Corpus-Based Philological Study of Semantic Shifts and Specialized Terms Within Marine Science Literature

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Abstract

The present work forecasts semantic changes in specialized terms in the marine science domain using a corpus-based philological approach. Every field has words that change meaning, and in marine science, a highly specialized domain, such changes are significant. This work will identify and focus on a few shifts in marine science, their causes and consequences, and their implications for the science of discourse. Through a meticulously designed corpus of texts in marine science spanning several decades, the study sought to uncover changes in the terms and associated marine science terminology, which were broadening. This study isolates changes in specialized marine science terms and their meanings to identify their migration. New shifts in discourse that applied technology and new science, through multidisciplinary fields, altered the use of migrated terms. A change in the terms of discourse on marine science, making engineering terms for ecosystems and sustainability more prominent, demonstrates linguistic shifts in that discourse. The study employs specialized linguistic engineering to discuss marine science. The research also outlines implications for further examination of the paradigmatic transformations in marine science and their potential consequences for cross-disciplinary synergy, policymaking, and popular science communication. This work also addresses the evolution of language in response to the evolution of science and

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society. It brings to the forefront the cross-disciplinary reality of linguistics and marine science.

Keywords: Semantic shifts, Specialized terminology, Corpus-based study, Marine science, Philological approach, Scientific discourse, Interdisciplinary influence

Introduction

The examination of specific fields in semantics is essential for gaining insight into how language shifts across various scientific domains (Bocanegra-Valle, 2024). Philological analysis using corpora is relevant in fields such as marine sciences, where the literature is abundant. In particular, marine sciences consist of complex biological, physical, and ecological systems and require the use of many specialized lexicons (Khudayberganova *et al*., 2025). As the discipline evolves, the lexicon is constantly changing, and even newly coined words may undergo subtle or significant shifts in meaning (Lazri, 2025). New advancements, interdisciplinary scope, or technological alterations may even trigger such changes.

The shifts in marine sciences vary in importance from field to field, and even within marine sciences, communication, understanding, and the utilization of knowledge may not be in sync. Hence, the importance of precise terminology that elaborates on complex concepts within the scope of marine sciences (Chen and He, 2024). In the field of aquatic sciences, it is noted that the scope of a terminology may widen or narrow. Hence, it is essential to study the terminology that evolves to understand the shifts that marine sciences make when responding to new issues .

Corpus linguistics and philological approaches come together to create an original research framework for analyzing semantic change in marine science specialized literature. The framework will offer valuable insights into the discipline's development by articulating ways to study the evolution of particular terms and their impact on scientific discourse (Wafa'Za'al Alma'aitah *et al*., 2024). The research phenomenon's discipline and evolution will show the importance of studying semantic change in specific terms and articulate ways to study semantic change in terms so that the emerging discipline's discourse is clear and accessible to a larger audience.

Key Contribution:

- The purpose of the study is to analyze changes in the meanings of some marine science vocabulary over the years, driven by new research and discoveries in the field.
- This study introduces a new approach in corpus linguistics, combining computational and traditional philology to improve analysis accuracy.
- The study asserts that shifts in meaning must be understood to foster research and communication in marine science, benefiting practitioners, policymakers, and those in the transdisciplinary science realm.

Section I of the study discusses the purpose of the research: the use of corpus-based philology to examine semantic changes in particular marine science vocabulary. Section II presents the semantic shifts in vocabulary and discusses the literature on the evolution of terminology in specialized discourse. Section III describes the corpus of specialized terminology, the identification of such terms, and the methods for analyzing semantic shifts. Section IV describes the primary shifts in vocabulary and the reasons for such changes. Section V explains how changes in the language used in communication can enhance scientific discourse and outlines potential research activities. Finally, Section VI describes the main findings of the research and the implications for studying the evolution of vocabulary in marine science.

