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Effects of conservation interventions on terrestrial and freshwater invertebrates: a protocol for subject-wide evidence synthesis

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Abstract

Terrestrial and freshwater invertebrates are under pressure from multiple threats, such as agriculture, forestry, pollution, urban and industrial development, invasive species and climate change, and many species are declining in number. There is therefore an increasing need for evidence-based conservation of terrestrial and freshwater invertebrate populations. Reviewing the evidence is a time-consuming and costly exercise. In general, the assessment of the evidence-base is approached on a case-by-case basis and different stakeholders independently conduct evidence reviews relative to their specific application or enquiry. This approach is counter to the philosophy of 'produce once and use many times over' and is a highly inefficient use of resources. The methods outlined in this protocol are designed to identify and synthesise the available evidence for the effectiveness of conservation interventions for terrestrial and freshwater invertebrates (excluding bees, for which a synthesis has already been produced; Dicks et al., 2010). This protocol uses wording that is standard for a subject-wide Conservation Evidence synthesis.

Key Words: subject-wide evidence synthesis, terrestrial invertebrates, freshwater invertebrates, molluscs, arthropods, conservation, intervention, management

Background

Terrestrial and freshwater invertebrates are among the most abundant and speciose groups on the planet. Many species, or functional groups, play a vital role in maintaining the health and function of most, if not all, terrestrial and freshwater ecosystems, as well as providing numerous ecosystem services to people (Potts et al., 2016; Vaughn, 2018). For example, it has been estimated that 80% of wild plant species, and 75% of crop plants, are directly dependent on insect pollination (Potts et al., 2010). Meanwhile, soil invertebrate diversity has been proposed as the best possible measure of soil quality (Lavelle et al., 2006) and freshwater cycling and purification depend upon a diverse benthic biota (Covich et al., 1999). However, beyond the notable exceptions of bees and butterflies (Fox et al., 2015; Potts et al., 2010), invertebrate conservation has received relatively little attention, with many taxa having a "Data Deficient" status according to the International Union for Conservation of Nature (IUCN) (Buckley et al., 2012; Diniz-Filho et al., 2010; Strayer, 2006). The long-term studies which are available demonstrate worrying declines in many invertebrate groups, similar to or even exceeding those observed in vertebrate taxa (Conrad et al., 2006; Hallmann et al., 2017; Lister and Garcia, 2018; Potts et al., 2010; Schuch et al., 2012; van Strien et al., 2019). The threats faced by terrestrial and freshwater invertebrates are numerous, including infrastructure development, habitat loss and fragmentation, chemical and light pollution, biological invasions, and climate change (Collen et al., 2012).

The last IUCN assessment of the conservation status of invertebrates found that 20% of all invertebrate species are threatened with extinction, with a higher rate for freshwater invertebrates compared to terrestrial and marine species. However, this assessment was based upon less than 1% of all known species, and over 27% of those species assessed were listed

as Data Deficient with insufficient information available to assess the status of their populations (Collen et al., 2012). Since then, the rate of assessment has more than doubled, but still represents just a tiny proportion of invertebrate diversity (Eisenhauer et al., 2019). As with vertebrates, the highest threat levels seem to occur in less mobile groups and those with smaller ranges; up to a third of freshwater molluscs, for example, are threatened, whilst around 10% of flying insects such as butterflies and dragonflies are threatened (Collen et al., 2012). Conservation management is required to reverse these declining population trends, and to recover both individual species which have been lost and ecological communities which have collapsed. Some such conservation actions for target species have been remarkably successful. For example, the Large Blue butterfly, which went extinct in the UK in 1979, was successfully reintroduced in the 1980s following concerted conservation effort to understand its complex ecological requirements, and the grassland management interventions needed to create them (Fox et al., 2015; Thomas et al., 2009).

Evidence-based knowledge is key for planning successful conservation strategies and for the cost-effective allocation of scarce conservation resources (Sutherland et al., 2004). Targeted reviews may be carried out to collate evidence on the effects of a particular conservation intervention, but this approach is labour-intensive, expensive and ill-suited for areas where the data are scarce and patchy. The evidence within the literature for the effectiveness of conservation interventions aimed at terrestrial and freshwater invertebrates has taken longer to accumulate than for vertebrate taxa (Eisenhauer et al., 2019), and accordingly only a small number of targeted reviews exist (e.g. Bernes et al., 2018; Davies et al., 2008; Humbert et al., 2012; Jakobsson et al., 2018). Thus, the evidence for the majority of conservation interventions targeting terrestrial and freshwater invertebrates have not yet been synthesised under a formal review and those that have would benefit from an update as new research becomes available. Moreover, assembling the existing evidence for invertebrate conservation interventions in one place, alongside information for other taxa, facilitates easy-access for both conservation scientists and conservation practitioners (Sutherland et al., 2019).

Here, we use a subject-wide evidence synthesis approach (Sutherland et al., 2019; Sutherland and Wordley, 2018) to simultaneously summarise the evidence for the wide range of interventions dedicated to the conservation of terrestrial and freshwater invertebrates (excluding bees, for which a synthesis has already been produced; Dicks et al., 2010). By simultaneously targeting the entire range of potential interventions for this group, we are able to review the evidence for each intervention cost-effectively, and the resulting synopsis can be updated periodically and efficiently to incorporate new research. The synopsis will be freely available at www.conservationevidence.com and, alongside the *Conservation Evidence* online database, will be a valuable asset to the toolkit of practitioners and policy makers seeking sound information to support terrestrial and freshwater invertebrate conservation.

Scope of the review

1. Review subject

This synthesis focuses on evidence for the effectiveness of global interventions for the conservation of terrestrial and freshwater invertebrates (excluding bees; Dicks et al., 2010). This subject has not yet been covered using subject-wide evidence synthesis. This is defined as a systematic method of evidence synthesis that covers entire subjects at once, including all closed review topics within that subject at a fine scale and analysing results through study summary and expert assessment, or through meta-analysis; the term can also refer to any product arising from this process (Sutherland et al., 2019). The topic is therefore a priority for the discipline-wide Conservation Evidence database.

The global synthesis will collate evidence for the effects of conservation actions for wild terrestrial and freshwater invertebrates, except bees. Evidence for the effectiveness of interventions targeting the conservation of bees are covered in a separate synopsis (Dicks et al., 2010).

This synthesis covers evidence for the effects of conservation interventions for wild terrestrial and freshwater invertebrates (i.e. not in captivity). We will not include evidence from the literature on husbandry of terrestrial and freshwater invertebrates kept in zoos or aquariums. However, where these interventions are relevant to the conservation of wild declining or threatened species, they will be included, e.g. captive breeding for the purpose of reintroductions or gene banking (for future release). For this synthesis, conservation interventions will include management measures that aim to conserve wild terrestrial or freshwater invertebrate populations and ameliorate the deleterious effects of perceived threats. The output of the project will be an authoritative, transparent, freely accessible evidence-base that will support terrestrial and freshwater invertebrate management objectives and help to achieve conservation outcomes.

