Identifying knowledge gaps for successful restorative aquaculture of *Ostrea edulis*: a bibliometric analysis [version 1; peer review: 1 not approved]

Camilla Bertolini*1, Roberto Pastres

DAIS, Ca' Foscari University of Venice, Venice, 30170, Italy

**Abstract**

**Background:** Active restoration is necessary to enhance the recovery of *Ostrea edulis* reefs, which contribute to many ecosystem services. Restoration can be integrated within aquaculture practices, bringing positive environmental changes while maximising space utilisation. The restoration project MAREA (MAatchmaking Restoration Ecology and Aquaculture) aims to bring back *O. edulis* in the North-West Adriatic addressing the feasibility of its cultivation. Both successful restoration and sustainable aquaculture require a thorough understanding of the ecological needs, as the requirements of both activities (e.g. to maximise ecosystem services, seed production, settlement for maintaining population and for starting a new culture) need to be harmonized. Therefore, one of the preliminary activities before embarking on the pilot was the completion of a thorough literature review to identify research directions and gaps required for ‘restorative aquaculture’, aiming to gather the most up to date *O. edulis* knowledge on a global and local scale.

**Methods:** Internet (Web of Science, Scopus, Google scholar) and physical resources (libraries) were searched for all available global and local knowledge on *O. edulis*. Bibliometrix was used to identify the main research topics using keywords, titles and abstracts analyses. Studies were then manually screened and summarised to extract knowledge specific to restoration and aquaculture.

**Results:** While restoration studies are recent, evidence for the loss of this species and potential causes (and solutions) have been discussed since the end of the 19th century. While diseases was a leading cause for reef loss, substratum limitation appears to be one of the leading limiting factors for both restoration and aquaculture of *O. edulis*, and was already mentioned in the early texts that were found.

**Conclusions:** Information regarding the best materials, location and timing for larval settlement were collated in this review, and the focus of MAREA will be shifted to the crucial stage of settlement.
Keywords
ecological requirements, European oysters, literature review, Ostrea edulis

Corresponding author: Camilla Bertolini (camilla.bertolini@unive.it)

Author roles: Bertolini C: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Visualization, Writing – Original Draft Preparation; Pastres R: Conceptualization, Funding Acquisition, Supervision, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Grant Agreement N° 886037.

Copyright: © 2021 Bertolini C and Pastres R. 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: Bertolini C and Pastres R. Identifying knowledge gaps for successful restorative aquaculture of Ostrea edulis: a bibliometric analysis [version 1; peer review: 1 not approved] Open Research Europe 2021, 1:103 https://doi.org/10.12688/openreseurope.14074.1

First published: 06 Sep 2021, 1:103 https://doi.org/10.12688/openreseurope.14074.1
Introduction

Many benthic bivalve species are considered ecosystem engineers (Jones et al., 1994) and are involved in forming reefs, which are important habitats supporting the biodiversity of marine ecosystems and contribute to multiple ecosystem services, including carbon accumulation (Lee et al., 2020; Lovelock & Duarte, 2019; van der Schatte Olivier et al., 2020). These habitats, in particular oyster beds, are considered amongst the most degraded and imperilled, with 85% of natural reefs lost worldwide (Beck et al., 2011). Oysters are traditionally harvested for food. Aquaculture can be a solution to avoid overharvesting of natural populations, which can hinder the recovery of natural beds (Smyth et al., 2009). Culturing of this species is not new and has been practiced since the Roman times, particularly in Italy, which was the European leader of aquaculture until the 19th century. It is estimated that during the 1870s in the northern Adriatic Sea alone there was an annual production of 10 million oysters just from cultivation ‘parks’ (Mattei & Pellizzato, 1997).

The Adriatic Sea is one of the shallower basins of the Mediterranean, with the northernmost part averaging depths of less than 100 m. It is also one of the areas boasting both the greatest invertebrate species diversity and the greatest risk from trawling and dredging and general exploitation of marine resources by fisheries (Coll et al., 2012). A historical study of the Adriatic Sea food-web and ecosystem functioning (Lotze et al., 2011) revealed that oyster reefs were pristine in the ‘pre-human’ period (before c.ca 100000 BC) then became abundant during the ‘hunter-gatherer’ period (100000 – 6000 BC) until the classical period (500BC-600AD), when they became depleted before becoming rare in the ‘early global’ cultural period (1900–1950). In other areas the loss of oyster beds was lamented in the early 19th century, and suggestions were proposed such as no harvesting during spawning season, enforcing regulations with fines in case of possession of oysters, resting ‘old’ beds for at least one year, and helping new beds form with the use of culch from a good bed (Eyton, 1858). The human role in this loss is also highlighted in Mautner et al. (2018), which focused on the north-east Adriatic Sea ecosystem shifts and concluded that “while the mollusc community has changed continually over the past ~10,000 yrs and most of these changes have not been anthropogenically induced, the loss of vast Arca and Ostrea bottoms can be clearly linked to intensive and destructive fishing methods and other human-induced disturbances and regaining this special ecosystem, at least on a local scale, could be the goal of future restoration efforts”.