Literature Survey

There is a discernible comparative lack of research literature focusing specifically on marine science and semantic recontextualization vis-a-vis the corpus of literature on recontextualization in the general scientific domain. The evolution and recontextualization of word meanings has been a field of study in the general study of linguistics. The evolution of the meanings of words such as broadening, narrowing, and semantic shift has also been a long and rich field of study (Liu *et al.*, 2023). In contrast or in symmetrical fashion, the evolution of scientific languages and terminologies in the various scientific fields is an area that has gone largely neglected or poorly integrated into the main literary canon (Makhmaraimova *et al.*, 2024; Anatolyevich and Valeryevna, 2023). Every scientific field, including marine sciences, which has long been a field of scientific inquiry, is in desperate need of varied and rich scientific vocabularies. Yet, such change has been poorly tracked, if at all.

Prior studies have shown that shifts in meaning are crucial to the progress of science, as theories, discoveries, and technologies redefine and amend the understandings and terminology of the sciences. Medicine, engineering, and environmental science are the primary examples (Wijitsopon, 2025). The emergence of terminology is not just an advancement in knowledge, but also acknowledges the practical applicability of the understanding. In medicine, engineering, and environmental science, the emergence of specialized terminology results from changes in the field's research focus or its engagement with a particular social issue, such as public health or sustainable technology (Tian and Zhang, 2023).

In contrast, there is a dearth of research on the specific focus of semantic shifts in the marine science literature. Like all sciences, marine science also relies on a specialized lexicon that shifts to include terminology. Despite the need, there appears to have been little systematic exploration into the meaning of terms in marine science, such as 'ecosystem,' 'sustainability,' and 'biodiversity,' as the field advances (Bruno and Muraleedaran, 2025). Given that marine science is inextricably linked to the discourse of climate change, environmental policy, and global sustainability, understanding shifts in its meaning is not just for marine scientists

but also for policymakers, the public, and environmental activists.

Like its sister disciplines, marine science uses technical language and is multidimensional, frequently interfacing with other scientific fields, including ecology, geology, and economics (Zeini and Jadidi, 2017). Marine science is also unique in that many of its terms need to convey meaning to both highly specialized scholars and the general public (Jain and Chatterjee, 2024). This is especially evident in marine science terms, including the public's right to know about ocean conservation, climate change, and the responsible use of aquatic resources. Therefore, the study of marine science terminology and its meanings over time is significant for maintain in gunambiguus communication in science and in the mass communication of science (Li *et al*., 2022).

There is little research on specific semantic shifts in the marine science literature (Wang and Hu, 2023). While this research gap contributes to understanding change within the scientific discourse of literature, changes in this particular literature domain have yet to be established. This gap is critical to ensuring that the new changes in the marine science lexicon, semantic or otherwise, facilitate interdisciplinary communication, information dissemination, and policy formulation. Moreover, shifts in semantic understanding may provide a framework for understanding and defining marine conservation and environmental sustainability more efficiently. Clarity on terminology and standards may simplify and broaden the global discourse on marine conservation and environmental sustainability.

Methodology

Challenges stem from the complexity of the task these methodologies are designed to address, as well as the trade-offs inherent to the types of methods involved. Specialized language differs from ordinary language because rapid scientific development changes it. There is in-situ development of the science, knowledge, research questions, marine analytical methods, and the associated language/categorization of observations. The methodology aligns well with qualitative assessment methods in specialized language development.

Figure 1 provides a stepwise breakdown of how the terminology in marine science undergoes semantic change, employing a stratified model. It all starts with the Data Layer, which involves acquiring and preprocessing a corpus of marine science literature. The Processing Layer uses text analysis tools to process and annotate texts. It is followed by semantic shift detection and specialized term extraction. In the Analysis and Output Layer, the focus is on providing philological insights from diachronic analysis and on defining the terms, leading to the final results being visualized and reported, thereby providing a diachronic analysis of terms. This structure assists in deciphering the evolution of terminology in marine science, thus enhancing effective and uniform use of terms across all levels of research, policy, and interdisciplinary collaborations.

