

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

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Abstract

Globally, marine and freshwater mammals face multiple threats, including fishing, hunting, pollution (including noise), habitat loss, shipping, and habitat change, and many species are declining in number. With the pressure of these threats combined with the unknown impact of climate change, there is an urgent need for evidence-based conservation of marine and freshwater mammal 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 time and resources. Here, we use a subject-wide synthesis approach: a systematic method of reviewing and synthesising evidence for broad subject areas (such as the conservation of entire taxa). The methods outlined in this protocol are designed to simultaneously collate and summarise the evidence for the effectiveness of the entire range of potential conservation interventions for marine and freshwater mammals (cetaceans, pinnipeds and sirenians). A conservation intervention is any action taken to protect, manage, enhance or restore marine or freshwater mammal populations. The wording used throughout this protocol is standard for a subject-wide Conservation Evidence synthesis.

Key Words: subject-wide evidence synthesis, marine mammals, freshwater mammals, cetaceans, pinnipeds, sirenians, conservation, intervention, management

Background

Marine and freshwater mammals (cetaceans, pinnipeds and sirenians for the purpose of this synopsis, see below) inhabit a diverse range of aquatic habitats such as rivers, estuaries, coastal shallows, shelf waters and deep seas. Many marine and freshwater mammal species play a vital role in maintaining the health and integrity of these ecosystems, and act as key sentinels of ecosystem change (e.g. Bonde et al. 2004, Wells et al. 2004, Roman et al. 2014). A recent report by the Society of Conservation Biology (Roman et al. 2017) highlighted the significant ecosystem services provided by cetaceans, particularly large migratory whales. It has been postulated that these animals enhance marine primary productivity and sequester carbon on large scales thus contributing not only to the functioning of marine ecosystems, but also to the overall health of the planet (Roman et al. 2017). However, many species are threatened by anthropogenic impacts such as urban and industrial development, tourism, chemical and noise pollution, hunting and direct harvesting, incidental entanglement in fishing gear, interactions with marine debris, and vessel collisions (Avila et al. 2018). Climate change also has the potential to have serious direct and indirect effects (e.g. Evans & Bjørge 2013, Frederiksen & Haug 2015), which are challenging to predict.

The last comprehensive International Union for the Conservation of Nature (IUCN) assessment of the conservation status of mammals in 2008 revealed that the status of marine

species is of particular concern, with over a third of marine mammal species estimated to be threatened with extinction in the wild (Schipper et al. 2008). In addition to this, 38% of marine mammal species were classified as ‘data deficient’ with insufficient information available to assess the status of their populations. Freshwater cetaceans are also highly threatened and are among the world’s most endangered mammals (e.g. Veron et al. 2008, Huang *et al.* 2017). The most recent IUCN assessment (IUCN 2019) indicates that the situation has not improved, although separate statistics are not available for marine and freshwater mammals. There is therefore a clear and pressing need for effective conservation strategies.

Conservation efforts have led to population recoveries for some species, particularly those that occupy nearshore or coastal habitats, which may be easier to protect or manage (Magera et al 2013). A recent study found that 18 marine mammal populations (of 23 analysed) increased significantly in abundance after they became legally protected under the US Endangered Species Act (ESA) and a range of conservation measures were implemented (Valdivia et al. 2019).

Evidence-based knowledge is key for planning successful conservation strategies and for the cost-effective allocation of scarce resources for conservation programmes. Parsons et al. (2015) listed ‘*Better understanding of conservation interventions*’ as a key theme of global importance for cetacean conservation. 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. There is a paucity of evidence within the literature for the effectiveness of conservation interventions aimed at marine and freshwater mammals, and although targeted reviews do exist, the results can be inconclusive. For example, a recent review of technical solutions to reduce marine mammal bycatch and entanglement concluded that while several solutions showed some promise for certain species, the results were inconsistent and there was overall a lack of strong evidence for the effectiveness of most interventions and substantial development and research is still required (Hamilton & Baker 2019). Most conservation interventions targeting marine and freshwater mammals have not yet been synthesised under a formal review and those that have would benefit from periodic update as new research becomes available.

