Forty Years of UN Ocean Governance:

Stakeholder Power and Policy Shifts (1982–2022)

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Abstract

This study employs natural language processing (NLP) methods to examine the evolution of global marine policy discourse and stakeholder influence in United Nations marine policy documents from 1982 to 2022. Drawing from a corpus of over 3,000 UN policy documents, including materials from UNCLOS, UNFCCC, UNOC, and biodiversity conventions, this research analyzes how marine policy priorities have shifted in response to climate change, scientific advancements, and increased participation by non-state actors such as youth, Indigenous groups, and NGOs. Using a GPT-based classification model, the study categorizes text spans by Sustainable Development Goal (SDG) 14 Targets and a set of marine policy concerns, quantifying changes in thematic focus over time and across conference types. The results reveal a growing emphasis on climate-integrated ocean strategies—such as blue carbon and ocean-based renewable energy—alongside declining attention to traditional biodiversity protection. Regression analyses indicate significant increases in references to ocean acidification and economic benefits for small island developing states (SIDS), suggesting emerging priorities shaped by both ecological concerns and growing political advocacy. Additionally, shifts in UNFCCC conference attendee demographics reflect the rising visibility of non-governmental stakeholders, whose growing presence correlates with broader changes in ocean policy discourse. These findings underscore the value of computational methods in analyzing long-term policy trends and stakeholder dynamics within international marine governance.

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I. Introduction

In recent years, the United Nations has worked to invest in the environmental and economic value of the oceans as a tool for sustainable development. This effort has led to an increase in global marine policy literature aiming to represent the interests of policymakers, scientists, and affected groups, including indigenous communities, non-governmental organizations, and youth. The UN has implemented the UN Framework Convention on Climate Change (UNFCCC) Ocean Dialogues to promote collaboration between policymakers and scientists and to address climate change from a marine and terrestrial perspective (Eddebar et al., 2015) and the UN Oceans Conferences to address marine policy goals for sustainable development. These efforts have led to an expansion of blue-carbon initiatives that seek to utilize marine carbon sinks and heat absorption to reduce the impacts of fossil fuel emissions (Galland et al., 2012).

This research seeks to expand the political understanding of changes in global marine policy and identify potential causes for shifts in national and international priorities to answer the question: how have the areas of focus within marine policy literature from global ocean conferences evolved to accommodate shifts in political representation and the priorities of stakeholders? To address this question, the study will explore marine policy literature from global ocean conferences, including the UN Convention on the Law of the Sea (UNCLOS), the UNFCCC Conference of Parties (COPs), the UNFCCC Ocean Dialogues, the United Nations Oceans Conference (UNOC) documents, and marine-specific documents from UN environmental policy conferences (such as the UN Conference on Biological Diversity and international fisheries agreements).

History of Marine Policy Conferences

The 1972 United Nations (UN) Conference on the Human Environment was the first major internation conference to address environmental concerns such as pollution and ecosystem management. However, the 1982 UN Convention on the Law of the Sea (UNCLOS) is widely regarded as the first global conference to address ocean policy from both economic and environmental perspectives. This conference established key principles such as defining Exclusive Economic Zones (EEZs), territorial seas, deep-sea interactions (e.g., the maintenance of submarine cables), and setting preliminary policies for fishery management in international waters (United Nations, "Conferences – Sustainable Development"). In 1992, the UN Conference on the Environment and Development (also called the Rio "Earth Summit" or UNCED) introduced new goals for sustainable development and led to the formation of the UN Framework Convention on Climate Change (UNFCCC) and the Convention of Biological Diversity (CBD). It also modified UN policies on migratory fish stocks (United Nations, "Conferences – Sustainable Development"). The 1992 UNCED also offered a "global forum" for non-governmental organizations (NGOs), although the main conference was composed of almost entirely party-affiliated members (Dobush et al., 2022). The UNCED agenda was scheduled to be reviewed five years after the conference, in 1997, which was the same year that the Kyoto Protocol laid the foundation for modern climate policy (United Nations, "Conferences – Sustainable Development").

In 2000, the UN Millennium Summit in New York City set a framework for global development in the 21st century. While not marine-focused, it established eight Millennium Development Goals (MDGs), which later influenced the creation of the 17 SDGs. Among the initial eight goals, the UN highlighted "ensuring environmental stability" as a key pillar for continued development into the next millennia (United Nations, “Conferences – Sustainable Development”). The 2002 World Summit on Sustainable Development in Johannesburg built upon the UNCED goals, MDGs, and Kyoto Protocol, underscoring the need for increased ocean ecosystem protection through the development of marine protected areas (MPAs) (United Nations, “Conferences – Sustainable Development”). In 2004, the Global Reporting and Assessment of the Marine Environment initiative began, aiming to provide a scientific foundation for UN policy decisions relating to ocean health and conservation (United Nations, “Conferences – Sustainable Development”).

In 2012, the 20-year review of the UNCED marked the establishment of the 17 SDGs. SDG 14, “Life below water,” highlighted a global commitment to marine-specific conservation and development (United Nations, “Conferences – Sustainable Development”). These conference documents contain some of the first mentions of the “blue economy,” recognizing the critical role of the oceans in combatting climate change and fueling economic growth (Vanderklift et al.). In 2015, the Paris Agreement (UNFCCC COP 21) established a new international climate change framework. This agreement required countries to submit nationally determined contributions (NDCs) to climate change mitigation, with updates every five years (United Nations, “Conferences – Sustainable Development”).

Following the Paris Agreement, the UN began a series of marine-specific conferences with the first UN Oceans Conference (UNOC) in 2017 (United Nations Sustainable Development Goals, “UN Oceans Conference”). This conference was specifically focused on the targets of SDG 14 in relation to ecosystem/biodiversity conservation, fisheries management, and blue carbon (United Nations Sustainable Development Goals, “UN Oceans Conferences”). In 2020, the UNFCC incorporated the Ocean Dialogues as a part of the COP process to further integrate marine policy and blue carbon into climate change mitigation efforts (United Nations, "Conferences – Sustainable Development"). The second UNOC in 2022 sought to revitalize the goals of SDG 14 following the COVID-19 pandemic (United Nations Sustainable Development Goals, "UN Oceans Conference"). This conference amplified the voices of indigenous communities, small island nations (SIDS), and youth, reflecting a trend of increased involvement from NGOs, scientists, and non-party actors (Dobush et al., 2022). In 2022 changes the UNCLOS High Seas Treaty updated efforts to enhance fisheries regulation (United Nations, "Conferences – Sustainable Development").

In 2023, these regulation efforts continued with the UNCLOS agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (BBNJ), which established policies on the creation of MPAs and the use of scientific surveys to support environmental management on the high seas (United Nations, "Conferences – Sustainable Development"). The third UNOC is scheduled for June 2025 in Nice, France (United Nations Sustainable Development Goals, "UN Oceans Conference").

Understanding Marine Policy Stakeholders

Early marine and environmental conferences primarily focused on party-affiliated voices with separate forums for NGOs. For example, the 1992 UNCED in Rio included a "global forum" for NGOs, but the main conference consisted almost entirely of party-affiliated members (United Nations, "Conferences – Sustainable Development"). In recent years, the UN has increasingly welcomed NGOs and non-party members to participate in global environmental conferences. These efforts aim to amplify the voices of scientists, indigenous communities, and youth in climate —and consequently marine —policy (United Nations, "Conferences – Sustainable Development"). The UNFCCC Ocean Dialogues, for example, have facilitated increased discourse between party and non-party conference participants (Dobush et al., 2022). During this period, ocean policy and climate policy have become increasingly interconnected (Dobush et al., 2022).

II. Literature Review

Keyword Frequency Studies on Environmental Policy Literature

Several studies have examined environmental policy literature to understand shifts in policy focus or changes in participant demographics over time. Many of these studies employ a keyword frequency model to compare mentions of specific policy terms across peer-reviewed literature, multiple editions of conference documents, or between documents from conferences on different areas of environmental policy. For instance, keyword studies on abstracts and journal article titles have been used to analyze long-term changes in policy focus across large corpora of documents (Pang et al., 2024; Rudd, 2017). However, these methods often fail to provide a comprehensive understanding of the full content of the documents, which may impair the accuracy of the findings. This limitation stems largely from the reliance on human classification of keyword categories across extensive datasets.

Although earlier studies were not marine-specific, Dobush et al. (2021) analyzes party and non-party submissions to the inaugural UNFCCC Ocean Dialogues, which aimed to bridge the gap between climate policy and marine policy. Text spans from these 47 documents were labeled with key themes and subtopics by both a law/policy expert and a scientist. The results were averaged to reduce individual bias in the classification process. This study identified several prominent themes, including blue carbon, ecosystem services, fisheries, and coastline protection. To extend analysis beyond simple keyword frequency, some studies have employed quantitative methods to determine which countries or documents focus more heavily on specific areas. For example, Elsler et al. (2022) introduced biodiversity focus factors (BFF), climate focus factors (CFF), and carbon focus factors (CaFF) to compare the focus of policies across different documents. Similarly, Gallo et al. (2017) developed a marine focus factor (MFF) to quantitatively assess the relationship between national demographics (e.g., population in low-lying areas, coastline length, small island developing states) and the frequency of marine topics in NDCs.

These studies reveal several trends in the evolution of marine policy. Climate documents are increasingly marine-focused, with the ocean playing a central role in global carbon reduction efforts. References to "blue carbon" have grown more frequent across multiple studies (Gallo et al., 2017; Dobush et al., 2022). Additionally, climate and marine policy discussions have become more science-driven, with policymakers increasingly seeking guidance from researchers (Tessnow-von Wysocki et al., 2020). This collaboration has produced more informed NDCs and Climate Action Plans (CAPs) that emphasize the ocean's role in climate change mitigation and highlight the risks marine ecosystems face from warming and acidification (Galland et al., 2012; Vanderklift et al., 2022). Furthermore, solution-oriented approaches, such as developing a blue carbon economy and utilizing marine biodiversity as natural carbon sinks, are becoming more prevalent than adaptation-based strategies (Vanderklift et al., 2022). These new approaches not only address the root causes of climate change but also show increased respect for traditional practices and ecosystem diversity (Oostdijk et al., 2022; Galland et al., 2012).

Natural Language Processing and Large Language Models

The methodology for this research is inspired by Corringham et al. (2021), who trained a model to classify text spans from the Paris Agreement NDCs into the categories of adaptation, agriculture, economy, energy, environment, equity, industry, land use, mitigation, strategy, and waste, or assign no label. These classifications allowed for a detailed analysis of topic frequency within the NDCs. Unlike keyword frequency analysis, natural language processing (NLP) models interpret complete sentences and provide greater contextual understanding.

NLP models have proven effective for processing large datasets and corpora that would be infeasible for manual annotation (Lambert et al., 2021). In a study on common-pool resources, artificial intelligence demonstrated the ability to classify literature at lower cost and greater efficiency than human researchers while maintaining high accuracy (Lambert et al., 2021). Additionally, NLP models can classify themes and attitudes in policy documents to analyze emphasis on specific climate policy areas across jurisdictions. For example, Hsu and Rauber (2021) used a trained NLP model combined with social network analysis to compare local, regional, national, and corporate action plans. The ability of NLP models to understand tone and context distinguishes them from traditional text-mining and keyword frequency approaches, making them uniquely suited for this type of analysis.

III. Theory and Argument

Existing Theories

Developments in Global Conservation Priorities Create a Shift to Holistic Ecosystem Protection. Over the past several decades, global conservation priorities have shifted to reflect an increasing emphasis on climate change mitigation, biodiversity conservation, and ecosystem-based management. Initially, international conservation efforts primarily focused on preserving specific species and habitats, as seen in early agreements such as the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, contemporary priorities have evolved to address broader systemic threats, particularly those posed by climate change. Landmark agreements, such as the Paris Agreement (2015) and the Kunming-Montreal Global Biodiversity Framework (2022), emphasize the interconnectivity between climate change, biodiversity loss, and sustainable development (Díaz et al., 2019). This expansion of conservation efforts coincides with the push to include marine environments as solutions within climate change literature (Elsler et al., 2022). These efforts include the UN's "30 by 30" target, which aims to protect 30% of the world's oceans and land by 2030 (CBD Secretariat, 2022). Conferences such as the Convention on Biological Diversity (CBD), Conference of the Parties (COP) and the UN Ocean Conference have reinforced this transition toward integrating marine ecosystems into global conservation discussions (Pörtner et al., 2021). These shifts demonstrate a growing recognition of the need for holistic, ecosystem-based approaches in global conservation policy. Based on these observations, researchers have theorized that there is a distinct trend toward climate-focused and marine-inclusive policies within the United Nations (Elsler et al., 2022).

The Growth of Public Demand for Environmental Justice Has Spurred National and International Policy Action. Public demand for environmental justice has gained momentum on a global scale, influencing policy decisions and shaping the priorities of international organizations such as the United Nations. It is theorized that this global focus has been the result of decades of environmental justice activism at regional and national levels. For example, the U.S. environmental justice movement emerged in the 1980s in response to the disproportionate exposure of marginalized communities to environmental hazards (Bullard, 2000). Federal policies have reflected varying levels of commitment to environmental justice, with notable advancements under President Clinton's Executive Order 12898 (1994) and the Biden administration's Justice40 initiative, which aimed to direct 40% of climate-related federal investments to disadvantaged communities (Celermajer et al., 2020). Recent UN Climate Change Conferences of the Parties (COPs) have highlighted this intersection between climate justice and human rights. Additionally, developing nations, including Small Island Developing States (SIDS), have pushed for climate reparations and the establishment of a loss and damage fund (Roberts and Parks, 2010). As explained in the aforementioned sources, current theories suggest that this growing advocacy reflects a broader shift toward equitable and inclusive environmental governance within policy literature.

The Impact of UN Sustainable Development Goals (SDGs) on Policy Priorities and UN Procedures. The United Nations Sustainable Development Goals (SDGs) were adopted in 2015 as part of the 2030 Agenda for Sustainable Development. These goals aim to provide a guiding framework for global environmental and socioeconomic policies. Several of the 17 SDGs [Appendix 1] directly pertain to marine conservation and environmental justice. These include SDG 14 (Life Below Water) and SDG 15 (Life on Land), which aim to protect marine and terrestrial ecosystems (Le Blanc, 2015). SDG 13 (Climate Action) also plays a crucial role in integrating climate change mitigation strategies across multiple policy areas. These goals shape UN funding priorities, international agreements, and policy implementation at a national and international level (Kanie & Biermann, 2017). For instance, SDG 14 influences the priorities of the UN BBNJ Treaty by encouraging the establishment of marine protected areas in international waters. Moreover, the SDGs have reinforced the UN's emphasis on equity and environmental justice, as seen in SDG 10 (Reduced Inequalities) and SDG 16 (Peace, Justice, and Strong Institutions). These goals advocate for inclusive governance and equitable access to natural resources, indicating a growing focus on conservation and activism in developing nations (Sachs et al., 2021). These goals have been used to integrate equitable, climate-based conservation efforts within global and national documents. For example, many of the UNFCCC NDCs prioritize the use of ecosystems (such as the oceans) as carbon sinks and aim to reduce the burden of climate disasters on developing nations (Vanderklift et al., 2022). Thus, the SDGs continue to shape the UN conservation efforts in marine and terrestrial environments.

The Growing Involvement of Youth and Indigenous Groups Creates New Platforms and Stakeholders in Global Environmental Policy. Several researchers have theorized that both youth and Indigenous groups have played an increasingly central role in shaping global environmental policies by challenging traditional power structures and advocating for a more inclusive decision-making process. Youth-led movements have brought climate issues to the forefront of international discourse and have prompted national and international governing bodies to adopt more ambitious environmental and climate-related goals (Fisher, 2019). The UN has helped to facilitate this growth through the creation of platforms such as the Youth Advisory Group on Climate Change (Hayward, 2020). Similarly, Indigenous groups have gained greater recognition in environmental governance, particularly in the context of biodiversity and climate adaptation. International agreements, such as the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) and the Convention on Biological Diversity, have emphasized the critical role of indigenous collaboration in sustainable resource management and the vulnerability of these marginalized communities (Whyte, 2018). Indigenous-led conservation initiatives, such as Canada's Indigenous Protected and Conserved Areas (IPCAs), have also demonstrated the role of traditional ecological knowledge in developing modern conservation strategies (Artelle et al., 2019). Research suggests that both youth and indigenous populations are becoming increasingly active within the sphere of environmental justice and conservation, reinforcing the idea that effective conservation policies must include diverse perspectives.

Research Hypothesis

I hypothesize that ocean policies that directly contribute to climate solutions and adaptation, such as those involving blue carbon and economic development, have become increasingly prevalent when compared to policies on specific ecosystems due to the growing global focus on the oceans within climate change conferences. This shift corresponds to the rise of new voices from youth, indigenous communities, and NGOs in the political and public sphere (referred to as "non-party actors"). While political entities place a greater emphasis on maintaining existing industries and reducing the costs of climate change (Dobush et al., 2022), many of these non-party stakeholders are more directly impacted by climate change. I theorize that the presence of more non-party affiliates has increased climate-related ocean policies as these affected individuals call for greater governmental action from the voting parties at the UN conferences. To test this hypothesis, this research will quantify shifts in ocean policy focus areas to reveal the most influential factors in marine policy literature and the role of political, scientific, and social perspectives in shaping the evolution of these areas of emphasis from 1992–2021.

Confounding Variables

Several confounding variables complicate the identification of a purely causal relationship between conference attendee demographics and the policies reflected in UN marine policy documents. These factors include external influences that may shape policy outcomes independently of attendee composition and limitations to the research methodology. Thus, throughout this research, we aim to establish a correlation between these factors and a foundation for further studies on causality.

Lobbying and External Influences of Industries and Non-Governmental Organizations. One significant confounding variable is the role of lobbying, which can introduce external pressures favoring certain industries or demographic groups. Although these interest groups may not be directly involved in official discussions or included on conference attendee lists, they can have a substantial influence on voting behavior and contributions from both UN party and non-party actors. Industrial fisheries, oil and gas, and maritime trade have historically leveraged lobbying efforts to align international marine policies with their economic interests, often at the expense of conservation priorities (Brulle, 2018). The financial and political power of these groups allows them to exert influence through side agreements, informal negotiations, and economic incentives that extend beyond the direct demographic representation in conferences. They may also exert this influence to gain access to conferences, possibly taking accreditations or attendee spots from non-governmental organizations and non-party actors with fewer financial and political assets (Vormedal, 2008).

Geopolitical Strain on Climate Cooperation and UN Priorities. Geopolitical developments also play a crucial role in shaping conference participation and policy focus. Shifts in global priorities due to conflicts or economic crises can divert attention away from environmental efforts. For instance, the Russia-Ukraine conflict has led to economic strain on many nations, forcing them to reallocate resources toward defense, humanitarian aid, and energy security rather than climate and conservation initiatives during the later portion of the corpus for this study (Tagliapietra, 2022). Additionally, these geopolitical rifts have disrupted international cooperation in environmental governance as diplomatic tensions impact collaboration on climate policy and conservation efforts (Puppim de Oliveira, 2023).

Technological Advancements in Conference Accessibility. Another key factor influencing conference participation is the advancement of digital communication technologies. In recent years, virtual conference formats and digital panels have expanded access to a broader range of stakeholders, particularly those who may have previously faced financial or geographic barriers to participation. Early UN marine policy discussions were limited by physical attendance constraints, often excluding non-party actors from smaller or less economically developed nations. The introduction of digital platforms has allowed for greater inclusivity, enabling more voices—particularly from Indigenous communities, small island developing states (SIDS), youth, and grassroots environmental organizations—to be heard in global policy discussions (Bennett et al., 2021). These virtual platforms also provide options for reducing the carbon footprint of individual conference attendees and the conference as a whole. However, disparities in digital access and technological literacy may still create inequities in participation, limiting the influence of digitally engaged actors relative to those present in person. Thus, current theories suggest that the impacts of virtual conference options may have both positive and negative impacts on stakeholder influence, which may be difficult to distinguish in this time series.

