Other aggregative reviews (e.g. Meta-analyses, Critical reviews)

Title
What are the economic, social, and ecological impacts of the loss of ecosystem services caused by forest management practices? A review protocol

Citation:
Louise Dupuis, Joseph Langridge, Cécile Jacques, Hervé Jactel. What are the economic, social, and ecological impacts of the loss of ecosystem services caused by forest management practices? A review protocol: a Other aggregative reviews (e.g. Meta-analyses, Critical reviews). PROCEED-24-00213 Available from:
https://proceedevidence.info/protocol/view-result?id=213
https://doi.org/10.57808/proceed.2024.11

Corresponding author's email address
louise.dupuis@fondationbiodiversite.fr

Keywords
Negative externalities; Anthropogenic activities; Silviculture; Forest management; Biodiversity erosion

Background
We are currently living an unprecedented era of biodiversity loss worldwide (Ceballos et al., 2015; Ceballos and Ehrlich, 2023). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has consistently alerted the policy arena about the main pressures causing biodiversity and ecosystem services loss: land-use change, direct exploitation of natural resources, etc. Anthropogenic activities such as agriculture and urban development, combined with the globalisation of trade, exacerbate these pressures on biodiversity. Forestry is no different, some forest management practices harmfully impact biodiversity and the societal benefits provided by preserved forests (Hanski, 2011), such as carbon sequestration, erosion control, groundwater management: important regulative services (Pukkala, 2022). Biological diversity enhances the resilience of forests to natural and anthropogenic disturbances (Jactel et al. 2017), ensuring ecosystem functioning critical for meeting current and future societal needs (Knoke et al., 2008; Biggs et al, 2012). Indeed, forest biodiversity loss is a major threat to ecological, social, and economic stability (Muys et al., 2022). Although the scientific literature has studied the effects of forest management on biodiversity and ecosystem services, a lack of systematic reviews exists collating studies linking the risks of negative externalities caused by forest management-induced loss of biodiversity and changes to ecosystem processes on human societies. Therefore, the review will elucidate the 3-way connection between i) forest management practices, ii) their impact on biodiversity loss, and iii) the consequences for human societies in terms of economic, social, health and environmental externalities. This will be a helpful guide for public policy.

Theory of change or causal model
Nowadays, it is not easy for policymakers to understand the links between forest management practices, impacts on biodiversity, and consequences for human societies. Public policies do not have a cross- and multi-disciplinary approach, and tend to favour economic arguments in their decision-making, i.e. yield, cost-benefit analysis, life-cycle analysis (Ackerman and Heinzerling, 2002; Oates and Portney, 2003). However, highlighting the links between forest management practices and negative externalities other than economic ones would improve the overall picture of the impact of

anthropogenic activities both on their environment and on humanity itself, e.g. the health costs of water pollution due to pesticide use in forest management, the loss of well-being of people living near forests because of frequent clear-cutting, etc (see Figure 1).

Stakeholder engagement

This review will be conducted with the engagement of the "Fondation Crédit Mutuel Alliance" (FCMA). The foundation of "Crédit Mutuel Alliance Fédérale", which is a cooperative mutual bank, supports and funds projects of common interest, including projects relating to the environment and the loss of biodiversity. The current project was co-built between the French Foundation for Biodiversity Research (FRB) and the stakeholder, in line with FRB's activities of collaborative research. The stakeholder had a collaborating role in formulating the scope and research question, and is frequently consulted throughout the process, to address its concerns, and ensure that the findings are understandable and usable. However, to ensure objectivity, they will not be able to modify or redirect the research question during the project should, for example, results go against the activities and investments of the "Crédit Mutuel Alliance Fédérale".

Objectives and review question

The systematic review's main objective is to highlight the link between forest management practices, their impacts on ecosystem services loss, and their roles on associated negative externalities for human societies. The primary question formulated for this subject is therefore as follows: "What are the economic, social and ecological impacts of the loss of ecosystem services caused by forest management practices".