Here, we use a subject-wide evidence synthesis approach (Sutherland & Wordley 2018, Sutherland et al. 2019) to simultaneously summarize the evidence for the wide range of interventions dedicated to the conservation of marine and freshwater mammals (cetaceans, pinnipeds and sirenians, see below). 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 (comprising all summarized information from the synopsis along with expert assessment scores), should be a valuable asset to the toolkit of practitioners and policy makers seeking sound information to support marine and freshwater mammal conservation.

Scope of the review

1. Review subject

This synthesis focuses on global evidence for the effectiveness of interventions for the conservation of marine and freshwater mammals. This subject has not yet been covered using subject-wide evidence synthesis. This is defined as a systematic method of reviewing and synthesising evidence that covers broad subjects (in this case conservation of multiple taxa) 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 interventions for marine and/or freshwater cetaceans (whales, dolphins and porpoises), pinnipeds (seals, walrus and sea lions) and sirenians (manatees and dugong). Evidence for the effectiveness of interventions targeting the conservation of other aquatic or semi-aquatic mammals (such as polar bear, otter species, water vole etc.) are covered in separate synopses.

This synthesis covers evidence for the effects of conservation interventions for wild marine and freshwater mammals (i.e. not in captivity). We will not include evidence from the substantial literature on husbandry of marine and freshwater mammals 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 or interventions that aim to conserve wild marine or freshwater mammal populations and reduce or remove the negative effects of threats. The output of the project will be an authoritative, transparent, freely accessible evidence-base of summarised studies and expert assessment scores that will support marine and freshwater mammal management decisions and help to achieve conservation outcomes.

2. Advisory board

An advisory board made up of international conservationists and academics with expertise in marine and freshwater mammal 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 searching 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 interventions that have been carried out or advised to support populations or communities of wild marine and freshwater mammals, whether evidence for the effectiveness of an intervention 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 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>).

For interventions with a large literature, the intervention may be split into different methods of implementation (e.g. different designs, implementation in different seasons, different methods for acclimatisation before release etc.), different species/functional groups, or broad habitats, if relevant to do so and provided that each has five or more studies testing it.

Depending on the amount of available evidence, it may not be possible to summarise the evidence for all interventions within the time frame of this project. Under those circumstances, once the comprehensive list of interventions has been produced, we will ask the advisory board to prioritise specific interventions for completion. We will then summarise the evidence starting with that for the highest priority intervention/group of interventions, and then work down the priority list.

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 search 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 marine and freshwater mammals (marked with an asterisk in Appendix 1).

iii) New searches

In addition to the list of journals in Appendix 1, focused searches of journals relevant to the conservation of marine and freshwater mammal populations listed below will be undertaken. These journals were identified through expert judgement by the project researchers and the advisory board and ranked in order of relevance, to prioritise searches that were 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.

- Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Science
- Frontiers in Marine Science
- Marine and Freshwater Research
- New Zealand Journal of Marine and Freshwater Research
- Antarctic Science
- Marine Ecology
- Aquatic Biology
- Marine Biology
- Marine Biodiversity
- Marine Policy

- Deep Sea Research II
- Polar Biology

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 marine and freshwater mammals, 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 marine and freshwater mammal conservation as listed below. These searches will review 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.

- International Council for the Exploration of the Sea (ICES) Expert Groups web directory of reports (www.ices.dk/publications/our-publications/Pages/Expert-Group-Reports.aspx) e.g. Working Group on Marine Mammal Ecology (WGMME) and Working Group on Bycatch of protected species (WGBYC)
- International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) Specialist Group reports e.g. Cetacean, Marine Mammal Protected Area, Pinniped, Sirenia (www.iucn.org/ssc-groups/mammals)
- Convention on the Conservation of Migratory Species of Wild Animals (CMS) Technical Series reports (www.cms.int/en/publications/technical-series)
- International Whaling Commission publications (<https://archive.iwc.int/pages/themes.php?theme1=Reports>)
- Scientific Committee on Antarctic Research (SCAR) Expert Group on Birds and Marine Mammals (EGBAMM) publications (<https://www.scar.org/science/eg-bamm/>)
- Whale and Dolphin Conservation (WDC) publications (<https://uk.whales.org/policy/wdc-publications-and-reports/>)