The Role of the COVID-19 Pandemic on UN Conference Format and Attendance. The COVID-19 pandemic introduced additional disruptions to conference attendance and participation. Many high-profile UN conferences were postponed, canceled, or shifted to online formats from 2020 to 2022, leading to decreased in-person engagement and shifts in representation. While virtual conferences increased accessibility for some, they also posed challenges in fostering negotiations and informal discussions, which are often crucial in international policymaking (Tao et al., 2021). The long-term effects of this shift remain uncertain based on the timeframe of this research, but early observations suggest that while digital platforms may have democratized access in some respects, they have also weakened opportunities for critical in-person negotiations that drive substantive policy commitments. As the international community continues to adapt to hybrid conference models, future studies should examine how these changes have affected decision-making processes and representation within the UN marine policy sphere.

IV. Research Methodology

NLP Methodology Overview

This model will use the OpenAI Generative Pre-trained Transformer (GPT) to identify the key marine focus factors within individual sentence-length spans of text from a selected corpus of documents. We use two sets of marine focus topics for the classification ontology. One set of marine focus topics is selected from Gallo et al. (2019) who considered keyword frequencies related to 31 marine policy topics in the 2016 Paris Agreement NDCs [Appendix 3]. Another set of marine focus topics is derived from a dataset provided by ClimateWatch in which researchers hand-labeled approximately 10,000 text spans and classified them by specific UN Sustainable Development Goals (SDGs) and targets [Appendix 1, Appendix 2] (ClimateWatch). There are 17 SDGs and 169 associated sub-targets. We will focus specifically on SDG 14, Life Below Water, and its associated 10 sub-targets [Appendix 2]. A corpus of 3,083 documents (71,651 pages) from the UNFCCC Ocean Dialogues, UN Ocean Conference, UN Convention on the Law of the Seas, Paris Agreement NDCs, Global Ocean Policy Summit, and other materials have been compiled for NLP analysis [Appendix 5] (Elsler et al., 2022). Our models will classify spans from this corpus based on the Gallo and UN SDG marine focus topics for each span. The documents have been organized by year of publication to provide a timeline for the evolution of topic frequency. Publication dates were obtained by applying GPT to the first 500 tokens of each document.

Assembling the UN Marine Policy Corpus

The documents analyzed in this study were originally compiled by Elsler et al. in "Protecting Ocean Carbon through Biodiversity and Climate Governance" (2022). Their methodology identifies relevant topics in marine biodiversity and climate governance treaties using a database of 3,083 binding and non-binding policy documents, including decisions, guidelines, resolutions, actions, and strategic plans from 1982 to 2021 (Elsler et al., 2022) [Appendix 4, Appendix 5]. To enhance the dataset, we incorporated additional key documents, such as the finalized 2023 Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (BBNJ), which was not available when the original corpus was compiled. Furthermore, we updated the collection of UNFCCC Nationally Determined Contributions (NDCs) to include additional submissions made by countries since 2021. While we attempted to comprehensively update the dataset, the initial collection process took over four months. Thus, we faced significant time constraints for this research and decided to update the most critical binding agreements through 2024 where possible.

Categorization of SDG 14 Targets

SDG 14, "Life Below Water," aims to conserve and sustainably use marine resources. It is divided into 10 targets [Appendix 2]. To categorize these SDG 14 Targets in policy documents, we utilized a combination of human annotation and automated classification which was evaluated using inter-annotator agreement analysis. We began by obtaining 483 pre-labeled, SDG 14-related spans from the Climate Watch database. Climate Watch labeled over 10,000 text spans from the initial 2016 round of UNFCCC Nationally Determined Contributions related to the 17 SDGs, of which 483 were labeled with SDG14 Targets. These annotations were manually reviewed and re-labeled by a human annotator to ensure the consistency of the data. The verified spans were then sorted into their corresponding SDG 14 Targets and used to evaluate the GPT-4o mini model. GPT-4o mini was subsequently tasked with categorizing all 483 spans. These preliminary classifications were compared against the original Climate Watch labels and human annotations to measure agreement. We also compared the similarity between the results from GPT-4o mini when given the same prompt in two trials. We then prepared the larger corpus of 3,083 UN policy documents by converting them into plain text format using PyMuPDF and Google Tesseract and segmenting them into over one million text spans over 77,000 pages. Spans that contained no English words or were shorter than four words were removed to ensure data quality. From this refined corpus, we randomly selected 500 spans for manual annotation, which were then independently classified by GPT-4o mini [Appendix 9, Appendix 10]. The model was prompted to assign multiple SDG 14 sub-targets to a single span if applicable. Agreement metrics were calculated between human and GPT classifications, as well as between multiple GPT-generated labels, to assess the model's accuracy in identifying and categorizing SDG 14-related content [Appendix 11]. This was used to evaluate the efficacy of GPT-4o mini in replicating human classification efforts and to provide insights into its potential for large-scale policy analysis.

Categorization of Marine Policy Concerns

We categorized the marine policy goals using a similar methodology to the SDG 14 categorization process. 500 randomly selected text spans were manually annotated with relevant marine policy themes, drawing from the classification frameworks established by Gallo et al. in “Ocean Agreements Under the Paris Agreement.” The Gallo framework consists of 31 categories (Table 1) that emphasize specific marine ecosystems and environmental impacts, including wetlands, coral reef conservation, and offshore energy production. GPT-4o mini was subsequently tasked with labeling the 500 spans according to the relevant Gallo categories. The model was allowed to assign multiple classifications to a single span if applicable. To evaluate the model’s reliability, agreement metrics were calculated between the human annotations and the GPT-4o mini classifications and across multiple iterations of GPT-4o mini’s own classifications. This provided an assessment of the model’s capacity to accurately classify marine policy content in alignment with the designated policy focus.

Evaluation of GPT Versus Human Labels

Agreement metrics between human and GPT labels were reasonable [Appendix 11]. Using a liberal matching criterion, which counts two sets of labels as equivalent if there is any overlap, yields agreement metrics of 0.90 for the SDG14 Targets and 0.77 for the Gallo topics. Accuracy of GPT relative to human labels for SDG14 Targets was 0.48, and F1 was 0.65. Accuracy for Gallo topics was 0.51, and F1 was 0.68. For these metrics, 0 indicates a complete mismatch, and 1 indicates a perfect match. Using a more stringent multi-label agreement metric, we found Jaccard similarities of 0.19 on SDG14 Targets and 0.09 on Gallo topics. For reference, the Jaccard similarities between two independent runs of GPT were 0.12 for SDG14 Targets and

0.26 for Gallo topics. These agreement metrics are in line with previous climate text classification studies (Corringham et al., 2019; Spokoyny et al., 2024).

UNFCCC Attendee Compilation and Categorization

Due to the time constraints of this research, it was not feasible to compile attendee lists for the entire corpus spanning from 1982 to 2021. Additionally, older documents were often difficult to locate, limiting the scope of analysis. As a result, this study focused on analyzing attendee changes at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) meetings. These records were similarly structured and systematically maintained from COP 3 to COP 28.

The attendee lists were sourced from the official UNFCCC website and the PDF files were converted into HTML format using PyMuPDF and Google Tesseract. Given the token limitations of the GPT-4o mini model, the HTML files were segmented into five pages with a two-page overlap to facilitate efficient processing. GPT-4o mini was then prompted to extract structured outputs from the five-page text spans. The requested outputs included the attendee's name, country, affiliated organization, and organization type [Appendix 9]. The organization types were categorized into seven groups: government entities, intergovernmental organizations (IGOs), non-governmental organizations (NGOs), universities and research institutions, youth organizations, indigenous and marginalized community organizations, and corporations or industry representatives.

Marine Focus Factor Use and Modifications

We will employ the Marine Focus Factor (MFF) calculation methodology developed by Gallo et al. [Appendix 6] to assess the variation in marine focus across different UN conference types. While the original MFF was formulated to analyze the variation of marine-related keywords between each country's first NDC, we will adapt this metric to facilitate cross-conference comparisons for Gallo Marine Focus (GMF) topics and the SDG 14 Targets. The original MFF was computed by multiplying the frequency of marine keywords per 1,000 words in each NDC by one plus the ratio of GMFs mentioned within a document set to the total number of GMF topics (30) [Appendix 6]. We will use a modified Marine Focus Factor (mMFF) to extend the scope of GMF analysis to our entire UN marine policy corpus by calculating the mMFF for each of the ten conference types [Appendix 7]. The mMFF is calculated by multiplying the frequency of GMF occurrences per 1,000 words in a given conference set by one plus the proportion of GMFs mentioned within that set relative to the total GMF topics (31) [Appendix 7]. We will also introduce a complementary metric to assess SDG 14 target focus among the ten conference types, termed the Target Marine Focus Factor (tMFF). The tMFF is computed by multiplying the frequency of SDG 14 target mentions per 1,000 words by one plus the proportion of SDG 14 Targets referenced in the conference set relative to the total SDG 14 Targets (10) [Appendix 8]. By employing both mMFF and tMFF, we aim to capture the nuances in marine policy emphasis among the ten conference types.

Data Analysis

Regression Models and Variables. The derived frequency data for each marine focus topic by document or by document section will be modeled over time to better understand how marine policy goals have changed and which specific areas are currently receiving the most focus. A second area of analysis will utilize the Gallo Marine Focus Factor (MFF) [Appendix 6], and the SDG14 Targets to compare the relevance and importance of marine policy topics to different countries. While the MFF was initially only applied to each nation's first NDC, we will be using this comparative metric to quantify the marine policy emphasis for each set of documents (rather than by country). This information will be used to understand which type of UN conference had the greatest marine focus and how certain factors, such as the inclusion of non-party actors, have increased or decreased areas of marine focus.

We will apply a series of regression analyses to assess the evolution of marine policy topics over time using the SDG 14 Targets and Gallo marine focus (GMF) topics. The independent variable in these regressions will be the document year of publication, while the dependent variable will be the frequency of SDG 14 Targets or GMF topics per 1000 words (Table 1). To determine whether these trends represent statistically significant changes across the UN marine policy corpus from 1992 to 2021, we will evaluate the 95% confidence intervals of the regression slopes. A change in topic frequency will be considered statistically significant if a) the 95% confidence interval of the regression slope does not include zero and b) if the calculated *p*-value for the slope remains below the chosen significance threshold (α). Additionally, we will interpret the absolute value of the regression slope as an indicator of the magnitude of policy focus shifts, with larger absolute values representing greater changes in emphasis on specific SDG targets or GMF topics over time.

Table 1: Regression Variables

Title	Independent Variable (x)	Dependent Variable(s) (y)
SDG 14 Target Frequency Changes	Year of publication	SDG 14 Target frequencies per 1000 words
Gallo Marine Topic Frequency Changes	Year of publication	Gallo Marine Topic frequencies per 1000 words
Attendee Demographic Changes	UNFCCC COP Year	Attendee porportions for each stakeholder category

Table 1: Independent and dependent variables for each regression by experimental subject. Note that some subjects may have multiple regressions per category or variable.

The initial regression model will use a pooled Ordinary Least Squares (OLS) regression over the entire corpus of UN marine policy documents. However, because the document publication dates are not normally distributed for each conference, the data is susceptible to bias. Some conferences released large volumes of documents at the beginning or end of the corpus timeframe, whereas others followed fixed publication cycles occurring every few years [Appendix 5]. These variations could distort the time series analysis of the marine policy focus data. To address this issue, we will conduct a secondary fixed effects regression to account for the variability in document release across the ten conference types. Given that our dataset is constrained (since frequency counts cannot take negative values), we will use a count regression model rather than OLS for this analysis. Specifically, we will apply a negative binomial regression, which is appropriate for discrete data and ensures that results will yield only positive integers. This approach will provide a more robust assessment of long-term trends in UN marine policy while mitigating the effects of irregular publication schedules.

We will also use an OLS regression to compare the proportion of attendees from each stakeholder group over time at the UNFCCC Conferences of the Parties (COPs) from 1997 to 2022 (COPs 3–28). This approach will be used to identify shifts in participation among key groups, including government entities, non-governmental organizations (such as those representing youth and indigenous groups), industries, and research institutions. Since the attendee data is sourced exclusively from the UNFCCC documents, it is more limited than the SDG 14 and Gallo Marine Focus (GMF) frequency data (which spans the entire corpus of UN marine policy documents). To account for this constraint, we will apply an adjusted significance criterion. Changes in attendee proportions will be considered statistically significant if the *p*-value for the regression slope falls below the chosen significance threshold (α).

Finally, we will conduct a 100 regressions model with a Bonferroni Correction for each SDG 14 Target frequency or GMF Topic frequency across all nine convention types [Appendix 4].

This will provide data on the individual convention impacts on the overall frequency changes to a high degree of certainty. Because of this, we will use a chosen significance threshold (α) that is smaller than the thresholds used for the other areas of analysis. This will ensure that any frequency variations by convention over time will not be a result of random chance.

Modified Marine Focus Factor (mMFF) and Target Marine Focus Factor (tMFF) Analysis. To further analyze the variation in marine focus across conference types, we will compare the modified Marine Focus Factor (mMFF) and the Target Marine Focus Factor (tMFF) as descriptive data values for each conference set. These equations account for two key dimensions of marine focus: the frequency of relevant terms per 1,000 words and the breadth of marine policy topics covered within each conference type. By incorporating both prevalence and thematic diversity, our analysis will highlight distinctions between conferences that engage broadly with marine policy and those that concentrate on more specialized marine objectives.

V. Results and Analysis

SDG 14 Target Variation by UN Marine Policy Convention

SDG 14 Target Distribution in UN Marine Policy Documents. We modeled the frequency of each SDG 14 target per 1,000 words within the documents for each category of UN conference [Appendix 5], enabling a comparison across different conference types (Figure 1). The model in Figure 1 highlights the size of each conference category and the proportion of spans classified for each of the SDG 14 Targets. Larger bars indicate higher page and span counts for the specific document categories, while the color-coded sections show the relative frequency of the SDG 14 Targets.

Figure 1: SDG 14 Target Frequencies by Convention

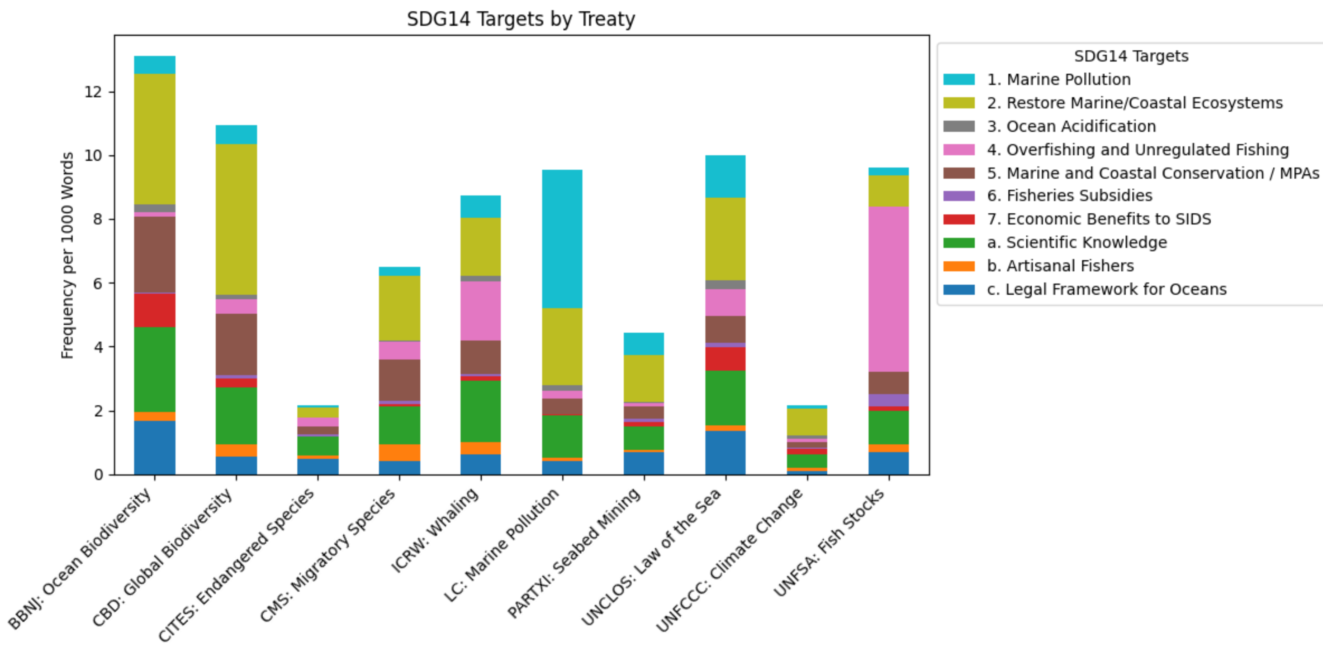


Fig. 1: Frequency of the 10 UN Sustainable Development Goal 14 Targets per 1,000 words for the 10 UN marine conference categories [Appendix 4] as labeled by GPT-4o mini. Documents were sourced from the Elsler et al. 2022 corpus and modified to include documents through 2024.

The results support expected trends in SDG 14 target distribution across conference types and reinforce our confidence in the accuracy of the classification process. For example, the London Convention (LC), formally known as the "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter," recorded the highest frequency of SDG 14.1 (marine pollution), reflecting its primary objectives of pollution mitigation (Figure 1). The UN Fish Stocks Agreement (UNFSA) documents contained the highest frequency per 1,000 words of SDG 14.4 (overfishing and unregulated fishing) and SDG 14.6 (fisheries subsidies), aligning with its focus on economic growth and sustainable fisheries management (Figure 1, Figure 2). These findings support the classification capabilities of GPT-4o mini (additional agreement and confidence metrics are detailed in Appendix 10). SDG 14.2 (Restoring Marine and Coastal

Ecosystems) appeared most frequently across the entire corpus, demonstrating that ecosystem restoration remains a central theme in UN ocean policy discussions. Since this target broadly applies to the restoration and sustainable management of marine resources, its prominence is expected, given the presence of several biodiversity and resource-related conferences. These include the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement under the Law of the Sea, the Convention on Biological Diversity (CBD), the Convention on Migratory Species (CMS), the International Convention for the Regulation of Whaling (ICRW), and the UN Fish Stocks Agreements (UNFSA).

Understanding SDG 14 Target Frequency Values. We calculated the SDG 14 target frequencies for each target category across the entire corpus and for each set of convention documents (Figure 2). SDG target 14.2 (Restoring Marine and Coastal Ecosystems) was the most mentioned target, with a frequency of 2.12 per 1,000 words across the entire corpus. This emphasis was particularly pronounced in the Biodiversity Beyond National Jurisdiction (BBNJ) and Convention on Biological Diversity (CBD) documents, underscoring a connection between ecosystem restoration and biodiversity-focused conventions. However, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) displayed the lowest SDG 14.2 frequency at just 0.31 terms, despite its focus on species protection. This discrepancy suggests that CITES discussions prioritize terrestrial biodiversity over marine-specific restoration efforts, which may explain the reduced frequency of SDG 14.2 terms in its documents.