2. Advisory board

An advisory board made up of international conservationists and academics with expertise in terrestrial and freshwater invertebrate conservation has been formed. These experts will input into the evidence synthesis at three key stages: a) reviewing the protocol including identifying key sources of evidence, b) developing a comprehensive list of conservation interventions for review and c) reviewing the draft evidence synthesis. The advisory board is listed above, although additional experts may be added during the production of the synopsis. The final list will be published in the synopsis document and online (https://www.conservationevidence.com/site/page?view=methods).

3. Creating the list of interventions

At the start of the project, a comprehensive list of interventions will be developed by scanning the literature and in partnership with the advisory board. The list will also be

checked by Conservation Evidence to ensure that it follows the standard structure. The aim is to include all actions that have been carried out or advised to support populations or communities of wild terrestrial and freshwater invertebrates, whether evidence for the effectiveness of an action is available or not. During the synthesis process further interventions may be discovered, which will be integrated into the synopsis structure.

The list of interventions will be organized into categories based on the International Union for the Conservation of Nature (IUCN) classifications of direct threats (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme) and conservation actions (http://www.iucnredlist.org/technical-documents/classification-schemes/conservation-actions-classification-scheme-ver2).

Depending on the amount of available evidence, it may not be possible to summarise the evidence for all interventions for both terrestrial and freshwater invertebrates within the time frame of this project. Under those circumstances, we will consider the amount of evidence for each group (terrestrial and freshwater, and possibly species groups within those) and summarise the evidence for the highest level group possible within the time available. The aim will be for Conservation Evidence to summarise evidence for any remaining groups as soon as resources become available.

Methods

1. Literature searches

Literature will be obtained from the Conservation Evidence discipline-wide literature database, and from searches of additional subject specific literature sources. The Conservation Evidence discipline-wide literature database is compiled using systematic searches of journals and organisational reports; relevant publications describing studies of conservation interventions for all species groups and habitats are saved from each journal and are added to the database.

a) Global evidence

Evidence from all around the world will be included.

b) Languages included

Only English language journals will be included. A recent study on the topic of language barriers in global science indicates that approximately 35% of conservation studies may be in non-English languages (Amano et al., 2016). While searching only English language journals may therefore potentially introduce some bias to the review process, project resources and time constraints determine the number of journals that can be searched within the project timeframe.

c) Journals searched

i) From Conservation Evidence discipline-wide literature database

All of the journals (and years) listed in Appendix 1 have already been searched and relevant papers have been added to the Conservation Evidence discipline-wide literature database. An asterisk (*) indicates the journals most relevant to this synopsis. Others are less likely to have included papers relevant to this synopsis, but if they did, they will be summarised.

ii) Update searches

Additional searches up to the end of 2018 will be undertaken for journals likely to yield studies for terrestrial and freshwater invertebrates (marked with a '$^{+}$' in Appendix 1).

- Acta Oecologica – International Journal of Ecology
- Aquatic Ecosystem Health and Management
- Limnologica – Ecology and Management of Inland Waters
- Neotropical Entomology
- Revista de Biología Tropical
- Tropical Conservation Science
- Tropical Ecology

iii) New searches

Additional, focused searches of journals most relevant to the conservation of terrestrial and freshwater invertebrate populations listed below will be undertaken. These journals were identified through expert judgement by the project researchers and the advisory board and are listed in order of relevance, to prioritise searches considered likely to yield higher numbers of relevant studies. Journals with large numbers of papers each year, or that are long-running may not be searched from the first year of publication; instead searches will be undertaken backwards from the end of 2018 for 30 years for long-running journals. It may not be possible to search all of the journals listed within the time frame of this project. Journals will be searched in the order presented below.

- Ecological Entomology
- Environmental Entomology
- Knowledge and Management of Aquatic Ecosystems
- Riparian Ecology and Conservation
- Invertebrate Conservation News
- Annual Review of Entomology
- Current Opinion in Insect Science
- Bulletin of Entomological Research
- Entomologia Experimentalis et Applicata
- Austral Entomology (Australian Journal of Entomology)
- International Journal of Entomology Research
- Journal of the Entomological Research Society
- Freshwater Ecology

- Fundamental and Applied Limnology
- Urban Ecology
- Ecology and Management
- Journal of Insect Biodiversity
- Journal of Tropical Entomology
- European Journal of Entomology
- Applied Entomology and Zoology
- Journal of the British Dragonfly Society

d) Reports from specialist websites searched

i) From Conservation Evidence discipline-wide literature database

All of the report series (and years) below have already been searched for the Conservation Evidence project. An asterisk (*) indicates the report series most relevant to this synopsis. Others are less likely to have included reports relevant to this synopsis, but if they did they will be summarised.

• Amphibian Survival Alliance	1994-2012	Vol 9 - Vol 104
• British Trust for Ornithology	1981-2016	Report 1-687
• IUCN Invasive Species Specialist Group	1995-2013	Vol 1 - Vol 33
• Scottish Natural Heritage*	2004-2015	Reports 1-945

ii) Update searches

Updates to reports already searched as part of the wider Conservation Evidence project will be undertaken for those most relevant to terrestrial and freshwater invertebrates, i.e. for Scottish Natural Heritage. Searches will be completed to the end of 2018.

iii) New searches

New searches will target specialist reports relevant to terrestrial and freshwater invertebrate conservation as listed below. These searches will scan every report title and abstract or summary within each report series (published before the end of 2018) and add any relevant report to the project database. It may not be possible to search all of those listed within the time frame of this project. Reports will be searched in the order presented below.

- Natural England Access to Evidence reports (http://publications.naturalengland.org.uk/) classified under “Species > Freshwater Invertebrates” (http://publications.naturalengland.org.uk/category/96015) and “Species > Terrestrial Invertebrates” (http://publications.naturalengland.org.uk/category/30001)

e) Other literature searches

The online database www.conservationevidence.com will be searched for relevant publications that have already been summarised.

Where a systematic review is found for an intervention, if the intervention has a small literature (<20 papers), all publications including the systematic review will be summarised. If the intervention has a large literature (≥20 papers), then only the systematic review and any publications published since the review will be summarised. Where a non-systematic review (or editorial, synthesis, preface, introduction etc.) is found for an intervention, all relevant publications referenced within it will be included, but the review itself will not be summarised. However, if the review also provides new/collective data, then the review itself will also be included/summarised (indicating which other summarized publications it includes). Relevant publications cited in other publications summarised for the synopsis will not be included (due to time restrictions).

f) Supplementary literature identified by advisory board or relevant stakeholders

Additional journal or specialist website searches, and relevant papers or reports suggested by the advisory board or relevant stakeholders will also be included, where time permits.