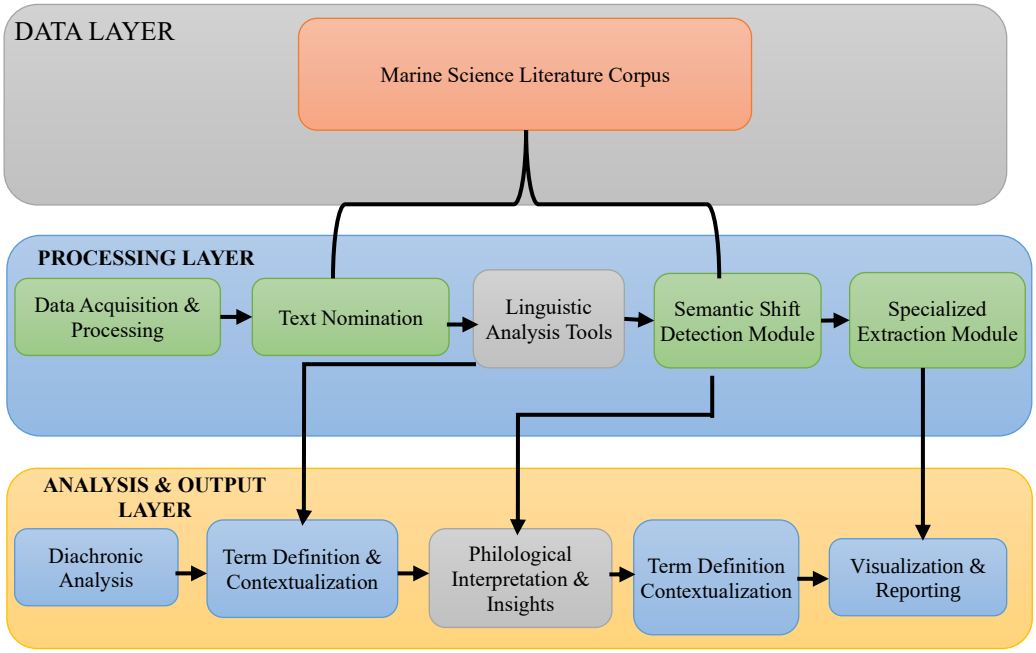

Figure 1: Marine science literature corpus analysis framework.

Selection of Corpus for Analysis

The study draws on an extensive compilation of marine science literature, both primary (e.g., peer-reviewed articles) and secondary (e.g., textbooks), spanning multiple decades. The 20 – 30year scope provides an adequate understanding of the evolution of terminology in the marine science domain. The corpus is structured into sub-disciplines, such as oceanography and marine biology, to capture the entirety of the discipline. The literature is digitized and processed to recognize pertinent terminology using specialized NLP analysis.

Criteria for Identifying Specialized Terms

Specific patterns of occurrence and technicality characterize specialized vocabulary in marine science. Specific terms in the domain of marine science use specialized terminology rather than their broader definitions. Such terms are identified through automated NLP techniques that isolate domain-specific, high-frequency, contextual terms within the corpus. This automation improves the reliability of the process and minimizes the likelihood of selecting terms irrelevant to the field's discourse.

Analyzing Semantic Shifts

About semantic shifts, this stems from tracking how specific terms have changed over time within the corpus. It can be divided into two types of analysis that is, time-based analysis, which is concerned with the relative increase/decrease of occurrence of words and the situational context over various periods, and the other is contextual analysis, which aims to understand how the mechanisms of terms changed over time due to novel research, findings, or emergent social conditions. This enables overcoming the problem of analyzing changes in meaning over time by providing qualitative and quantitative mechanisms for analysis.

Statistical Model for Measuring Semantic Shifts

In determining semantic changes over time, the statistical model indicates changes in meaning via the cosine similarity measure. This approach analyzes and correlates the spatial arrangements of the words and their contextual definitions as vectors within the corpus. The following equation provides the calculation of cosine similarity, in this measure:

$$\text{Cosine Similarity}(A, B) = \frac{A \cdot B}{\| A \| \| B \|} \qquad (1)$$

As noted in Equation (1), A and B are vectors designated for the contextual representation of the input term at two different chronological instances. This approach enables the quantification of the shift in meaning and, therefore, the assessment of the various changes undergone by terms over time with greater precision.