Figure 2: SDG 14 Target Frequency Values by Convention

Figure 2: SDG 14 Target frequencies by conference (per 1000 words) for each set of convention texts and the entire UN marine policy corpus for this study ("Average over Conventions"). Convention type is found in the chart columns, and SDG 14 target categories are found in the rows. Darker colors indicate a greater SDG 14 Target frequency value per 1000 words for the given convention.

SDG 14.a (Scientific knowledge) ranked second in overall frequency, appearing 1.34 times per 1,000 words. This finding indicates a strong emphasis on scientific data in shaping conservation policies across multiple conventions. Documents from the BBNJ conventions, International Convention for the Regulation of Whaling (ICRW), CBD, and UNCLOS (UN Conference on the Law of the Sea) exhibited particularly high frequencies of SDG 14.a, which may reflect the presence of a greater number of research-focused stakeholders within these forums. Additionally, SDG 14.a emphasizes technology transfer for ocean monitoring, which could explain its elevated frequency in UNCLOS documents, given their role in defining maritime regulations and technological cooperation.

The discussion of SDG 14.4 (Overfishing and Unregulated Fishing) had an overall frequency of 0.97 terms per 1,000 words. However, this value was disproportionately influenced by the United Nations Fish Stocks Agreement (UNFSA) and ICRW, which exhibited markedly higher frequencies of 5.18 and 1.85 terms, respectively. The concentration of SDG 14.4 discussion within these two conventions suggests that overfishing remains a primary concern for forums addressing fishery regulations. In contrast, SDG 14.6 (Ending Harmful Fisheries Subsidies) had the lowest overall frequency in the corpus (0.10 terms per 1,000 words), indicating that economic policies affecting fisheries receive less attention compared to overfishing itself. This could be a result of political pressures from industry-affiliated groups.

SDG 14.5 (Protecting Marine and Coastal Ecosystems/MPAs), which focuses on the legal protection of ecosystems through the establishment of marine protected areas (MPAs), had an overall frequency value of 0.95 terms per 1,000 words. This suggests that the legal frameworks governing MPAs receive considerable attention within UN marine policy discussions. SDG 14.1 (Marine Pollution) displayed a similar frequency pattern to SDG 14.4, with an overall corpus value of 0.9 terms per 1,000 words. This frequency value was largely influenced by the UNCLOS and London Convention documents, which specifically address pollution-related regulations. The prominence of SDG 14.1 within these conventions aligns with their focus on maritime dumping and waste management. Notably, the UNFSA documents exhibited a low SDG 14.1 frequency (0.26 terms per 1,000 words) despite the impact of discarded fishing gear on marine pollution. This suggests that UNFSA discussions prioritize fish stock management over broader environmental concerns associated with fishing practices. SDG

14.c (Legal Frameworks) appeared 0.70 times per 1,000 words, driven by the UNCLOS and related BBNJ Agreement documents, which emphasize maritime law enforcement at governmental, industrial, and ecological levels.

The remaining SDG 14 Targets exhibited frequency values of less than 0.5. In descending order, these include SDG 14.7 (Economic Benefits to Small Island Developing States), 14.b (Support for Small-Scale Fisheries), 14.3 (Ocean Acidification), and 14.6 (Ending Harmful Fisheries Subsidies). The limited focus on SDGs 14.7 and 14.b suggests that issues affecting low-income and developing nations receive less attention within the UN marine policy corpus. This may reflect structural imbalances in global policy discussions, where nations with greater resources and political influence shape the agenda. Increasing representation from stakeholders in these regions could elevate the prominence of these issues in future policy discussions. The low frequency of SDG 14.3 suggests that ocean acidification may also be a lesser priority outside of the scientific community. This may stem from its primary impact on specific ecosystems, such as the deep sea, that receive less attention from the public.

Gallo Marine Focus (GMF) Topic by UN Marine Policy Convention

The Gallo Marine Focus (GMF) topics offer a comprehensive analysis of the marine policy priorities within the broader framework of United Nations (UN) Marine Policy conventions. By modeling GMF topic frequency per 1,000 words, it becomes possible to quantify the areas of greatest and least marine focus across various international agreements (Figure 3).

Figure 3: Gallo Marine Focus Topic Frequency by Convention

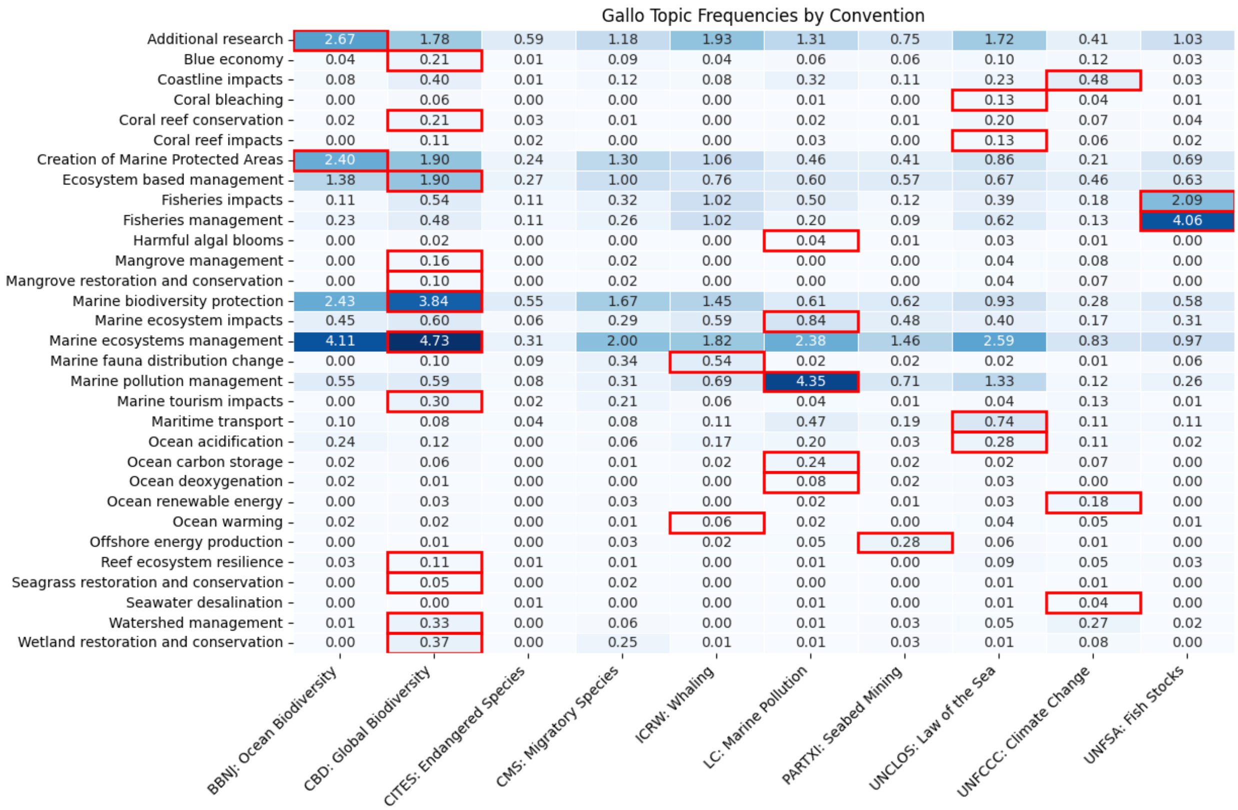


Figure 3: Gallo Marine Focus (GMF) Topic frequencies by convention (per 1000 words) for each set of convention texts. Convention type is found in the chart columns, and the Gallo Marine Focus Topic categories are found in the rows. Darker colors indicate a greater SDG 14 Target frequency value per 1000 words for the given convention. Red boxes indicate the row maxima (convention with the greatest frequency value for each Gallo Marine Focus Topic).

GMF Trends and SDG 14 Target Similarities. The greatest GMF topic frequency per 1,000 words is observed in the Convention on Biological Diversity (CBD) documents, with a "marine ecosystems management" frequency of 4.73 terms. This topic has a frequency value of 4.11 terms in the Biodiversity Beyond National Jurisdiction (BBNJ) documents, marking it as the most prevalent category across the entire corpus. This trend aligns with observations from the SDG 14 target data, which emphasize the importance of marine ecosystem restoration and management (SDG 14.2). The CBD and BBNJ documents also exhibit an increased topic frequency for "marine biodiversity protection" and the "creation of marine protected areas," which parallels the prevalence of SDG 14.5 target frequency. The "additional research" topic also demonstrated an elevated frequency across the corpus, with the greatest values found in the BBNJ (2.67 terms), ICRW (1.93 terms), CBD (1.78 terms), and UNCLOS (1.72 terms) documents. The detailed discussions on scientific whaling in the ICRW documents also likely contribute to this observation. Furthermore, the topic of "marine pollution" follows the trends observed in the SDG 14 target data, with the London Convention exhibiting the highest frequency value (4.35 terms), followed by the UNCLOS documents (2.59 terms). These strong correlations between GMF topic frequencies and SDG 14 target frequencies support the evaluation capabilities of the GPT-4o mini model.

GMF Topic Focus by Convention Set. The analysis of GMF topic frequency by convention set reveals distinct thematic priorities across international marine policy agreements. For example, the BBNJ topic frequencies support the convention's goals of promoting biodiversity and international cooperation with a focus on research and the sustainable management and protection of ecosystems. This conference has two topic frequency maxima (noted by red boxes in Figure 3), indicating that it had the greatest topic frequency for the "creation of MPAs" and "additional research" out of the entire corpus.

In contrast, the CITES and UNFCCC documents exhibit consistently low values across all GMF topics, suggesting that while these conventions incorporate elements of marine policy and utilize marine resources, their primary focus remains broader and more terrestrial. The CITES documents, in particular, may not extensively discuss marine-specific ecosystem impacts, leading to lower classification values for GMF topics in comparison to broader SDG 14 Targets. Similarly, the UNFCCC documents, despite widespread recognition of the ocean's critical role in climate mitigation and the vulnerability of its ecosystems to climate change, appear to frame the ocean primarily as a climate solution rather than addressing specific ecosystem protections. This perspective is further supported by the three topic frequency maxima found within the UNFCCC documents: “coastline impacts” (0.48 terms), “ocean renewable energy” (0.48 terms), and “seawater desalination” (0.04 terms). These maxima are all closely associated with climate-related adaptations and mitigation strategies. “Coastline impacts” pertains to the effects of sea-level rise caused by increasing global temperatures and melting ice caps, whereas “seawater desalination” represents a response to water scarcity resulting from climate variability, including prolonged droughts. Meanwhile, “ocean renewable energy” serves as a potential alternative to fossil fuels, functioning as a climate mitigation strategy. The frequency of the “seawater desalination” topic may also reflect concerns regarding the environmental and energetic costs of large-scale desalination projects.

The CBD documents have 12 topic frequency maxima for the categories of “blue economy,” “coral reef conservation,” “ecosystem-based management,” “mangrove management,” “mangrove restoration and conservation,” “marine biodiversity protection,” “marine ecosystems management,” “marine tourism impacts,” “reef ecosystem resilience,” “seagrass restoration and conservation,” “watershed management,” and “wetland restoration and conservation.” This broad scope underscores the CBD's comprehensive approach to conserving global biodiversity with a particular focus on marine ecosystems, unlike the UNFCCC and CITES documents, where ecosystems and solutions are generalized to terrestrial concerns. The CMS documents, while lacking a corpus topic maximum, prioritize "marine ecosystems management" and "marine biodiversity protection," reflecting an emphasis on ecosystem-based management, research, and MPAs.

The ICRW documents, in comparison, contain two topic frequency maxima for "marine fauna distribution change" (0.54 terms) and "ocean warming" (0.06 terms). The prominence of "marine fauna distribution change" aligns with the convention's initial purpose of addressing the near extinction of numerous cetacean species due to extensive hunting. Additionally, the highest frequency topic, "additional research," likely originates from the discussions of scientific whaling. This prioritization suggests a strong focus on research and scientific input, which may explain the increased attention given to "ocean warming" as a contributing factor to shifts in marine mammal distribution and population recovery. Although fisheries-related topics also appear in the ICRW documents, their frequency values remain lower than those observed in conventions specifically addressing fish stocks.

The London Convention documents exhibit five topic frequency maxima, which is somewhat unexpected given the convention's relatively narrow focus on marine pollution. While "marine pollution management" is the greatest of these maxima at 4.35 terms per 1000 words, this convention also has the highest topic frequencies for "marine ecosystem impacts," "ocean carbon storage," "ocean deoxygenation," and "harmful algal blooms." Ocean deoxygenation and harmful algal blooms have been linked to organic pollution, including fertilizers and agricultural runoff, which fuel algal growth and cause eutrophication and coastal hypoxia. "Ocean carbon storage" refers to carbon sequestration in marine ecosystems as a means of reducing atmospheric carbon dioxide. This is a potential climate-change mitigation strategy, which may also explain the prevalence of the "additional research" topic to better understand atmospheric and marine pollutant remediation. This data, coupled with the lower pollution frequency values in the UNFSA documents, suggests that the London Convention stakeholders were more focused on the impacts of organic wastes, chemical byproducts, and emissions than fishing gear. The Part XI convention documents on seabed mining contain one topic frequency maximum for “offshore energy production” (0.28 terms), though “marine ecosystem impacts” (1.46 terms) had the highest topic frequency value. This pattern reflects the convention’s dual focus on resource extraction and compliance with international guidelines for ecosystem protection and mining practices.

The UNCLOS documents have four topic frequency maxima: “maritime transport,” “ocean acidification,” “coral bleaching,” and “coral reef impacts.” The greatest topic frequency was for “marine ecosystems management” (2.59). Increased frequency values were also observed for areas related to marine pollution, fisheries, and research. This variety in topics presents an interesting dichotomy between the role of the UNCLOS in regulating marine vessels (as seen with the transport, pollution, and fisheries topics) while also aiming to restore and protect ecosystems. It is also interesting to note that the UNCLOS documents specifically mentioned coral reefs while largely omitting other ecosystems like wetlands and mangroves. The expansive range of topics within the UNCLOS documents could indicate a greater variety in conference attendee demographics, with some areas being party/IGO focused (like vessel regulations and fisheries), while other topics (such as reef conservation and ecosystems management) indicate a strong scientific presence. The ocean acidification frequency may also suggest a potential emphasis on climate-related impacts on ecosystem health and biodiversity, which could be motivated by NGOs or industry stakeholders.

Finally, the UNFSA documents exhibit two frequency maxima for the expected topics of “fisheries impacts” (2.09 terms) and “fisheries management” (4.06 terms). Other frequently discussed areas include ecosystem-based management and the creation of MPAs. The inclusion of ecosystem management and conservation topics is likely motivated by the fishing industry’s dependence on sustainable fish stocks. However, the relatively high frequency of "creation of MPAs" may indicate that this issue is viewed through a more contentious lens, particularly in relation to industry stakeholders' influence on convention literature.

Modified Marine Focus Factor and Target Marine Focus Factor by Convention

Target Marine Focus Factor (tMFF) Variation. The Target Marine Focus Factor (tMFF) serves as a descriptive variable for comparing variation in marine focus across the ten conference categories based on their SDG 14 target frequencies (Table 2). This metric accounts for both the frequency of SDG 14 target mentions within each document set and the range of SDG 14 Targets addressed, providing a more comprehensive measure of marine focus. By utilizing a ratio of target terms to total words rather than raw counts, the tMFF ensures comparability across corpora of varying document sizes. Additionally, by incorporating the diversity of SDG 14 Targets within each convention set, this metric facilitates comparisons between broadly focused and highly specific marine policy documents.

The BBNJ convention exhibited the highest tMFF score (26.206), reinforcing previous findings that the convention documents contain frequent references to SDG 14 Targets and address a broad spectrum of marine policy concerns. The CBD follows with a tMFF score of 21.8456, demonstrating a similar distribution of SDG 14 Targets to the BBNJ documents but with a slightly lower target frequency per 1,000 words. In contrast, the CITES and UNFCCC conventions display the lowest tMFF values, at 4.11236 and 4.334, respectively, which aligns with prior analyses suggesting that these conventions adopt broader environmental policies with a reduced marine focus. The SDG 14 Targets are more generalized than GMF topics, and nearly all the convention sets include some reference to each target. Thus, the tMFF metric is more dependent on overall target frequency than target variety. Consequently, we must employ a more specialized categorization—such as the GMF topics—to better understand the diversity in marine focus topics across conventions.

Table 2: SDG 14 Target Marine Focus Factor (tMFF) by Convention

Convention	tMFF
BBNJ: Ocean Biodiversity	26.206
CBD: Global Biodiversity	21.846
CITES: Endangered Species	4.112
CMS: Migratory Species	13.024
ICRW: Whaling	17.443
LC: Marine Pollution	19.066
PARTXI: Seabed Mining	8.880
UNCLOS: Law of the Sea	19.982
UNFCCC: Climate Change	4.334
UNFSA: Fish Stocks	19.251

Table 2: SDG Target Marine Focus Factor (tMFF) calculated using a modified methodology from Gallo et al. [Appendix 8].

Modified Marine Focus Factor (mMFF) Variation. Like the target Marine Focus Factor (tMFF), the Modified Marine Focus Factor (mMFF) serves as a descriptive variable for assessing variations in marine focus across documents. However, the mMFF specifically evaluates the ten convention types by analyzing differences in Gallo Marine Focus (GMF) topic frequency and diversity. Because GMF topics are more specialized than SDG 14 Targets, convention texts must exhibit a higher degree of specificity in marine policy discussions to be classified by the GPT-4o mini model. As a result, the mMFF provides a more precise representation of marine policy diversity within the corpus compared to the tMFF, offering a refined metric for understanding variations in marine focus across different conventions.

Table 3: Modified Gallo Marine Focus Factor (mMFF) by Convention

Convention	mMFF
BBNJ: Ocean Biodiversity	26.971
CBD: Global Biodiversity	38.440
CITES: Endangered Species	4.038
CMS: Migratory Species	19.100
ICRW: Whaling	18.869
LC: Marine Pollution	24.488
PARTXI: Seabed Mining	11.534
UNCLOS: Law of the Sea	23.672
UNFCCC: Climate Change	9.677
UNFSA: Fish Stocks	22.044

Table 3: Modified Gallo Marine Focus Factor (mMFF) calculated using a modified methodology from Gallo et al. [Appendix 7].

The results of the mMFF calculation indicate that the CBD has the highest degree of marine focus across the corpus when analyzed for both topic frequency and variety of topics, followed by the BBNJ (Table 3). This aligns with the overall GMF frequencies (Figure 3), where the CBD and BBNJ both have relatively high frequencies and several topic maxima. The data also shows that the LC documents are fairly diverse despite the conference having a large focus on marine pollution. This suggests that the LC documents must address multiple types of pollutants, which are indicated in the Gallo concerns. Additionally, these results indicate that the convention documents discuss these impacts across a diverse range of ecosystems (hence the high frequency and variety in the GMF topic mentions).

The UNCLOS documents also encompass a variety of marine topics and were previously observed to have increased GMF topic frequencies across categories with several frequency maxima (Figure 3). The UNFSA mMFF score also supports previous observations of a strong marine focus in these documents (especially in the areas of fisheries management). The mMFF score also shows that despite being concentrated on fisheries issues, the UNFSA documents address a variety of marine policy concerns.

The CITES and UNFCCC documents had the lowest mMFF scores. The CITES mMFF was likely influenced by the focus on terrestrial issues and broad ecological concerns related to endangered species. Since these areas do not specifically address individual marine concerns or environments, the model does not identify them under the GMF topics, which decreases the variability in GMF and further decreases the mMFF score. In the case of the UNFCCC documents, a greater variety of marine topics were addressed when compared to the CITES, but the overall frequencies in each area were fairly low. This means that while the UNFCCC documents addressed a multitude of marine issues and ecosystem-specific concerns, the frequencies were likely diluted by the other non-ocean policies for climate change mitigation.