Additional searches may be added during the production of the synopsis. The final list of evidence sources searched for this synopsis will be published in the synopsis document (including a summary using Appendix 2), and the full list of journals and report series searched published online (https://www.conservationevidence.com/journalsearcher/synopsis).

g) Search record database

A database will be created of all relevant publications found during searches. Reasons for exclusion will be recorded for all those included during screening that are not summarised for the synopsis.

2. Publication screening and inclusion criteria

A summary of the total number of evidence sources and papers/reports screened will be published in the synopsis using the diagram in Appendix 2.

a) Screening

To ensure consistency/accuracy when screening publications for inclusion in the literature database, an initial test using the Conservation Evidence inclusion criteria (provided below) and a consistent set of references was carried out by authors, compared with the decisions of the experienced core Conservation Evidence team. Results were analysed using Cohen's Kappa test (Cohen 1960). Where initial results did not show 'substantial' (K=0.61-0.8) or 'almost perfect' agreement (K= 0.81-1.0), authors were given further training. A second Kappa test will be used to assess the consistency/accuracy of article screening for the first two years of the first journal searched by each author. Again, where results do not show 'substantial' (K=0.61-0.8) or 'almost perfect' agreement (K= 0.81-1.0), authors will receive further training before carrying out further searches.

Authors of other synopses who have searched journals and added relevant publications to the Conservation Evidence literature database since 2018, and all other searchers since 2017 have

undertaken the initial paper inclusion test described above; searchers prior to that have not. Kappa tests of the first two years searched has been carried out for all new searchers who have contributed to the Conservation Evidence literature database since July 2018.

We acknowledge that the literature search and screening method used by Conservation Evidence, as with any method, will result in gaps in the evidence. The Conservation Evidence literature database currently includes relevant papers from over 270 English language journals as well as over 150 non-English journals. Additional journals are frequently added to those searched, and years searched are often updated. It is possible that searchers will have missed relevant papers from those journals searched. Publication bias will not be taken into account, and it is likely that additional biases will result from the evidence that is available, for example there are often geographic biases in study locations.

b) Inclusion criteria

The following Conservation Evidence inclusion criteria will be used.

Criteria A: Conservation Evidence includes studies that measure the effect of an action that might be done to conserve biodiversity

1. Does this study measure the effect of an action that is or was under the control of humans, on wild taxa (including captives), habitats, or invasive/problem taxa? If yes, go to 3. If no, go to 2.
2. Does this study measure the effect of an action that is or was under the control of humans, on human behaviour that is relevant to conserving biodiversity? If yes, go to Criteria B. If no, the study will be excluded.
3. Could the action be put in place by a conservationist/decision maker to protect, manage, restore or reduce impacts of threats to wild taxa or habitats, or control or mitigate the impact of the invasive/problem taxon on wild taxa or habitats? If yes, the study will be included. If no, the study will be excluded.

Explanation:

1.a. Study must have a measured outcome on wild taxa, habitats or invasive species: excludes studies on domestic/agricultural species, theoretical modelling or opinion pieces. See Criteria B for actions that have a measured outcome on human behaviour only.

1.b. Action must be carried out by people: excludes impacts from natural processes (e.g. wave action, natural storms), impacts from background variation (e.g. sediment type, climate change), correlations with habitat types, where there is no test of a specific action by humans, or pure ecology (e.g. movement, distribution of species).

2. Study must test an action that could be put in place for conservation. This excludes assessing impacts of threats (actions which remove threats would be included). The test may involve comparisons between sites/factors not originally put in place or modified for conservation but which could be (e.g. fished vs unfished sites, dredged vs undredged sites – where the removal of fishing/dredging is as you would do for conservation, even if that was not the original intention in the study).

If the title and/or abstract are suggestive of fulfilling our criteria, but there is not sufficient information to judge whether the action was under human control, the action could be applied by a conservationist/decision maker or whether there are data quantifying the outcome, then the study will be included. If the article has no abstract, but the title is suggestive, then a study will be included.

We sort articles in to folders by which taxon/habitat they have an outcome on. If the title/abstract does not specify which species/taxa/habitats are impacted, then the full article will be scanned and then assigned to folders accordingly.

The outcome for wild taxa/habitats can be negative, neutral or positive, does not have to be statistically significant but must be quantified (if hard to judge from abstract, then it will be included). It could be any outcome that has implications for the health of individuals, populations, species, communities or habitats, including, but not limited to the following:

- *Individual health, condition or behaviour, including in captivity:* e.g., growth, size, weight, stress, disease levels or immune function, movement, use of natural/artificial habitat/structure, range, or predatory or nuisance behaviour that could lead to retaliatory action by humans.
- *Breeding:* egg/sperm production, sperm motility/viability after freezing, artificial fertilization success, mating success, birth rate, litter size, calf/pup condition, 'overall recruitment'
- *Genetics:* genetic diversity, genetic suitability (e.g. adaptation to local conditions, use of correct flyways for migratory species, etc.)
- *Life history:* age/size at maturity, survival, mortality
- *Population measures:* number, abundance, density, presence/absence, biomass, movement, cover, age-structure, species distributions (only in response to a human action), disease prevalence, sex ratio
- *Community/habitat measures:* species richness, diversity measures (including trait/functional diversity), community composition, community structure (e.g. trophic structure), area covered (e.g. by different habitat types), physical habitat structure (e.g. rugosity, height, basal area)

Actions within the scope of Conservation Evidence include:

- Clear management actions: closing an area to fishing, modifying fishing gear to reduce bycatch, controlling invasive species, creating or restoring habitats.
- International or national policies
- reintroductions or management of wild species in captivity,
- actions that reduce human-wildlife conflict
- actions that change human behaviour, resulting in an impact on wild taxa or habitats
- See https://www.conservationevidence.com/data/index for more examples of actions.

Note on study types:

Literature reviews, systematic reviews, meta-analyses or short notes that review studies that fulfil these criteria will be included.

Theoretical modelling studies will be excluded, as no action has been taken. However, studies that use models to analyse real-world data, or compare models to real-world situations will be included (if they otherwise fulfil these criteria).

Criteria B: Conservation Evidence includes studies that measure the effect of an action that might be done to change human behaviour for the benefit of biodiversity

1. Does this study measure the effect of an action that is or was under human control on human behaviour (actual or intentional) which is likely to protect, manage, restore or reduce threats to wild taxa or habitats? If yes, go to 2. If no, the study will be excluded.
2. Could the action be put in place by a conservationist, manager or decision maker to change human behaviour? If yes, the study will be included. If no, the study will be excluded.

Explanation:

1.a. Study must have a measured outcome on actual or intentional human behaviour including self-reported behaviours: excludes outcomes on human psychology (tolerance, knowledge, awareness, attitude, perceptions or beliefs)

1.b. change in human behaviour must be linked to outcomes for wild taxa and habitats, excludes changes in behaviour linked to outcomes for human benefit, even if these occurred under a conservation program (e.g. we would exclude a study demonstrating increased school attendance in villages under a community based conservation program).

