

White Paper

# Navigating the Sargassum Crisis



Interreg  
Caraïbes  
SARGCOOP II



A Scientific Review to Support Evidence-Based Policy  
2025

# Preface

**of the President of the Regional Council of Guadeloupe to the international community and our partners**



Dear stakeholders in international cooperation, dear partners. Since 2011, the massive strandings of sargassum seaweed on the coasts of the Caribbean islands, particularly in Guadeloupe, have caused an unprecedented environmental, health, and socio-economic crisis. The proliferation of these seaweed, fuelled by climate change and human activities, releases toxic gases as they decompose, threatening the health of populations, biodiversity, and local economies. Faced with this cross-border challenge, a collective and science-based response is essential.

The scientific advocacy we present today is the result of rigorous work to compile and analyse all research conducted on sargassum since 2011. It covers the biological characterization of these algae, the formation and trajectory of sargassum rafts, and their impacts on health, the environment, and local economies. It also addresses legal and governance considerations, as well as collection, management, and valorisation techniques, to propose sustainable and innovative solutions.

This advocacy is part of the continuity of actions supported by the INTERREG Caribbean program, which funded the SARG'COOP I (2019-2022) and SARG'COOP II projects. These initiatives have structured regional and international cooperation for coordinated and effective sargassum management. They have also facilitated the sharing of knowledge, tools, and best practices among affected territories.

Our goal is clear: to make science a tool for diplomacy by bringing together expertise and political will to transform this crisis into an opportunity. This document is intended for the international community, decision-makers, scientists, and civil society, to mobilize collective and sustainable action.

Guadeloupe, alongside its international partners, reaffirms its commitment to championing this cause. We hope that this publication will inspire strengthened mobilization and adapted governance to protect our coasts, our populations, and our common future.

**Ary Chalus**

**President of the Regional Council of Guadeloupe**



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# Executive Summary

Pelagic *Sargassum*, a free-floating brown macroalgae forming a massive bloom in the Atlantic Ocean, is recognized as a new reality. This bloom is a multidimensional challenge because of its complexity, its ample geographic distribution including West Africa, Brazil, Central America, and the larger Caribbean; and its ecological, socioeconomic, and public health impacts. This bloom is primarily composed of three morphotypes—*Sargassum fluitans* III, *S. natans* I, and *S. natans* VIII—whose composition varies regionally, with significant ecological and physiological differences. While recent advances in taxonomy and genetic analysis efforts are significant, the classification remains elusive. Similarly, while physiological studies are helping our understanding of growth rates and differential thermotolerance of morphotypes, there are still discrepancies that need to be addressed. Important questions regarding our understanding of physiological responses need attention, especially regarding stress responses to combined environmental factors at different spatial scales. Major advances have been achieved in the understanding of potential triggers and sustaining mechanisms. The present working hypothesis points to linking the bloom to oceanographic and climatic shifts following the 2009–2010 negative North Atlantic Oscillation (NAO) and linking the bloom’s persistence to nutrient-rich waters at the Atlantic Basin scale, vertical mixing in the growing zone of the Great Atlantic Sargassum Belt (GASB) in the North Equatorial Recirculation region (NERR), and atmospheric nitrogen fixation by nitrifying bacteria within sargassum blades’ biofilm. The northward transport from this region into the tropical Atlantic is associated with oceanic currents and wind patterns, with seasonal and annual variability responding to climate changes such as El Niño and La Niña events. Significant advances in satellite monitoring methods are improving, allowing for better monitoring of ocean currents and floating sargassum rafts. However, limitations in detection persist mainly for coastal waters, where local monitoring techniques such as drones and citizen science programs are of utmost importance to fill these gaps. Recognized impacts of this bloom are related with the loss of biodiversity and extensive damage to ecosystems, as sargassum accumulates on coastal zones in the region since 2011. Reduction of resilience of coral reefs, seagrass beds, and mangroves are causing the loss of ecological services provided by these ecosystems, such as sustaining healthy fisheries, coastal protection, and carbon sequestration, impacting all regions, particularly the Caribbean considered a biodiversity hotspot. These impacts have wide-ranging environmental, health, and socioeconomic consequences. As the ecosystems are damaged, disruption in fisheries and tourism are evident, and risks to human health—especially in vulnerable coastal regions of the Caribbean and West Africa are increasing. While some progress has been made in understanding these impacts, current evidence remains limited. Studies have documented losses in fisheries and tourism, both of which are critical sources of income for affected regions. Research has also highlighted public health concerns related to the accumulation and decomposition of sargassum,

which releases harmful gases such as hydrogen sulfide and ammonia. However, more comprehensive data is needed to fully assess and quantify the extent of these impacts. Responses from government agencies, international organizations, private sector and stakeholders at large, have been fragmented, with many nations lacking integrated or enforceable management frameworks, highlighting the need for coordinated efforts. Collection of accumulated sargassum and treatment strategies vary based on geography and scale, differential strategies need to be implemented based on the United Nation Convention for the Law of the Oceans, from international agreements in the high seas, to multinational and national strategies at the Exclusive Economic Zone and territorial waters. Offshore management and sustainable harvesting offer promising solutions, though ecological risks and the lack of standardized processing protocols remain major barriers. Nonetheless, the resource potential of sargassum is being explored across various industries, such as compost and from biofuels to bioplastics, creating opportunities for innovation and sustainable development, while facing the challenges of the presence of heavy metals like Arsenic and others. Funding research to improve scientific understanding of the bloom needs to continue and be tailored towards solving detected knowledge gaps. Public health and economic systematic studies are a major knowledge gap that needs to be addressed. Allocating funds to evaluate and implement solutions in both sectors are an urgent need. Definitions and regulations of sargassum require coordinated efforts at international, regional, and national levels. Valorization and use will need the private sector to consider ecological risks of their practices and benefit local communities as well as their industries. Major efforts are needed to better organize responses to protect local communities and tourists alike; such responses will need programs that will incorporate locals in any decision-making, ensuring the protection of their livelihoods and benefit from this potential opportunity. It is imperative to recognize the lessons learned and pursue the creation of a task force that will address the rapid rate of new knowledge coming out as publications, reports, government documents, and update annually or biannually the community at large to develop and evaluate solutions minimizing ecological consequences. Any investment, as well as management policies and actions, need to envision strategies to benefit locals. Based on all the scientific advances presented in this document, it is clear that the sargassum issue is a symptom of a planetary problem that can use science diplomacy advances as a framework to address the next era of this multidimensional problem. While sargassum can become an opportunity, we cannot forget that the cause of the problem is related to the triple crises - biodiversity loss, climate change, and pollution related to our extractive lifestyle.