Evolution of UN Marine Policy Focus

As the UN marine policy forum has expanded to include specialized conventions, the overall volume of policy documents has significantly increased. To understand the evolution of marine policy focus in UN marine policy literature, we must interpret the frequencies of SDG 14 Targets or GMF topics as a function of time. Figure 4 shows the SDG 14 target frequency per 1000 words for the entire corpus by publication year from 1992–2021. To further interpret these results, we will utilize several regression models to determine the significance of changes to marine policy focus (through SDG 14 Targets or GMF topics) over time. To be considered significant, the data must yield a non-zero regression slope within the 95% confidence interval and a *p*-value that is less than the predetermined significance threshold (α). For this analysis, we will use a standard α value of 0.05.

Figure 4: Trends in SDG 14 Target Frequencies by Publication Year

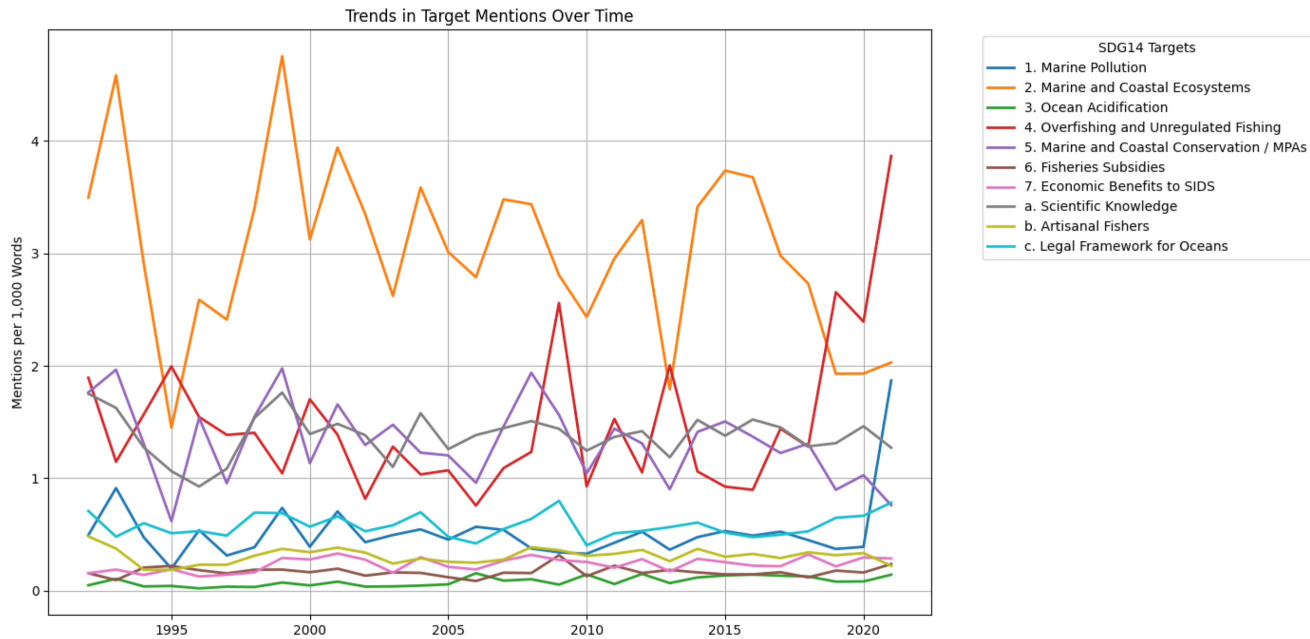


Figure 4: Changes in SDG 14 target frequency per 1000 words by target number for the Elsler corpus from 1992–2021. Each SDG 14 target is represented by a specific color (see key).

Pooled regression results for marine focus metrics from 1992–2021. The initial results from the pooled regression data for the SDG 14 target frequencies by year of publication suggest that only SDG 14.3 (Ocean Acidification) and SDG 14.7 (Economic benefits to SIDS) have a non-zero slope within the 95% confidence interval (Figure 5). Both SDG 14.3 and SDG 14.7 have a positive slope value for the regression, meaning that these targets increased in frequency from 1992–2021 in the UN marine policy corpus. Targets 14.2 (Restoring Marine and Coastal Ecosystems), 14.4 (Overfishing and Unregulated Fishing), and 14.5 (Marine and Coastal Conservation/MPAs) do not meet the significance conditions but have a pronounced trend that may be significant in further research. Targets 14.2 and 14.5 have a possible negative slope value, meaning that the data suggests that these targets may have decreased in frequency within the UN marine policy corpus from 1992–2021. Target 14.4 has a possible positive slope, indicating that overfishing is possibly an area of increased focus over time, which could be explained by the large number of UNFSA documents released at the end of the corpus.

Figure 5: Regression Slopes for SDG 14 Target Frequencies by Publication Year

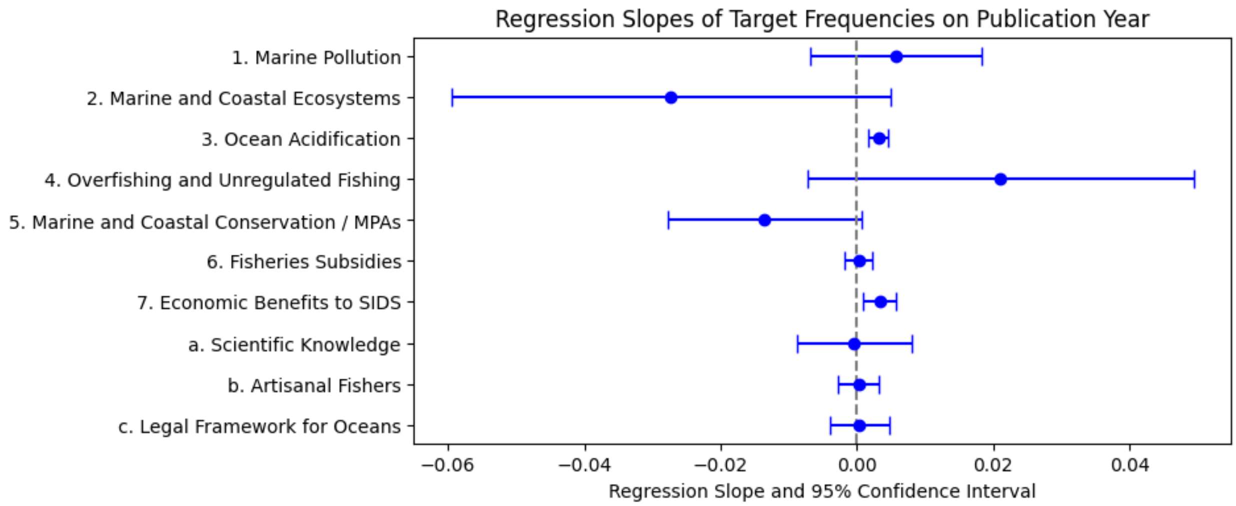


Figure 5: Regression slope values for SDG 14 target frequency vs. publication year (1992–2021) for the Elsler et al. (2022) UN marine policy corpus. Error bars represent the 95% confidence interval for each regression slope. Values were calculated using an ordinary least squares (OLS) regression. A regression slope may be considered significant if the 95% confidence interval does not include 0.

The second criterion for significance in target frequency variation is a *p*-value that is less than the chosen significance threshold (0.05). The *p*-value data (Table 4) supports the observations in Figure 5 and indicates that SDG 14.3 (Ocean Acidification) and SDG 14.7 (Economic Benefits to SIDS) had a significant change in frequency from 1992–2021. The *p*-value data also supports the observations that SDG 14.2 and SDG 14.5 were near significant, and that further research may confirm this significance. Thus, it is possible that the UN's focus on restoring marine and coastal ecosystems and creating MPAs may have decreased during the timeframe of the research. The *p*-value for SDG 14.4 is more than twice the value for the significance threshold, and thus, the observed increase in overfishing and unregulated fishing is less likely to be significant than in the aforementioned areas. The remainder of the topics have considerably higher *p*-values and, thus, are not considered significant based on this regression.

Table 4: Pooled Regression Values for SDG 14 Target Frequencies

SDG 14 Target	Regression Slope	Lower Bound	Upper Bound	*p*-Value
1. Marine Pollution	0.005739	-0.006782	0.01826	0.355837
2. Marine and Coastal Ecosystems	-0.027259	-0.059502	0.004985	0.094326
3. Ocean Acidification	0.003115	0.001679	0.004552	0.000127
4. Overfishing and Unregulated Fishing	0.021086	-0.007304	0.049476	0.13937
5. Marine and Coastal Conservation / MPAs	-0.01353	-0.027768	0.000707	0.061668
6. Fisheries Subsidies	0.000216	-0.001737	0.002168	0.822441
7. Economic Benefits to SIDS	0.003315	0.000963	0.005666	0.007418
a. Scientific Knowledge	-0.000383	-0.00885	0.008084	0.926797
b. Artisanal Fishers	0.000221	-0.002715	0.003158	0.878348
c. Legal Framework for Oceans	0.000401	-0.004036	0.004839	0.854361

Table 4: Pooled regression values for SDG 14 target frequency changes from 1992–2021. Target title, pooled regression slope, and upper and lower bounds for the 95% confidence interval for the slope are shown. Green rows indicate that the target is statistically significant at the 5% level.

As with the above SDG 14 target frequency regressions, many of the Gallo Marine Focus topics do not have a non-zero regression slope within the 95% confidence interval and, thus, fail the first criterion for significance. Two GMF topics have non-zero negative slopes with 95% confidence: marine biodiversity protection and wetland conservation and restoration. This suggests that these areas have become less prevalent as marine policy concerns from 1992–2021. Maritime transport, ocean acidification, ocean carbon storage, ocean renewable energy, and ocean warming have non-zero positive slopes, indicating a potential increase in focus for the corpus. The negative slope for marine biodiversity protection is somewhat surprising, given that many of the documents had high frequency values for this GMF (Figure 3) and the corresponding SDG 14.2 target (Marine and coastal ecosystems) (Figure 2). This disconnect between the observed GMF frequency values and the regression slopes suggests that the early documents in the corpus (such as those from the CBD) may be more skewed toward marine biodiversity and ecosystem protection, which would cause the appearance of decreasing focus.

Figure 6: Regression Slopes for Gallo Marine Focus Topic Frequencies by Publication Year

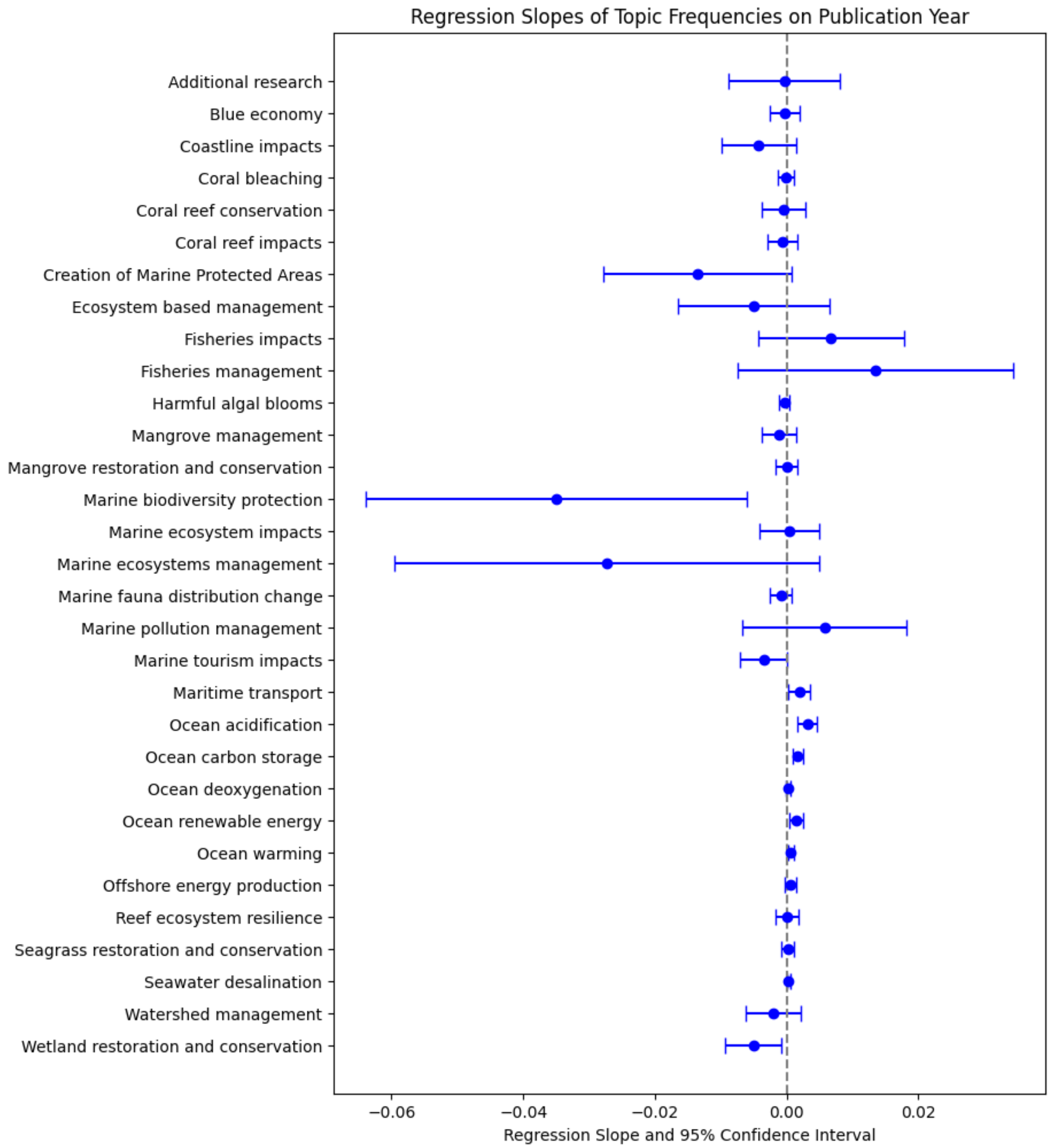


Figure 6: Regression slope values for GMF topic frequency vs. publication year for the Elsler et al. (2022) UN marine policy corpus. Error bars represent the 95% confidence interval for each regression slope. Values were calculated using an ordinary least squares (OLS) regression. A regression slope may be considered significant if the 95% confidence interval does not include 0.

Table 5: Pooled Regression Values for Gallo Marine Focus Topic Frequencies

Gallo Marine Focus Topic	Regression Slope	Lower Bound	Upper Bound	*p*-Value
Additional research	-0.000383	-0.00885	0.008084	0.926797
Blue economy	-0.000332	-0.002607	0.001943	0.767468
Coastline impacts	-0.004267	-0.009907	0.001373	0.132435
Coral bleaching	-0.000111	-0.001388	0.001166	0.86029
Coral reef conservation	-0.00043	-0.003766	0.002906	0.793788
Coral reef impacts	-0.000691	-0.002929	0.001547	0.53199
Creation of Marine Protected Areas	-0.01353	-0.027768	0.000707	0.061668
Ecosystem based management	-0.005	-0.01657	0.00657	0.383593
Fisheries impacts	0.006728	-0.004317	0.017773	0.222448
Fisheries management	0.013465	-0.007415	0.034345	0.197205
Harmful algal blooms	-0.000355	-0.001106	0.000396	0.340704
Mangrove management	-0.0012	-0.003799	0.001399	0.352247
Mangrove restoration and conservation	-0.000004	-0.00168	0.001672	0.996303
Marine biodiversity protection	-0.034994	-0.063877	-0.006112	0.019339
Marine ecosystem impacts	0.000474	-0.004048	0.004996	0.831487
Marine ecosystems management	-0.027259	-0.059502	0.004985	0.094326
Marine fauna distribution change	-0.00087	-0.002565	0.000825	0.30213
Marine pollution management	0.005739	-0.006782	0.01826	0.355837
Marine tourism impacts	-0.003515	-0.007064	0.000035	0.052167
Maritime transport	0.001912	0.000204	0.003619	0.029548
Ocean acidification	0.003115	0.001679	0.004552	0.000127
Ocean carbon storage	0.001668	0.000838	0.002498	0.000307
Ocean deoxygenation	0.000261	-0.00008	0.000602	0.12831
Ocean renewable energy	0.00141	0.000354	0.002466	0.010667
Ocean warming	0.000646	0.000155	0.001137	0.011813
Offshore energy production	0.00061	-0.000292	0.001513	0.176697
Reef ecosystem resilience	0.000026	-0.001731	0.001782	0.976444
Seagrass restoration and conservation	0.000139	-0.00078	0.001058	0.758342
Seawater desalination	0.000279	-0.000018	0.000576	0.064716
Watershed management	-0.00205	-0.006258	0.002158	0.326814
Wetland restoration and conservation	-0.005036	-0.009276	-0.000795	0.021642

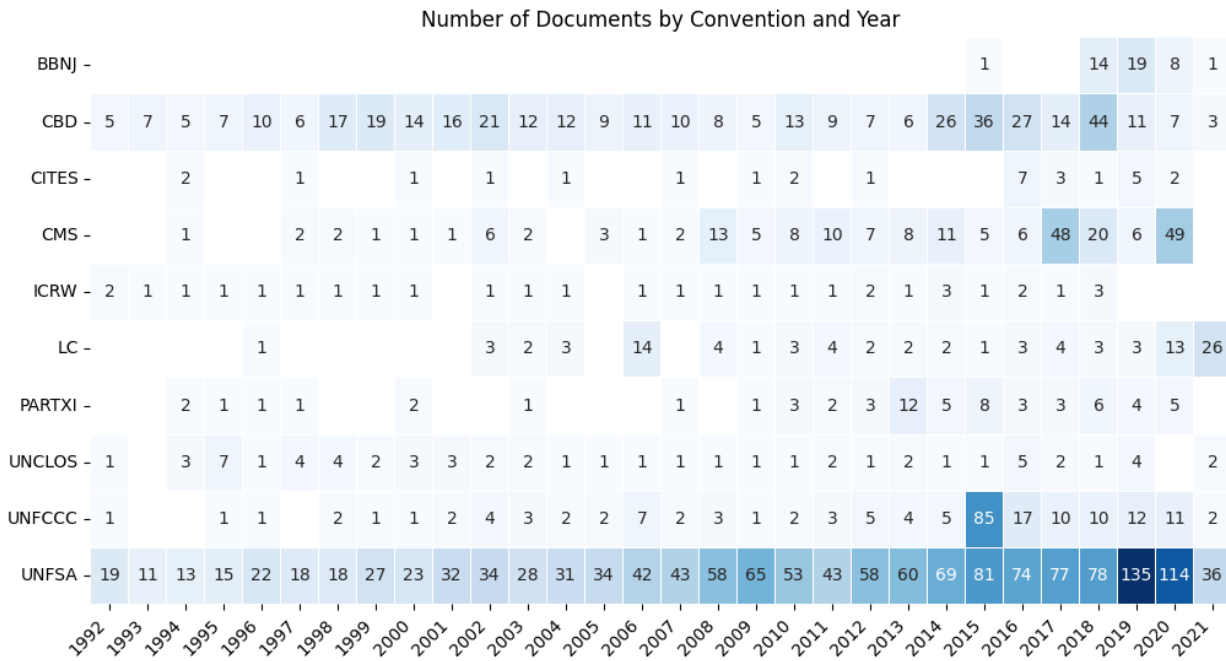
Table 5: Pooled regression values for GMF topic frequency changes from 1992–2021. Target title, pooled regression slope, and upper and lower bounds for the 95% confidence interval for the slope are shown Green rows indicate that the target is statistically significant at the 5% level.