1.c. Action must be under human control: excludes impacts from climatic or other natural events.

2. Study must test an action that could be put in place for conservation: excludes studies with no action e.g. correlating human personality traits with likelihood of conservation-related behaviours.

The human behaviour outcome of the study can be negative, neutral or positive, does not have to be statistically significant but must be quantified (if hard to judge from abstract, then it will be included). It could be any behaviour that is likely to have an outcome on wild taxa and habitats (including mitigating the impact of invasive/problem taxon on wild taxa or habitats). Outcomes include, but are not limited to the following:

- Change in adverse behaviours (which directly threaten biodiversity) e.g. unsustainable fishing (industrial, artisanal, recreational), urban encroachment, creating noise, entering sensitive areas, polluting or dumping waste, clearing or habitat destruction, introducing invasive species.
- Change in positive behaviours e.g. uptake of alternative/sustainable livelihoods, number of households adopting sustainable practices, donations

- Change in policy or conservation methods e.g. placement of protected areas, protection of key habitats/species
- Change in consumer or market behaviour e.g. purchasing, consuming, buying, willingness to pay, selling, illegal trading, advertising, consumer fraud.
- Behavioural intentions to do any of the above

Actions which are particularly likely to have a behaviour change outcome include, but are not limited to the following:

- Enforcement: Closed seasons, size limits, fishing/hunting gear restrictions, auditable/traceable reporting requirements, market inspections, increase number of rangers, patrols or frequency of patrols in, around or within protected areas, improve fencing/physical barriers, improve signage, improve equipment/technology used by guards, use of UAVs/drones for rapid response, DNA analysis, GPS tracking.
- Behaviour Change: promote alternative/sustainable livelihoods, payment for ecosystem services, ecotourism, poverty reduction, increased appreciation or knowledge, debunking misinformation, altering or re-enforcing local taboos, financial incentives.
- Governance: Protect or reward whistle-blowers, increase government transparency, ensure independence of judiciary, provide legal aid
- Market Regulation: trade bans, taxation, supply chain transparency laws
- Consumer Demand Reduction: Increase awareness or knowledge, fear appeals (negative association with undesirable product), benefit appeal (positive association with desirable behaviour), worldview framing, moral framing, employing decision defaults, providing decision support tools, simplifying advice to consumers, promoting desirable social norms, legislative prohibition.
- Sustainable Alternatives: Certification schemes, captive bred or artificial alternatives, sustainable alternatives.
- New policies for conservation/protection

We allocate studies to folders by their outcome. All studies under Criteria B go in the ‘Behaviour change’ folder. They are additionally duplicated in to a taxon/habitat folder if there is a specific intended final outcome of the behaviour change (if none mentioned, they will be filed only in Behaviour change).

c) Relevant subject

Studies relevant to the synopsis subject will include those focused on the conservation of wild, native terrestrial and freshwater invertebrates (excluding bees).

d) Relevant types of intervention

An intervention has to be one that could be put in place by a manager, conservationist, policy maker, advisor or consultant to protect, manage, restore or reduce the impacts of threats to wild native terrestrial and freshwater invertebrates. Alternatively, interventions may aim to change human behaviour (actual or intentional), which is likely to protect, manage, restore or

reduce threats to terrestrial and freshwater invertebrate populations. See inclusion criteria above for further details.

If the following two criteria are met, a combined intervention will be created within the synopsis, rather than repeating evidence under all the separate interventions: a) there are five or more publications that use the same well-defined combination of interventions, with very clear description of what they were, without separating the effects of each individual intervention, and b) the combined set of interventions is a commonly used conservation strategy.

e) Relevant types of comparator

To determine the effectiveness of interventions, studies must include a comparison, i.e. monitoring change over time (typically before and after the intervention was implemented), or for example at treatment and control sites. Alternatively, a study could compare one specific intervention (or implementation method) against another. For example, this could be comparing the abundance of an invertebrate species before and after the banning of pesticides in an area, or the change in invertebrate species' diversity under different grazing or cutting practices. Exceptions, which may not have a control but will still be included are, for example, the effectiveness of captive breeding or rehabilitation programmes.

f) Relevant types of outcome

Below we provide a list of anticipated metrics; others will be included if reported within relevant studies.

- **Community response**
  - *Community composition*
  - *Richness/diversity*
- **Population response**
  - *Abundance:* number, density, presence/absence, biomass, movement, age-structure, sex ratio
  - *Reproductive success:* egg/sperm production, artificial fertilization success, mating success, fecundity, offspring quality/condition, overall recruitment, age/size at maturity
  - *Survival:* survival, mortality
  - *Condition:* growth, size, weight, condition factors, biochemical ratios, stress, disease levels or immune function
- **Usage**
  - *Uptake*
  - *Use*
  - *Behaviour change:* movement, use of natural/artificial habitat/structure, range, nuisance behaviour that could lead to retaliatory action by humans
- **Other**
  - *Change in human behaviour*

g) Relevant types of study design

The table below lists the study designs included. The strongest evidence comes from randomized, replicated, controlled trials with paired-sites and before and after monitoring.

Table 1. Study designs

Term	Meaning
Replicated	The intervention was repeated on more than one individual or site. In conservation and ecology, the number of replicates is much smaller than it would be for medical trials (when thousands of individuals are often tested). If the replicates are sites, pragmatism dictates that between five and ten replicates is a reasonable amount of replication, although more would be preferable. We provide the number of replicates wherever possible. Replicates should reflect the number of times an intervention has been independently carried out, from the perspective of the study subject. For example, 10 plots within a mown field might be independent replicates from the perspective of plants with limited dispersal, but not independent replicates for larger motile animals such as birds. In the case of translocations/release of captive bred animals, replicates should be sites, not individuals.
Randomized	The intervention was allocated randomly to individuals or sites. This means that the initial condition of those given the intervention is less likely to bias the outcome.
Paired sites	Sites are considered in pairs, within which one was treated with the intervention and the other was not. Pairs, or blocks, of sites are selected with similar environmental conditions, such as soil type or surrounding landscape. This approach aims to reduce environmental variation and make it easier to detect a true effect of the intervention.
Controlled*	Individuals or sites treated with the intervention are compared with control individuals or sites not treated with the intervention. (The treatment is usually allocated by the investigators (randomly or not), such that the treatment or control groups/sites could have received the treatment).
Before-and-after	Monitoring of effects was carried out before and after the intervention was imposed.
Site comparison*	A study that considers the effects of interventions by comparing sites that historically had different interventions (e.g. intervention vs no intervention) or levels of intervention. Unlike controlled studies, it is not clear how the interventions were allocated to sites (i.e. the investigators did not allocate the treatment to some of the sites).
Review	A conventional review of literature. Generally, these have not used an agreed search protocol or quantitative assessments of the evidence.
Systematic review	A systematic review follows an agreed set of methods for identifying studies and carrying out a formal 'meta-analysis'. It will weight or evaluate studies according to the strength of evidence they offer, based on the size of each study and the rigour of its design. All environmental systematic reviews are available at: www.environmentalevidence.org/index.htm

Study	If none of the above apply, for example a study looking at the number of people that were engaged in an awareness raising project. Or a study measuring change over time in only one site and only after an intervention.