- Sea Mammal Research Unit (SMRU) - Marine Mammal Scientific Support to Scottish Government (dated or numbered reports) (<http://www.smru.st-andrews.ac.uk/research-policy/reports-to-scottish-government/>) and dated reports for funders (<http://www.smru.st-andrews.ac.uk/reports/>)
- Joint Nature Conservation Committee (JNCC) Report Series (dated and numbered reports) (<http://archive.jncc.gov.uk/page-2132>)
- Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) outputs (dated reports and plans) (<https://www.ascobans.org/en/documents/action-plans>)
- Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) outputs (numbered resolutions for conservation actions) (<http://www.accobams.org/documents-resolutions/resolutions/>)
- North Atlantic Marine Mammal Commission (NAMMCO) outputs (dated reports) (<https://nammco.no/library/>)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries Science & Data Resources (dated) for Species Categories: Whales, Dolphins & Porpoises, Seals and Sea lions (https://www.fisheries.noaa.gov/resources/all-science?title=&species%5B54%5D=54&species%5B1000000066%5D=1000000066&species%5B53%5D=53&field_species_vocab_target_id=&sort_by=created)
- Department of Conservation, New Zealand Report Series (numbered) (<https://www.doc.govt.nz/about-us/science-publications/series/>)

The following resource has published over 9,000 reports and therefore systematic searches of every title will not be possible within the time frame of this project. Instead, key word searches (for ‘cetacean’, ‘pinniped’, ‘sirenian’, ‘whale’, ‘dolphin’, ‘porpoise’, ‘seal’, ‘sea lion’, ‘dugong’, and ‘manatee’) will be carried out within the topic ‘Biology and Life Sciences’.

- National Academies Press Reports (<https://www.nap.edu/>)

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 individually. If the intervention has a large literature (≥20 papers), then only the systematic review will be summarised as will any publications published since the review or not included within it. 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 have 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 intervention that might be done to conserve biodiversity

1. Does this study measure the effect of an intervention 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 intervention 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 intervention be put in place by a conservationist/decision maker to protect, manage or restore wild taxa or habitats, 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 interventions that have a measured outcome on human behaviour only.

b. Intervention 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 intervention by humans, or pure ecology (e.g. movement, distribution of species).

2. Study must test an intervention that could be put in place for conservation. This excludes assessing impacts of threats (interventions 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 intervention was under human control, the intervention 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 into 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 searched 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)

Interventions within the scope of Conservation Evidence include:

- Clear management interventions: e.g. 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
- Interventions that reduce human-wildlife conflict
- Interventions that change human behaviour, resulting in an impact on wild taxa or habitats

See <https://www.conservationevidence.com/data/index> for more examples of interventions.

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 intervention 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 intervention that might be done to change human behaviour for the benefit of biodiversity

1. Does this study measure the effect of an intervention that is or was under human control on human behaviour (actual or intentional) which is likely to protect, manage or restore wild taxa or habitats, or reduce threats to wild taxa or habitats? If yes, go to 2. If no, the study will be excluded.
2. Could the intervention 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. Intervention must be under human control: excludes impacts from climatic or other natural events.
2. Study must test an intervention that could be put in place for conservation: excludes studies with no intervention 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). Interventions include, but are not limited to the following:

- Change in adverse behaviours (which directly threaten biodiversity) e.g. unsustainable fishing (industrial, artisanal or 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

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

- **Enforcement:** Closed seasons, size limits, fishing gear/hunting 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
- **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 into 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 marine and freshwater mammals (cetaceans, pinnipeds and sirenians).