The *p*-value data for these seven topics supports the conclusion that these results are statistically significant and that the aforementioned topics have demonstrated a change in focus within the UN marine policy corpus from 1992–2021. For all seven topics, the *p*-value is less than the significance threshold of 0.05. Additionally, two of these topics (ocean acidification and ocean carbon storage) have *p*-values less than 0.005. This means that the observed frequency changes for these two categories during the timeframe are even less likely to have occurred as a result of chance.

Based on this regression, we can infer that climate mitigation strategies have likely contributed to the increased focus on ocean acidification, ocean carbon storage, and ocean renewable energy. Since the UNFCCC documents were mostly released later in the corpus, this could suggest that the COPs have had a major impact on this shift in ocean policy toward climate-related concerns. This reasoning could also apply to the increases in maritime transportation if the frequency increase is a result of discussions on fueling maritime vessels and reducing their emissions.

Fixed effect regression results for marine focus metrics from 1992–2021. Using a fixed effect regression controlling for the convention type allows us to account for variations in frequency during the timeframe that result from possible patterns in the document publication timeline that may skew the time-series data. For example, the UNFCCC documents occurred much later in the corpus and released many documents within a short period of time through the nationally determined contributions (NDCs) and additional COP documents (Figure 7). Similarly, the UNFSA began releasing more regionally-specific documents in the later portion of the corpus, which could further skew the results of topics that impact fisheries stocks (i.e., biodiversity and the creation of MPAs), regulation, and subsidies. Thus, these regression results help to reduce the bias in the frequency data and provide a more comprehensive approach to the marine focus analysis.

Figure 7: Document Publication Dates and Quantities by Convention Type



The fixed effect regression for the SDG 14 target frequencies supports these concerns that individual convention effects may have altered the regression analysis (Figure 8). Unlike the pooled regression results, the controlled data indicates that all of the topics other than SDG 14.6 (Harmful Fisheries Subsidies) increased over time (Figure 8). The greatest variation (based on the absolute value of the slope) appears to have occurred in SDG 14.2 (Marine and Coastal Ecosystems), followed by SDG 14.4 (Overfishing and Unregulated Fishing), and SDG 14.c (Expanding scientific knowledge). However, the areas from the initial regression with a significant positive slope (SDG 14.3 and 14.7) remain both positive and significant in this data. This suggests that the results from the pooled regression may still be useful when wanting to better understand document context. More research is needed to better understand what variables within the conventions led to this negative effect on the slopes in the pooled data.

The mean slope values and error margins can also help us to better understand how these increases compare across SDG 14 Targets. SDG 14.2 (Marine and Coastal Ecosystems) likely had the greatest increase in focus from 1992–2021 based on the slope value. The margin of error, however, indicates that the exact change in focus for this area may overlap with the possible values for other topics. SDG 14.4 (Overfishing and Unregulated Fishing), SDG 14.c (Scientific Knowledge), and SDG 14.5 have the next greatest slope values (though with varying margins of uncertainty. Overall, this data suggests that the oceans are gaining a greater focus in UN policy literature over time, though the focus on broader categories (such as those applicable to a variety of countries and ecosystems) may be increasing at a greater rate. This means that topics that are less known or more applicable to smaller and developing nations (such as ocean acidification, economic benefits to SIDS, and artisanal fisheries) may be more likely to be overlooked. This could be a result of lesser representation from these demographics in convention forums, although the positive slopes indicate that this representation could be increasing over time.

Figure 8: Regression Coefficient Estimates for SDG 14 Targets (Controlled for Convention)

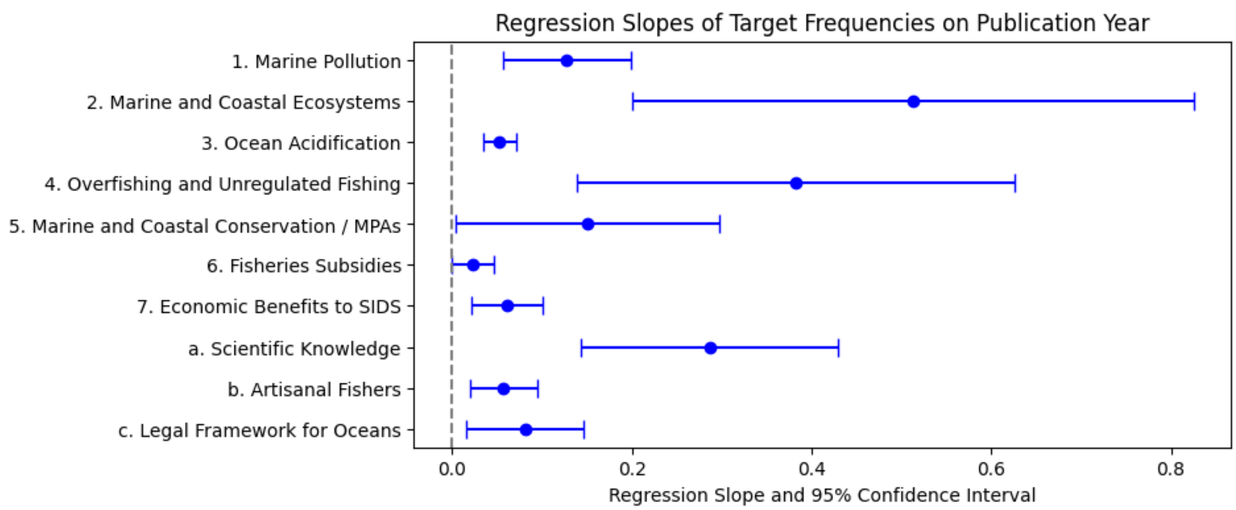


Figure 7: Regression coefficient estimates for SDG 14 target frequencies calculated using a fixed regression controlling for convention type [Appendix 4]. Values were calculated using a negative binomial counts regression. A regression slope may be considered significant if the 95% confidence interval does not include 0.

The *p*-values for the nine conferences with positive, non-zero coefficient estimates (within 95% confidence) are all well below the chosen significance threshold of 0.05 (Table 6). This data supports the observations that all SDG 14 Targets except SDG 14.6 (Fisheries Subsidies) increased in frequency from 1992–2021. This indicates that SDG 14 has become more prevalent in the UN corpus since 1992 and suggests that these conventions have begun to consciously incorporate these topics and that the Sustainable Development Goals have been a successful tool within UN policy literature to ensure that critical topics receive a greater focus at conventions.

Table 6: Regression Coefficient Estimates for SDG 14 Targets (Controlled for Convention)

SDG 14 Target	Regression Coefficient	Lower Bound	Upper Bound	P-Value
1. Marine Pollution	0.127917	0.056559	0.199276	4.48E-04
2. Marine and Coastal Ecosystems	0.513321	0.200585	0.826058	1.31E-03
3. Ocean Acidification	0.052501	0.034263	0.070739	1.86E-08
4. Overfishing and Unregulated Fishing	0.382499	0.139559	0.625439	2.04E-03
5. Marine and Coastal Conservation / MPAs	0.150802	0.004552	0.297053	4.33E-02
6. Fisheries Subsidies	0.022964	-0.000968	0.046896	6.00E-02
7. Economic Benefits to SIDS	0.061407	0.021624	0.10119	2.50E-03
a. Scientific Knowledge	0.286637	0.143553	0.429721	8.81E-05
b. Artisanal Fishers	0.057469	0.020698	0.094241	2.20E-03
c. Legal Framework for Oceans	0.081106	0.015295	0.146918	1.57E-02

Table 6: Fixed effect regression coefficient estimates for GMF topic frequency changes from 1992–2021 controlling for convention type [Appendix 4]. Target title, fixed effect regression slope, and upper and lower bounds for the 95% confidence interval for the slope are shown. Green rows indicate that the target meets both criteria for significance.

We used the same fixed effect regression for the GMF topics and found that correcting for the convention had similar impacts on the GMF topic frequency results. As with the fixed SDG 14 target regression values, this calculation yielded an increase in significant GMF topics. All the slope values for the fixed effect regression are positive, though not all meet the significance criteria.

Figure 9: Regression Coefficient Estimates for GMF Topic Frequencies (Controlled for Convention)

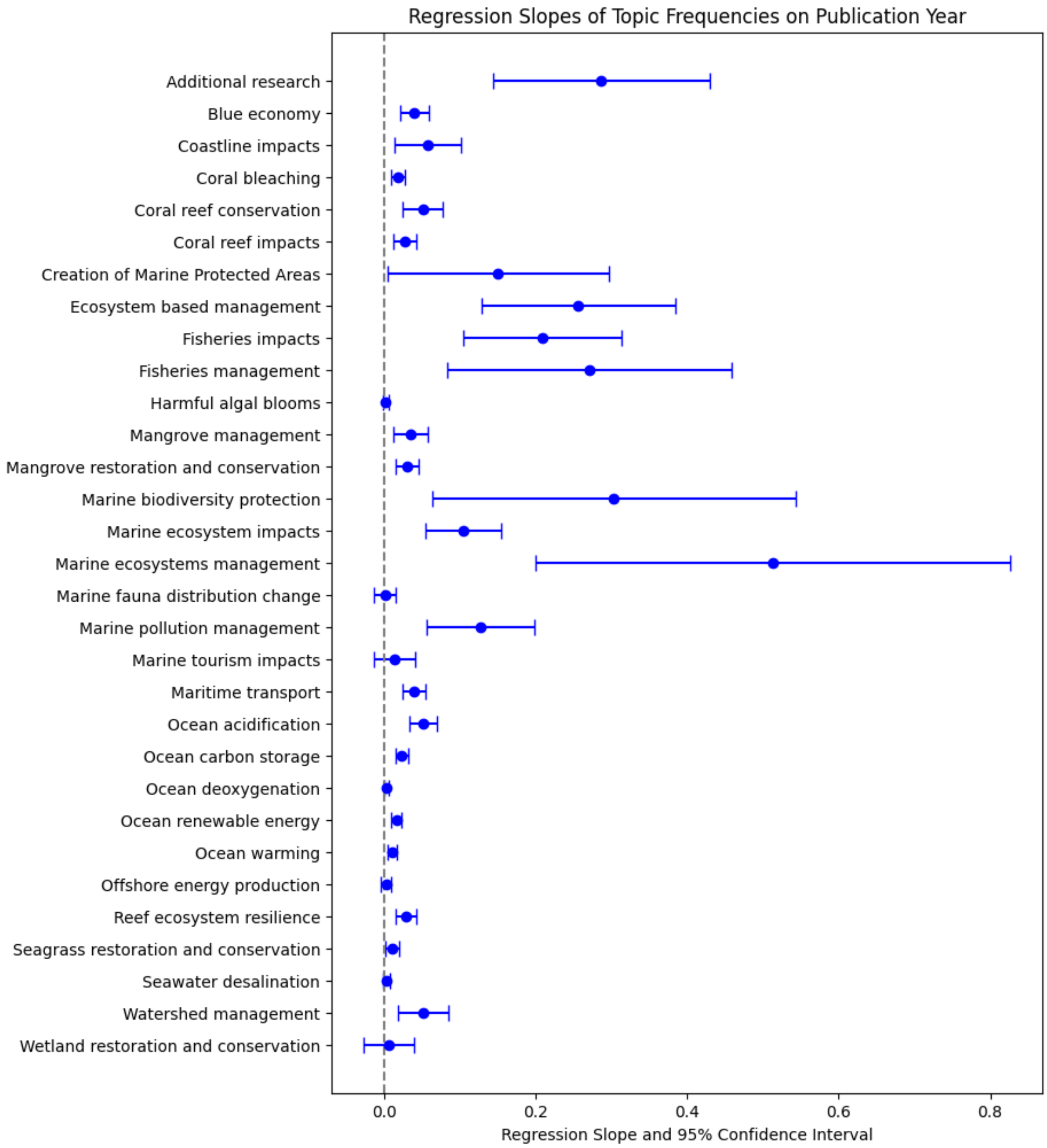


Figure 9: Regression coefficient estimates for GMF topic frequencies calculated using a fixed regression controlling for convention type [Appendix 4]. Values were calculated using a negative binomial counts regression. A regression slope may be considered significant if the 95% confidence interval does not include 0.

The greatest increases appear to be for Marine Ecosystems Management, Marine Biodiversity Protection, Additional Research, Fisheries Management, Ecosystem-Based

Management, and Fisheries Impacts. Unlike the initial data from the pooled regressions, this suggests that there is an increase within the UN policy corpus on management goals. These include specific areas of management, such as ecosystems or fisheries stocks, and management approaches (i.e., ecosystem-based methods). Additional research suggests that there is an increase in scientific focus, which could be a result of greater platforms for scientific discussion at conventions and a greater percentage of convention attendees from universities and research institutions. The increase in fisheries topics may suggest that the fishing industry is becoming more involved in conventions. However, it is important to note that the GMF topics do not explicitly separate artisanal fisheries from industrial fisheries (as seen with the SDG 14 Targets).

The fixed effect regression *p*-values support the above observations of significance (Table 7). All GMF topics with 95% confidence intervals not including 0 have *p*-values that are less than the chosen significance threshold of 0.05. It is important to note that all GMF topics with significant changes in the pooled regressions (except for wetland restoration and conservation) maintained significant changes in the same direction for the fixed effect regressions. This suggests that the pooled model may be useful for more dramatic changes in the time series, while the fixed effect is better for detecting smaller changes that may be overlooked in the presence of convention bias. The following GMF topics do not meet the significance criteria: harmful algal blooms, marine fauna distribution change, marine tourism impacts, offshore energy production, seawater desalination, and wetland restoration and conservation.

Table 7: Regression Coefficient Estimates for GMF Topic Frequencies (Controlled for Convention)

Gallo Marine Focus Topic	Regression Coefficient	Lower Bound	Upper Bound	p-Value
Additional research	0.286637	0.143553	0.429721	8.81E-05
Blue economy	0.040468	0.021517	0.059418	2.93E-05
Coastline impacts	0.057836	0.013626	0.102045	1.04E-02
Coral bleaching	0.018607	0.009788	0.027426	3.64E-05
Coral reef conservation	0.051558	0.024835	0.078281	1.59E-04
Coral reef impacts	0.027968	0.012971	0.042964	2.61E-04
Creation of Marine Protected Areas	0.150802	0.004552	0.297053	4.33E-02
Ecosystem based management	0.256529	0.128876	0.384183	8.37E-05
Fisheries impacts	0.209567	0.10501	0.314123	8.73E-05
Fisheries management	0.271416	0.08452	0.458312	4.44E-03
Harmful algal blooms	0.002471	-0.001086	0.006027	1.73E-01
Mangrove management	0.03541	0.012499	0.058321	2.47E-03
Mangrove restoration and conservation	0.030547	0.015852	0.045241	4.73E-05
Marine biodiversity protection	0.303523	0.063633	0.543413	1.32E-02
Marine ecosystem impacts	0.104871	0.055058	0.154685	3.79E-05
Marine ecosystems management	0.513321	0.200585	0.826058	1.31E-03
Marine fauna distribution change	0.00178	-0.012697	0.016257	8.09E-01
Marine pollution management	0.127917	0.056559	0.199276	4.48E-04
Marine tourism impacts	0.01368	-0.01342	0.04078	3.22E-01
Maritime transport	0.039599	0.024147	0.055051	5.42E-07
Ocean acidification	0.052501	0.034263	0.070739	1.86E-08
Ocean carbon storage	0.024015	0.015575	0.032455	2.70E-08
Ocean deoxygenation	0.004056	0.000937	0.007175	1.08E-02
Ocean renewable energy	0.017106	0.010409	0.023803	5.90E-07
Ocean warming	0.011798	0.005873	0.017723	9.71E-05
Offshore energy production	0.002906	-0.004478	0.010291	4.40E-01
Reef ecosystem resilience	0.028666	0.014988	0.042344	4.10E-05
Seagrass restoration and conservation	0.011264	0.002556	0.019971	1.13E-02
Seawater desalination	0.002984	-0.001562	0.007531	1.98E-01
Watershed management	0.052204	0.018985	0.085423	2.08E-03
Wetland restoration and conservation	0.006792	-0.026375	0.039958	6.88E-01

Table 7: Fixed effect regression coefficient estimates for GMF topic frequency changes from 1992–2021 controlling for convention type [Appendix 4]. Target title, fixed effect regression slope, and upper and lower bounds for the 95% confidence interval for the slope are shown. Green rows indicate that the target meets both criteria for significance.

Regression Coefficient Analysis for 100 Regressions. Given the observed differences between the pooled and fixed effect regressions, we will use the data from a 100 regressions model with a Bonferroni Correction to evaluate the impacts of individual conventions on the SDG 14 Target frequency variations. Because this model shows the frequency change by convention, this will also help to confirm our assumptions that certain conferences were more impactful on specific targets. This, along with the variation in document publication timelines, could potentially explain why the fixed effect regression yielded significantly different results from the initial pooled regressions.

Figure 10: Regression Coefficients for 100 Regressions with Convention Fixed Effects (Negative Binomial Regression with Bonferroni Correction)

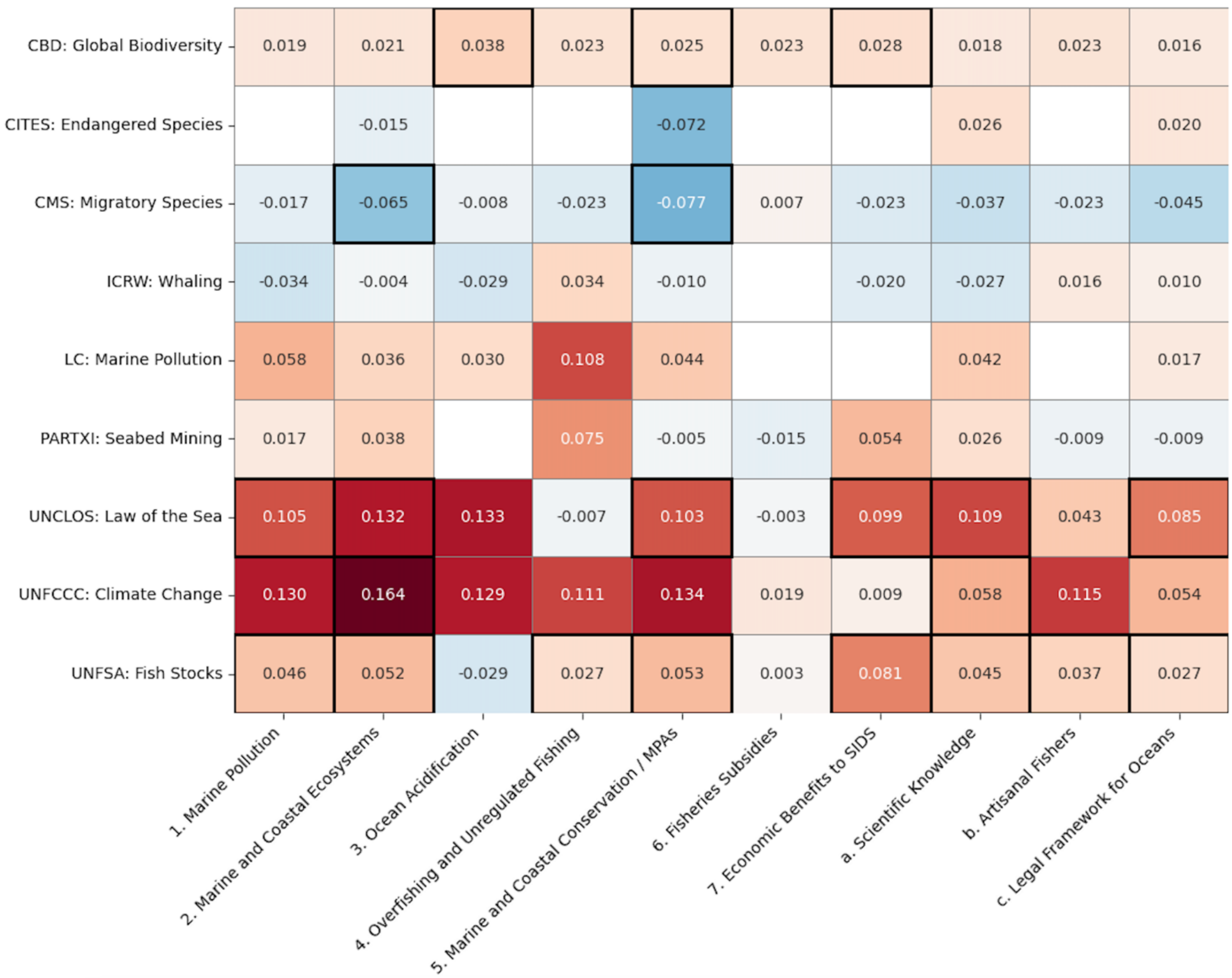


Figure 10: Regression coefficients for SDG 14 Target frequencies over time by convention. Regression values were calculated for 100 regressions with fixed effect controls for convention. Darker reds indicate a more positive slope value, while darker blues indicate a more negative slope value. Black boxes indicate significant changes in SDG 14 Target frequency from 1992–2021, as determined by a p-value (not shown) less than the chosen significance threshold of 0.00005.