Bivalve aquaculture has in recent years returned in the first line with an emphasis on sustainability (Duarte et al., 2009; Shumway et al., 2003; Smaal et al., 2019). More recently, terms such as ‘restorative aquaculture’ have made an appearance (Carranza & Ermgassen, 2020). This approach may benefit all hierarchies of biodiversity, from the preservation of an imperilled species (e.g. Ostrea lurida Ridlón et al., 2021) to the recreation of habitat of value (Theuerkauf et al., 2021). Yet, being a new field, several of these consequences remain to be quantified, and the relative and absolute success of different strategies is yet to be assessed systematically. Successful restoration implies a deep understanding of the ecology of the target species, and of the historical baselines (Basconi et al., 2020; Thurston et al., 2020), as aspects such as location and timing of restoration projects can be essential to determine their success (Cook et al., 2021). In order to understand the potential to combine restoration and aquaculture of oysters in the Adriatic region, this literature review aims to identify research gaps required for ‘restorative aquaculture’ of this species, gathering the most up to date Ostrea edulis research on both a global and local scale.

Methods

Global knowledge

Web of Science and Scopus were searched (all databases, last search 9/07/2021) using the keyword ‘Ostrea edulis’. Titles and abstracts were then independently screened by the author (C.B.) to ensure research was about this species. Only peer reviewed, English language articles were selected in this search.

R (version 4.0.5) was used (R Development Core Team, 2021) for both automated and manual analyses of the selected literature.

The package bibliometrix was used for initial automated analyses. Author keywords were ranked based on their number of occurrences, after removal of words related to those directly ‘searched for’: ‘European oyster’, ‘flat oyster’, ‘Ostrea’, ‘Ostrea edulis’, ‘ostreidae’, ‘oyster’ (and plurals). Keywords that appeared in at least 10 papers were considered ‘popular’. Topic identification was aided by the use of ‘conceptualStructure’: firstly on the popular keywords (setting the minimum degree of occurrence to 10), the dendrogram output was used for interpretation of the word makeup of the different clusters to identify topics. Where possible, for each of the clusters, the algorithm was applied again, searching the titles for common word combination patterns. Papers in each subcluster were then read and manually categorised.

The ‘year’ field was extracted from the row names to calculate annual production and plot the number of articles per year.

To gather insights into articles on restoration and aquaculture the words ‘restoration’ and ‘aquaculture’ were searched for in keywords, titles and abstracts. Articles were then manually categorised into broad topics. Studies were summarised with particular attention to the identified environmental variables, the conclusions and recommendations for both restoration and aquaculture. Main countries where the studies were conducted were also noted down to understand the geographical distribution of the studies.

Local knowledge

Internet resources (Web of Knowledge, Scopus, Google Scholar) were searched for ‘Ostrea edulis’ AND ‘Northern Adriatic’ OR ‘NW Adriatic’ OR ‘Adriatic lagoons’ OR ‘Venice’ OR ‘Venice lagoon’ and local library resources were also searched for any information available on oysters and molluscs, in particular their aquaculture, via the portal Bibliovea. Italian search terms were used in this library search.
Results and discussion

Global knowledge

The searches yielded 514 results of which 508 were classified as research articles and six were reviews (full reference list available as underlying data (Bertolini & Pastres, 2021)). The first study found was from 1926, then (Figure 1) a few articles were produced a year until the 1960s when the number started to increase until reaching upwards of 35 articles in 2020.

The most relevant keywords (N occurrences, %tot) were: Bonamia ostreae (52, 10%), Crassostrea gigas (28, 5.4 %), Restoration (21, 4%), Bivalve (16, 3%), Aquaculture (14, 2.7 %), growth (14, 2.7%), flow cytometry (12, 2.3%), temperature (12, 2.3 %), haemocytes (11, 2.1%), bonamiosis (10, 1.9%). A first interpretation of this result is that infection appears as a concern, with at least 13% of the studies concerned with infection from Bonamia. The clustering method used only 156 (30%) papers with common keyword associations. Clusters are shown in the dendrogram in Figure 2. Words from subclusters are reported in Table 1.

