Check for updates

STUDY PROTOCOL

Paleo-species distribution modelling in the marine realm: protocol for a global scoping review

[version 1; peer review: 2 approved with reservations]

Emna Ben Lamine[1], Konstantina Agiadi[2], Maria Bas López[3], Grégory Beaugrand[4], Tatiana Theodoropoulou[5], Virginie Raybaud[1]

[1]ECOSEAS, CNRS, Université Côte d'Azur, Nice, Provence Alpes Côte d'Azur, 06108 Cedex 2, France
[2]Department of Geology, Josef-Holaubek-Platz 2, University of Vienna Polymer and Composites Engineering Group, Vienna, Vienna, 1090, Austria
[3]Departament de Recursos Marins Renovables, Institut de Ciencies del Mar, Passeig Marítim de la Barceloneta, 37-49, Barcelona, 08003, Spain
[4]Université Littoral Côte d'Opale, Universite de Lille, CNRS, UMR 8187 LOG, Wimereux, 62930, France
[5]CEPAM, UMR 7274, CNRS, Université Côte d'Azur, Nice, Provence-Alpes-Côte d'Azur, 06100, France

v1 **First published:** 28 Aug 2024, **4**:188
https://doi.org/10.12688/openreseurope.18381.1
Latest published: 28 Aug 2024, **4**:188
https://doi.org/10.12688/openreseurope.18381.1

Abstract

Background

Studying the spatial distribution of marine species and its alterations through time is fundamental for understanding how they respond to environmental changes, as well as the changes of marine biodiversity, its geographic patterns, and how to best preserve it. Species distribution models (SDM) and Ecological Niche Models (ENM) are statistical tools widely used to investigate distribution range shifts under future and past climate change. The present work provides a protocol for conducting a scoping review (ScR) to assess the contribution of SDM and ENM to the study of past environmental suitability, its spatial and temporal extent and gaps, as well as to identify methodological challenges.

Protocol

The ScR follows the Joanna Briggs Institute (JBI) methodology. Two online databases, Web of Science and Scopus, will be used for the bibliographic search. Inclusion criteria will be as follows: studies applying SDM and/or ENM in the marine realms worldwide, with clear methodological details, to identify to what extent they contributed to paleobiology. Both peer-reviewed articles, book chapters and grey literature will be considered for eligibility. No search limitations will be

Open Peer Review

Approval Status ? ?

	1	2
version 1 28 Aug 2024	? view	? view

1. **Luciano Bosso**, National Research Council of Italy, Portici,, Italy

2. **Hannah Lois Owens**, University of Copenhagen, Copenhagen, Denmark
University of Florida, Gainesville, USA

Any reports and responses or comments on the article can be found at the end of the article.

applied regarding publication year, geographic area and source type. Studies in English, Spanish and French will be reviewed. The Covidence software will be used for document selection and data extraction.

Conclusions

This comprehensive approach will provide a visual representation of the available studies, enhancing the understanding and interpretation of the results focusing on the contribution of SDM and ENM to species potential ancient distribution knowledge, identifying the spatial and temporal extent and the presence of gaps of knowledge in their use.

Keywords
Species distribution modelling, ecological niche modelling, Biogeography, scoping review, JBI methodology, PRISMA

This article is included in the European Research Council (ERC) gateway.

This article is included in the Horizon 2020 gateway.

Corresponding author: Emna Ben Lamine (emna.ben-lamine@univ-cotedazur.fr)

Author roles: Ben Lamine E: Conceptualization, Resources, Software, Writing – Original Draft Preparation, Writing – Review & Editing; **Agiadi K**: Conceptualization, Formal Analysis, Methodology, Resources, Software, Writing – Review & Editing; **Bas López M**: Conceptualization, Formal Analysis, Methodology, Resources, Software, Writing – Original Draft Preparation, Writing – Review & Editing; **Beaugrand G**: Conceptualization, Methodology, Resources, Software, Writing – Review & Editing; **Theodoropoulou T**: Conceptualization, Formal Analysis, Funding Acquisition, Resources, Software, Writing – Original Draft Preparation, Writing – Review & Editing; **Raybaud V**: Conceptualization, Formal Analysis, Methodology, Resources, Software, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: This project has received funding from the European Union's Horizon 2020 Framework programme under grant number 101002721 as supported by Marine Ecosystems, Animal Resources and Human Strategies in Ancient Mediterranean: Integrated Studies on Natural and Societal Resilience -MERMAID
The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Copyright: © 2024 Ben Lamine E *et al*. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Ben Lamine E, Agiadi K, Bas López M *et al.* **Paleo-species distribution modelling in the marine realm: protocol for a global scoping review [version 1; peer review: 2 approved with reservations]** Open Research Europe 2024, **4**:188 https://doi.org/10.12688/openreseurope.18381.1