After conducting the 100 regressions for each topic and convention type, 21 significant regression coefficient values emerged, as indicated by a *p*-value less than the chosen significance threshold of 0.00005 (Figure 10). The frequency of SDG 14.1 (marine pollution) increased in the UNCLOS and UNFSA documents, suggesting a heightened emphasis on pollution concerns in international maritime law and fisheries management. While an increase might have been expected in the London Convention (LC) due to its specific focus on marine pollution, the absence of significant changes in frequency indicates that the convention has maintained a stable approach to this issue over time. The LC documents exhibit no notable shifts in SDG 14 target frequencies, reinforcing the notion that their policy priorities have remained consistent.

The frequency of SDG 14.2 (restoration of marine and coastal ecosystems) increased in the UNCLOS, UNFCCC, and UNFSA documents, highlighting a growing focus on ecosystem restoration within international law, climate policy, and fisheries management. This trend aligns with broader goals to leverage ocean-based solutions for climate change mitigation and to address ecosystem degradation caused by climate variation (such as ocean warming and acidification). The increase in the UNFSA convention documents suggests a growing recognition of the role of ecosystem restoration in sustaining fish stocks and aiding the recovery of vulnerable populations. However, SDG 14.2 experienced a significant decline in the CMS documents, implying a potential shift away from marine migratory species toward a broader or more terrestrial focus.

Despite ocean acidification being a prominent issue in global ocean policy discussions, it only increased significantly in the CBD documents. This pattern suggests an influx of scientific concerns regarding the effects of acidification on biodiversity, possibly signaling an increasing presence of more specialized marine policy topics within the CBD framework. Similarly, SDG

14.4 (overfishing and unregulated fishing) demonstrated a substantial increase over time in the UNFSA documents, reflecting a heightened focus on fish stock depletion. This shift may indicate growing awareness among industry representatives and an increased presence of scientists at these conventions, pointing to a greater collaboration between scientific research and industry-driven policymaking.

The frequency of SDG 14.5 (creation of MPAs) increased in the CBD, CMS, UNCLOS, and UNFSA convention sets. Given the importance of MPAs in biodiversity conservation and ecosystem management, this rise is expected in the CBD and CMS documents, since MPAs serve as a key tool for species and habitat protection. The increase in the UNCLOS documents may reflect the global expansion of MPAs, which has elevated their relevance in international maritime law. While SDG 14.5 also increased in the UNFSA documents, the model does not differentiate whether MPAs were discussed positively or negatively. As a result, this increase may reflect industrial attempts to access protected ecosystems due to stock depletion elsewhere or misconceptions that these ecosystems have fully recovered (Aburto-Oropeza et al., 2025). Unlike other SDG 14 Targets, SDG 14.6 (eliminating harmful fisheries subsidies) did not exhibit significant changes in any of the convention sets. This stability aligns with the pooled and fixed effect regression results, which show no notable variations in the frequency of this target over time.

In contrast, SDG 14.7 (economic benefits to small island developing states, or SIDS) increased in the CBD, UNCLOS, and UNFSA conventions, potentially indicating a greater representation of lower-income nations in these policy discussions. These findings align with the upward trend observed in the fixed effect regression analysis.

The frequency of SDG 14.a (increasing scientific knowledge) increased in the UNCLOS, UNFCCC, and UNFSA documents, reinforcing the critical role of scientific research and technological development in marine policy. The UNCLOS convention, which oversees marine technology regulation, resource extraction, and data collection, has a vested interest in advancing scientific knowledge. Similarly, the UNFSA convention relies on scientific research to analyze catch data and implement conservation strategies. The UNFCCC's increasing emphasis on SDG 14.a likely reflects its commitment to developing new climate change mitigation solutions, which require continuous technological advancements, adaptation strategies, and scientific monitoring to assess the effectiveness of implemented measures.

The frequency of SDG 14.b (support for local and artisanal fisheries) increased in the UNFSA convention documents, suggesting a growing awareness of non-industrial fishing within these conferences. This trend may indicate a rise in stakeholder participation from artisanal fishing communities, including representatives from low-income countries and Indigenous groups. Finally, SDG 14.c (legal framework for ocean governance) increased in both the UNCLOS and UNFSA documents. This is a predictable outcome, given the role of the UNCLOS in regulating ocean law, policy implementation, and enforcement. The rise in SDG 14.c frequency within the UNFSA documents may suggest increased engagement with fisheries policy development or ongoing debates surrounding legal constraints on fishing practices.

Understanding Stakeholder Representation Through UNFCCC Attendee Demographics

Changes in UNFCCC COP Attendee Demographics. The regression data for the attendee demographics indicated that the percentage of attendees from the youth and indigenous stakeholder categories [Appendix 12] shows a significant change in COP attendee representation from 1997–2022, as indicated by a *p*-value that is less than the chosen significance threshold of

0.1 (Table 7). The youth stakeholder category represents individuals and organizations (which may overlap with the NGO attendees) who work to include youth in global policy forums and share the concerns of younger generations with policymakers [Appendix 12]. This category showed a small (but significant) increase in COP attendees from 1997–2022. The indigenous stakeholder category represents individuals and organizations that seek to amplify the voices of indigenous communities (and may overlap with NGO attendees). This stakeholder group also showed a significant increase in attendee percentage from 1997–2022 [Appendix 12]. The rate of increase for the indigenous attendees is approximately half of the observed rate of increase for the youth attendees.

Table 7: Regression Data for UNFCCC COP Attendee Demographics from 1997–2022

Stakeholder Type	Regression Slope	*p*-Value
Party	-0.001945	0.641531
NGO	0.002279	0.176855
Research	0.001181	0.116582
Youth	0.000575	0.072876
Indigenous	0.000279	0.090026
Industry	-0.002639	0.114323
IGO	0.000589	0.45379

Table 7: Regression data for UNFCCC COP attendee demographics by stakeholder group from 1997–2022. Regression values were calculated using an ordinary least squares (OLS) regression. Green rows indicate that the target is statistically significant at the 10% level.

While not significant, the *p*-values for the industry and research stakeholder categories are near the significance threshold (within approximately 10% of our chosen value) [Appendix 12]. It is possible that further data from other conferences within the UNFCCC or the full marine corpus may yield significant results for these areas. The current results, while not significant, indicate that the percentage of individuals from universities or research institutions may have seen a slight increase during the timeframe. Meanwhile, the percentage of attendees serving as industrial representatives may have shown a potential decrease. The percentages of party-affiliated attendees, attendees from intergovernmental organizations (IGOs), and attendees representing non-governmental organizations (NGOs) appear to remain consistent within the timeframe, though more data may reveal trends within these stakeholder groups.

VI. Discussion and Caveats

Evaluation of the Hypothesis and Research Goals

Our findings largely support the hypothesis that ocean policies linked to climate solutions and adaptation, such as blue carbon initiatives and economic development, have become increasingly prominent in UN marine policy discussions. The data reveals that topics associated with climate solutions—such as ocean carbon storage, ocean acidification, and ocean renewable energy—have shown significant increases in frequency from 1992 to 2021. This trend aligns with the expectation that policies addressing climate-related ocean functions have gained traction due to the heightened global emphasis on oceans in climate change conferences. In contrast, discussions centered on specific ecosystems, such as wetlands or marine fauna distribution, have seen relatively smaller increases in frequency. This shift suggests a broadening of conservation strategies toward ecosystem-based management and the establishment of marine protected areas (MPAs), which provide a more flexible and widely applicable approach to biodiversity protection than policies focused on individual ecosystems. These findings reinforce the idea that climate-oriented marine policies are being prioritized over more localized or ecosystem-specific concerns, supporting the hypothesis that climate conferences have played a key role in shaping marine governance.

However, the portion of the hypothesis regarding the role of non-party actors in driving these policy shifts requires some refinement based on the results. While economic benefits for small island developing states (SIDS) did see a significant increase across all regression models, suggesting greater representation of developing nations in policy discussions, the data indicates a more complex relationship between stakeholder participation and policy outcomes. The results show that youth and Indigenous activists had a small increase in attendance at UNFCCC conferences, whereas NGOs and research institutions did not exhibit a significant rise over the same period. This suggests that while certain non-party groups are becoming more influential, their impact on policy content may not be as direct as initially hypothesized. Instead of a broad increase in non-governmental involvement leading to stronger climate-focused marine policies, the data suggests that the influence of specific underrepresented populations—such as Indigenous and youth activists—may be amplifying discussions on climate adaptation and economic justice within marine governance. This pattern implies that while non-party affiliates do contribute to policy change, the mechanisms of their influence may vary across different groups, requiring further investigation into the nuances of their participation and advocacy.

The findings also support the expectation that political entities prioritize maintaining existing industries and mitigating the financial costs of climate change. The UNFSA, which plays a central role in fisheries management and industry regulation, has maintained a strong presence in marine policy discussions, with consistent engagement from industry representatives. This continued involvement may explain why ecosystem-based management approaches—rather than ecosystem-specific policies—have gained prominence, as they offer a compromise between conservation objectives and economic interests. Additionally, while the study revealed an increasing focus on marine research and technological development across the corpus—

especially in relation to climate solutions—the strongest influence on these research-driven categories emerged from the UNFCCC convention documents, which did not show a major change in science and research-based stakeholders during the timeframe. This suggests that while scientific perspectives have played a crucial role in shaping marine policy, their growing influence is likely not attributed to a growing number of advocates from these institutions within the convention forums.

Ultimately, the results reinforce the theory that climate change has been a dominant driver in shaping marine policy by contributing political, scientific, and social concerns to the UN governance framework. However, while the presence of youth and Indigenous activists in UNFCCC proceedings supports the idea that non-party stakeholders contribute to these shifts, the lack of a significant increase in NGO participation suggests that other factors, such as institutional priorities and economic considerations, also play a major role in directing policy focus. These findings suggest that while marginalized voices are becoming more visible within marine policy discussions, the extent of their influence on formal policy decisions requires further study. Additionally, the results highlight the need for a continued examination of how political and economic stakeholders shape the trajectory of marine governance, particularly in balancing climate adaptation efforts with industry interests. The increasing role of science and technology in marine policy further supports the notion that climate-related solutions are being prioritized, reinforcing the overarching idea that climate change has become one of the most prominent factors driving contemporary ocean governance from 1992 to 2021.

Data Limitations

Difficulty in Understanding Policy Efficacy on a National and Global Scale. The inclusion of both binding and non-binding documents in the corpus presents a potential limitation in accurately assessing the efficacy of UN marine policy implementation. While documented policies may outline proposed measures, they do not necessarily indicate which policies were enacted by the UN or signatory parties. This discrepancy is exemplified by the United States' withdrawal from the Paris Agreement during the first and second Trump administrations. This action, which undermined the nation's commitment to its Nationally Determined Contributions (NDCs) has signaled a broader retreat from international climate obligations. Byrne et al. (2022) discuss how such policy reversals contribute to climate inaction and disrupt global efforts in a case study of the initial U.S. withdrawal in 2016. Furthermore, the absence of U.S. political delegates at subsequent Conferences of the Parties (COPs) likely altered the percentage of attendees from non-governmental organizations, research institutions, and advocacy groups in lieu of party-affiliated actors. This shift in stakeholder dynamics may indicate a false trend of increased percentage of participation from non-party actors during the first Trump administration. However, this period may also provide insight into if or how these groups were able to influence policy dialogues and negotiations in the absence of certain governmental entities. Additionally, the U.S. departure from these dialogues may have caused other nations to be less compelled to maintain stringent environmental standards or adhere to established timelines in the absence of U.S. participation, which could lower overall policy efficacy. Consequently, the observed policy changes within the corpus may not fully reflect actual implementations, thereby limiting the accuracy of assessments regarding stakeholder influence in the evolution of UN marine policies.

Corpus Timeframe and Completeness. The timeframe of the corpus also poses potential limitations to the applications of these results, since the policy literature is only complete through 2021. This prevents a comprehensive analysis of certain confounding variables. For example, it is not possible to observe developments during the majority of the COVID-19 and post-pandemic era. The pandemic significantly altered the format of international policy discussions, leading to a shift toward virtual and hybrid conferences that may have influenced stakeholder participation and policy priorities (Tao et al. 2021). Given that these changes occurred at the end of the timeframe, it is difficult to ascertain how they may have affected UN marine policy discussions and broader environmental governance. Future research with data from subsequent years could provide valuable insights into how new conference formats have reshaped stakeholder influence.

Additionally, political shifts within highly involved parties, such as the United States, posit another potential limitation. The transition from the Trump administration to the Biden administration in 2021 marked a significant shift in U.S. climate and environmental policies, with the Biden administration rejoining the Paris Agreement and prioritizing climate action in international forums. However, without more recent data extending into subsequent years, it remains unclear how these shifts—and future transitions, such as a second Trump administration—will alter the trajectory of marine and climate policy discussions at the international level. Given the United States' role as a major global actor in environmental negotiations, changes in its administrative priorities could significantly impact the implementation and enforcement of UN agreements. Thus, this corpus struggles to provide data on how recent shifts in leadership affect long-term policy commitments and stakeholder engagement.

Attendee Data Collection, Scope, and Assumptions. This study is inherently limited by the scope of available data, as this study only references attendee information for UNFCCC COP 3 through COP 28 (1997–2022). Consequently, our direct analysis of stakeholder representation is constrained to these specific conferences. Given this limitation, we focused on assessing the impacts of stakeholder participation during the publication periods of the first and second NDCs to demonstrate the correlation between non-party representation and policy results. However, to provide a broader perspective on stakeholder influence beyond the UNFCCC conferences, we also applied these shifts in stakeholder demographics across the entire corpus of UN policy documents published during the period between COP 3 (1997) and COP 27 (2022). Therefore, this approach assumes that the trends in stakeholder representation at UNFCCC COPs are reflective of broader shifts in UN climate and marine policy conference attendance.

It is important to acknowledge that this assumption introduces several potential limitations. Foremost, the UNFCCC COPs are among the most high-profile and widely attended UN climate conferences. These meetings tend to attract a greater presence of both party-affiliated and non-party actors (including NGOs, research institutions, advocacy groups, and corporations) when compared to smaller or more specialized UN policy forums (Gallo et al. 2017). As a result, the observed trends in stakeholder demographics at UNFCCC COPs may not be entirely representative of stakeholder participation across all UN marine policy negotiations. While this study provides valuable insights into stakeholder influence within the UN system, the true conference demographics may not exhibit the same level of stakeholder diversity or engagement as the UNFCCC COPs.

Another limitation of this study (and future research) is the lack of standardization in conference attendee lists. As a result, the scope of this research was limited by the time required to manually locate and download the UN attendee documents for each conference. These records are inconsistently formatted, difficult to access, and dispersed across various institutional repositories, making large-scale data collection a labor-intensive process. This absence of a centralized database of conference data further complicates efforts to analyze long-term trends in stakeholder representation. As a result, this study was constrained by the feasibility of data retrieval within the given time frame (approximately 20 weeks). To overcome this challenge in future research, we suggest the development of an AI-powered web-scraping tool to enhance data collection efficiency (as used in the 2021 Corringham et al., California Climate Action Plan study). Such a tool could automate the extraction and structuring of attendee data from publicly available conference records to create a more comprehensive dataset. By streamlining this process, researchers could expand their analyses to a broader range of conferences and stakeholders, ultimately improving the accuracy and application of future studies on stakeholder representation in international policy forums.

VII. Future Research

Understanding Ecosystem-Specific Impacts

While the GMF topics encompass a range of marine policy issues, they represent only a small fraction of all marine concerns and are primarily oriented toward generalized topics and those related to the UNFCCC corpus. This design reflects the model's intended purpose as a comparative metric for assessing marine focus within Nationally Determined Contributions (NDCs). Future research could refine this approach by utilizing the existing corpus or developing a specialized corpus tailored to specific marine issues or ecosystems and incorporating keywords aligned with relevant research and policy interests. For instance, the focus on deep ocean topics within the UN marine policy corpus could be examined using terms specific to this domain, such as abyssal circulation, benthic zones, deep ocean biodiversity, deep ocean carbon cycle, deep ocean chemistry, deep ocean warming, deep oceanic basins, deep-ocean energy resources, deep-ocean minerals, deep-ocean technology, and deep-sea mining. A similar regression-based analysis could then be employed to track changes in these topic frequencies over time and across different conferences. Additionally, comparisons with external variables—such as the number of deep-sea-focused conferences or the volume of deep-sea-related research publications released annually—could provide insight into the relationship between increased scientific research and policy attention. Future studies could also develop a metric analogous to the Marine Focus Factor (MFF) that is exclusively based on deep-sea topics, offering a more precise tool for evaluating policy trends in this critical, but often underrepresented, area of marine governance.

Artificial Intelligence as Marine Policy Tool

Recent struggles in the establishment and maintenance of Marine Protected Areas (MPAs) highlight the need for innovative management approaches that integrate both ecological and socio-economic factors. Our findings indicate a potential decline in focus on SDG 14.5, which emphasizes the protection of marine and coastal environments, including the establishment of MPAs. This trend aligns with concerns raised by Aburto-Oropeza et al., who argue that the effectiveness of MPAs is often constrained by long recovery times and socio-economic pressures that extend beyond conservation measures alone (2025). Their research suggests that while MPAs are essential tools for marine ecosystem recovery, their success is contingent on long-term ecological processes that may take years to yield observable results (Aburto-Oropeza et al., 2025). Additionally, MPAs often face external pressures such as illegal fishing and encroachment from industrial activities, further limiting their conservation impact. As a response to these challenges, Aburto-Oropeza et al. propose the concept of Marine Prosperity Areas (MPpAs), a framework that integrates ecological protection with socio-economic benefits to align conservation objectives with human well-being and the blue economy (Aburto-Oropeza et al.).