* Note that "controlled" is mutually exclusive from "site comparison". A comparison cannot be both controlled and a site comparison. However, one study might contain both controlled and site comparison aspects e.g. study of fertilized grassland, compared to unfertilized plots (controlled) and natural, target grassland (site comparison).

3. Study quality assessment & critical appraisal

We will not quantitatively assess the evidence from each publication or weight it according to quality. However, to allow interpretation of the evidence, we make the size and design of each study we report clear.

We will critically appraise each potentially relevant study and will exclude those that do not provide data for a comparison to the treatment, do not statistically analyse the results (or if included this will be stated in the summary paragraph) or have obvious errors in their design or analysis. A record of the reason for excluding any of the publications included during screening will be kept within the synopsis database.

4. Data extraction

Data on the effectiveness of the relevant intervention (e.g. mean species abundance inside or outside a protected area; reduction in bycatch after installation of a bycatch reduction device) will be extracted from, and summarised for publications that include the relevant subject, types of intervention, comparator and outcomes outlined above. A summary of the total number of evidence sources and papers/reports scanned and the total number of publications included following data extraction will be published in the synopsis using the diagram in Appendix 2.

In addition to ensuring consistency/accuracy when screening publications for inclusion in the discipline-wide literature database (see above), for a set of publications, relevant data will be extracted by a member of the core Conservation Evidence team as well as the author to ensure agreement for inclusion in the synopsis. In addition, at the start of each month, authors will swap three summaries with another author to ensure that the correct type of data has been extracted and that the summary follows the Conservation Evidence standard format.

5. Evidence synthesis

a) Summary protocol

Each publication will usually have just one paragraph for each intervention it tests describing the study in (usually) no more than 150 words using plain English. Each summary will be in the following format:

A [TYPE OF STUDY] in [YEARS X-Y] in [HOW MANY SITES] in/of [HABITAT] in [REGION and COUNTRY] [REFERENCE] found that [INTERVENTION] [SUMMARY OF ALL KEY RESULTS] for [SPECIES/HABITAT TYPE]. [DETAILS OF KEY RESULTS, INCLUDING DATA]. In addition, [EXTRA RESULTS, IMPLEMENTATION OPTIONS, CONFLICTING RESULTS]. The [DETAILS OF EXPERIMENTAL DESIGN, INTERVENTION METHODS and KEY DETAILS OF SITE CONTEXT]. Data was collected in [DETAILS OF SAMPLING METHODS].

Type of study - use terms and order in Table 1.

Site context - for the sake of brevity, only nuances essential to the interpretation of the results are included. The reader is always encouraged to read the original source to get a full understanding of the study site (e.g. history of management, physical conditions).

For example:

A replicated, randomized, paired, controlled study in 1936–2009 in eight sagebrush steppe sites in Oregon, USA (1) found that increasing the number of livestock decreased grass and herb cover, but did not significantly alter shrub cover. Grass and herb cover in grazed areas were lower (grass: 9%, herb: 17%) than in areas that were not grazed (grass: 18%, herb: 24%). However, shrub cover was not significantly different in grazed (16%) and ungrazed (16%) areas. Eight 2 ha fenced areas excluding livestock were established in 1936. Areas adjacent to the fenced areas were grazed by cattle from 1936–2008. In summer 2009, four 20 m transects were established in each study area and vegetation cover was assessed using a line intercept method.

(1) Davies K.W., Bates J.D., Svejcar T.J. & Boyd C.S. (2010) Effects of long-term livestock grazing on fuel characteristics in rangelands: an example from the sagebrush steppe. Rangeland Ecology & Management, 63, 662–669.

A replicated, randomized, controlled, before-and-after study in 1993–1999 of five harvested hardwood forests in Virginia, USA (2) found that harvesting trees in groups did not result in higher salamander abundances than clearcutting. Abundance was similar between treatments (group cut: 3; clearcut: 1/30 m^2). Abundance was significantly lower compared to unharvested plots (6/30 m^2). Species composition differed before and three years after harvest. There were five sites with 2 ha plots with each treatment: group harvesting (2–3 small area group harvests with selective harvesting between), clearcutting and an unharvested control. Salamanders were monitored on 9–15 transects (2 x 15 m)/plot at night in April–October. One or two years of pre-harvest and 1–4 years of post-harvest data were collected.

(2) Knapp S.M., Haas C.A., Harpole D.N. & Kirkpatrick R.L. (2003) Initial effects of clearcutting and alternative silvicultural practices on terrestrial salamander abundance. Conservation Biology, 17, 752–762.

b) Terminology used to describe the evidence

Unless specifically stated otherwise, results will reflect statistical tests performed on the data i.e. we will only state that there was a difference if it was a significant difference or will state that there was no difference if it was not significant. Table 1 above defines the terms used to describe the study designs.

c) Dealing with multiple interventions within a publication

When separate results are provided for the effects of each of the different interventions tested, separate summaries will be written under each intervention heading. However, when several interventions were carried out at the same time and only the combined effect reported, the result will be described with a similar paragraph under all relevant interventions. The first sentence will make it clear that there was a combination of interventions carried out, i.e. '.....(REF) found that [x intervention], along with [y] and [z interventions] resulted in [describe effects]'. Within the results section we will also add a sentence such as: 'It is not clear whether these effects were a direct result of [x], [y] or [z] interventions', or 'The study does not distinguish between the effects of [x], and other interventions carried out at the same time: [y] and [z].'

d) Dealing with multiple publications reporting the same results and reviews

If two publications describe results from the same intervention implemented in the same space and at the same time, we will only include the most stringently peer-reviewed publication (i.e. journal of the highest impact factor). If one includes initial results (e.g. after year one) of another (e.g. after 1-3 years), we will only include the publication covering the longest time span. If two publications describe at least partially different results, we will include both but make clear they are from the same project in the paragraph, e.g. 'A controlled study..... (Gallagher et al. 1999; same experimental set-up as Oasis et al. 2001).....'.

Basic (i.e. not systematic) reviews will only be summarised if they provide new/collective data; the individual publications will also be summarised to provide full details of each study. Publications identified in all other basic reviews will be obtained and summarised individually (where time allows). Where there is a systematic review of an intervention with a large associated literature ($\geq$ 20 papers), the systematic review will be summarised along with any papers/reports published since the systematic review. If the intervention has a small literature (<20 papers), all publications including the systematic review will be summarised.

e) Taxonomy

Taxonomy will not be updated but will follow that used in the original publication. Where possible, common names and Latin names will both be given the first time each species is mentioned within each summary.

f) Key messages

Each intervention will have a set of concise, bulleted key messages at the top, written once all the literature has been summarised. These will include information such as the number, design and location of studies included.