First published: 28 Aug 2024, **4**:188 https://doi.org/10.12688/openreseurope.18381.1

Introduction

The Earth's climate has experienced profound changes through geologic history (Zachos *et al.*, 2001), between extreme hyperthermal periods and ice ages (Burke *et al.*, 2018). As changing climate influences the distribution ranges of marine and terrestrial species (Shaviv *et al.*, 2023), understanding their responses to past climatic or environmental changes is essential for predicting responses under future climate change scenarios (Araújo & Pearson, 2005).

Species distribution modelling (SDM) and Ecological niche modelling (ENM) offer new possibilities for estimating the environmental suitability and the past distributions of organisms (Svenning *et al.*, 2011). Over the last few years, the number of studies using SDM and ENM to address paleobiological and paleoecological questions has increased considerably (Melo-Merino *et al.*, 2020). SDM and ENM offer important opportunities for advances in these fields by providing a quantitative ecological perspective that contributes to the reconstruction of ancient ecosystems and conservation biology. For example, estimating the range shift of species due to past climate changes can give us clues about the modern climate change impacts and can be informative for ecological restoration (Beaugrand & Kirby, 2016; Svenning *et al.*, 2011). Some studies complemented fossil and genetic evidence by providing projections of the past species distributions. Hereafter, we will use the term "paleo-SDM" to describe the application of SDM and/or ENM to paleobiology. In the marine realm, SDMs and ENMs have been used for some marine species of bivalves and gastropods, seaweed, molluscs, crustaceans, fish and mammals (Melo-Merino *et al.*, 2020).

Here, we present a scoping review (ScR) protocol aiming at assessing the contribution of SDM and ENM in improving the description and the understanding of ancient marine species distribution, environmental suitability and ecology, and in determining how the past has shaped present-day biodiversity. Our scoping review will evaluate the latest developments at the cutting-edge of SDM and ENM application to paleobiology, in the marine realm, at a global scale. To our knowledge, the most recent review about the application of SDMs to paleobiology was published in 2011 and showed that they are mostly combined with genetically inferred patterns (49%), with palaeoecological records (22%), or both (6%) (Svenning *et al.*, 2011).

The objectives of this ScR are as follows:

- Identify the various objectives and outputs of paleo-SDMs for improving the knowledge of past species distribution and environmental suitability in the marine realm.
- Map the extent of the current knowledge, and identify the geographic scope and the timeline of the studies.
- Highlight the knowledge gaps by taxonomic group.
- Identify and compare the methodologies used for addressing past marine species distribution and environmental suitability (e.g., models, types of variables, validation)
- Explore and discuss key methodological issues, assumptions and uncertainties (regarding the data and the methods).

Review questions

The ScR will attempt to answer the following sub-questions:

1. What is the spatial and temporal coverage of the application of marine paleo-SDMs?
2. What are the marine taxonomic groups concerned with marine paleo-SDMs?
3. What are the criteria/methodologies/tools for implementing marine paleo-SDMs?
4. What are the challenges in the application of paleo-SDMs for the marine realm?

Methods

The Scoping Review (ScR) will adhere to the framework established by Arksey and O'Malley (2005), refined by Levac *et al.* (2010), and further advanced by the Joanna Briggs Institute (JBI). Specifically, the procedures outlined by Peters *et al.* (2020) for scoping reviews will be implemented. Moreover, PRISMA-Reporting guidelines will be used (Moher *et al.*, 2015).

Inclusion/ exclusion criteria

(following the methodology of Peters *et al.*, 2020 for scoping reviews)

The inclusion criteria of the ScR are presented in Table 1 and were discussed with participants of the ScR. The development of the inclusion criteria for the ScR determining which sources will be considered for inclusion, are aligned with the mnemonic "Participants, Concept, and Context (PCC)" (Peters *et al.*, 2020) (Table 1).