# 1

## Introduction to Pelagic Sargassum

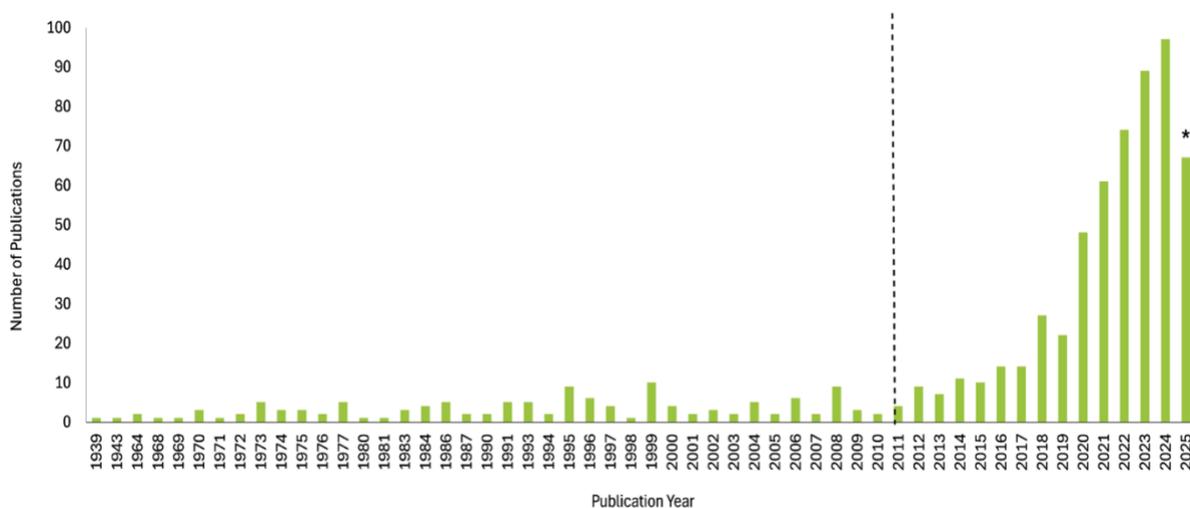
### Background and importance of pelagic sargassum

The tropical Atlantic, since 2011, has been living under a new reality that is particularly detrimental to the larger Caribbean and coasts of West Africa. Massive influxes and landings are composed of two species, *Sargassum* (*Sargassum natans* (Linnaeus) Gaillon and *Sargassum fluitans* (Børgesen) Børgesen) that have been demonstrating enormous ecological, social, public health, and economic impacts. These two species of the genus *Sargassum* are unique in their pelagic ecology, often found free-floating in the open ocean throughout most of their entire life cycle. Blooms associated with these species are referred to by its common name sargasso or sargassum to distinguish from other benthic species of the genus *Sargassum*. Throughout this document, we will be referring to exclusively pelagic species of the genus *Sargassum* through the use of its common name, “sargassum”.

This white paper aims to provide an overview of the state of the research on sargassum which includes both scientific publications identified and listed in Appendix D and other additional resources. We identified scientific studies published in peer-reviewed journals and book chapters using the methods listed in Appendix C.

Scientific research on studies related to the genus *Sargassum* increased significantly after the establishment of the bloom, with an acceleration of publications since 2018 (**Figure 1**). Significant advances in the understanding of triggers, maintenance drivers, and impacts of the bloom, such as growth rates, nutrient and temperature regulators of growth, levels of metals and gases, and ecosystem impacts, are becoming better understood through experimentation and monitoring programs (see sections for details). While significant scientific advances are evident with 554 publications identified from January 2011 to September 2025, and up to 67 publications from January 2025 to September 2025 (**Figure 1**), there is still much work to be done in our understanding of the triggers that establish new growth areas for sargassum, as well as supportive drivers and transportation mechanisms to impacted regions. The direct link between global land-use practices, such as how agriculture and industrial waste end up in the ocean, requires immediate monitoring and the development of both local and international coastal zone

management practices and regulations. Management, collections and uses of sargassum is still an uneven development with little publications while many different practices have been established locally. A lack of common regulations and definitions for the management of this resource is evident as well as the understanding of the potential role as a resource, opportunity, or problem depending on where the collection of materials occurs. What is becoming increasingly clear is that this Atlantic-wide massive algal bloom is a symptom of a global problem; the major triggers and drivers of this phenomenon are changes or anomalies in climate patterns and Atlantic currents, temperature increases, and nutrient availability at a basin scale; see sections below), clearly demonstrating a global problem that needs immediate international coordinated action. Therefore, with up-to-date scientific evidence, this document provides data and recommendations to support managers and policymakers in activating the organization and mobilizing resources to establish and enact integral strategies at local, regional, and international scales.