Findings

Identification of Semantic Shifts in Specialized Terms

While conducting a consolidated study of marine sciences, a few notable semantic changes regarding certain field-specific terminologies were observed. Some previously more focused were redefined and made broader in scope, while others became more narrowly defined. For instance, an "ecosystem," in the early days, pertained to a collection of only living organisms; it now includes the abiotic physical and chemical elements as well. The change is an indicator of the evolving sophistication with which marine ecosystems are examined, underscored by an increasing multi-disciplinarity and wider encompassing of environmental systems. The changes in definition are the results of the evolution of scientific inquiry and new techniques to describe marine phenomena.

Examples of Semantic Shifts within Marine Science Literature

The meaning of the word “plankton” has changed enormously over time. Plankton used to be defined as small organisms that drifted throughout water bodies, but now it includes bigger organisms and other life stages like planktonic larvae. This shift encapsulates advancing complexity and understanding of marine food webs and deeper ecological insights. This change within marine biology illustrates the depth of the field and how advancing research continues to shift and broaden terms used within the field.

The term “sustainability” has changed in a similar way within marine science. Focused originally on the ecological side of things, it has changed to include the social, economic, and governance factors as well. Marine conservation has increasingly started to interlace with global sustainability; thus, the term has broadened. This change in the term “sustainability” reflects the complexity and the depth of the field as well to illustrate the balance that effective marine management needs.

Discussion of Potential Reasons for Semantic Shifts

A number of elements can explain these semantic changes. First, increases in technology and various scientific breakthroughs may require more abstract or more exact definitions. Second, the field of marine science is interdisciplinary. It also includes, for example, borrowed and modified terms

from economics and the social sciences. Third, the language of marine science can reflect cultural changes. The growing public and scholarly interest, for instance, in the climate and environment can change definitions and usage of terms. These factors of change reflect the character of marine science; its terminology, definitions, and usage adapt to new scientific knowledge and changing society.

To illustrate the semantic shifts discussed above, the following table 1 shows some marine science terms that have undergone significant changes in meaning over time:

Table 1: Example of specialized terms and their shifts.

Term	Original Meaning	Current Meaning	Reason for Shift
Ecosystem	Biological community and its physical environment	Includes physical, chemical, and ecological processes	Advances in ecological science and interdisciplinary research
Plankton	Small drifting organisms in water	Includes larger organisms and various life stages	New discoveries in marine biology and ecological complexity
Sustainability	Focus on ecological conservation	Encompasses environmental, economic, and social dimensions	Growing integration of economics, policy, and conservation
Biodiversity	Variety of species in an ecosystem	Includes genetic diversity and ecosystem diversity	Expansion of conservation focus to include genetic and ecosystem components
Ocean Acidification	Process of ocean pH decrease due to CO2 absorption	Now also refers to the impact on marine organisms and ecosystems	Increased focus on climate change and its effects on marine life