Participants

The ScR will consider all studies applying paleo-SDMs (documenting spatial distributions studies / environmental suitability through SDM or ENM or including guidelines for paleo-SDM or informing them by providing software, scripts, and algorithms). Studies applying other correlative statistical modelling approaches such as trophic niche modelling will not be taken into account. Moreover, studies that apply other types of modelling or that mention ENM and SDM without methodological details, or that apply SDM to pseudo-species will not be considered for this ScR objectives.

Concept
The concept adopted by the ScR will be the assessment of how SDMs and/or ENMs were applied to paleobiological data to assess past species distribution and species environmental suitability and how the niche conservatism hypothesis was addressed, so far in the scientific literature. Studies that do not provide sufficient methodological details but simply mention the use of a specific paleo-SDM tool will not be taken into account.

Context
In our ScR, we will consider spatially explicit case studies of marine species, globally, regionally and at a national or a local level. Studies without a marine component (primarily terrestrial or freshwater) will not be included. In terms of past time frame, studies that apply SDM to past periods ranging from the Last Glacial Maximum (LMG) to the pre-industrial Era (from approximately 20,000 yrs BP to 1850) will be included in the scope of our review.

Types of sources
This Scoping Review (ScR) will include a range of peer-reviewed literature, such as research articles, reviews, book chapters, letters, editorials, and books. There will be no limitations on publication year, publication status (whether final or in press), subject area, or source type. Only peer-reviewed sources will be included. Language restrictions will be applied based on the authors' language proficiency, encompassing studies published in English, French, and Spanish.

Search strategy
The bibliographic search will be conducted using two databases: (a) Scopus (https://www.scopus.com/home.uri) and (b) Web of Science (https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform/). Our search will utilize a combination of keywords applied to the document title, abstract, and keywords fields (see Table 2).

Data extraction
The data extraction tool will be embedded in the Covidence systematic review management software (Table 3) to facilitate the import, screening, uploading and export of selected literature (Table 3), as well as the cooperation and interaction between reviewers. Covidence is a web-based collaboration software platform that streamlines the production of systematic and other literature reviews (https://www.covidence.org/reviewers/). At least two co-authors should perform the same documents through ScR.

Data analysis and presentation
The findings synthesized in this Scoping Review (ScR) will be aligned with the review's objectives and questions. Data will be showcased through a combination of graphical and tabular formats, utilizing various software tools. A narrative summary will supplement these tables and charts, elucidating how the results address the review's objectives and questions. The analysis of the extracted data will be confined to basic descriptive statistics. These descriptive findings will be illustrated using various visual representations.

Table 1. Inclusion and exclusion criteria for the Scoping Review.

	Inclusion criteria	Exclusion criteria
PARTICIPANTS	Studies applying SDM or ENM (to marine species) with clear guidelines for Paleo-SDM Studies informing Paleo-SDM approaches by providing software, scripts, and algorithms	Studies that apply other types of modelling or that mention ENM and SDM without details. Studies that include geographic distribution or environmental suitability without modelling Studies applying SDM/ ENM to the present Studies applying SDM/ENM to pseudo-species
CONCEPT	Systematic review about methods and tools used for SDM or ENM: All studies applying paleo-SDM for marine species, clearly describing the applied methods/tools and the used databases.	Studies that do not provide sufficient methodological details but simply mention the use of ENM and SDM
CONTEXT *Global, marine realm*	Studies in: - Marine realm - Globally or regionally or locally Studies that apply SDM and/ or ENM to ancient periods from the Last Glacial Maximum (LGM) to the pre-industrial Era (from approximately 22,000 yrs BP to approximately 1850)	Studies where the marine component or species will not be included. Studies applying SDM before the LGM or after the pre-industrial Era.
EVIDENCE TYPES & SOURCES	- peer-review literature - grey literature if any - all years of publications	Conference papers Strictly methodological papers

Table 2. Details of Scoping Review databases.