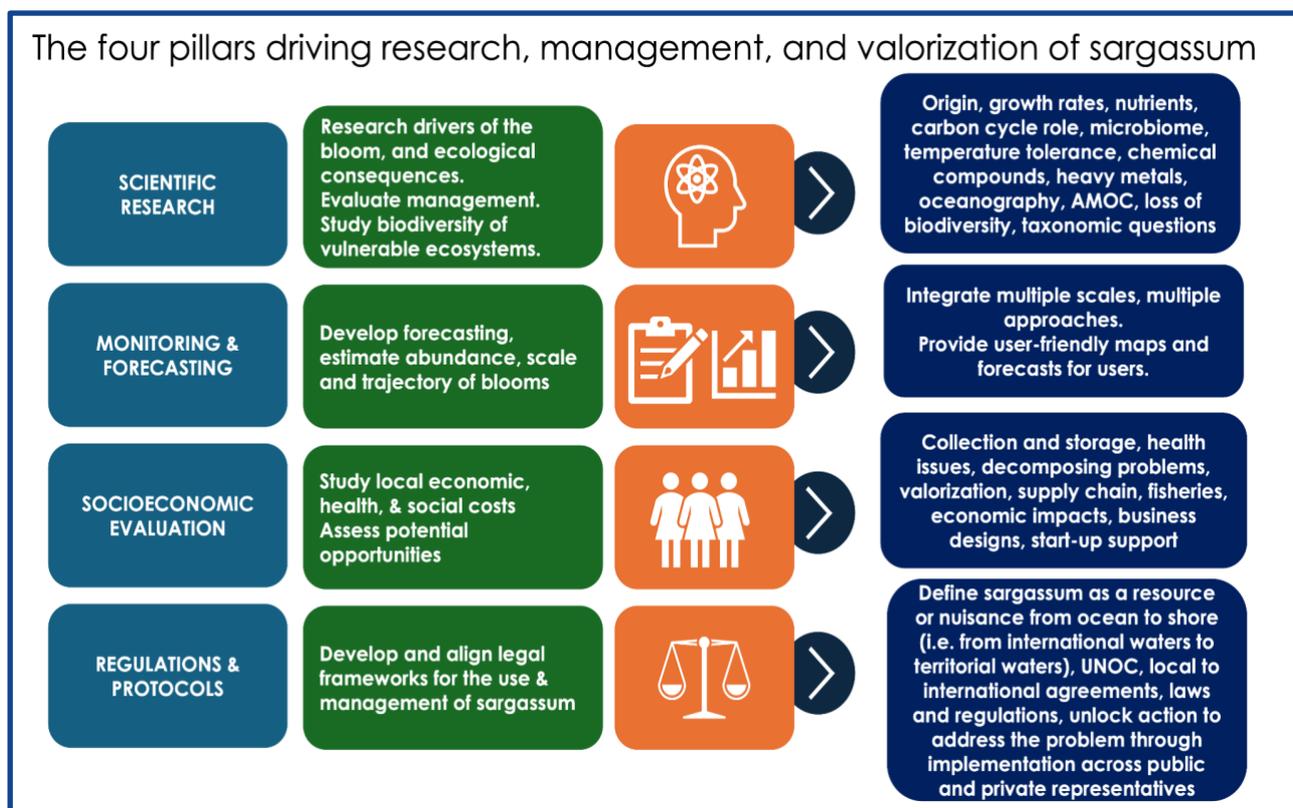


**FIGURE 1.** NUMBER OF PUBLICATIONS OVER TIME BASED ON A SYSTEMATIC REVIEW ACROSS FIVE DATABASES USING THE KEYWORDS “PELAGIC SARGASSUM”, “SARGASSUM FLUITANS”, “SARGASSUM NATANS” AND “ATLANTIC” (SEE APPENDIX C FOR METHODOLOGY). THE DASHED LINE INDICATES THE ONSET OF ANOMALOUS PELAGIC SARGASSUM LANDINGS IN 2011 WITH 554 PUBLICATIONS BETWEEN JANUARY 2011 TO SEPTEMBER 2025. THE ASTERISK (\*) ABOVE 2025 INDICATES PUBLICATION RECORDS LISTED ARE ONLY FROM JANUARY TO SEPTEMBER 2025.

The document is divided into seven main sections addressing the multidimensional aspects of this sargassum bloom. It covers the scientific advances in the areas of the biology of sargassum, followed by advances in the understanding of potential triggers, supporting conditions, and trajectories across the Atlantic. The next section is an analysis of the state of knowledge related to ecological, economic, and public health impacts of the bloom, followed by a section addressing legal and governance considerations. Finally, a section addressing collections techniques, and valorization challenges including management and potential uses and risks closes the white paper information analysis. Based on the critical analysis of all the literature, we recognize four pillars that have driven the sargassum

phenomenon research, management and valorizations; each pillar has multidimensional process and levels of advancement, but they have common ways to address their challenges, those pillars are not isolated between them, but their identification will help guide next steps and action roadmaps (**Figure 2**). An integration section was added including the potential role of science diplomacy at the stage we are at after 14 years of this problem, followed by a series of recommendations addressed to funding agencies, policymakers, managers, scientists, and the community at large.

This white paper includes a literature review from 2011 up to September 2025, but because the scientific production since September has been exploding, we updated the important findings within the text. We included papers up to December 2025. We are aware that more literature will keep coming out as we write these final words.



**FIGURE 2.** GRAPHIC REPRESENTATION OF THE FOUR PILLARS THAT HAVE DRIVEN SARGASSUM RESEARCH, MANAGEMENT AND VALORIZATION.

# 2

## Biological Characterization of Sargassum

### Highlights

- Floating sargassum mats are limited to the Atlantic region and consist of three morphotypes, *S. fluitans* III, *S. natans* I, and *S. natans* VIII which can be distinguished using morphological characteristics.
- Our understanding of taxonomy among sargassum morphotypes is improving with the use of a combination of genetic, chemical, and morphological characteristics.
- Composition of morphotypes vary across space, with the Sargasso Sea dominated by *S. natans* I morphotype with rare occurrences of *S. natans* VIII while the GASB is dominated by *S. fluitans* III and *S. natans* VIII morphotypes. However, these patterns are shifting in recent years.
- Unresolved bloom-sustaining mechanisms, and consistently elevated toxic elements—particularly arsenic—currently limit reliable, large-scale applications and underscore the need for mechanistic and biogeochemical resolution before sustainable management or utilization strategies can be realized.
- Despite the inconsistencies with studies of sargassum growth rates, we have a better understanding of sargassum physiology, including thermal tolerance of morphotypes. However, physiological studies, particularly in situ, which explore other factors as drivers of the bloom such as nutrients remain limited.
- Sargassum functions as a self-sustaining pelagic ecosystem which provides habitat to support high biodiversity, mediates nutrient cycling through its microbiome, and facilitates long-distance species dispersal—making its recent expansion ecologically consequential and a priority for sustained monitoring and management.

The genus *Sargassum* belongs to the class Phaeophyceae and contains approximately 358 species (Guiry and Guiry 2025). Of these species, the recent blooms and landings of sargassum across the

Atlantic have solely been composed of two species, *Sargassum fluitans* (Børgesen) Børgesen and *Sargassum natans* (Linnaeus) Gaillon. These species are thought to have originated in the Sargasso Sea but have since expanded its distribution to form the Great Atlantic Sargassum Belt (GASB) due to climatic anomalies (see Section 3 for further details). This section will address the current state of the scientific advances and knowledge on distinguishing pelagic species of sargassum based on morphological and genetic analyses, differences in elemental and biochemical content which can affect its valorization potential and the biodiversity that sargassum supports.