Definitions of the question components

The components of the question according to a "PICO" structure are as follows: Population: decline in forest biodiversity (and decline in its ecosystem services) at above- or below-ground level. All relevant taxonomic groups, including animals (e.g. birds, insects, mammals), micro-organisms (e.g. fungi, bacteria), plants (e.g. trees, weeds, etc.). Intervention: all forest management practices across silvicultural cycles, including individual practices at the land and soil preparation stage (e.g. stump removal, ploughing), at the regeneration of stand stage (e.g. planting), concerning the management of the stand, i.e. structure (e.g. even-aged and uneven-aged, pure and mixed, thinning, cleaning, tending, weeding (under-story) etc), and at the harvesting stage (e.g. logging, clear cutting). Comparator: spatial or temporal comparisons e.g. different management types, effects of a single management type over time. This may translate as Before-After, Control-Intervention, Control-Treatment, Before-After-Control-Intervention studies. Outcomes: all negative externalities related to: Economic indicators (e.g. GDP, expenditures, etc.); human health indicators (e.g. health and disease, mortality, well-being); social indicators (e.g. inequalities and injustices, food security, poverty) and environmental indicators (e.g. loss of ecosystems services, i.e. contributions to people).

Search strategy

We will search for peer-reviewed and grey literature (e.g., journal articles, books, theses, non-commercial technical reports) through database searches (see Additional File 1 – database access), search engines, and specialised websites. To control the volume of literature and achieve review objectives within a timeframe of approximately 6-9 months, we will search one database: Web of science core collection (WOSCC), and two web-based search engines: Google Scholar, and PubMed using a search string of English terms only. We will also search appropriate organisational websites for grey literature. Based on the question elements, we have identified key terms referring to the population, intervention, and outcomes. These will be combined using Boolean operators 'OR' within each block and 'AND' between blocks, such that a publication will be retrieved if: i) it studies a decline in biodiversity OR ecosystem services AND ii) it relates it to forest management AND iii) it assesses the outcome in terms of economic, social, health or environmental consequences. Review

articles will not be coded because the request is to focus primarily on empirical evidence. However, back chasing of citations from retained reviews may be undertaken. No context limitation will be applied. Thus, worldwide studies will be eligible. Likewise, no date range limitation will be applied.

Bibliographic databases

Firstly, a scoping exercise was conducted in the Web of Science Core Collection database to explore the sensitivity and specificity of chosen keywords (cf. Additional file 2 – Building search string) TS=((biodiversity OR species OR "ecosystem service$" OR "provisioning service$" OR "regulating service$" OR "regulation service$" OR "cultural service$" OR "recreational service$" OR "carbon storage" OR "carbon fixation" OR "carbon sequest*" OR "cultural service$" OR "recreational service$" OR "nursery service$" OR "native forest$" OR "sacred forest$" OR "heritage forest$" OR natur* OR wood) NEAR/1 (loss* OR declin* OR degrad* OR decreas* OR reduc* OR disturbance$ OR damage)) AND TS = ((*forest* OR stand$ OR plantation$) AND (management OR harvest* OR logging OR cut* OR tend* OR thin* OR retention OR regenerat* OR convert* OR plant* OR clear-cut OR "clear cut" OR "clear fell*" OR clearfell* OR clear-fell* OR "stump removal" OR fertilis* OR fertiliz* OR amendment$ OR plough* OR weed* OR native OR non-native OR exotic OR pure OR mixed OR monoculture OR *even-aged OR "*even aged" OR shelterwood$)) AND TS=(((impact$ OR consequence$ OR externalit*) NEAR/1 (social OR health OR environmental OR "socio-economic" OR economic)) OR GDP OR dollar OR price$ OR cost$ OR value$ OR yield$ OR "year$ of life" OR disease$ OR "death rate" OR mortality OR "life expectancy" OR inequalit* OR vulnerability OR "human development index" OR "healthy life years" OR "disability-adjusted life expectancy" OR DALY OR HALE OR poverty OR well-being OR wellbeing OR conflict$ OR lawsuit$ OR deforestation)