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 or restore wild, native marine and freshwater mammals or reduce the impacts of threats to them. Alternatively, interventions may aim to change human behaviour (actual or intentional), which is likely to protect, manage or restore wild, native marine and freshwater mammals or reduce threats to them. 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 duplicating 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 a mammal species before and after the closure of an area to fishing activities, or the reduction in mammal bycatch using different types of fishing gear. 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, spatial distribution, biomass, movement, age-structure, sex ratio
 - Reproductive success: egg/sperm production, artificial fertilization success, mating success, birth rate, pup/calf quality/condition, overall recruitment, age/size at maturity

- Survival: survival, mortality
- Condition: growth, size, weight, condition factors, biochemical ratios, stress, energetics, disease levels or immune function
- Usage:
 - Uptake
 - Use
 - Behaviour change: movement, use of natural/artificial habitat/structure, range, predatory or nuisance behaviour that could lead to retaliatory action by humans
- Other
 - Bycatch reduction
 - 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 water quality or adjacent land use. 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 assessment 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 bycatch by fishers using modified nets (e.g. with a smaller mesh size) and unmodified nets (controlled), and fishers using an alternative net modification, e.g. stiffened nets (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 searched 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, paired, site comparison study in 2002 of two coastal coral reefs in the Philippines (1) found that establishing a marine reserve closed to fishing resulted in higher density and biomass of species of fish taken by local fishers within the reserve compared to a fished area in one of two cases. For species taken by fishers, density and biomass inside reserve one was higher (density: 68 fish/500 m²; biomass: 89 kg) than outside (27/500 m²; 25 kg), but not significantly different inside and outside reserve two (density inside and outside: 41/500 m²; no biomass data provided). For fish species not subject to fishing, density was higher inside both reserves compared to outside; however, statistical tests showed this was mainly due to habitat variation not protection status (reserve one: 146 fish/250 m² inside, 113/250 m² outside; reserve two: 93/250 m² inside, 32/250 m² outside). No-take reserves approximately 450 m long (protected for 20 years) and 650 m long (protected for 15 years) off two islands were each compared to fished areas approximately 500 m away. Fish were surveyed in November and December 2002. Divers surveyed fish at six (reserve one) and eight (reserve two) coral reef slope sites inside and outside each reserve. Counts were along 50 x 10 m transects for fish taken by fishers and 50 x 5 m transects for fish not fished. Transects were surveyed twice.

(1) Abesamis R.A., Russ G.A., Alcala A.C. (2006) Gradients of abundance of fish across no-take marine reserve boundaries: Evidence from Philippine coral reefs. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 16, 349–371.

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 m²). Abundance was significantly lower compared to unharvested plots (6/30 m²). 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.

A replicated, randomized, paired, controlled study in 1936–2009 in eight sagebrush steppe sites in Oregon, USA (3) 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.

(3) 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.

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. If there is a good reason to report differences between treatments and controls that were not tested for statistical significance, it will be made clear within the summary that statistical tests were not carried out. 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 (≥ 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. USA¹, Australia² not Australia², USA¹. 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):**

If no evidence is found for an intervention, the following text will be added in place of the key messages above:

- We found no studies that evaluated the effects of [INTERVENTION] on [TARGET POPULATION].

'We found no studies' means that we have not yet found any studies that have directly evaluated this intervention during our systematic journal and report searches. Therefore we have no evidence to indicate whether or not the intervention has any desirable or harmful effects.