## 2.1 Morphology

The two species, *S. fluitans* and *S. natans*, are considered pelagic because no benthic phase is associated as the source of the floating masses. Unlike other species within the genus which contain sexual stages within their life cycles, it is thought that pelagic species' only mode of reproduction is through vegetative growth and fragmentation (Butler et al. 1983), with no current studies showing reproductive structures on thalli within floating mats. Aggregations of these two species are responsible for the sargassum crisis in recent times plaguing numerous countries across the tropical Atlantic. Within each species of pelagic sargassum, there is diversity in the morphological forms or varieties (i.e. morphotypes) which were first described by Winge (1923) and revised by Parr (1939). These early studies described two varieties of *S. fluitans* (III and X) and four varieties of *S. natans* (I, II, VIII, and IX). Recently, there are three recognized morphotypes found in the Atlantic region: *S. fluitans* III, *S. natans* I, and *S. natans* VIII (**Figure 3 A, B, and C**, respectively) with the latter being rarely found within the Atlantic and limited to the western Caribbean (Parr 1939) until the increase in biomass of pelagic sargassum reported in 2011. However, the previously rare morphotype, *S. natans* VIII has become one of the most predominant morphotypes alongside *S. fluitans* III within the new source region for sargassum in the tropical Atlantic (Schell et al. 2015, García-Sánchez et al. 2020, Hatt et al. 2024).

Historical taxonomic identification between the species and morphotypes of pelagic sargassum were solely based on morphological distinctions. Research conducted on post-2011 blooms of pelagic sargassum characterize and distinguish morphotypes using four distinct characteristics described by Schell et al. (2015): clump appearance, thorns on the stem, spines on air bladders (also referred to as aerocysts), and blade size (also referred to as fronds). First, the presence or absence of thorns on the stem is used to distinguish *S. fluitans* from *S. natans*. *Sargassum fluitans* III is further characterized by smooth oval-shaped air bladders and short and wide blades/fronds (**Figure 3A**) while *S. natans* I has small round air bladders with spines with long and narrow blades/fronds (**Figure 3B**) and *S. natans* VIII by large round smooth air bladders, rarely containing spines and long and wide blades/fronds (**Figure 3C**). When using spines on air bladders as an identifying feature, care should be taken that the spines are not

A.

Thorns present along main axis (stem)

Thorns are visible with the naked eye but viewing under a dissecting microscope can help confirm this feature if necessary

No spines present on air bladders; often elongated or oblong

NOTE: there may be pointed ends on some air bladders as shown above but this **does not** indicate spines. There also may be some individuals that have a few air bladders (1-2) with spines present but it is not ubiquitous.

Clump appearance: leafy with blades densely packed and tightly arranged along axis - full and bushy appearance

Blades are short and wide

***Sargassum fluitans* III**  
OR *Sargassum* var. *fluitans*

B.

Clump appearance: Open structure with less dense branching allowing the stem to be more visible between the blades

Spines are present on air bladders; small and round

NOTE: there may be a few airbladders (particularly smaller newly formed air bladders) that do not contain spines, however, the majority of airbladders contain spines

No thorns along the stem

Blades are long and narrow

***Sargassum natans* I**  
OR *Sargassum* var. *natans*

C.

Clump appearance: sparsely branched with large visible portions of stem - more open appearance

Spines are not present on air bladders, large and round

Blades are long and wide

While it is not a unique or distinguishing feature, hydroids are more abundant along blades of this morphotype

No thorns along the stem

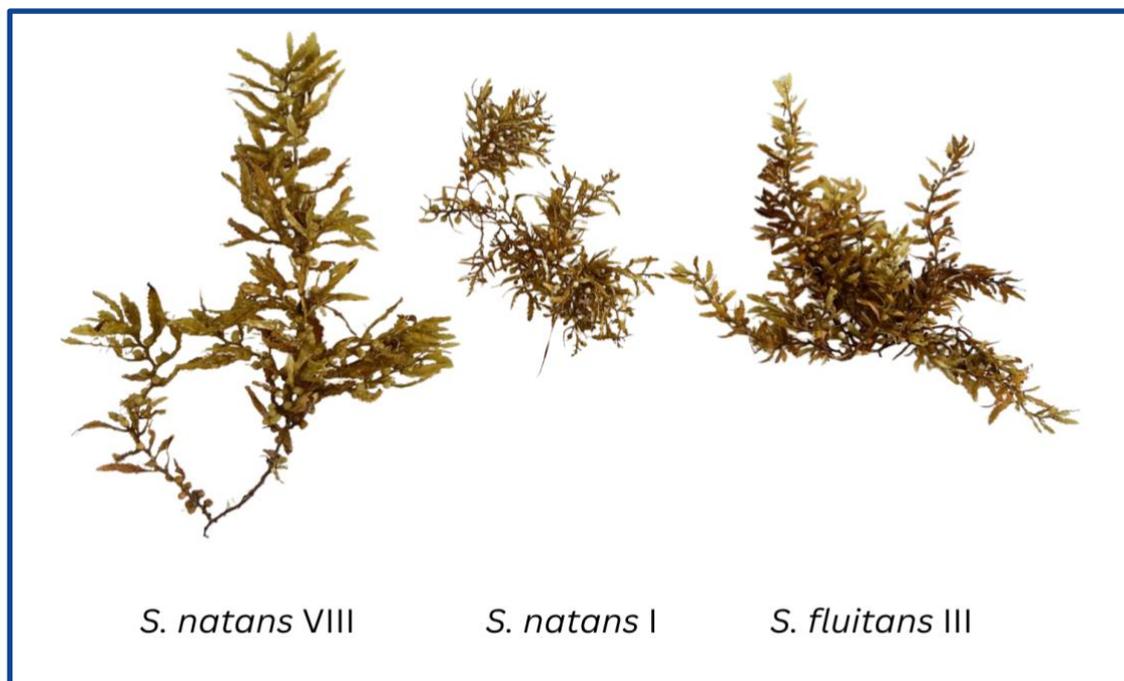
Smooth axis

***Sargassum natans* VIII**  
OR *Sargassum* var. *wingei*

**FIGURE 3. THE FOUR COMMONLY USED MORPHOLOGICAL CHARACTERISTICS USED TO VISUALLY IDENTIFY EACH OF THE SARGASSUM MORPHOTYPES A. *S. FLUITANS* III, B. *S. NATANS* I, AND C. *S. NATANS* VIII**

misconstrued as hydroids, a common epiphytic invertebrate on sargassum. Kergosien et al. (2024) have since added 18 additional morphological characteristics that can be used to distinguish morphotypes from one another alongside an updated taxonomic dichotomous key for guidance.

