studies to be included in the systematic review are determined, consistency of data extraction will also be checked by dual screening.

## Inclusion criteria

In this systematic review we will use a "PICO/PECO" approach (P=populations/subjects, I=interventions/E=exposures, C=comparators, O=outcomes) to determine eligibility criteria. To be included in our systematic review studies must attain the criteria detailed in Table 1.

Table 1 - Inclusion criteria

| Component | Criteria |
|---|---|
| Eligible populations | Himalayan balsam plants |
| Eligible interventions | Management interventions that attempt to (i) prevent invasion by Himalayan balsam or (ii) control Himalayan balsam once it has become invasive. Studies of control are likely to focus on biological, chemical (e.g. herbicide application), and physical control (e.g. cutting or burning) of the species. |
| Eligible comparators | Comparison with area with no treatment or an alternative treatment (e.g. comparison of herbicide vs cutting) that we refer to as a control-impact study (CI). Comparison with a time when no intervention was used (before-and-after, BA) or comparison treated and untreated areas before and after a treatment is imposed (before-after-control-impact, BACI). What should we say about replicated vs unreplicated studies? We will also include site comparison studies. |
| Eligible outcomes | Abundance, density, cover, and above- and below-ground biomass of Himalayan balsam. |

We will exclude studies carried out in laboratories, but will include studies carried out in natural habitats or under greenhouse conditions.

TBA: Classification of interventions and outcomes
- Should I retain studies that look at invaded vs uninvaded sites until I have read the full text. There is some potential that these studies might be useful site comparisons.
- We will only include studies where effect sizes can be calculated from the data presented in the paper/supplementary materials. We will not request additional data from authors.

## Reasons for exclusion

We will provide a list of publications that were excluded at the full-text stage, with reasons for exclusion (e.g., "no intervention" or "cannot access").

# Critical appraisal

## Critical appraisal strategy

Studies that meet our inclusion criteria will be subjected to critical appraisal. We will assess the susceptibility of each study to bias. Studies that have any of the following limitations will be excluded:

1. Poor matching of intervention and control sites (e.g. sites clearly different before an intervention carried out).
2. Differences in methodology used to quantify Himalayan balsam abundance at intervention and control sites.

During data extraction details of study design and methods will be extracted and used as part of the critical appraisal process during synthesis. We will assign various factors as resulting in low, medium or high bias. We will record in detail how we assessed these variables for each study.

Table 2 - Critical appraisal criteria

|  | **Low bias** | **Medium bias** | **High bias** |
|---|---|---|---|
| Observation type | Experimental |  | Observational |
| Study design | BACI | BA and CI | SC |
| Randomization | Randomized |  | Non-randomized |
| Homogeneity of study plot size | Homogenous plot size |  | Heterogenous plot size |
| Replication |  |  |  |
| Pairing | Paired |  | Unpaired |

| Blocking | Blocked | | Unblocked |
|---|---|---|---|
| Duration of study | >1 year | | <1 year |
| Accounting for confounding variables | Yes | | No |

## Critical appraisal used in synthesis

## Consistency checking

As with other steps, a random sample of 10% of the studies to be included will be critically appraised by two people. Any discrepancies between reviewers will be discussed and the metadata adjusted accordingly. No kappa analysis will be performed at this stage as our goal will be for complete agreement between reviewers.

# Data extraction

## Metadata extraction and coding

Metadata will be extracted from studies that meet our selection criteria. Metadata on the context and PICO elements that we will extract from each study are detailed below.

Context
- Country where work was carried out
- Latitude and longitude coordinates of sites
- Start date of study
- End date of study

Population
- Himalayan balsam subspecies/hybrid studied

Intervention
- Description of the management intervention

Comparator
- Type of study design (e.g. SC, CI, BA or BACI)
- Randomization used in study
- Homogeneity of plot sizes used
- Number of replicates

- Pairing
- Blocking
- Distance between sites/replicates

Outcome
- Himalayan balsam cover
- Himalayan balsam abundance/density
- Himalayan balsam biomass (above- or below-ground)

## Data extraction strategy

Data will be extracted from narrative sections of articles or from tables or figures. Comparisons will be made within one figure/table but not between figures/tables. For example, if studies were done in two or more areas, but these results were presented in separate figures/tables, we will assume that a comparison cannot be made across tables unless specified otherwise in the article text. Where data are presented for multiple years data from all years will be extracted. No attempts will be made to contact primary authors to ask for additional data not available in studies.

## Approaches to missing data

Missing data can present a serious issue for meta-analyses in ecology and conservation as reporting standards in the literature are very variable. This often includes missing information (i) about sampling variance or sample sizes and (ii) about moderators.

## Consistency checking

Consistency of data extraction will be checked by randomly sampling 10% of studies that meet inclusion criteria from which data will be extracted by two people. Discrepancies in the data extracted will be discussed and extracted data modified accordingly. No kappa analysis will be performed at this stage as our goal will be for complete agreement between reviewers.

# Potential effect modifiers/reasons for heterogeneity

- Study in pot/field
- Rate of application of herbicide/cutting
- Type/mechanism of herbicide
- Frequency of intervention (e.g. repeated spraying with herbicide)
-

## Data synthesis and presentation

Narrative synthesis strategy

Quantitative synthesis strategy

Qualitative synthesis strategy

Other synthesis strategies

Assessment of risk of publication

Knowledge gap identification

## Declarations

# References

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# Additional file 1: Classification of interventions

https://www.metadataset.com/himalayan-balsam/browse-by-intervention/

# Additional file 2. Classification of outcomes

TBA but probably based on https://www.metadataset.com/cassava/browse-by-outcome/