The first bullet point will describe the total number of studies that tested the intervention and the locations of the studies, followed by key information on the relevant metrics presented under the headings and sub-headings shown below (with number of relevant studies in parentheses for each).

X studies examined the effects of [INTERVENTION] on [TARGET POPULATION]. Y studies were in [LOCATION 1][1,2] and Z studies were in [LOCATION 2][3,4]. *Locations will usually be countries (and water bodies/seas where relevant), ordered based on chronological order of studies rather than alphabetically, i.e. USA[1], Australia[2] not Australia[2], USA[1]. However, when more than 4-5 separate countries, they may be grouped into regions to make it clearer e.g. Europe, North America. The distribution of studies amongst habitat types may also be added here if relevant.*

COMMUNITY RESPONSE (x STUDIES)

- **Community composition (x studies):**
- **Richness/diversity (x studies):**

POPULATION RESPONSE (x STUDIES)

- **Abundance (x studies):**
- **Reproductive success (x studies):**
- **Survival (x studies):**
- **Condition (x studies):**

USAGE (x STUDIES)

- **Uptake (x studies):**
- **Use (x studies):**
- **Behaviour change (x studies):**

OTHER (x STUDIES) *(Included only for interventions/chapters where relevant)*

- **[Sub-heading(s) for the metric(s) reported will be created] (x studies):**

6. Dissemination/communication of evidence synthesis

The information from this evidence synthesis will be available in three ways:

- A synopsis pdf, downloadable from www.conservationevidence.com, will contain the study summaries, key messages and background information on each intervention.
- The searchable database at www.conservationevidence.com will contain all the summarized information from the synopsis, along with expert assessment scores.
- A chapter in *What Works in Conservation*, available as a pdf to download and a book from [https://www.conservationevidence.com/content/page/79], will contain the key messages from the synopsis as well as expert assessment scores on the effectiveness and certainty of the synopsis, with links to the online database.

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APPENDIX 1. Journals (and years) searched and for which relevant papers have been added to the Conservation Evidence discipline-wide literature database. An asterisk (*) indicates the journals most relevant to this synopsis which have already been searched to the end of 2018. A cross (+) indicates the journals most relevant to this synopsis for which updated searches to the end of 2018 will be conducted.

Journal	Years Searched	Topic
Acrocephalus	2009-2018	All biodiversity
Acta Chiropterologica	1999-2018	All biodiversity
Acta Herpetologica	2006-2016	All biodiversity
Acta Oecologica-International Journal of Ecology +	1990-2017	All biodiversity
Acta Theriologica	1977-2014	All biodiversity
Acta Theriologica Sinica	1981-2018	All biodiversity
African Bird Club Bulletin	2010-2016	Bird conservation
African Journal of Ecology	1963-2016	All biodiversity
African Journal of Herpetology	1990-2016	Reptile & amphibian conservation
African Journal of Marine Science	1983-2018	All biodiversity
African Primates	1995-2012	Primate conservation
African Zoology	1979-2013	All biodiversity
Agriculture, Ecosystems and Environment*	1983-2018	All biodiversity
Aliens: The Invasive Species Bulletin (IUCN)	1995-2013	All biodiversity
Ambio	1972-2011	All biodiversity
American Journal of Primatology	1981-2014	Primate conservation
American Naturalist	1867-2018	All biodiversity
Amphibia-Reptilia	1980-2012	Reptile & amphibian conservation
Amphibian and Reptile Conservation	1996-2016	Reptile & amphibian conservation
Animal Biology	2003-2013	All biodiversity
Animal Conservation	1998-2018	All biodiversity
Animal Welfare	1992-2016	Primate & amphibian conservation
Annales Zoologici Fennici	1964-2013	All biodiversity
Annales Zoologici Societatis Zoologicae Botanicae Fennicae Vanamo	1932-1963	All biodiversity
Annual Review of Ecology, Evolution and Systematics	1970-2018	All biodiversity
Antarctic Science	1980-2018	All biodiversity
Anthrozoos	1987-2013	All biodiversity
Apidologie	1958-2009	All biodiversity
Applied Animal Behaviour Science	1998-2014	All biodiversity
Applied Herpetology	2003-2009	Reptile & amphibian conservation
Applied Vegetation Science	1998-2017	All biodiversity
Aquaculture Research	1972-2008	All biodiversity
Aquatic Biology*	2007-2018	All biodiversity
Aquatic Botany	1975-2017	All biodiversity
Aquatic Conservation: Marine and Freshwater Ecosystems*	1991-2018	All biodiversity
Aquatic Ecology*	1968-2018	All biodiversity

Aquatic Ecosystem Health & Management [+]	1998-2016	All biodiversity
Aquatic Invasions	2006-2016	All biodiversity
Aquatic Living Resources	1988-2018	All biodiversity
Aquatic Mammals	1972-2018	All biodiversity
Ardeola	1996-2018	All biodiversity
Arid Land Research and Management	1987-2013	All biodiversity
Asian Primates	2008-2012	Primate conservation
Asiatic Herpetological Research	1993-2008	Reptile & amphibian conservation
Auk	1980-2016	Bird conservation
Austral Ecology*	1977-2018	All biodiversity
Australasian Journal of Herpetology	2009-2012	Reptile & amphibian conservation
Australian Mammalogy	2000-2018	All biodiversity
Avian Conservation and Ecology	2005-2016	Bird conservation
Basic and Applied Ecology*	2000-2018	All biodiversity
Basic and Applied Herpetology	2011-2016	Reptile & amphibian conservation
Behavior	1948-2013	All biodiversity
Behavioral Ecology	1990-2013	All biodiversity
Bibliotheca Herpetologica	1999-2017	Reptile & amphibian conservation
Biocontrol	1956-2016	All biodiversity
Biocontrol Science and Technology	1991-1996	All biodiversity
Biodiversity and Conservation*	1994-2018	All biodiversity
Biological Conservation*	1981-2018	All biodiversity
Biological Control	1991-2017	All biodiversity
Biological Invasions	1999-2017	All biodiversity
Biology and Environment: Proceedings of the Royal Irish Academy	1993-2017	All biodiversity
Biology Letters	2005-2018	All biodiversity
Biotropica	1990-2018	All biodiversity
Bird Conservation International	1991-2016	Bird conservation
Bird Study	1980-2016	Bird conservation
Boreal Environment Research	1996-2014	All biodiversity
Bulletin of the Herpetological Society of Japan	1999-2008	Reptile & amphibian conservation
Canadian Field Naturalist	1987-2018	All biodiversity
Canadian Journal of Fisheries and Aquatic Sciences	1901-2018	All biodiversity
Canadian Journal of Forest Research	1971-2013	All biodiversity
Caribbean Journal of Science	1961-2013	Reptile & amphibian conservation
Chelonian Conservation and Biology	2006-2016	All biodiversity
Coastal Engineering	2000-2011	All biodiversity
Community Ecology	2000-2012	All biodiversity
Conservation Biology*	1987-2018	All biodiversity
Conservation Evidence*	2004-2018	All biodiversity
Conservation Genetics	2000-2013	All biodiversity
Conservation Letters*	2008-2018	All biodiversity
Contemporary Herpetology	1998-2009	Reptile & amphibian