Web-based search engines

A supplementary retrieval of publications will be undertaken using web-based search engines. Firstly, PubMed (https://pubmed.ncbi.nlm.nih.gov/advanced/), then Google Scholar. Concerning Google Scholar, we will use the software program ‘Publish or perish’ (version 6) to retrieve all academic citations. The use of Boolean operators and the number of permitted keywords in Google Scholar differs from WOSCC. As a result, the search string will be broken down into separate searches to achieve a similar sensitivity, as only a maximum of 256 characters can be used per search string. Additionally, Google Scholar will be used primarily for academic literature searching, thus we will limit to the first 200-300 hits, in line with recommendations (Haddaway et al., 2015). The search terms will cover the population, intervention, and outcome components: e.g. biodiversity loss AND forest practices AND social/economic/health impacts (cf. section 7.1).

Organisational websites

The following specialist organisations will be searched for relevant grey literature such as technical reports containing primary data on forestry-induced impacts:
https://revues.cirad.fr/index.php/BFT/index
https://ur-forets-societes.cirad.fr/publications-et-communication/publications-scientifiques
https://www.fao.org/publications/ https://www.fao.org/forestry/en/ European Forest Institute: https://efi.int/

Comprehensiveness of the search

To ensure the comprehensiveness of the search, we pre-defined a list of 10 benchmark articles, i.e. a test-list, composed of scientific articles relevant to our overriding question, that we identified before starting the research. We tested our preliminary search string against this test-list using WOS, until all the articles of the test-list were retrieved. If missing articles from our benchmark list prevailed, we modified and improved the search string by adding keywords to increase the sensitivity. The process is provided in Additional file 2.

Search update
No update of the literature search is planned as the initial timeline must be respected for the stakeholder's use of results.

Screening strategy
We will use a three-step filtering process to select eligible articles. We will first screen all titles, then all retained abstracts, then we will screen all full texts after recovering the associated pdf files. To help us during this selection process, we pre-defined screening and study eligibility criteria (cf. Additional file 3 - selection criteria). We will use a conservative approach during the screening process: if any doubt persists, or if we do not have enough information to retain or reject a study (e.g., publication without abstract), then the publication will automatically go through the next eligibility step (abstract or full text).

Eligibility criteria
We will review the collated studies obtained from the searches using the flowing set of criteria: Title and abstract inclusion criteria: firstly, all titles and abstracts will be retained if presence of evidence of declining populations of forest-related native/indigenous and wild terrestrial species – the associated ecosystem service must be specified. Also, evidence of loss of an ecosystem function provided by biological communities will be retained. All forest management practices, including the planting of exotic species will also be retained (cf. section 7.1). Title and abstract exclusion criteria: articles will not be retained if the studied population is invasive species or domestic species, or all marine species and their associated ecosystem services. They will not be retained if the studied practice is not a forest management related intervention. Full-text inclusion criteria: regarding comparator components, all studies that make temporal or spatial comparisons will be retained; all external effects/impacts/consequence/costs i.e. externalities of forest management due to the loss of biodiversity and associated ecosystem services, in line with predefined indicators (cf. section 7.1). Full-text exclusion criteria: similar to those applied at title and abstract screening, but if no evidence of any effect, impact or negative externalities, the study will be excluded. If the indicator or mention of effect/impact is not related to a loss of biodiversity (genetic, species, habitat, ecosystem) and/or loss of functioning and/or loss of an ecosystem service; and if the effect/impact is not a consequence of a forest management practice studied.