The shift toward Marine Prosperity Areas is designed to address the limitations of MPAs by incorporating the needs of stakeholders through sustainable economic opportunities, including ecotourism and community-driven marine management. This model seeks to frame marine conservation as a driver of economic resilience rather than an impediment to development. Recognizing the necessity of adaptive management tools, the Aburto Lab at the Scripps Institution of Oceanography has begun developing artificial intelligence-driven solutions to improve MPA conservation strategies. Many MPAs lack tailored management plans, and even those with structured conservation frameworks often struggle to incorporate evolving scientific data. In response, the Aburto Lab is working on ChatMPA**,** an AI-powered system designed to bridge the gap between researchers, policymakers, and on-the-ground conservation workers. By integrating policy-based and biological data, ChatMPA aims to generate adaptive protection protocols suited to the unique conditions of individual MPAs. This initiative represents a critical advancement in conservation technology, offering a scalable tool to enhance the effectiveness of MPAs and support a transition toward Marine Prosperity Areas. Further research into stakeholder roles and AI-driven conservation frameworks is essential to reversing the observed policy decline in this area and ensuring long-term marine ecosystem resilience.

VIII. Conclusion

This study highlights the evolving landscape of UN marine policy, demonstrating that non-party stakeholders, including youth activists, Indigenous groups, and NGOs, have maintained a consistent presence within marine policy discussions, with certain demographics showing signs of growth. Furthermore, the increasing representation of smaller and lower-income countries within party-affiliated attendance underscores the critical role of inclusive representation in shaping policy discourse. These findings support the broader understanding that stakeholder involvement—both from party and non-party actors—directly influences the trajectory of marine governance. As climate change continues to shape global policy priorities, the extent to which political entities prioritize climate-based solutions will be instrumental in predicting future shifts in marine policy focus. The results suggest that ocean-related climate policies are increasingly being integrated into broader discussions of environmental governance, reinforcing the connection between marine resource management and climate mitigation strategies.

However, the withdrawal of the United States from key UN climate agreements and recent cuts to environmental research funding suggests that the nation may experience a decline in marine policy engagement (World Resources Institute). The U.S. departure from the Paris Agreement has restricted the ability of U.S. organizations to send stakeholders to COP conferences, reducing their influence on international policy discussions. Additionally, reduced funding for research into the blue economy and marine conservation as climate solutions further weakens the country's role in advancing marine policy (NOAA Research). Without strong political representation at COPs, NGOs and scientists may need to assume a greater leadership role in advocating for marine conservation policies. Unfortunately, without governmental support, the implementation of these policies may prove more challenging, and the diminished presence of the U.S. could discourage other nations from committing to more ambitious marine conservation and climate mitigation measures. Given the historical significance of the U.S. in climate negotiations, this shift could undermine international enforcement mechanisms and potentially disrupt the trends observed in this study. However, since the full effects of these policy shifts will not be immediately evident, further analysis will be necessary in the coming years.

Despite these potential challenges, grassroots activism may emerge as a pivotal force in driving marine policy action. The increasing involvement of youth and Indigenous activists in UN climate and marine discussions suggests that these groups are gaining greater visibility and influence in shaping environmental policy. Their role in advocating for marine conservation and climate adaptation measures may be instrumental in counterbalancing political disengagement from major actors such as the U.S. By amplifying the voices of vulnerable populations, grassroots movements could play a crucial role in maintaining the momentum of marine-focused climate policies at both national and international levels.

Beyond the scope of the UNFCCC COPs, this study contributes to a broader understanding of stakeholder representation and policy impact. The findings underscore the necessity of increasing the representation of smaller, more climate-affected nations to prevent their interests from being overlooked in international policy negotiations. However, access to these forums remains a significant barrier, often limiting direct participation by these groups. As a result, much of the influence on public policy may occur outside of formal conference settings through lobbying, activism, and other mechanisms that shape party voting behavior. For those seeking to influence marine policy, climate governance, or broader environmental policymaking, understanding these barriers is essential. Strategic efforts to influence voting behaviors of party representatives—who are guaranteed a voice in discussions—may prove more effective in shaping long-term policy outcomes than solely focusing on expanding non-party attendance at conferences.

As technological advancements reduce physical barriers to conference participation, the current stagnation of stakeholder demographics may begin to shift. Since this study's dataset extends only through early 2022, the long-term impacts of expanded virtual accessibility on stakeholder representation remain unclear. Future research should examine how increased digital participation influences the inclusivity and effectiveness of marine policy discussions. Furthermore, this study reveals the challenges of analyzing stakeholder influence based on attendance data, as much of this information remains inaccessible. Greater transparency in reporting stakeholder demographics and participation patterns would provide deeper insights into the roles different groups play in marine policy conventions and broader public policy forums.

Finally, this study underscores the potential of AI-driven methodologies in policy analysis. As natural language processing (NLP) and artificial intelligence models become more sophisticated, their ability to process and analyze vast corpora of policy documents will continue to improve. This study demonstrates that GPT-based models can successfully extract marine policy terms and quantify policy shifts with reasonable accuracy. Additionally, the structured output capabilities of AI models provide a novel approach to analyzing stakeholder participation and demographic trends within policy forums. As AI tools evolve, they will likely become increasingly effective in answering complex policy questions. This can be used to inform environmental conservation strategies and integrate real-time biological and political data into decision-making processes.

Ultimately, this research not only implements the use and development of novel technologies for marine policy analysis but also provides replicable methods for further research on policy evolution in other fields of study. By using these tools to understand the role of stakeholders in niche areas of governance, we can better understand the role of interest groups and individuals in influencing public policy on a national and global scale.

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Appendix

Appendix 1: UN Sustainable Development Goals

SDG Number	Title	Description
1	No Poverty	End poverty in all its forms everywhere.
2	Zero Hunger	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
3	Good Health and Well-Being	Ensure healthy lives and promote well-being for all at all ages.
4	Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5	Gender Equality	Achieve gender equality and empower all women and girls.
6	Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all.
7	Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all.
8	Decent Work and Economic Growth	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
9	Industry, Innovation, and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
10	Reduced Inequality	Reduce inequality within and among countries.
11	Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient, and sustainable.
12	Responsible Consumption and Production	Ensure sustainable consumption and production patterns.
13	Climate Action	Take urgent action to combat climate change and its impacts.
14	Life Below Water	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
15	Life on Land	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16	Peace, Justice, and Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
17	Partnerships for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Appendix 2: SDG 14 Targets

Sub Target Label	Title	Description
14.1	Reduce marine pollution	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
14.2	Protect and restore marine and coastal ecosystems	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.
14.3	Minimize ocean acidification	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.
14.4	Regulate harvesting and end overfishing	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.
14.5	Conserve coastal and marine protected areas	By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.
14.6	Eliminate harmful fisheries subsidies	By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation.
14.7	Increase economic benefits to Small Island Developing States	By 2030, increase the economic benefits to Small Island developing States (SIDS) and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism.
14.a	Increase scientific knowledge, research, and technology	Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.
14.b	Support artisanal fisheries	Provide access for small-scale artisanal fishers to marine resources and markets

14.c	Implement a legal framework for conservation	Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want.

Appendix 3: Gallo et al. (2021) Marine Focus (GMF) Topics

Topic Name	Description
Coastline impacts	Effects of natural and human activities on coastal erosion, flooding, and habitat loss.
Ocean warming	Rising ocean temperatures due to climate change and their consequences.
Fisheries impacts	Changes in fish populations and marine food webs due to overfishing and environmental factors.
Marine ecosystem impacts	Disruptions to oceanic food chains, habitats, and biodiversity from human and natural influences.
Additional research	The need for further scientific studies to understand and address marine environmental challenges.
Mangrove management	Strategies for conserving and sustainably utilizing mangrove forests.
Marine tourism impacts	Effects of tourism on marine ecosystems, including pollution and habitat degradation.
Marine biodiversity protection	Efforts to safeguard marine species and habitats from threats like overfishing and climate change.
Ecosystem-based management	Holistic approach to managing marine environments considering ecological interactions.
Coral reef impacts	Consequences of environmental changes and human activities on coral reef health.
Mangrove restoration & conservation	Efforts to rehabilitate and protect mangrove forests for coastal protection and biodiversity.
Creation of MPAs	Establishing marine protected areas (MPAs) to conserve marine life and habitats.
Watershed management	Managing land-water interactions to protect marine and freshwater ecosystems.
Fisheries management	Sustainable practices and regulations to maintain fish populations and marine resources.
Maritime transport	The environmental and economic effects of shipping and marine transportation.
Ocean acidification	Declining ocean pH due to increased CO_2 absorption, affecting marine organisms.
Ocean renewable energy	Harnessing ocean resources like tides and waves for sustainable energy.
Marine fauna distribution change	Shifts in marine species locations due to climate change and habitat alterations.
Seawater desalination	Process and impacts of converting seawater into fresh drinking water.
Coral bleaching	Loss of coral color and health due to stressors like high temperatures and pollution.
Wetland restoration & conservation	Efforts to restore and protect coastal wetlands for biodiversity and flood control.
Marine ecosystems management	Strategies for maintaining the health and sustainability of marine environments.
Ocean carbon storage	The ocean’s role in absorbing and storing carbon to mitigate climate change.
Seagrass restoration & conservation	Protecting and rehabilitating seagrass meadows for their ecological benefits.
Marine pollution management	Controlling and reducing pollution sources affecting ocean health.

Reef ecosystem resilience	Enhancing coral reef systems' ability to recover from environmental stressors.
Blue economy	Sustainable use of ocean resources for economic growth and conservation.
Harmful algal blooms	Overgrowth of toxic algae that harm marine life and human health.
Coral reef conservation	Protection and restoration efforts for coral reefs against environmental threats.
Offshore energy production	Extraction of energy resources like oil, gas, and wind from marine environments.
Ocean deoxygenation	Declining oxygen levels in oceans due to climate change and pollution.

Appendix 4: UN Marine Policy Convention Categories (from Elsler et al. 2022 Marine Policy Corpus)

Convention Title	Abbreviation	Description	Year Created
Convention on Biological Diversity	CBD	Promotes global conservation, sustainable use of biodiversity, and fair sharing of benefits from genetic resources.	1992
Convention on International Trade in Endangered Species of Wild Fauna and Flora	CITES	Regulates international trade in endangered species to ensure it does not threaten their survival.	1973
Convention on the Conservation of Migratory Species of Wild Animals	CMS	Protects migratory species across international borders through coordinated conservation efforts.	1979
International Convention for the Regulation of Whaling	ICRW	Governs the conservation and management of whale populations, including whaling regulations.	1946
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	LC	Aims to prevent marine pollution from the dumping of hazardous waste and materials.	1972
Part XI of the UN Convention on the Law of the Sea (Seabed Mining Regulations)	PARTXI	Regulates the exploration and exploitation of deep-sea mineral resources in international waters.	1982
United Nations Convention on the Law of the Sea	UNCLOS	Defines maritime rights, territorial boundaries, and ocean resource management among nations.	1982
United Nations Framework Convention on Climate Change	UNFCCC	Provides the foundation for global efforts to combat climate change, leading to agreements like the Kyoto Protocol and Paris Agreement.	1992
United Nations Fish Stocks Agreement	UNFSA	Ensures the sustainable management of straddling and highly migratory fish stocks in international waters.	1995

Appendix 5: Elsler et al. 2021 Corpus Details

Convention	Documents	Pages	Sentences
BBNJ	43	1399	12099
CBD	510	34016	450532
CITES	101	511	5682
CMS	251	5649	86446
ICRW	57	541	4496
LC	95	632	5963
PARTXI	88	2536	26466
UNCLOS	66	1911	18421
UNFCCC	233	7706	79586
UNFSA	1634	16750	159569

The United Nations policy documents analyzed in this study were compiled from ten major marine-related conventions included in the Elsler et al. corpus. These conventions vary significantly in document volume and total page count, reflecting the diversity of focus and institutional engagement across the corpus. For the purposes of natural language processing analysis, each document was segmented into sentence-length text spans to facilitate classification by thematic focus. A detailed summary of the conventions, including the number of documents, total pages, and associated publication years, is provided in Appendix 4.

Appendix 6: Gallo et al. (2017) Marine Focus Factor (MFF) Formula

$$\text{MFF} = 1{,}000 \times \left(\frac{\text{Marine Keywords in NDC}}{\text{Total NDC Word Count}}\right) \times \left(1 + \frac{\text{Marine Categories in NDC}}{\text{Total Marine Categories}}\right)$$

(Gallo et al., 2017)

The MFF equation from Gallo et al. (2017) was used to calculate the marine focus for the first UNFCCC NDC documents for each country based on the 31 Gallo Marine Focus (GMF) topic categories [Appendix 3]. "Marine Keywords in NDC" refers to the number of keyword mentions in the NDC. This value is divided by the total number of words in the NDC and multiplied by 1000 to get the GMF topic frequency per 1000 words. "Marine Categories in NDC" refers to the number of GMF categories that were mentioned in the NDC (frequency value > 0). This value is divided by the total number of categories (31) to understand the variety of GMF topics addressed.

Appendix 7: Modified Marine Focus Factor (mMFF) Formula

$$\text{mMFF} = 1{,}000 \times \left(\frac{\text{GMF Topic Frequencies for Convention Text}}{\text{Word Count for Convention Text}}\right) \times \left(1 + \frac{\text{Number of GMF Topics in Convention Text}}{\text{Total Number of GMF Topics}}\right)$$

The mMFF uses the Gallo MFF structure adjusted for the GMF Topic frequency analysis over a set of convention documents. Instead of using the term "keyword" we use the term "topic frequencies" since our data was collected using GPT classification, rather than the keyword frequency methodology from Gallo et al. The "Total Number of GMF Topics" will be 31 for our study, since we used the same 31 categories from the original Gallo et al. study.

Appendix 8: SDG 14 Target Marine Focus Factor (tMFF) Formula

$$\text{tMFF} = 1{,}000 \times \left(\frac{\text{SDG 14 Target Frequencies for Convention Text}}{\text{Word Count for Convention Text}}\right) \times \left(1 + \frac{\text{Number of SDG 14 Targets in Convention Text}}{\text{Total Number of SDG 14 Targets}}\right)$$

The tMFF uses the Gallo MFF structure adjusted for the SDG 14 Target frequency analysis over a set of convention documents. Instead of using the term "keyword" we use the term "target frequencies" since our data was collected using GPT classification for SDG 14 Targets, rather than the keyword frequency methodology from Gallo et al. The "Total Number of SDG 14 Topics" is 10 [Appendix 2].

Appendix 9: GPT-4o Mini Prompts and Extracted Text Samples

Text was extracted from 3,081 documents at both the sentence and page levels. Using PDF parsing tools, a total of 71,651 pages were processed, yielding 1,023,943 sentence-level spans and 23,547,454 space-separated words (Figure 11). A comprehensive cleaning protocol was implemented to remove illegible or nonsensical sentence fragments that could interfere with classification accuracy. Examples of such fragments include:

“194.5, CBD art.”,

“11.9 (Rev.”, “'* ~.E&.lM*ff1t¨ï Çƒ¢ Çƒ¢ ~~~~~~~.~ .d~~~~~ff~~~.”

“..... .. 1 ..”

Figure 11: Distribution of English Word Count (per Convention)

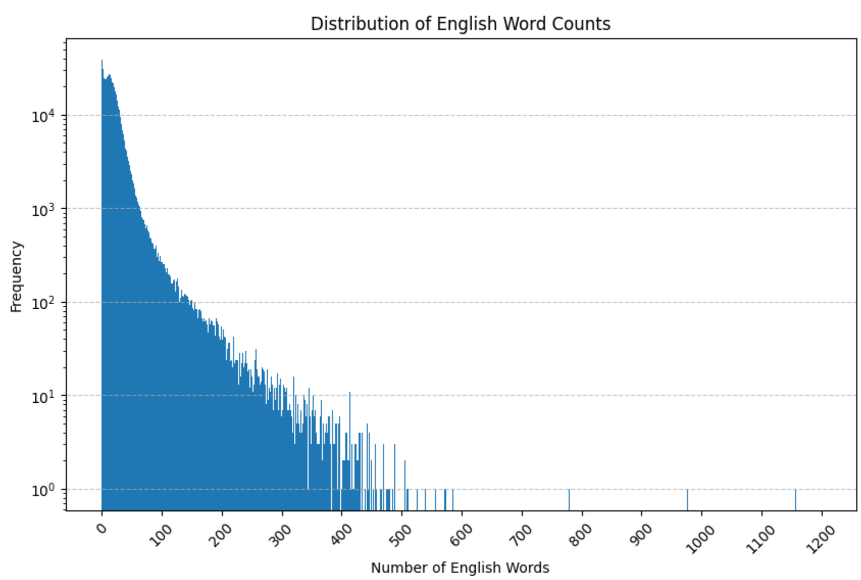

Figure 11: English words per set of convention texts within the Elsler et al. corpus. Nonsense sentences were eliminated, but non-English sentences were retained.

Following this cleaning process, the number of valid sentences suitable for classification was reduced from 1,023,943 to 850,773. Of these, 755,850 were identified as English-language spans using the Pycountry package (Figure 12). All sentence spans, regardless of language classification, were retained in the dataset, as the GPT model employed for analysis has demonstrated strong performance in multilingual text classification tasks. The sentence-level text spans were used for evaluation against human annotation. However, for the final classification used in the analysis, a page-level annotation scheme was used to provide GPT with more context. Time and resource limitations precluded an assessment of page-level GPT-human label agreement.

Figure 12: Fraction of English Words per Sentence (for entire Elsler et al. corpus)

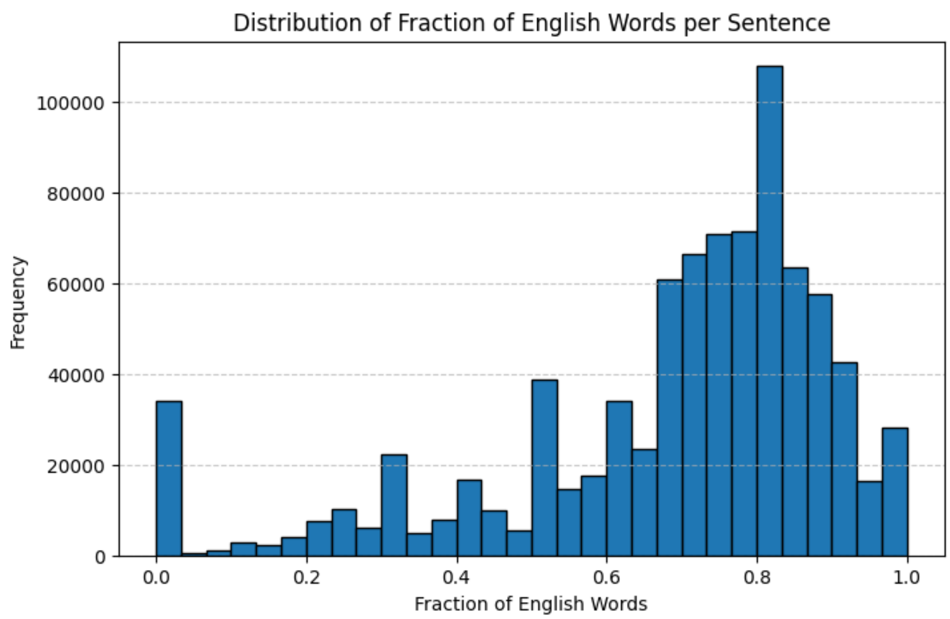

Figure 12: Fraction of English words per sentence for the entire Elsler et al. corpus. Nonsense sentences were eliminated, but non-English sentences were retained.

The sentence-level text spans were used for evaluation against human annotation. However, for the final classification used in the analysis, a page-level annotation scheme was used to provide GPT with more context. Time and resource limitations precluded an assessment of page-level GPT-human label agreement.