		conservation
Contributions to Primatology	1974-1991 (final published volume)	Primate conservation
Copeia	1910-2016	Reptile & amphibian conservation
Cunninghamia	1981-2016	All biodiversity
Current Herpetology	1964-2016	Reptile & amphibian conservation
Dodo	1977-2001	All biodiversity
Ecological and Environmental Anthropology	2005-2008	All biodiversity
Ecological Applications*	1991-2018	All biodiversity
Ecological Indicators	2001-2007	All biodiversity
Ecological Management & Restoration*	2000-2018	All biodiversity
Ecological Restoration*	1981-2018	All biodiversity
Ecology*	1936-2018	All biodiversity
Ecology Letters	1998-2013	All biodiversity
Ecoscience	1994-2013	All biodiversity
Ecosystems	1998-2013	All biodiversity
Emu	1980-2016	Bird conservation
Endangered Species Bulletin	1966-2003	All biodiversity
Endangered Species Research	2004-2017	All biodiversity
Environmental Conservation*	1974-2018	All biodiversity
Environmental Evidence*	2012-2018	All biodiversity
Environmental Management*	1977-2018	All biodiversity
Environmentalist	1981-1988	All biodiversity
Estuaries and Coasts	In progress	All biodiversity
Ethology Ecology and Evolution	1989-2014	All biodiversity
European Journal of Soil Science	1950-2012	Soil Fertility
European Journal of Wildlife Research	1955-2018	All biodiversity
Evolutionary Anthropology	1992-2014	Primate conservation
Evolutionary Ecology	1987-2014	All biodiversity
Evolutionary Ecology Research	1999-2014	All biodiversity
Fire Ecology	2005-2016	All biodiversity
Fish and Fisheries	2000-2018	All biodiversity
Fisheries	2017-2018	All biodiversity
Fisheries Management and Ecology	1994-2018	All biodiversity
Fisheries Oceanography	1992-2018	All biodiversity
Fisheries Research	1990-2018	All biodiversity
Flora	1991-2017	All biodiversity
Folia Primatologica	1963-2014	Primate conservation
Folia Zoologica	1959-2013	All biodiversity
Forest Ecology and Management*	1976-2018	All biodiversity
Freshwater Biology	1975-2017	All biodiversity
Freshwater Science	1982-2018	All biodiversity
Frontiers in Marine Science	2017-2018	All biodiversity
Functional Ecology	1987-2013	All biodiversity
Genetics and Molecular Research	2002-2013	All biodiversity
Geoderma	1967-2012	Soil Fertility
Gibbon Journal	2005-2011	Primate conservation

Global Change Biology	1995-2017	All biodiversity
Global Ecology and Biogeography	1991-2014	All biodiversity
Global Ecology and Conservation	2014-2018	All biodiversity
Grass and Forage Science	1980-2017	All biodiversity
Herpetofauna	2003-2007	Reptile & amphibian conservation
Herpetologica	1936-2012	Reptile & amphibian conservation
Herpetological Bulletin	1980-2016	Reptile & amphibian conservation
Herpetological Conservation and Biology	2006-2016	Reptile & amphibian conservation
Herpetological Journal	1985-2014	Reptile & amphibian conservation
Herpetological Monographs	1982-2016	Reptile & amphibian conservation
Herpetological Review	1967-2014	Reptile & amphibian conservation
Herpetology Notes	2008-2014	Reptile & amphibian conservation
Human Wildlife Interactions	2007-2018	All biodiversity
Hydrobiologia*	2000-2018	All biodiversity
Hystrix, the Italian Journal of Mammalogy	1986-2018	All biodiversity
Ibis	1980-2016	Bird conservation
ICES Journal of Marine Science	1990-2018	All biodiversity
iForest	2008-2016	All biodiversity
Insect Conservation and Diversity*	2008-2018	All biodiversity
Integrative Zoology	2006-2013	All biodiversity
International Journal of Pest Management	1969-1979	All biodiversity
International Journal of Primatology	1980-2012	Primates
International Journal of the Commons	2007-2016	All biodiversity
International Journal of Wildland Fire	1991-2016	All biodiversity
International Wader Studies	1970-1972	All biodiversity
International Zoo Yearbook	1960-2015	Management of Captive Animals
Invasive Plant Science and Management	2008-2016	All biodiversity
Israel Journal of Ecology & Evolution	1963-2013	All biodiversity
Italian Journal of Zoology	1978-2013	All biodiversity
Journal for Nature Conservation*	2002-2018	All biodiversity
Journal of Animal Ecology*	1932-2018	All biodiversity
Journal of Apicultural Research	1962-2009	All biodiversity
Journal of Applied Ecology*	1964-2018	All biodiversity
Journal of Aquatic Plant Management	1962-2016	All biodiversity
Journal of Arid Environments	1993-2017	All biodiversity
Journal of Avian Biology	1980-2016	Bird conservation
Journal of Bat Conservation and Research	2000-2018	
Journal of Cetacean Research and Management	1999-2018	All biodiversity
Journal of Coastal Research	2015-2018	All biodiversity
Journal of Ecology*	1933-2018	All biodiversity
Journal of Environmental Management*	1973-2018	All biodiversity