Language	English	Spanish	French
Date of search:	30 April 2024	02 May 2024	02 May 2024
Database	Scopus	Scopus	Scopus
Query:	TITLE-ABS-KEY "ecological niche model*" OR "species distribution model*" AND "paleo*" OR "palaeo*" OR "past" OR "Holocene" OR "Pleistocene" OR "Quaternary" OR "Pre-industrial" OR "Preindustrial" OR "Last glacial maximum" OR "interglacial" OR "ancient" OR "historical" OR "roman" OR "antiquity" OR "medieval" AND "marine" OR "ocean*" OR "sea*" Refine search "marine"	"modelo* de nicho ecológico" OR "modelo* de distribución de especies" AND "paleo*" OR "pasado" OR "Holoceno" OR "Pleistoceno" OR "Cuaternario" OR "Pre-industrial" OR "Preindustrial" OR "Último máximo glacial" OR "interglacial" OR "antiguo" OR "histórico" OR "romano" OR "antigüedad" OR "medieval" AND "marino" OR "océano*" OR "mar*" Refine search "marino"	"modèle de niche écologique*" OR "modèle de distribution des espèces*" AND "paléo*" OR "palaeo*" OR "passé" OR "Holocène" OR "Pléistocène" OR "Quaternaire" OR "Pré-industriel" OR "Préindustriel" OR "Dernier maximum glaciaire" OR "interglaciaire" OR "ancien" OR "historique" OR "romain" OR "antiquité" OR "médiéval" AND "marin" OR "océan*" OR "mer*" Refine search "marine"
Results:	306	0	0
Database	Web of Science Academy	Web of Science Academy	Web of Science Academy
Query:	Same as previous	Same as previous	Same as previous
Results:	347	0	0

Table 3. Data extraction tool of the Scoping Review (ScR) with examples.

Field	Metadata	Data to be extracted (examples)	Remarks/guidance to reviewers
1	Study ID		free text
2	Title		free text
3	Author(s)		free text
4	Year of publication		free text
5	Journal		free text
6	Keywords		free text
7	DOI		free text
8	URL		free text
9	Literature category	Journal article, Book chapter, Report (grey literature)	Single choices field
10	Language	English; Spanish; French	Single choices field
11	Marine realm (sensu Spalding *et al.*, 2007)	Arctic; Mediterranean; temperate northern Atlantic; temperate northern Pacific; tropical Atlantic; western IndoPacific; central Indo-Pacific; eastern Indo-Pacific; tropical eastern Pacific; temperate South America; temperate southern Africa; temperate Australasia; southern Ocean; more than one realm; global	Single or multiple choices field
12	Marine taxonomic group	Bacillariophyta, Dinoflagellata, Chlorophyta, Rhodophyta, Haptophyta (Coccolithophores), Ochrophyta (Brown algae (including kelp)), Porifera, Cnidaria, Ctenophora, Annelida,Mollusca, Platyhelminthes, Sipuncula, Arthropoda, Chaetognatha, Brachiopoda, Bryozoa, Phoronida, Echinodermata, Ascidiacea, Thaliacea, Agnatha, Chondrichthyes, Osteichthyes, Reptilia, Aves, Mammalia	Single or multiple choices field

Field	Metadata	Data to be extracted (examples)	Remarks/guidance to reviewers
13	Does the study concern one species or more?	one species, more than one species	single choice field
14	If "more" is the answer to the previous question, how many species are considered?		Free text
15	Taxon common name		Free text
16	Taxon scientific name		Free text
17	Spatial scale	Global, regional, National, local	Single or multiple choices field
18	Spatial resolution of the model		Free text
19	Rationale	the objective of the study, of using SDM /ENM	Free text
20	Methodology 1	ex: Ecological Niche modelling: Boosted Regression Trees (BRT)	Free text
21	Methodology 2 if any		Free text
22	Methodology 3 if any		Free text
23	Methodology 4 if any		Free text
24	Environmental data source	ex: Interdisciplinary Research on Climate (MIROC) and the Community Climate System Model (CCSM)	Free text
25	Model Evaluation method	ex: TSS	Free text
26	Highlighted challenges and criticism	Not discussed	Free text
27	Was Niche conservatism addressed? If yes, how?	No	Free text
28	Validation dataset DOI/URL	http://dx.doi.org/10.1016/j.marenvres.2015.11.005	if the code is published
29	Time period	Last maximum Glacial (20,000 years ago), Mid-Holocene (6,000 years ago), present (since 1990), and future (2050 and 2100)	Provide start and end
30	Temporal resolution	Temporal time lapse	Free text
31	Code used (and DOI)	if the code is published	Free text
32	Software/ algorithm used	ex: parallel computing using the packages adehabitat, doParallel, gbm, gdata, gstat, raster and SDMTools.	Free text

We will organize data into two main sections: (1) the first outlining the results of the search strategy and selection process, including a PRISMA flow diagram, and (2) the second presenting the key information or findings pertinent to the scoping review's objectives and questions.