All three morphotypes of sargassum are shown in **Figure 4**. It is also worth noting that advances in molecular analyses have clarified divergence among all three species (see Section 2.2), supporting replacement of the term “morphotype” with “genotype”, this change will require a careful comprehensive publication from molecular biologist/taxonomist well versed in nomenclatural rules to be fully incorporated by the scientific community. This contribution will clarify the process of genetic differences associated with the morphological differences existing across the three varieties of pelagic sargassum.



**FIGURE 4.** FULL THALLUS VIEW OF EACH OF THE THREE MORPHOTYPES OF PELAGIC SARGASSUM: *S. FLUITANS* III, *S. NATANS* I, AND *S. NATANS* VIII.

## 2.2 Genetic and Biochemistry

Genetic research on sargassum has advanced significantly in recent years, but key uncertainties remain regarding species delimitation and the genetic distinction between morphotypes which continues to make taxonomy difficult. Challenges in genetic research are largely due to pelagic sargassum’s reproductive mode being solely vegetative fragmentation. This asexual reproduction results in low genetic variation within each morphotype and complicates the typical criteria used to define separate species, which often rely on reproductive isolation.

Studies have consistently shown that the three dominant pelagic morphotypes—*S. fluitans* III, *S. natans* I, and *S. natans* VIII—exhibit genetic differences, though the level of divergence varies. The first

study to explore genetic variation among the morphotypes of sargassum was by Amaral-Zettler et al. (2017) by employing mitogenomes and chloroplast coding regions of sargassum to develop novel primers that amplified the *cox2* and *cox3* marker genes. This study's genomic analysis of sargassum revealed small but consistent genetic differences between *S. natans* I and *S. natans* VIII. The study also observed that both forms of *S. natans* are closely related to *S. fluitans*, suggesting they share a common evolutionary history (Amaral-Zettler et al. 2017). Dibner et al. (2022) further demonstrated that while genetic markers effectively separate morphotypes, sargassum populations exhibit complex evolutionary relationships influenced by oceanic dispersal and environmental adaptation. Using three mitochondrial (*cox3*, *nad6*, *mt16S*) genes and one RNA marker, their findings support the hypothesis that pelagic sargassum forms may have undergone recent divergence without deep genetic differentiation. Álvarez-Canali et al. (2024) expanded the genetic analysis to benthic *Sargassum* species, finding similarly low molecular diversity among North Atlantic populations and reinforcing the idea of recent colonization and early-stage speciation. Finally, Siuda et al. (2024) confirmed that while mitochondrial and plastid markers distinguish these morphotypes, *S. natans* I and *S. natans* VIII are more closely related, leading to a proposed taxonomic revision recognizing them as varieties rather than distinct species. The updated classification of nomenclature designates *S. fluitans* III as *S. fluitans* var. *fluitans*, *S. natans* I as *S. natans* var. *natans*, and a previously rare form, *S. natans* VIII as *S. natans* var. *wingei* (Siuda et al. 2024) further expanding the terminology used to refer to sargassum (**Figure 5**). All studies conducted on the genetic analysis of pelagic sargassum collectively indicate that while genetic tools have improved the resolution of sargassum taxonomy, further high-throughput sequencing, primarily nuclear genome sequencing, is necessary to resolve taxonomic conflicts. These advancements in resolving genetic distinctions across



**FIGURE 5.** THE DIFFERENT NAMES USED TO REFER TO MORPHOTYPES OF *SARGASSUM NATANS* AND *SARGASSUM FLUITANS*, AND TO THE BLOOM.

the pelagic species have prompted the use of the word genotypes; however, due to the remaining ambiguity between *S. natans* I and *S. natans* VIII, this paper will continue to distinguish these three as morphotypes.

More recently, chemo-typing has been used to further distinguish between the morphotypes (Kergosien et al. 2024, Nirma et al. 2025). Kergosien et al. (2024) demonstrated that morphotypes could be further distinguished using differences in fatty acid profiles and phlorotannin structure alongside morphological characteristics. Their study presented a dichotomous key, identifying *S. natans* VIII by higher proportions of cis-7-hexadecenoic acid (16:1n-9), palmitoleic acid (16:1n-7), and margaric acid (17:0). *S. natans* I exhibited greater proportions of  $\alpha$ -linolenic acid (18:3n-3), eicosatetraenoic acid (20:4n-3), and eicosapentaenoic acid (20:5n-3) than the other two morphotypes, while *S. fluitans* III contained higher levels of myristic acid (14:0) and cis-11-eicosenoic acid (20:1n-9) than *S. natans* VIII and *S. natans* I. Additionally, *S. fluitans* had significantly lower phlorotannin content than both *S. natans* morphotypes. The study concluded that since all three morphotypes can be found within similar distributions, thereby experiencing similar environmental conditions, these differences in chemical components provide a useful tool for distinguishing the morphotypes. Kergosien et al. (2024) indicate that, for some algal taxa, morphological and chemical traits have driven species classification within the genus *Sargassum*, even in cases where genetic analyses do not resolve clear distinctions. Nirma et al. (2025) support the role of chemomarkers as a tool to detect differences between morphotypes. Authors conducted a chemotaxonomic study of samples of the three morphotypes of pelagic sargassum using a molecular network. Authors report a clear distinction in the metabolic profile of *S. natans* VIII compared with *S. natans* I and *S. fluitans* III. Thus, taxonomic re-classification of these morphotypes into species has been proposed (Dibner et al. 2022, Kergosien et al. 2024), while not fully accepted, recent studies are pointing in that direction. Reclassification of pelagic sargassum will need to have a comprehensive species concept including morphology, genetic difference together with chemical and physiological differences. A challenge to be addressed soon.