Cluster one (green) had eight articles and these were related to restoration. Sub-clustering was not possible due to the small number of papers.

Cluster two (blue) had 93 articles. Title sub-clustering identified three subclusters: subcluster 1 papers related mostly to growth and larval development, stock, reproduction, settlement, the effects of temperature and food. Restoration and diseases also appeared as words in this cluster. Subcluster 2 papers were on comparisons or interactions between C. gigas and O. edulis regarding species distribution, biomarkers, biochemical and genetic assays, but also epibionts. A third subcluster was formed by a single paper on the seasonal distribution of larvae in the Adriatic sea.

Cluster three (red) had 55 articles. Title sub-clustering identified three subclusters: subcluster 1 included papers on infection (Bonomiae), immunological activity and selection; subcluster 2 comprised papers on haemocyte parameters from different broodstocks in different geographic areas; and subcluster 3 papers were on the genetics of infections.

This analysis also gives some insights into the focus of the research concerning Ostrea edulis: the most numerous cluster contained papers mostly concerning the ecology of the species, while the second major cluster was formed by studies on infection and disease. In terms of this automated keyword association analysis, there appeared to be a few studies concerned solely with restoration.

On the other hand, searching for restoration in keywords and titles manually yielded 32 articles, spanning from 1999 to 2021. Geographically, studies were primarily from Atlantic and...
North Sea regions (France, Germany, Netherlands, UK). Out of these, 12 (35%, 1999–2020) are concerned with ecological understanding, in particular related to site selection and conditions for growth, 10 (31%, 2018–2021) were related to settlement and seed production, four (12.5%, 2018–2020) regarded policy, three (9%, 2016–2019) were concerned with methodology for restoration, three (9%, 2018–2020) touched on the benefits of restoration, two (6%, 2020–2021) dealt with infection in restored oysters and only one (3%, 2010) dealt with genetic diversity. In terms of the ecological understanding and species requirements, most papers agreed that the optimal range for current speed is 0.25-0.3 m/s (Kamermans et al., 2018; Merk et al., 2020; Pogoda et al., 2020) and bottom shear stress is <0.3-0.4 N/m² (Bennema et al., 2020; Pogoda et al., 2020). Substrate type seemed to be more variable amongst studies; however, most agreed on the need for coarse grain size or presence of shell and stones for settlement (Allison et al., 2020; Christianen et al., 2018; Kamermans et al., 2018; Pogoda et al., 2020) and one suggested the need for elevated culch (Sawusdee et al., 2015), a practice already used for other species (e.g. Marshall et al., 1999; Wesson et al., 1999). Another important threshold identified
by most of the papers was temperature: 7°C appears to be the minimum required for growth and gonad development (Maathuis et al., 2020; Merk et al., 2020). There was no consistency with regards to optimal chlorophyll or oxygen levels for optimal growth.

Searching for aquaculture in keywords and titles manually yielded 21 articles, spanning from 1977 to 2020. Geographically studies spanned both Atlantic and Mediterranean European regions (Croatia, France, Germany, Italy, Netherlands, UK), but there were also two studies concerning aquaculture of this species from the USA (Burrell, 1983; Mann & Ryther, 1977). Of the two largest subgroups of studies, one dealt with the practicalities of seed production, including selective breeding (6, 28.5%), and the other with growth and biochemical composition of the marketable oyster product (5, 24%). There were also studies concerned with ecological conditions at the production site (2, 9.5%), with interactions with C. gigas (2, 9.5%), with infections (2, 9.5%) and with effects on the environment (2, 9.5%). Single studies were also done on history (1, 5%) and farm management from the human perspective (1, 5%).

One common theme between the two searches was seed production, an issue affecting aquaculture that relies mostly on wild seed collection but also affects restoration programmes that rely on active ‘seeding’ of often large quantities of oysters. Within this theme, two papers (Colsoul et al., 2021; van den Brink et al., 2020) appeared in both searches. van den Brink et al. (2020) deals with the identification of the optimisation of collection, both in terms of collector types and methodology (e.g. timing), showing how ‘natural’ substrates (shell) would be optimal but raising questions related to the ‘economic viability’ of using this method for aquaculture purposes, which usually employs artificial collectors that simplify the process of detachment for the second phase of cultivation. Colsoul et al. (2021) provide a comprehensive review of seed production research in general, starting from the general biology of the species, identifying the stressors, and then looking at the history of production technologies, going into detail on seed production in polls, ponds and hatcheries. The review ends with a series of research gaps on the issue, such as the need to address the effects of climate change on reproductive patterns, something that is starting to be investigated in other bivalve species, e.g. mussels (Oliveira et al., 2021), but was already identified as a potential cause of seed scarcity in 2015 (Burioli et al., 2015).