Consistency checking
Three different reviewers will participate in the three-step filtering process, using the same pre-defined eligibility criteria. For each screening stage, a Kappa Fleiss test will be performed to ensure the criteria validity, homogeneity, and the replicability of our review (Frampton et al., 2017). These tests will also allow to refine the eligibility criteria when differences of opinion arise. To carry out the test, 10% of titles, 10% of abstracts, and 10% of full texts will be randomly pre-screened to check for agreement between the reviewers before starting each screening step. Kappa score should be at least 0.6 (Frampton et al., 2017): the process will be repeated until the score of 0.6 is reached. Once this score is reached, retaining disagreements will be discussed before beginning the screening process. A consistency check will also be performed for meta-data extraction, on the basis of 5% of the retained articles.

Reporting screening outcomes
We will provide a list of articles excluded at the 'full text' stage, with reasons for exclusion. An additional file will also be provided in the Review. In addition, we will follow the Environmental Evidence Guidelines and will conform to the ROSES standards. Equally, an additional file for our declaration and checklist of adherence to the ROSES guidelines will be included in the Review. The standardised ROSES flowchart will also be provided in the Review report used to illustrate the number of publications/studies that pass - or are eliminated at - each step. This flowchart will also be

provided in the Review report.

Study validity assessment
The critical appraisal is a major phase of the systematic review procedure. It will be carried out to assess the internal validity (e.g., cofounding factors) and the external validity (e.g., generalisability) before extracting quantitative data (Haddaway et al., 2020). We will define criteria according to the different types of identifiable biases: e.g., attrition bias, cofounding factors, outcome assessment bias, outcome reporting bias, publication bias. A score will be associated to each criterion allowing the bias level to be calculated. Any severe lack of information, jeopardising correct interpretation, for a given criterion will qualify as “high” risk of bias. Once a study is assessed, all scores will be summed up, giving a single total score per study. For the quantitative analysis, each study will be weighted according to this calculated score. Thus, we will not exclude studies with high risks of bias. Additional criteria and further specification may be developed in an iterative way as the review process progresses. The outcomes of the critical appraisal will be provided in an Additional file.

Consistency checking
Once the meta-data extraction has been completed, the critical appraisal of study validity will be tested on 5% of the retained publications, using the pre-defined critical appraisal criteria (cf. section 10), by at least two of the reviewers. Disagreements will be discussed and will lead to refine the criteria. Once agreement is reached between the reviewers, all studies will be critically appraised by the reviewers. At the end of the validity assessment stage, a second reviewer will cross-check 5% of publications critically appraised, leading to 10% of the final corpus being critically appraised by two reviewers. If disagreements persist across the 10% double-appraised publications after discussions between the reviewers, the most cautious assessment will stand (i.e. highest risk of bias).

Data extraction strategy
All studies obtained after the full-text screening will be subject to meta-data extraction for narrative synthesis. We will follow a pre-defined and tested extraction file (see Additional file 4 – extraction sheet). Concerning statistical approaches, if enough quantitative data suitable for meta-analysis, i.e. availability of descriptive data such as mean, sample-size, and a measure of the amount of variation (i.e. standard deviation, standard error, confidence intervals etc.) are present, then meta-analysis will be pursued. Data will be extracted from figures, tables, text and supplementary material if data are not available directly in the article manuscript. We will use the R package metaDigitise (Pick et al., 2018) for summary data extraction from figures.

Meta-data extraction and coding strategy
The meta-data extraction must address the primary question. We will use a bespoke Excel sheet, in which each all-necessary information to extract and code will be recorded. The information will include bibliometric information (authors, title, journal, year), population information (biodiversity affected, ecosystem affected, ecosystem services affected, etc.), intervention information (individual forestry practice studied, forest context, management of stand, etc.), study design details (BA, CI, BACI), outcomes information (type of externalities, indicator, cost, etc.) and information on the data extraction (mean, effect-size, population, etc.). The sheet regrouping all the variables is provided in Additional file 4.