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 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

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

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*	1981-2017	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*	1983-2017	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
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
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
Ardeola	1996-2018	All biodiversity
Aquaculture Research	1972-2008	All biodiversity
Aquatic Botany	1975-2017	All biodiversity
Aquatic Conservation: Marine and Freshwater Ecosystems*	1991-2017	All biodiversity
Aquatic Ecology*	1968-2016	All biodiversity
Aquatic Ecosystem Health & Management*	1998-2016	All biodiversity
Aquatic Invasions*	2006-2016	All biodiversity
Aquatic Living Resources*	1988-2016	All biodiversity

Aquatic Mammals*	1972-2017	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	1977-2017	All biodiversity
Australasian Journal of Herpetology	2009-2012	Reptile & amphibian conservation
Australian Mammalogy*	2000-2017	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
Behavior 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*	1981-2017	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	2005-2017	All biodiversity
Biotropica	1990-2017	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*	1901-2017	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
Collinsorum	2012-2014	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	2008-2017	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*	2012-2017	All biodiversity
Environmental Management*	1977-2017	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*	1955-2017	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	1982-2017	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	2000-2013	Reptile & amphibian conservation
Herpetological Conservation and Biology	2006-2012	Reptile & amphibian conservation
Herpetological Journal	2005-2012	Reptile & amphibian conservation
Herpetological Monographs	1982-2012	Reptile & amphibian conservation
Herpetological Review	1967-2014	Reptile & amphibian conservation
Herpetology Notes	2008-2014	Reptile & amphibian conservation
Human Wildlife Interactions*	2007-2017	All biodiversity
Hydrobiologia*	2000-2017	All biodiversity
Hystrix, the Italian Journal of Mammalogy*	1986-2017	All biodiversity
Ibis	1980-2016	Bird conservation
ICES Journal of Marine Science*	1990-2018	All biodiversity
iForest	2008-2016	All biodiversity
Integrative Zoology	2006-2013	All biodiversity
International Journal of Pest Management (formerly PANS Pest Articles & News Summaries 1969 - 1975, PANS 1976-1979 & Tropical Pest Management 1980-1992)	1969-1979	All biodiversity
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*	2002-2017	All biodiversity
Journal of Animal Ecology*	1932-2017	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 Cetacean Research and Management*	1999-2012	All biodiversity
Journal of Coastal Research*	2015-2018	All biodiversity
Journal of Ecology*	1933-2017	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	2009-2013	Reptile & amphibian conservation
Journal of Herpetology	1968-2015	Reptile & amphibian conservation
Journal of Insect Science	2003-2018	All biodiversity
Journal of Kansas Herpetology	2002-2011	Reptile & amphibian conservation
Journal of Mammalian Evolution	1993-2014	All biodiversity
Journal of Mammalogy*	1919-2017	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*	1961-2017	All biodiversity
Journal of the Japanese Institute of Landscape Architecture	1934-2017	All biodiversity
Journal of the Marine Biological Association of the United Kingdom*	1887-2006	All biodiversity
Journal of Tropical Ecology	1986-2017	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	1945-2017	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*	2002-2016	All biodiversity
Lemur News	1993-2012	All biodiversity
Limnologica - Ecology and Management of Inland Waters	1999-2017	All biodiversity
Mammal Research*	2001-2017	All biodiversity
Mammal Review*	1970-2017	All biodiversity
Mammal Study*	2005-2017	All biodiversity
Mammalia*	1937-2017	All biodiversity
Mammalian Biology*	2002-2017	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 Ecological Progress Series*	2000-2018	All biodiversity
Marine Environmental Research*	1978-2017	All biodiversity
Marine Mammal Science*	1985-2017	All biodiversity
Marine Pollution Bulletin*	2010-2017	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 Primates	1993-2014	Primate conservation
New Journal of Botany	2011-2013	Plant conservation
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*	1950-2017	All biodiversity
Ostrich	1980-2016	Bird conservation
Pacific Conservation Biology*	1993-2018	All biodiversity
Pakistan Journal of Zoology	2004-2013	All biodiversity
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*	2015-2017	All biodiversity
Restoration Ecology*	1993-2017	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 Herpetology	1994-2000	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	2006-2012	Reptile & amphibian conservation
Southern Forests: a journal of Forest Science	2008-2013	All biodiversity
Southwestern Naturalist	1956-2013	All biodiversity
Strix	1982-2017	All biodiversity
Systematic Reviews Centre for Evidence-Based Conservation*	2004-2017	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*	1986-2017	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 Marine and freshwater mammal Synopsis

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