Local knowledge

With regards to oyster knowledge in the northern Adriatic, multiple sources were found spanning the end of the 19th and beginning of 20th century. The most notable were two reports on the status of oyster culture in both the southern (Molin, 1863) and northern (Molin, 1864) parts of the Venice lagoon, a book on oyster and mussel culture (Carazzi, 1893), and a thorough account of edible molluscs in the Venice lagoon with a whole chapter on oysters (Ninni, 1904). More recent (end of the 20th century) papers investigating settlement and culturing were also found (Pellizzato & Da Ros, 1985; Pellizzato & Renzoni, 1986). Many of these examples already mention failed attempts, in particular related to obtaining successful reproduction (“a mistake in which many who attempted cultivating oyster fell into was to believe that to have successful spat would be enough to have some seawater, some adult oysters as mothers and some tiles to serve as collectors” chapter XI (Carazzi, 1893)). In the two reports from the 1860s, the ‘substrate’ limitation driving oyster reef self-sustainment was highlighted, and the dredging of hard material from the bottom of canals was pinpointed as one of the leading causes of the dramatic oyster loss observed in the lagoon. It was suggested that adding cleaned oyster shells could bring natural populations back, leading to the formation of ‘oyster parks’ (Molin, 1863; Molin, 1864). The importance of location choice, collector specificity and timing, substratum type and environmental variables for the first stage of cultivation (seed harvesting) were already recognised as important (Carazzi, 1893), together with the need for oyster culture to rely on trials and ‘naturalists’ advice (Molin, 1863). The location of settlement, aside from having the right environmental conditions (for example a temperature warm enough to have sufficient spawning, even up to 28-30°C, but not higher to avoid mortality), would need to be close by to the location of culturing (at least for the first culturing phase, up to 3–4 cm) to avoid stressing the young oysters. The position of the collectors within the location was also already found to be an important issue: larvae were found to settle closer to the seabed, and for this reason, if collectors are on the seabed it is important to ensure the sediment is neither too muddy to avoid sinking nor too sandy (indicative of too strong currents). The timing of collectors’ placement was also already identified in these early texts as an essential aspect that could be as important as the materials, as both too early and too late can have negative effects, either due to fouling by other organisms (if placed out too early) or due to missing the settlement period (when placing too late).

Conclusions and perspectives

Articles concerning restoration are relatively new, mostly from the last five years, something already observed in other habitats (e.g. coastal wetlands (Bertolini & da Mosto, 2021)), likely due to a surge in restoration activity in this period (Duarte et al., 2020) and it is possible that restoration will become the main discipline in ecological research (Basconi et al., 2020). When looking at the historical perspectives, however, it is evident that concerns and suggestions for restoration were already present.

There are, however, potential issues surrounding restoration which remain unresolved, including the idea that protecting spaces inhibits other uses. In the marine environment for example, the creation of new Marine Protected Areas (with a goal of having 30% of the sea protected by 2030) can lead to space use conflicts (Knowlton, 2021). Having good legislation is necessary and correct maritime spatial planning designed to include restoration (Lester et al., 2020) can maximise space multi-functionality (Schupp et al., 2019), something possible in marine environments given they are three dimensional, providing conflict resolutions. In this context, the possibility
to integrate aquaculture with restoration (Giangrande et al., 2021) can be a solution. This is what MAREA sets out to achieve, combining *O. edulis* restoration and seed production within existing mussel culture areas. Restoration projects, however, are not always successful (Basconi et al., 2020). In the interest of maximising both time and resources, the collated information on the ecological drivers, such as those presented in this review regarding *Ostrea edulis*, should be used, coupled with local specificity and historical background of trials in the specific area where restorative aquaculture is to be set in place, which may require additional research in the grey literature, archives and other sources of local knowledge. Within MAREA, this led to the identification of a suitable area within the Venice lagoon to conduct the pilot and the design of the pilot itself had a heightened focus on the spawning and settlement stages. Furthermore, this knowledge should be convened in appropriate manners to aquaculture practitioners, bridging linguistic gaps, in order to make the two worlds coexist and limit the possibility of failed attempts.