Journal of Experimental Marine Biology & Ecology	1980-2016	All biodiversity
Journal of Field Ornithology	1980-2016	Bird conservation
Journal of Forest Research	1996-2018	All biodiversity
Journal of Great Lakes Research	1975-2017	All biodiversity
Journal of Herpetological Medicine and Surgery	2009-2016	Reptile & amphibian conservation
Journal of Herpetology	1968-2016	Reptile & amphibian conservation
Journal of Insect Science*	2003-2018	All biodiversity
Journal of Insect Conservation*	1997-2018	All biodiversity
Journal of Kansas Herpetology	2002-2016	Reptile & amphibian conservation
Journal of Mammalian Evolution	1993-2014	All biodiversity
Journal of Mammalogy	1919-2018	All biodiversity
Journal of Mountain Science	2004-2016	All biodiversity
Journal of Negative Results: Ecology & Evolutionary Biology	2004-2016	All biodiversity
Journal of Ornithology	2004-2018	All biodiversity
Journal of Primatology	2012-2013	Primate conservation
Journal of Raptor Research	1966-2016	Birds
Journal of Sea Research	1961-2018	All biodiversity
Journal of the Japanese Institute of Landscape Architecture	1934-2017	All biodiversity
Journal of the Marine Biological Association of the United Kingdom	1887-2018	All biodiversity
Journal of Threatened Taxa	2009-2013	Plants
Journal of Tropical Ecology*	1986-2018	All biodiversity
Journal of Vegetation Science	1990-2017	All biodiversity
Journal of Wetlands Ecology	2008-2012	All biodiversity
Journal of Wetlands Environmental Management	2012-2016	All biodiversity
Journal of Wildlife Diseases	1965-2012	All biodiversity
Journal of Wildlife Management	1945-2018	All biodiversity
Journal of Zoo and Aquarium Research	2013-2016	All biodiversity
Journal of Zoology*	1966-2018	All biodiversity
Jurnal Primatologi Indonesia	2009	Primate conservation
Kansas Herpetological Society Newsletter	1977-2001	All biodiversity
Lake and Reservoir Management	1984-2016	All biodiversity
Land Degradation and Development	1989-2016	All biodiversity
Land Use Policy	1984-2012	Soil Fertility
Latin American Journal of Aquatic Mammals	2002-2018	All biodiversity
Lemur News	1993-2012	All biodiversity
Limnologica - Ecology and Management of Inland Waters [+]	1999-2017	All biodiversity
Mammal Research	2001-2018	All biodiversity
Mammal Review	1970-2018	All biodiversity
Mammal Study	2005-2018	All biodiversity
Mammalia	1937-2018	All biodiversity
Mammalian Biology	2002-2018	All biodiversity
Mammalian Genome	1991-2013	All biodiversity
Management of Biological Invasions	2010-2016	All biodiversity

Mangroves and Salt Marshes	1996-1999	All biodiversity
Marine and Freshwater Research*	1980-2018	All biodiversity
Marine Ecology	1980-2018	All biodiversity
Marine Ecology Progress Series	2000-2018	All biodiversity
Marine Environmental Research	1978-2018	All biodiversity
Marine Mammal Science	1985-2018	All biodiversity
Marine Pollution Bulletin	2010-2018	All biodiversity
Mires and Peat	2006-2016	All biodiversity
Natural Areas Journal	1992-2017	All biodiversity
Nature Conservation	2012-2019	All biodiversity
Neobiota	2011-2017	All biodiversity
Neotropical Entomology [+]	2001-2007	All biodiversity
Neotropical Primates	1993-2014	Primate conservation
New Journal of Botany	2011-2013	Plant conservation
New Zealand Journal of Marine and Freshwater Research*	1980-2018	All biodiversity
New Zealand Journal of Zoology*	1974-2018	All biodiversity
New Zealand Plant Protection	2000-2016	All biodiversity
Northwest Science	2007-2016	All biodiversity
Oecologia*	1969-2018	All biodiversity
Oikos*	1949-2018	All biodiversity
Ornitologia Neotropical	1990-2018	All biodiversity
Oryx*	1950-2018	All biodiversity
Ostrich	1980-2016	Bird conservation
Pacific Conservation Biology*	1993-2018	All biodiversity
Pakistan Journal of Zoology	2004-2013	All biodiversity
Phyllomedusa	2002-2016	Reptile & amphibian conservation
Plant Ecology	1948-2007	All biodiversity
Plant Protection Quarterly	2008-2016	All biodiversity
PLOS	2006-2013	All biodiversity
Polish Journal of Ecology	2002-2013	All biodiversity
Population Ecology	1952-2013	All biodiversity
Preslia	1973-2017	All biodiversity
Primate Conservation	1981-2014	Primate conservation
Primates	1957-2013	All biodiversity
Rangeland Ecology & Management (previously Journal of Range Management 1948-2004)	1948-2016	All biodiversity
Raptors Conservation	2005-2016	All biodiversity
Regional Studies in Marine Science	2015-2018	All biodiversity
Restoration Ecology*	1993-2018	All biodiversity
Revista Chilena de Historia Natural	2000-2016	All biodiversity
Revista de Biología Tropical [+]	1976-2013	All biodiversity
River Research and Applications	1987-2016	All biodiversity
Russian Journal of Ecology	1993-2017	All biodiversity
Russian Journal of Herpetology	1994-2016	Reptile & amphibian conservation
Salamandra	2000-2016	Amphibian captive breeding

Slovak Raptor Journal	2007-2016	All biodiversity
Small Ruminant Research	1988-2017	All biodiversity
Soil Biology & Biochemistry	1969-2012	Soil Fertility
Soil Use and Management	1985-2012	Soil Fertility
South African Journal of Botany	1982-2016	All biodiversity
South African Journal of Wildlife Research	1971-2014	All biodiversity
South American Journal of Herpetology	2006-2016	Reptile & amphibian conservation
Southern Forests: a journal of Forest Science	2008-2013	All biodiversity
Southwestern Naturalist	1956-2013	All biodiversity
Systematic Reviews Centre for Evidence-Based Conservation*	2004-2018	All biodiversity
The Condor	1980-2016	Bird Conservation
The Open Ornithology Journal	2008-2016	All biodiversity
The Rangeland Journal	1976-2016	All biodiversity
Trends in Ecology and Evolution*	1986-2018	All biodiversity
Tropical Conservation Science [+]	2008-2014	All biodiversity
Tropical Ecology [+]	1960-2014	All biodiversity
Tropical Grasslands	1967-2010	All biodiversity
Tropical Zoology	1988-2013	All biodiversity
Turkish Journal of Zoology	1996-2014	All biodiversity
Vietnamese Journal of Primatology	2007-2009	Primate conservation
Wader Study Group Bulletin	1970-1977	All biodiversity
Waterbirds	1983-2016	Bird conservation
Weed Biology and Management	2001-2016	All biodiversity
Weed Research	1961-2017	All biodiversity
West African Journal of Applied Ecology	2000-2016	All biodiversity
Western North American Naturalist	2000-2016	All biodiversity
Wetlands	1981-2016	All biodiversity
Wetlands Ecology and Management	1989-2016	All biodiversity
Wildfowl	1948-2016	Bird conservation
Wildlife Biology	1995-2013	All biodiversity
Wildlife Monographs	1958-2013	All biodiversity
Wildlife Research	1974-2018	All biodiversity
Wildlife Society Bulletin	1973-2018	All biodiversity
Wilson Journal of Ornithology	1980-2016	Bird conservation
Zhurnal Obshchei Biologii	1972-2013	All biodiversity
Zoo Biology	1982-2016	All biodiversity
ZooKeys	2008-2013	All biodiversity
Zoologica Scripta	1971-2014	All biodiversity
Zoological Journal of the Linnean Society	1856-2013	All biodiversity
Zootaxa	2004-2014	All biodiversity

APPENDIX 2. Literature reviewed for the [NAME] Synopsis

The diagram below will be completed and included in the synopsis document to show the numbers of journals and report series searched for the synopsis, the total number of publications scanned within those, and the number of publications that were summarized from each source of literature.