Consistency checking
The meta-data extraction will be tested by at least two the reviewers on 5% of the retained publications before critical appraisal, to ensure the comprehensiveness of the study and the homogeneity of the interpretation of data between the reviewers. Any disagreement will lead to a discussion until a consensus is reached. Once data extraction has ended, a posteriori cross-check will be carried out by one of the reviewers to ensure no heterogeneity between coders persists.

Potential effect modifiers/reasons for heterogeneity
To understand and explain the variation in outcomes, we will identify and list the potential effect modifiers from the studies, as they may be several environmental and context-dependent factors that could result in the heterogeneity of impacts and results across publications. Some of the potential effect modifiers identified through reviewer's experience and previous literature findings that will be explored are the geographic context, the practice studied, the scale of the study (e.g. stand, landscape), the duration of the intervention (e.g. one month, one year). This list is not exhaustive and may be improved. If sufficient data are acquired, sub-group meta-analyses will be conducted in R (R Core Team, 2020) using the package metafor (Viechtbauer, 2010).

Type of synthesis
The type of synthesis planned is narrative and quantitative. However, quantitative analysis (i.e., meta-analytical approaches) will only be performed if enough studies - and quantitative data - with comparable outcomes are identified during the meta-data extraction stage.

Narrative synthesis methods
The aim of the narrative synthesis is to describe the quality of the studies, the main results and findings. It will include all publications which went through the meta-data extraction. A synthesis database will be provided in the supplementary material, detailing all metadata coded for each article. If one or more outcomes are presented in the same article, this article will be divided in few studies, each study and associated line in the database corresponding to a unique outcome (one study unit). The narrative database will be described with figures and tables of the most relevant results (e.g. types of forest studied, forestry activities studied, types of externalities studied). A geographic map will present the studied biomes and types of forest ecosystems studied. Using cross-tabulating key meta-data variables (e.g. studied practices x types of externalities), we will identify the knowledge gaps and the knowledge clusters of our research question.

Quantitative synthesis methods
All summary data will be extracted from the text, tables, and graphs of retained publications. We will use the R package metaDigitise (Pick et al., 2018) for extracting data from graphs. Meta-analyses will be carried out in R 4.0.3 (R Core Team, 2020) using the package metaphor (Viechtbauer, 2010). If quantitative analyses are possible, we will aim to calculate log response ratio effect sizes. This effect size gives an estimate of the logarithm of percentage of variation in the chosen metric between the experimental group (XE) and the « true » control group e.g., « no management », or the « before » condition (XC). It has the advantage of being directly interpretable in terms of magnitude (Barbier et al., 2009). Mixed-effects models will be used. Where possible, different outcome types i.e. economic indicators ; human health indicators ; social indicators and environmental indicators will be assessed by sub-group analyses or model comparison. Effect modifiers will be included as fixed-effect factors, while "case study" nested within "publication" will be included as a random effect to account for correlation among multiple study units within the same primary study. The multiple use of the same control will be controlled for by using a variance-covariance matrix. Forest plots will be produced to visualise the effect size and confidence intervals for subgroups. Finally, the strength of evidence to answer to the primary question will be discussed according to the significance of statistical tests and magnitude of mean effect sizes.

Qualitative synthesis methods
NA

Other synthesis methods
NA

Assessment of risk of publication bias
In the case where quantitative analyses can be run, we will examine the influence of publication bias on the results of our mixed-effects models by firstly qualitatively diagnosing meta-analytic models with classical funnel plots (Sterne and Egger, 2001), a common diagnostic tool that works well with models fitted in the metafor package. We may also use the Rosenberg's fail-safe numbers, and/or Q-Q plots to identify outliers.

Knowledge gap identification strategy
We will identify the knowledge gaps by analysing the distribution of the meta-data. The cross-tabulation will show the knowledge gaps and clusters in our review, in terms of forestry practices, types of externalities, and types of ecosystem services affected. We hypothesise there will be few studies assessing the impact on human health, on human well-being, on poverty.