**Data availability**

**Underlying data**


Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

**Acknowledgements**

We are thankful to the librarians at the Museo di storia naturale (MUVE) and Querin Stampalia.

**References**


Carazza D: *Ostricoltura e millecoliatura*. U. Hoepli. 1893. Reference Source


Mcevoy S, Smith D, Browne L: Impacts of unregulated harvesting on a recovering stock of native oysters (Ostrea edulis). Mar Pollut Bu...
Open Peer Review

Current Peer Review Status: 

Version 1

Reviewer Report 01 October 2021

https://doi.org/10.21956/openreseurope.15169.r27556

© 2021 Jeffs A et al. 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.

Andrew Jeffs
Institute of Marine Science, School of Biological Sciences, University of Auckland, Auckland, New Zealand

Trevyn Toone
University of Auckland, Auckland, New Zealand

In their manuscript “Identifying knowledge gaps for successful restorative aquaculture of Ostrea edulis: a bibliometric analysis” Camila Bertolini and Roberto Pastres seek to identify research gaps in the existing global and local literature surrounding Ostrea edulis, ultimately informing restorative aquaculture projects like MAREA. The concept of the review is compelling and the methods are generally sound, however, the review would greatly benefit from additional information throughout the manuscript. In particular, the introduction would benefit by providing additional background on the study species, MAREA, existing literature reviews, and the specific goals of the project. The results also need clarification around the clustering and subcategorization process. Additionally, the methodology around clustering and keyword analysis needs more information to demonstrate that it is an appropriate study design for this project. Finally, the current conclusions of the review are quite vague. Explicit and detailed recommendations would be very useful to future efforts in this field. Overall, the review has good potential, but the current conclusions and methodology are not supported well enough for the work to have sufficient rigour and ultimately impact for readers and end users.

Title and keywords:
The title is informative and describes the focus of the review well. Consider replacing the Ostrea edulis keyword as it is already present in the title and will be picked up by search engines.

Abstract:
The connection between the results and the conclusion is unclear in this abstract. I recommend clarifying the conclusions and more clearly establish the connection to the results.

Introduction:
Further clarification is needed on exactly what “research gaps required for restorative
aquaculture” this literature review is targeting. The previous sentence suggests a focus on either ecological gaps (how and where restorative aquaculture can be conducted) or historical baseline gaps (extent of historical populations), but the sentence prior to that suggests a focus on gaps around output quantification (“the relative and absolute success of different strategies”). Is the intention to search for information on all of these gaps or only a narrower scope?

Brief background information on Ostrea edulis would be very helpful in either in the introduction or the beginning of the methods section. This oyster has some unusual aspects to its biology which are particularly pertinent to restoration initiatives. Likewise, some detail of the nature of the biogenic habitat formed by this species would be valuable, and the geographic range of the species.

Additional information on the methods used here (particularly keyword tracking) would be useful in the introduction. Why is this method being used and what information can be garnered from it? Additional background on existing literature reviews of Ostrea edulis research would provide useful information on gaps already known to exist in the literature. The benefits of bivalve reef restoration: A global synthesis of underrepresented species (zu Ermgassen et al., 2020) documents the ecosystem services provided by Ostrea edulis after a systematic review of the literature while Conserving shellfish reefs – A systematic review reveals the need to broaden research efforts (Toone et al., 2020) reports on common restoration interventions undertaken for shellfish reefs including Ostrea edulis.

MAREA is mentioned in the abstract and conclusion, but never actually introduced anywhere in the manuscript, which seems a lost opportunity. Consider adding information on this project to the introduction.

**Methods:**
Clarification is needed in the fifth paragraph on whether ‘restoration’ and ‘aquaculture’ were ran through Web of Science and Scopus as new search terms or whether the already identified papers were then further narrowed down by these search terms.

Clarification on how the “broad topics” articles used for article sorting were developed would be useful. Were they pre-defined or developed after reading?

Why is the keyword clustering method being used? What information does it present that helps address the goals of this review?

Were repeats present between the global knowledge and local knowledge searches? The local knowledge database search appears to just be a more narrow repeat of the same search conducted earlier (any papers with the keywords ‘Ostrea edulis’ and one of the location specific terms should have already shown up under just ‘Ostrea edulis’).

Was the ‘local knowledge’ database search also conducted in Italian to initiate new results or only the library search?