Ethics and consent

Ethical approval and consent were not required.

Data availability

No data associated with this article.

References

Araújo MB, Pearson RG: **Equilibrium of species' distributions with climate.** *Ecography.* 2005; **28**(5): 693–695.
Publisher Full Text

Arksey H, O'Malley L: **Scoping studies: towards a methodological framework.** *Int J Soc Res Methodol.* 2005; **8**(1): 19–32.
Publisher Full Text

Beaugrand G, Kirby R: **Quasi-deterministic responses of marine species to climate change.** *Clim Res.* 2016; **69**(2): 117–128.
Publisher Full Text

Burke KD, Williams JW, Chandler MA, *et al.*: **Pliocene and Eocene provide best analogs for near-future climates.** *Proc Natl Acad Sci U S A.* 2018; **115**(52): 13288–13293.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Levac D, Colquhoun H, O'Brien K: **Scoping studies: advancing the methodology.** *Implement Sci.* 2010; **5**(1): 69.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Melo-Merino SM, Reyes-Bonilla H, Lira-Noriega A: **Ecological niche models and species distribution models in marine environments: a literature review and spatial analysis of evidence.** *Ecol Model.* 2020; **415**: 108837.
Publisher Full Text

Moher D, Shamseer L, Clarke M, *et al.*: **Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement.** *Syst Rev.* 2015; **4**(1): 1.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Peters M, Godfrey C, McInerney P, *et al.*: **Chapter 11: Scoping reviews.** In: Aromataris E, Munn Z (Eds) JBI Manual for Evidence Synthesis. JBI, 2020.
Publisher Full Text

Shaviv NJ, Svensmark H, Veizer J: **The Phanerozoic climate.** *Ann N Y Acad Sci.* 2023; **1519**(1): 7–19.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Spalding MD, Fox HE, Allen GR, *et al.*: **Marine ecoregions of the world: a bioregionalization of coastal and shelf areas.** *BioScience.* 2007; **57**(7): 573–583.
Publisher Full Text

Svenning JC, Fløjgaard C, Marske KA, *et al.*: **Applications of species distribution modeling to paleobiology.** *Quat Sci Rev.* 2011; **30**(21–22): 2930–2947.
Publisher Full Text

Zachos J, Pagani M, Sloan L, *et al.*: **Trends, rhythms, and aberrations in global climate 65 Ma to present.** *Science.* 2001; **292**(5517): 686–693.
PubMed Abstract | **Publisher Full Text**

Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 19 September 2024

https://doi.org/10.21956/openreseurope.19861.r44038

© **2024 Lois Owens H.** This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

?

Hannah Lois Owens
[1] University of Copenhagen, Copenhagen, Denmark
[2] University of Florida, Gainesville, Florida, USA

This work outlines a protocol for performing a review of all accessible studies using marine paleoecological niche modeling and/or species distribution modeling methods. The authors will use an established protocol to address five specific objectives and four sub-questions regarding how paleo niche models are generated and used.

I find the framework very clear and the scope of the planned review well-defined. Furthermore, the questions are generally interesting and relevant, as modeling marine species from a paleo perspective may circumnavigate some issues regarding shifting baselines in the ocean, which is historically heavily disturbed (especially near shore) while simultaneously being not well understood.

While it is tangentially mentioned in the objectives and Table 3, it may be interesting to specifically look some more specifics when environmental data used in the studies of interest--what environmental variables are used? Are environmental data derived from climate models, environmental proxies, or something else? Does the data infer surface and/or bottom conditions? Are there studies that attempt to approximate 3D distributions, as suggested by Melo-Martino et al in the 2020 review?