## 2.3 Elemental and Biochemical Properties

The rising concern over the economic, health, and ecological impacts of sargassum, particularly following the unprecedented increase in floating biomass and landings along coastlines, has sparked numerous efforts to find viable uses for this stranded material. Despite several proposed solutions, such as composting, burial, and potential valorization, no clear or widely accepted approach has emerged. To better assess the potential uses of sargassum biomass, it is crucial to understand the biochemical and elemental composition of sargassum thalli and how these components vary across morphotypes.

Several studies have sought to characterize both the elemental and biochemical composition of sargassum. There have been no differences in CNP content across species or morphotypes (Lapointe et

al. 2021, McGillicuddy et al. 2023, Hatt et al. 2024) of sargassum. Some studies have shown local variations in carbon content specifically (Vázquez-Delfín et al. 2021) of landed material, but other studies have not detected local differences in carbon, nitrogen, and phosphorus (CNP) content (Hatt et al. 2024). However, when comparing studies, it has been observed that on a larger regional scale, individuals from the Gulf of Mexico and the tropical Atlantic (GASB) show higher nitrogen and phosphorus concentrations than those from the Sargasso Sea (Lapointe et al. 2021, McGillicuddy et al. 2023, Hatt et al. 2024). While it requires further investigation, perhaps nutrient content combined with stable isotope analysis can be used as a marker for linking sargassum landings to an origin. Additionally, Lapointe et al. (2021) reported a 35% increase in tissue nitrogen content in sargassum collected during the 2010s compared to the 1980s, suggesting that an increase in nitrogen availability in marine systems—particularly near large rivers like the Amazon— may be a potential driver of the increase in abundance of sargassum. However, recent studies have challenged this enrichment hypothesis by proposing alternative mechanisms that sustain these blooms. In particular, Jouanno et al. (2025a) demonstrated that vertical mixing and climate-driven variability (i.e. anomalous NAO events) promote seasonal increases in surface-water nutrients (both nitrate and phosphorus) and exert a stronger influence than riverine inputs. Their model comparisons indicated that Amazon River inputs were not the primary driver of bloom development. More recently, Jung et al. (2025) expanded on this framework, proposing that annual bloom persistence results from the combined effects of nitrogen supplied by nitrogen-fixing epiphytic bacteria within the sargassum microbiome and excess phosphorus transported from the deep waters to the surface waters via equatorial upwelling and vertical mixing. Together, these processes were shown to be consistent with the high interannual and seasonal variability observed in sargassum abundance (see Section 3 for further details). Nevertheless, the role of temperature anomalies associated with large-scale climate patterns, and their interaction with nutrient dynamics, remains poorly resolved and warrants further investigation at the basin level.

Understanding the chemical composition of these species is essential for evaluating their valorization potential, particularly for agricultural uses such as animal feed and fertilizer. The current literature on the biochemical composition of the three morphotypes of sargassum has raised doubts about their suitability for these applications. Studies have quantified components such as ash, vitamins, fatty acids, amino acids, biogenic amines, monosaccharides, lipids, fiber, carbohydrates, phenolic compounds, and methane potential within sargassum (Oyesiku and Egunyomi 2014, Milledge and Harvey 2016, Chávez et al. 2020, Milledge et al. 2020, Davis et al. 2020, Nielsen et al. 2021, Vázquez-Delfín et al. 2021, Machado et al. 2022, Tonon et al. 2022). One initial problem posed with an applied use of sargassum is that fresh sargassum typically has a high moisture content, which increases the cost of drying for processes that require dry biomass, such as direct combustion, pyrolysis, and gasification (Milledge et al. 2020). In addition, while certain components of sargassum make it potentially suitable for nutritional purposes, its high ash and arsenic content, as well as its high fiber and salt concentrations

across all morphotypes, pose significant additional barriers to its use as food or animal feed (Nielsen et al. 2021). And lastly, the variability in the composition of these components across species, morphotypes, season, and location adds uncertainty to the development of reliable and robust industrial processes for sargassum utilization. Further information on advances in the valorization of sargassum is discussed in Section 6.4.

Another important biological factor when considering sargassum's use in developing applied approaches is the presence of toxic elements. A large body of research has focused on quantifying the heavy metal content of sargassum, given the potential risks posed by certain elements when they exceed specific thresholds (Addico and deGraft-Johnson 2016, Fernández et al. 2017, Rodríguez-Martínez et al. 2020, Tejada-Tejada et al. 2021, Cipolloni et al. 2022, Dassié et al. 2022, Ortega-Flores et al. 2022, Liranzo-Gómez et al. 2023, Hatt et al. 2024). These studies, conducted across the Caribbean and West Africa, indicate that sargassum in both the open ocean and after landing on shorelines contain a wide range of toxic pollutants, with arsenic being a major concern. Heavy metal concentrations vary not only by morphotype but also spatially, seasonally, and temporally. These variations are likely influenced by the environmental history of sargassum thalli, including its origin and dispersal pathway before reaching coastal areas. Arsenic consistently emerges as the metal with the highest concentration in all sargassum morphotypes, often surpassing the European Union's threshold for acceptable levels in seaweed used in animal fodder. This high arsenic content in sargassum has been linked to phosphorus limitation in the algae (McGillicuddy et al. 2023), as well as the presence of epibionts on sargassum thalli (Hatt et al. 2024). Although the mechanisms driving elevated arsenic levels remain unclear, these high concentrations pose significant health risks when sargassum lands on shorelines. Both acute and chronic exposure to high arsenic levels can lead to a range of health issues, including skin lesions, cardiovascular disease, neurological and reproductive problems, developmental abnormalities, and various cancers. Inorganic arsenic species, particularly As(III) and As(V), are more toxic than their organic counterparts, accounting for approximately 62% of total arsenic found in sargassum tissue in Barbados (Alleyne et al. 2023a). The elevated arsenic content in sargassum biomass not only poses challenges for its use in valorization after shoreline landings but may also influence the development of management strategies to reduce human exposure to sargassum, such as adjusting the frequency of removal operations to limit exposure to beachgoers or the modes of removal favoring mechanical over hand collections of sargassum (see Section 5 for further details). Despite the high concentrations of arsenic within the tissue of sargassum, early research shows promising advancements towards using anaerobic fermentation to substantially reduce arsenic content in sargassum-derived liquid biofertilizers, yielding products that fall within permissible regulatory limits (Rodríguez-Rodríguez et al. 2025). More research is needed to determine the reproducibility of this process. These treatments and its connection to heavy metal content within sargassum tissue are further explored in Section 5.