Demonstrating procedural independence
Authors of research studies included in this review will not be involved in any decisions regarding their own work. Procedural independence will be assured by not allocating articles during critical appraisal for which members of the review team are authors.

Competing interests
The authors declare no financial or non-financial conflict of interest.

Funding information
This Rapid Review will be part of a research partnership between the FRB and the FCMA funded by the latter.

Author's contributions
LD and JL wrote the protocol, which was reviewed and edited by CJ and HJ. LD, CJ, and JL defined the search string and screening criteria, which was reviewed by HJ. HJ reviewed and refined meta-data extraction methods and data analysis methods. All authors read and approved the final protocol manuscript.

Acknowledgements
The authors thank Marjolaine Garnier (FRB) for assuring discussions with the stakeholder, and Hélène Soubelet (FRB) for her very useful input in terms of question formulation, and screening criteria.

References
Ackerman, F. and Heinzerling, L. (2002) 'Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection', University of Pennsylvania Law Review, 150(5). https://doi.org/10.2307/3312947. Biggs, R. et al. (2012) 'Toward Principles for Enhancing the Resilience of Ecosystem Services', Annual Review of Environment and Resources, 37(1). https://doi.org/10.1146/annurev-environ-051211-123836. Ceballos, G. et al. (2015) 'Accelerated modern human–induced species losses: Entering the sixth mass extinction', Science Advances, 1(5). https://doi.org/10.1126/sciadv.1400253. Ceballos, G. and Ehrlich, P.R. (2023) 'Mutilation of the tree of life via mass extinction of animal genera', Proceedings of the National Academy of Sciences, 120(39). https://doi.org/10.1073/pnas.2306987120. Frampton, G.K., Livoreil, B. and Petrokofsky, G. (2017) 'Eligibility screening in evidence synthesis of environmental management topics', Environmental Evidence, 6(1). https://doi.org/10.1186/s13750-017-0102-2. Haddaway, N.R. et al. (2020) 'Eight problems with literature reviews and how to fix them', Nature Ecology & Evolution, 4(12). https://doi.org/10.1038/s41559-020-01295-x. Hanski, I. (2011) 'Habitat Loss, the Dynamics of Biodiversity, and a Perspective on Conservation', AMBIO, 40(3).

https://doi.org/10.1007/s13280-011-0147-3. Jactel, H. et al. (2017) ‘Tree Diversity Drives Forest Stand Resistance to Natural Disturbances’, Current Forestry Reports, 3(3). https://doi.org/10.1007/s40725-017-0064-1. Knoke, T. et al. (2008) ‘Admixing broadleaved to coniferous tree species: a review on yield, ecological stability and economics’, European Journal of Forest Research, 127(2). https://doi.org/10.1007/s10342-007-0186-2. Pukkala, T. (2022) ‘Assessing the externalities of timber production’, Forest Policy and Economics, 135. https://doi.org/10.1016/j.forpol.2021.102646. Sterne, J.A.C. and Egger, M. (2001) ‘Funnel plots for detecting bias in meta-analysis’, Journal of Clinical Epidemiology, 54(10). https://doi.org/10.1016/S0895-4356(01)00377-8. Viechtbauer, W. (2010) ‘Conducting Meta-Analyses in R with the metafor Package’, Journal of Statistical Software, 36(3). https://doi.org/10.18637/jss.v036.i03.

Authors and Affiliations

Name	Country	Affiliation
Louise Dupuis	***France***	***Fondation pour la Recherche sur la Biodiversité***
Joseph Langridge	France	Fondation pour la Recherche sur la Biodiversité
Cécile Jacques	France	Fondation pour la Recherche sur la Biodiversité
Hervé Jactel	France	Institut national de recherche pour l'agriculture, l'alimentation et l'environnement

Submitted: Mar 28, 2024 | Published: May 22, 2024