Target associations were extracted at the sentence level. Using OpenAI's structured outputs and Pydantic, each text span (sentence or page) was associated with a list of SDG 14 Targets. The prompt used is as follows: "Classify the text span according to the UN Sustainable

Development Goal 14 Life Below Water targets. Return the relevant SDG 14 target numbers as a list of strings, e.g., ['3'], ['7', 'a'], []. Do not include prefixes like 'SDG', 'SDG14', or '14.'. Return the related targets in order from most related to least related. The targets are roughly as follows: 1. Marine Pollution, 2. Marine and Coastal Ecosystems, 3. Ocean Acidification, 4. Overfishing and Unregulated Fishing, 5. Marine and Coastal Conservation / Marine Protected Areas, 6. Fisheries Subsidies, 7. Economic Benefits to Small Island Developing States, a. Scientific Knowledge, b. Artisanal Fishers, c. Legal Framework for Oceans." In-context examples could have been included to improve performance, but this simple prompt was used to reduce the number of tokens to keep the cost of inference manageable.

Appendix 10: GPT Annotation Agreement Metrics

A set of evaluation metrics were used to measure target and topic agreement between two runs of GPT and between GPT and the human annotator. The results for the SDG 14 Target classification are shown below:

Metric	GPT vs Human	GPT vs Human (Revised)	GPT vs GPT
Jaccard Similarity	0.0622	0.1948	0.1161
Exact Match	0.668	0.774	0.498
Overlapping Match	0.744	0.896	0.648
Accuracy	0.1701	0.4845	0.2
Precision	0.2079	0.6165	0.4337
Recall	0.4833	0.6935	0.2707
F1	0.2907	0.6528	0.3333

The same metrics were also calculated for the Gallo Marine Focus Topics (note that a revised human sample was not included for this portion of the study due to time constraints. The agreement metrics are shown below:

Metric	GPT vs Human	GPT vs GPT
Jaccard Similarity	0.094	0.2557
Exact Match	0.59	0.702
Overlapping Match	0.772	0.916
Accuracy	0.2092	0.5156
Precision	0.254	0.6865
Recall	0.5424	0.6745
F1	0.3459	0.6804

The agreement metrics between GPT and the human annotations are relatively low for this kind of task. The agreement metrics between GPT and the revised human annotations are higher, indicating that GPT performs better in comparison to a human's measured second assessment of target associations, with a Jaccard Similarity metric of 0.1948, high overlapping match metric of 0.896, and reasonable F1 score of 0.6528. It is important to note that Jaccard similarity is the most challenging agreement metric, so a value of 0.1948 is reasonable. The agreement between two runs of GPT is moderate, indicating some degree of noise in GPT's labels. In future work it may be possible to run GPT multiple times and take the intersection or union of GPT labels and compare these sets to the human gold label sets. The revised labeling approach was not used for the Gallo 2017 topics, but the GPT versus human Gallo topic agreement metrics are similar to the GPT versus human SDG 14 target agreement metrics.

Appendix 11: Pooled Regression Graphs by SDG 14 Target from 1992–2021

The results of the pooled regression analysis for the SDG 14 Target frequencies over time are shown below (from 1992 to 2021) (Figure 13). The significance data and *p*-values can be found in Figure 5 and Table 4. The regression analysis indicates minimal or no significant change in frequency over time for the following SDG Targets: 14.1 (Marine Pollution), 14.4 (Overfishing and Unregulated Fishing), 14.6 (Harmful Fisheries Subsidies), 14.a (Scientific Knowledge and Research Capacity), 14.b (Small-Scale Fisheries), and 14.c (Legal Frameworks). SDG 14.3 (Ocean Acidification) and SDG 14.7 (Economic Benefits to Small Island Developing States) exhibit potential upward trends, while SDG 14.2 (Ecosystem Restoration) and SDG 14.5 (Marine Protected Areas) display possible downward trends in frequency over the same period.

Among these, only SDG 14.3 and SDG 14.7 meet the established significance criteria for this study, with a p-value below the 0.05 threshold, indicating a statistically significant increase in policy attention to ocean acidification over the 30-year span.

Figure 13: Pooled Regression Results for SDG 14 Target Frequencies from 1992–2021

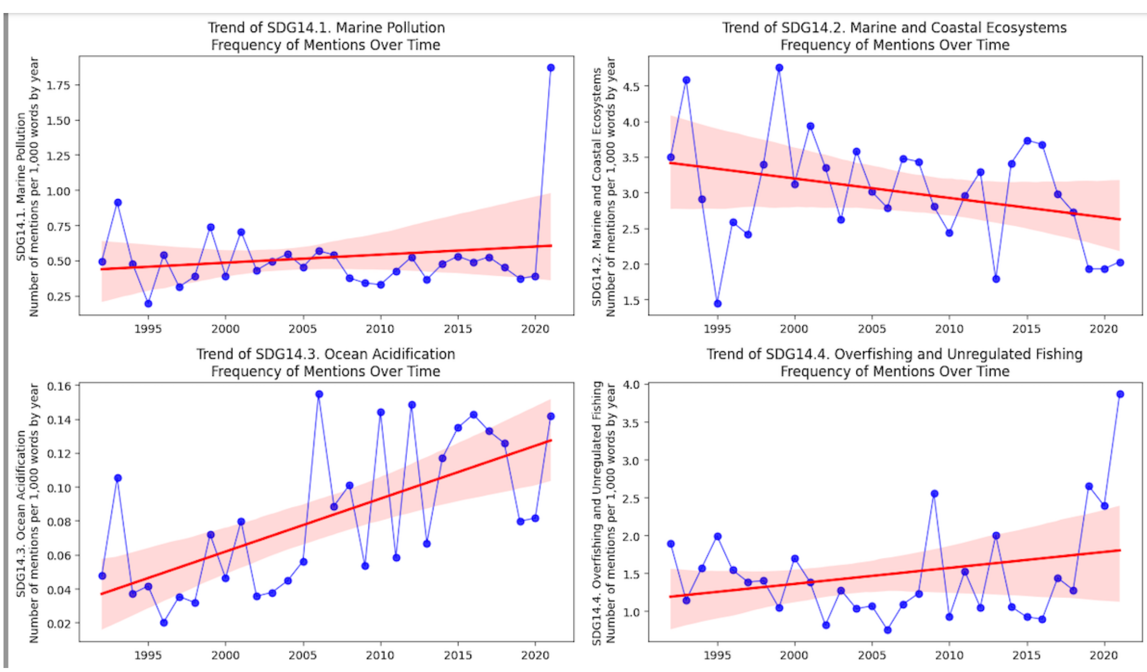

Figure 13 (Continued)

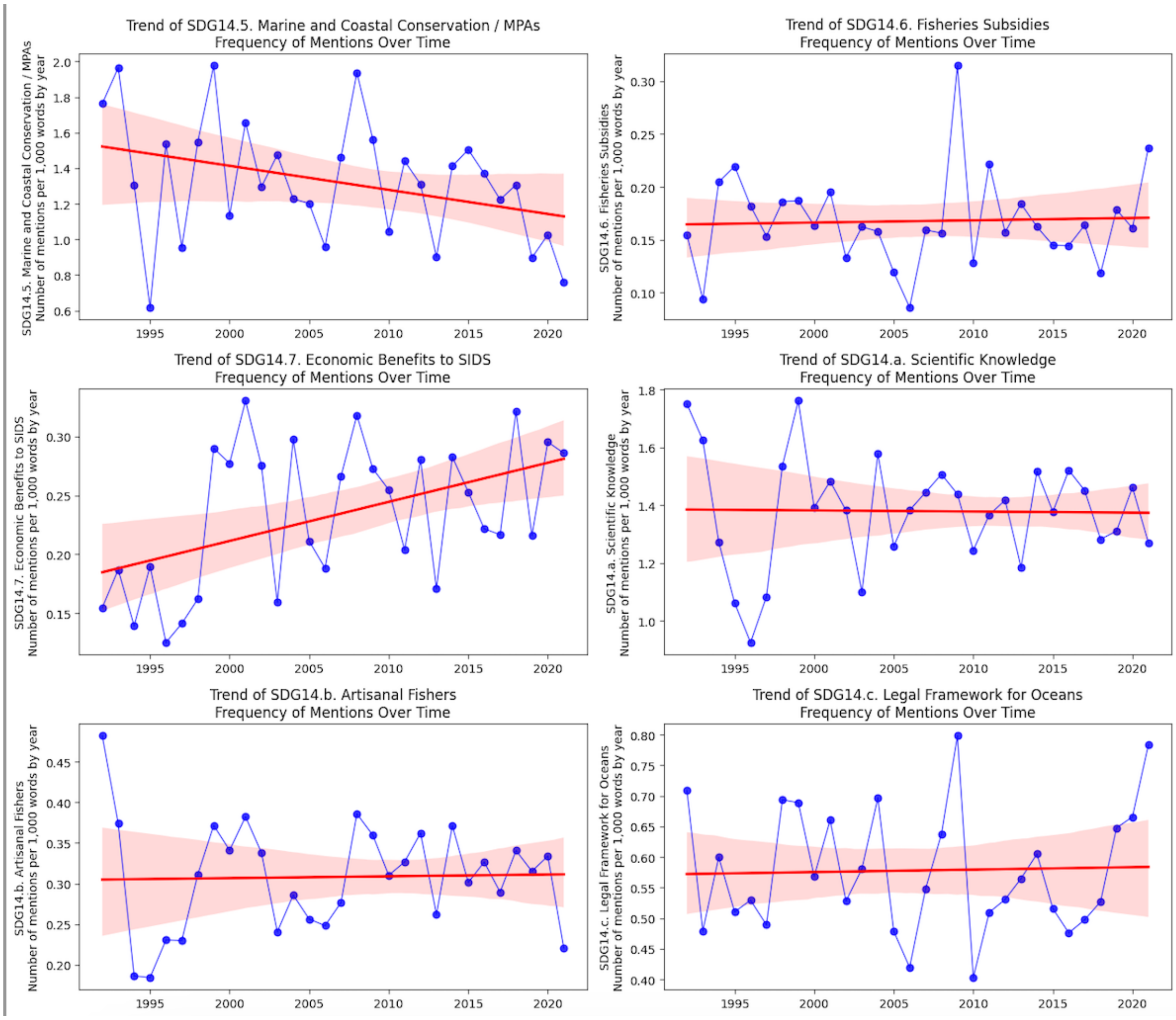

Figure 13: Pooled regression results for SDG 14 Target frequencies over time from 1992–2021. SDG 14.3 and 14.7 demonstrate significant trends within a 5% significance level.

Appendix 12: UNFCCC Attendee Demographic Regressions by Stakeholder Group

Regression results for the UNFCCC stakeholder demographics for COPs 3-28 are shown below. Only youth and Indigenous stakeholders showed significant increases to the 10% level. Further research is needed to better understand the demographic changes for the other stakeholder groups. The regression graphs indicate little to no change in party and IGO representation, while NGOs, research institutions, youth, and Indigenous groups saw possible increases (with varying levels of significance). There was a possible decrease in industry representatives during this time, but more research is required to determine if these results are significant.

Figure 14: Regression Results for Stakeholder Demographics Variation 1997–2022

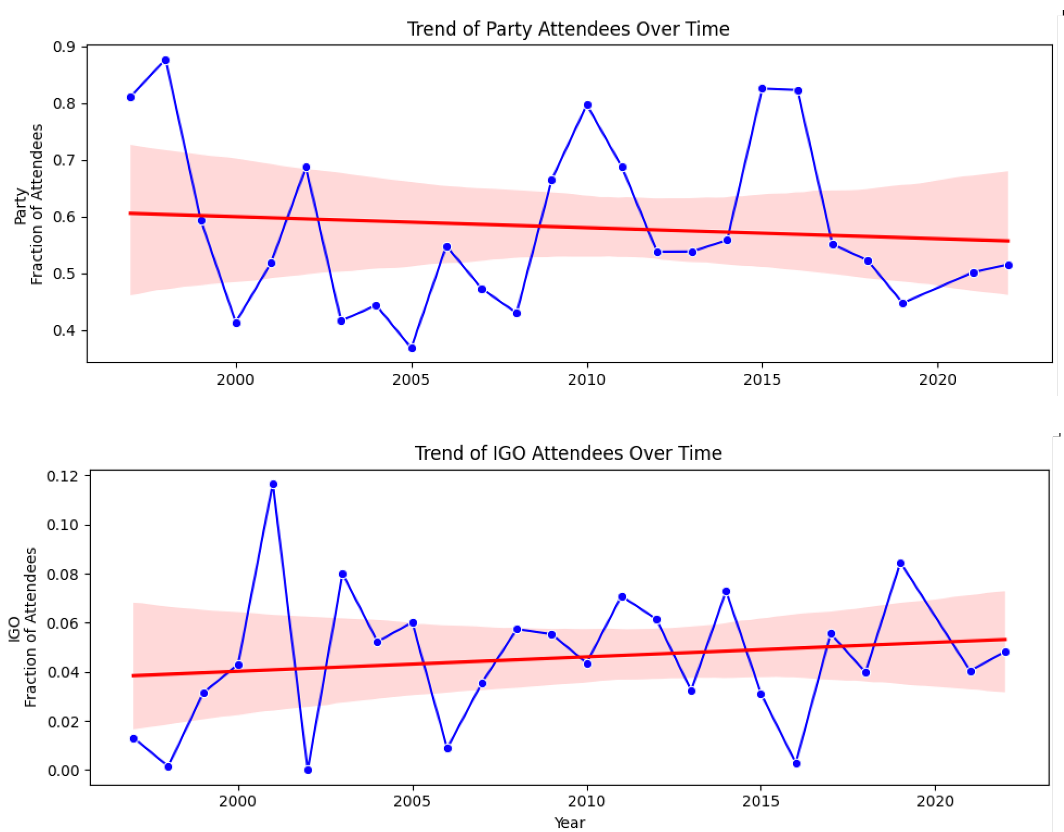

Figure 14: Party and IGO representation showed little to no change during the observed time period. Results are not significant.

Figure 14 (Continued):

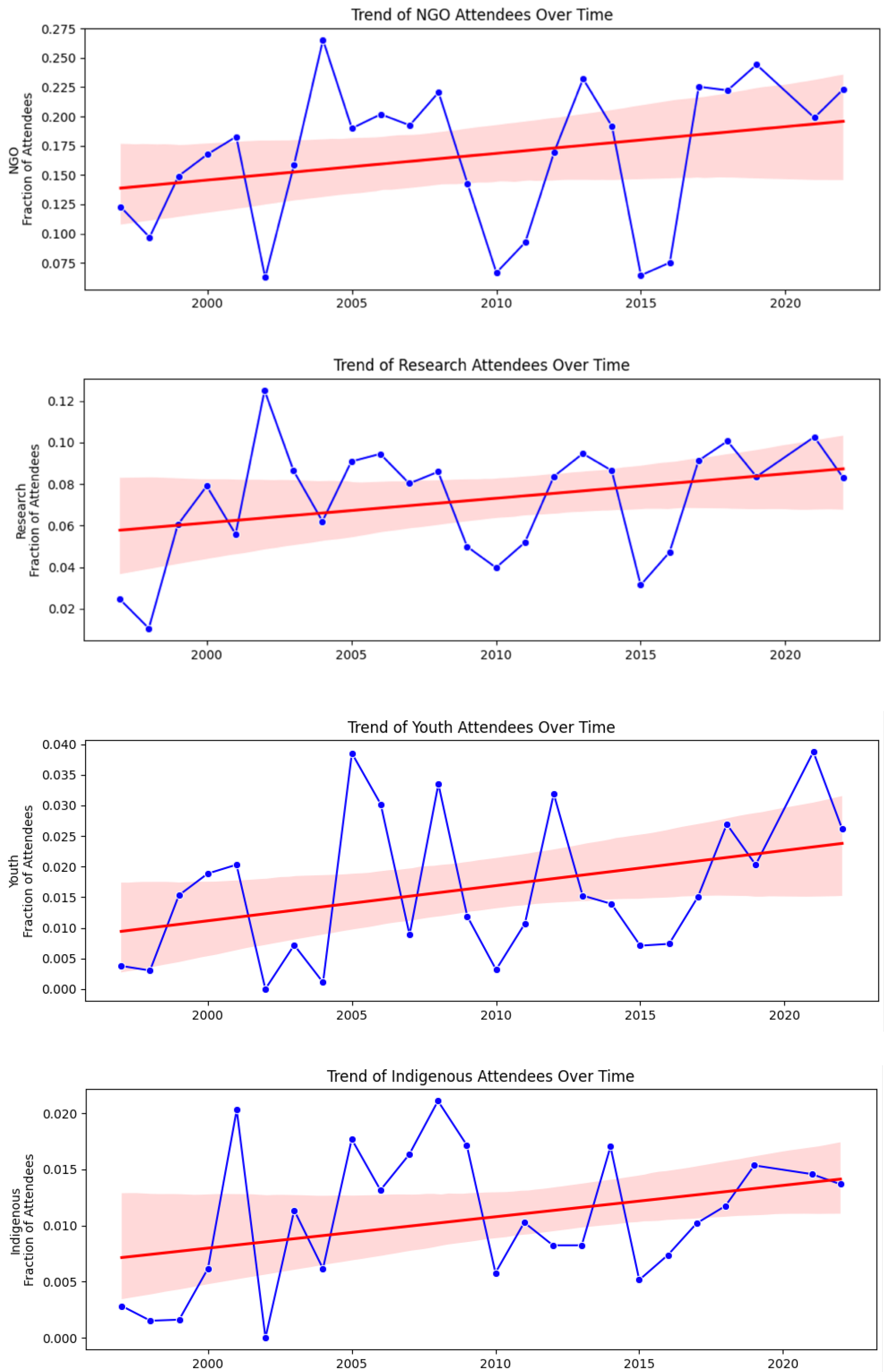

Figure 14 (Cont.): NGOs, research institutions, youth organizations, and Indigenous groups showed increases. Only youth and Indigenous results meet the significance criteria.

Figure 14 (Continued):

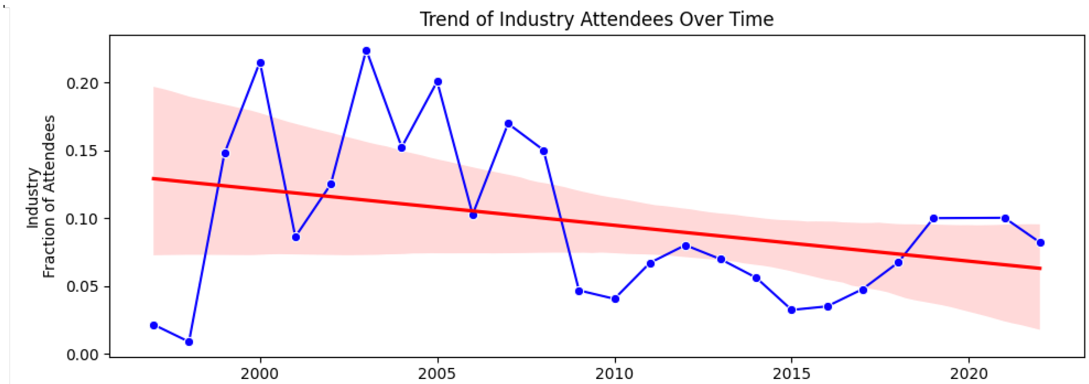

Figure 14 (Cont.): Industry representation showed a possible decrease from 1997–2022. Results do not meet the significance criteria.

Appendix 13: Research Code and Access

The code used for this project was written and processed by McKenna E. Carlson and Dr. Tom Corrignham. It can be accessed by contacting McKenna Carlson at mecarlson@ucsd.edu.