How were the papers that resulted from the ‘local knowledge’ search analysed? Identically to the global knowledge results or using different methods? This information should be added to the ‘Local knowledge’ subsection.
**Results and discussion:**
As a whole this section is very light on discussion and could benefit from a more in-depth insight into some of the implications of these findings. Separate results and discussion sections may prove useful.

The geographic results of this review are interesting, but difficult to ascertain in their current form. What are the numbers behind “Geographically, studies were primarily from Atlantic and North Sea regions” or “studies spanned both Atlantic and Mediterranean European regions”? A map of included studies as a figure may be a very useful addition in this regard.

The connection between Figure 2 and Table 1 is unclear. How do the subclusters identified in Table 1 correlate with the clades in Figure 2? For example, there's only two clear clades in cluster three (red) but three subclusters. How do the terms used to identify the leaves in the dendogram correlate with the words characterizing each subcluster? More information on these connections would be very informative.

Discussion on how the identified clustering informs restorative aquaculture decisions is needed. Where are the current gaps in the research? What does the clustering tell us about how to move forward with restorative aquaculture projects?

Why was the clustering method only used for 156 out of the 514 papers? Did the remaining papers have no common terms? Clarification would be useful.

There are 32 identified restoration articles, but the more detailed breakdown in the seventh paragraph reports 35 articles. Is this because a single article could be categorized into multiple themes? Did only three articles fit into multiple categories? Clarification in the methods section would be helpful.

The information presented in the seventh paragraph identifying ecological parameters for successful populations is very useful. Consider making this into a table to emphasize these findings and allow for easier interpretation.

Was it possible for the aquaculture papers to be subcategorized into multiple groups in the eighth paragraph and none were or was each paper intentionally only assigned a single subcategory?

The local knowledge section is very informative. Consider making additional comparisons between this historical local knowledge and the results of the current review as there seem to be interesting similarities and differences.

**Conclusions:**
This conclusion section is very brief and would benefit greatly from additional details. The conclusion states “…the collated information on the ecological drivers, such as those presented in the review regarding *Ostrea edulis* should be used...” but does not address how this information should be used.

These results “led to the identification of a suitable area within the Venice lagoon to conduct the pilot” for MAREA, but the conclusion does not state which results led to this ability or how they
were used. Were suitable areas compared with the ecological information? Was the local knowledge used to identify historical areas that could be used? How could another project use this information in a similar way?

Finally, the conclusion recommends that “this knowledge should be convened in appropriate manners to aquaculture practitioners, bridging linguistic gaps, in order to make the two worlds coexist and limit the possibility of failed attempts.” How would the authors suggest this is done? What are the “appropriate manners” and what exactly is the knowledge the authors are suggesting is shared? This review provides a lot of interesting results, but these recommendations need to be streamlined to clarify how the authors think this information will be more useful.

**Figures and tables:**
Consider adjusting the y-axes of the two inset graphs in Figure 1 to be identical (0-15). In the figure’s current form it appears the aquaculture and restoration subtopics contain similar numbers of articles, when aquaculture actually includes fewer articles than restoration but has a smaller scale on the y-axis.

Does the “Height” y-axis of Figure 2 correlate to any real values? I would suggest simply removing this axis.

**Typos:**
Abstract under the results subsection: “While diseases was a leading cause for reef loss...” should be “While diseases were a leading cause for reef loss”

First sentence of introduction: “...which are important habitats supporting the biodiversity of marine ecosystems and contribute to multiple ecosystem services...” should either be “...which are important habitats that support the biodiversity of marine ecosystems and contribute to multiple ecosystem services...” or “...which are important habitats supporting the biodiversity of marine ecosystems and contributing to multiple ecosystem services...”

First sentence of the third paragraph of the introduction: “Bivalve aquaculture has in recent years returned in the first line with an emphasis on sustainability.” What is the meaning of “returned in the first line”?

The placement of the “(Figure 1)” citation in the first paragraph of the results section is unusual and breaks up the sentence. Consider moving it to the end of the sentence.

**References:**
Burrell (1983) is entirely capitalized.
Check capitalization consistency throughout references as some use title case and others use sentence case.

Jones (1994) has extra word “organisms”.

**References**

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and does the work have academic merit?
Partly

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

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
No

**Competing Interests**: No competing interests were disclosed.

We confirm that we have read this submission and believe that we have an appropriate level of expertise to state that we do not consider it to be of an acceptable scientific standard, for reasons outlined above.