## 2.4 Physiology

Assessing physiological differences across algal species is essential for understanding their resilience and adaptability. Variability in morphology and physiology within species can influence the survival and success of individuals and populations under fluctuating environmental conditions. Laboratory experiments have been a primary tool for investigating how seaweeds adapt to major environmental factors. With temperature and nutrients hypothesized to be major drivers of the unprecedented increase in pelagic sargassum in 2011, studies on sargassum have primarily focused on determining the physiological responses of each morphotype to these abiotic factors.

Early studies on sargassum demonstrated optimal growth rates under varying temperature, nutrient, and salinity treatments (Lapointe 1986, Hanisak and Samuel 1987). However, there was a lack of morphotype-specific analyses and unreproducible methodologies within these earlier studies. Thus, recent efforts, such as those by Magaña-Gallegos et al. (2023a), began addressing these gaps through the quantification and comparison of growth rates of *S. fluitans* III and *S. natans* VIII from the Mexican Caribbean in novel in situ and ex situ experimental systems. Their findings suggested that both in situ and ex situ methods are feasible for culturing sargassum. Studies have also advanced to understand the role of temperature in the physiology of sargassum (Magaña-Gallegos et al. 2023b, Corbin and Oxenford 2023, Hatt et al. 2025a), as temperature plays an important role in the abundance and distribution of seaweeds (Martínez et al. 2012, Wernberg et al. 2013). Corbin and Oxenford (2023) were the first to quantify and compare growth rates at varying temperatures in situ for all three morphotypes of sargassum from the tropical Atlantic, while Magaña-Gallegos et al. (2023b) demonstrated the growth of all three morphotypes from the Mexico Caribbean region, and Hatt et al. (2025a) demonstrated the growth rates and photo-physiological responses of all three morphotypes from South Florida under a gradient of temperatures. It was consistently reported that despite the morphotype-specific differences in the growth of sargassum in response to thermal stress, there has not been consistency in the specific trends among morphotypes. For example, based on sargassum collected from the Mexican Caribbean (Magaña-Gallegos et al. 2023b) and from Martinique (Changeux et al. 2023), both reported *S. fluitans* III had the highest growth rates than either *S. natans* morphotypes. Multiple studies also reported lower growth rates in *S. natans* VIII compared to the other morphotypes (Changeux et al. 2023, Magaña-Gallegos et al. 2023b, Siuda et al. 2024). Magaña-Gallegos et al. (2023b) also observed that *S. natans* VIII had a reduced thermal tolerance at or above 28°C. This study suggested that their results support the hypothesis that higher-than-normal sea surface temperatures (SSTs) in 2011 may have resulted in a reduced seed population of *S. natans* VIII during the initial 2010-2011 anomaly and the predominance of *S. fluitans* III across the GASB. Contrastingly, Corbin and Oxenford (2023) found that in studies carried out in Barbados, *S. natans* VIII had higher growth rates than *S. fluitans* III and similarly Hatt et al. (2025a)

demonstrated that *S. natans* VIII collected from South Florida had optimal growth at 29°C. Variations in growth rates across studies likely stem from differences in culture systems (e.g. ex situ, in situ, mesocosms, jars etc.), environmental conditions, specimen origin, and biological factors such as health, age, and seasonal influences, highlighting the need for further research on physiological differences among sargassum populations in the tropical Atlantic and South Florida. Further physiological studies encompassing multiple populations of sargassum are needed to assess if there may be differences in physiological responses across the region.

Aside from temperature, there has been emerging literature examining the physiological responses of sargassum to gradients of light, salinity, and nutrients. Two studies have examined how light influences the growth and photosynthetic performance of sargassum (Hanisak and Samuel 1987, Vásquez-Elizondo et al. 2024). Their findings indicate pelagic sargassum species require significantly more light than benthic species. Vásquez-Elizondo et al. (2024) observed that under low light conditions, *S. fluitans* III and *S. natans* I exhibited high chlorophyll *a* content, with *S. fluitans* III also showing notably higher chlorophyll *c* levels than *S. natans* I. In contrast, high light conditions reduced pigment content, likely as an adaptation to regulate photosynthetic unit size and composition or to adjust the photosystem II to photosystem I ratio (PSII: PSI), minimizing light stress. Notably, in this study, *S. natans* I maintained stable growth regardless of light intensity, suggesting that other factors—such as prior environmental conditions, tolerance limits, nutrient availability, or extended acclimation periods—may play a more significant role in regulating its growth. Two studies have examined the effects of salinity on pelagic sargassum growth (Hanisak and Samuel 1987, Schell et al. 2024), both finding optimal growth for all species/morphotypes between 36-42 ppt. Growth declined in all species/morphotypes below 30 ppt, with Schell et al. (2024) demonstrating that *S. natans* VIII exhibited the widest salinity tolerance. Both studies showed that changes in salinity did not alter the effect of temperature on sargassum. To date, only one study has assessed elevated nutrients' effects on pelagic sargassum growth rate (Magaña-Gallegos et al. 2023a). The study showed that elevated nutrients did not result in higher growth rates, even though tissue content analysis showed that the algae took up both nitrogen (N) and phosphorus (P). High N:P ratios across the literature suggest that pelagic sargassum may be limited by phosphorus (Magaña-Gallegos et al. 2023a, Changeux et al. 2023, Hatt et al. 2024a). As discussed in the previous section, it has also been suggested that sargassum blooms are related to nitrogen increases in marine systems (Lapointe et al. 2021) and that tissue nutrient content differed between populations of sargassum with individuals found in the Sargasso Sea having lower tissue nutrient content than individuals of sargassum found within the GASB (McGillicuddy et al. 2023, Hatt et al. 2024a). While the importance of macronutrients (C, N, and P) is commonly explored in seaweeds, Leemans et al. (2025) recently demonstrated that iron (Fe) limitation also plays a critical role in the growth of *S. fluitans*. The study showed that N and P alone do not stimulate growth, whereas the addition of iron increased growth by 46%, highlighting the need to incorporate iron into future modeling efforts.