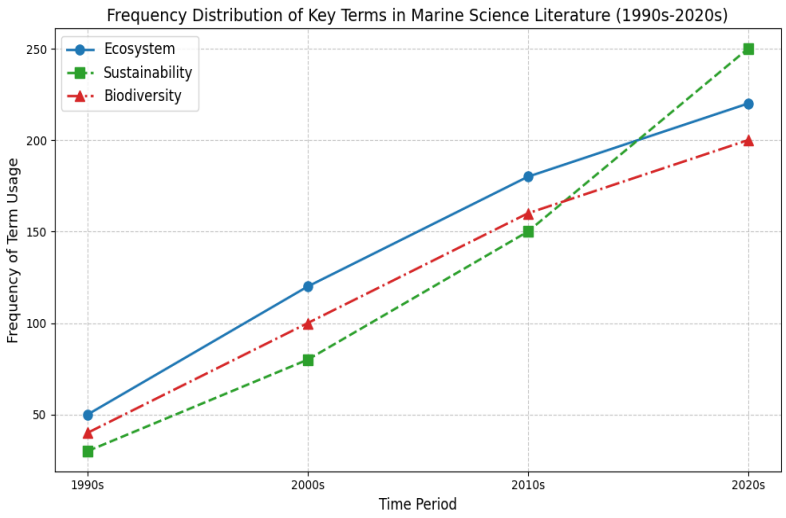

Figure 2: Frequency distribution of key terms in marine science literature (1990s-2020s).

In Figure 2, the frequency of three keywords, "ecosystem," "sustainability," and "biodiversity" in marine science studied literature for the last four decades (1990s, 2000s, 2010s, and 2020s) is illustrated. These keywords gained prominence suggesting the evolution and growing importance of marine science discourse. "Ecosystem" demonstrates increase in frequency suggesting growth in the scope of marine studies. "Sustainability" sharp increase is

evidenced in the last few years suggesting greater focus integration in marine conservation and policy. "Biodiversity" consistently increased signifying relevance and importance in studies, is also evident in scientific literature. Across different periods of time, unique colors and markers signify the unique words.

Implications

Impact of Semantic Shifts on Understanding Marine Science Literature

The evolution of key terminologies affects the understanding of the literature of marine sciences in the context of the temporal meaning of the fundamental concept under consideration. As the marine sciences branch and integrate with newer discoveries, technologies, and other disciplines, a previously tightly defined term may broaden, become more focused, or change altogether. This may create hurdles in the evaluation of the literature in the discipline, where older literature may have used certain terms in a unique manner. For example, the term “sustainability” refers to eco-sustainability, and its definition has changed over time to include the other social and economic aspects. Such varying definitions of terms used may greatly affect the reconciliation of older and newer literature. These gaps created by the temporal meaning of words will have to be monitored by researchers more so in the case of interdisciplinary studies or studies that analyze literature from multiple eras. Unawareness of such shifts in the meaning of words will lead to considerable misinterpretation of data, loss of coherence and gaps in the understanding of evolution of marine sciences.

Importance of Maintaining Consistency in Specialized Terminology

Uniformity in the employment of specialized lexicon is essential in upholding accuracy and exactness whilst communicating in the sciences. Marine sciences, and many other fields that employ specialized lexicon, may encounter systematic confusion when communicating research outside the primary discipline. Miscommunication of the specialized lexicon may stagnate the comparative analysis of research and the refinement of the research paradigm. For instance, "biodiversity" and "ecosystem" may be interpreted differently within the various sub-disciplines of marine science, such as marine biology and oceanography. Those challenges may assist in explaining the stagnation of interdisciplinary collaboration. The establishment of unambiguous and uniform terminologies facilitates marine scientists, policy makers and the general public in articulating and formulating collective frameworks and marine conservation strategies. Moreover, unambiguous and uniform terminologies clarify the misconceptions that unfavourable marine conservation strategies cause, particularly those employing the term “sustainable” or “resilient” in describing the strategies.

Conclusion

To summarize, this research underscores the need of staying aware of evolving semantics of marine science terminologies, given the changes that marine science terms underwent due to

interdisciplinary crossovers, scientific evolution, and changes in society. The semantic shifts are of utmost importance to the interdisciplinary and intra-scientific exchange of ideas. As marine science deals with the critical problems of climate change and sustainability, the need to stem the tide of new scientific research and technologies and to hold evolving terminologies to science, marine science in particular, is conclusive. Prolonged studies of the evolution of terminologies, interdisciplinary crossovers of marine science, the impact of technologies on new marine terms, and the construction of terms in marine science, are the focus of future studies. The frameworks of research, the construction of terms, and the informal linguistics of marine science are to be adapted and updated to the interdisciplinary science to meet the criteria of efficient and effective regulation.

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