Regarding the time frame of interest for literature--why limit the scope to between 22kybp and 1850? There are marine ENM studies going back to the Pliocene[1], the Cretaceous[2], and even the Triassic[3].

Once the data is extracted, will it be published along with the final manuscript? Once the data is collected, what software will be used to analyze it? If using R, Python, or another programming language, will scripts and/or notebooks and/or markdown documents be publicly available? Where?

References
1. Myers C, Stigall A, Lieberman B: PaleoENM: applying ecological niche modeling to the fossil record. *Paleobiology*. 2015; **41** (2): 226-244 Publisher Full Text
2. Saupe EE, Hendricks JR, Portell RW, Dowsett HJ, et al.: Macroevolutionary consequences of profound climate change on niche evolution in marine molluscs over the past three million years. *Proc Biol Sci*. 2014; **281** (1795). PubMed Abstract | Publisher Full Text
3. Jones LA, Mannion PD, Farnsworth A, Bragg F, et al.: Climatic and tectonic drivers shaped the tropical distribution of coral reefs.*Nat Commun*. 2022; **13** (1): 3120 PubMed Abstract | Publisher Full Text

Is the rationale for, and objectives of, the study clearly described?
Partly

Is the study design appropriate for the research question?
Yes

Are sufficient details of the methods provided to allow replication by others?
Yes

Are the datasets clearly presented in a useable and accessible format?
Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: species distribution modeling, ecological niche modeling, marine macroecology, biogeography

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 06 September 2024

https://doi.org/10.21956/openreseurope.19861.r43794

© 2024 Bosso L. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

?

Luciano Bosso
National Research Council of Italy, Portici,, Italy

In the paper "*Paleo-species distribution modelling in the marine realm: protocol for a global scoping review*" the authors provided a protocol for conducting a scoping review (ScR) to assess the contribution of SDM and ENM to the study of past environmental suitability, its spatial and temporal extent and gaps, as well as to identify methodological challenges. This manuscript is well

organized, and the drawn conclusions are coherent with the obtained results.

I hope to provide very useful suggestions to improve the overall clarity of your study as well as the quality of your analysis. I think that my suggestions look feasible to you, and I believe you will be able to address them. Thus, please take care to do a full revision of your manuscript according to all my comments. Improvements based on my comments will be crucial for acceptance. I have some concerns and suggestions for each aspect of the manuscript. Please see below:

It is Species Distribution Modelling (SDM) and Ecological Niche Modelling (ENM).

I think that you should these two references as examples to support your sentence: “SDM and ENM offer important opportunities for advances in these fields by providing a quantitative ecological perspective that contributes to the reconstruction of ancient ecosystems and conservation biology.”. I would like to suggest:
Salazar-Tortosa, D. F., et al., (2024). Climate change is predicted to impact the global distribution and richness of pines (genus Pinus) by 2070. Diversity and Distributions, e13849.
Di Febbraro, M., et al., (2023). Different facets of the same niche: Integrating citizen science and scientific survey data to predict biological invasion risk under multiple global change drivers. Global Change Biology, 29(19), 5509-5523.

It is Scoping Review (ScR).

You have written “Moreover, studies that apply other types of modelling or that mention ENM and SDM without methodological details, or that apply SDM to pseudo-species will not be considered for this ScR objectives.” How did you decide the level of details in the modelling methodology useful to be considered in your analysis?

In the “Types of sources” section you re-write the acronym “Scoping Review (ScR)”. Please delete it!

Reading the “Search strategy” section I would like to ask you why you not considered also Google Scholar…Can you provide more information about this exclusion?

You must add all the setting selected/used in the “Covidence systematic review management software” during your analysis in the supplementary materials of this review.

In the “Data analysis and presentation” section you re-write the acronym “Scoping Review (ScR)”. Please delete it!

I think that you should add and discuss your results with other methodology or protocol used in literature. I find this protocol not complete! I don’t understand if this protocol was reliable and efficient or not. Please provide explanations!

Is the rationale for, and objectives of, the study clearly described?

Yes

Is the study design appropriate for the research question?

Yes

Are sufficient details of the methods provided to allow replication by others?
No

Are the datasets clearly presented in a useable and accessible format?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: SDM and ENM

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.