While there have been advancements in understanding the role of nutrients in sargassum growth, it is important to note that there have been no physiological studies conducted to date on nutrient uptake of sargassum that verify this hypothesis.

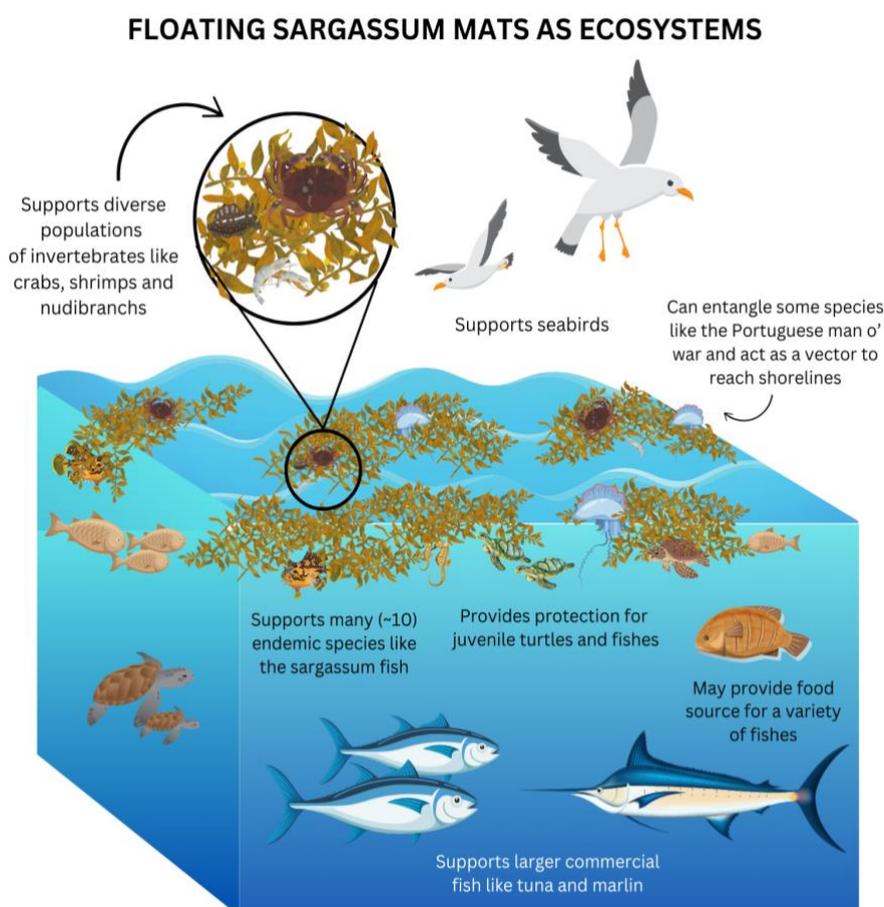
The literature examining the physiology of sargassum is still expanding, with significant gaps in knowledge still existing within this research. For instance, current controlled experiments on sargassum have shown that sargassum is only able to survive short-term under controlled experimental conditions (approximately 5-10 days). The mechanisms behind this short-term survival of sargassum in mesocosms are poorly understood. However, carbon limitation has been proposed as a potential issue in other physiological studies of algae (Littler 1979). In addition, sargassum's bacterial interactions (Léger-Pigout et al. 2024) and restricted water movement within mesocosms (Magaña-Gallegos et al. 2023a) should be explored as potential factors influencing survival. To overcome the challenges with the assessment of growth in these types of short-term experiments due to rapid mass loss (blades and vesicles) typically starting around day 5 in treatment condition, Schell et al. (2024) developed a daily health metric to quantitatively assess sargassum based on a combination of visual assessments such as color combined with quantification of loss of blades and vesicles to assess the age and health status of the algae. It is worth noting that researchers are continuing to explore these mechanisms for short-term survival in mesocosm settings and provide optimal conditions under which sargassum can survive long-term in mesocosm systems.

In addition, despite the advances in the literature assessing the role of temperature on the bloom, to date, all previously published studies have largely focused on growth rate as the primary indicator of thermal stress. However, reduced growth rates are a poor indicator of physiological performance as they do not capture the full complexity of energy allocation and physiological responses in marine macroalgae. To better understand the physiology, future studies should encompass various physiological parameters, including photosynthetic performance, nutrient uptake, and respiration rates, across different stages of development and environmental conditions.

Due to differences in seasonal and distributional patterns of sargassum across the region, understanding the role of temperature in the growth of pelagic sargassum morphotypes across various regions of the Atlantic, amongst other factors influencing their physiology (such as nutrients, salinity tolerance, or light, including their interactions), could help to understand the dynamics of the recent blooms in the tropical North Atlantic. Ultimately, it is important to continue research on understanding variations in various physiological responses such as pigment composition, photosynthetic performance, and growth rates as it can be a valuable tool for distinguishing between sargassum morphotypes when combined with morphological characteristics as morphology alone can sometimes be influenced by environmental conditions, integrating physiological traits provides a more comprehensive approach to classification.

## 2.5 Biodiversity

Sargassum has long been observed in the Sargasso Sea and has been observed with written records as early as the 15<sup>th</sup> century by Christopher Columbus (Winge 1923, Parr 1939, Ryther 1956). Floating mats of sargassum are recognized as keystone species (i.e., species that hold a habitat together and may have a disproportionately large impact on its ecosystem relative to its abundance) within the Sargasso Sea that are critical to supporting high biodiversity in an otherwise nutrient-poor Sargasso Sea (Lapointe et al. 2014, Ryther 1956). Floating sargassum in the open ocean can play a crucial role in marine ecosystems by supporting a wide variety of both flora and fauna, and therefore is considered an ecosystem of its own (Figure 6).



**FIGURE 6.** FLOATING SARGASSUM MATS SUPPORT A DIVERSE RANGE OF MARINE SPECIES IN THE OPEN OCEAN, BOTH DIRECTLY AND INDIRECTLY. AS THESE MATS ARE TRANSPORTED BY WINDS AND CURRENTS, SOME ASSOCIATED SPECIES, PARTICULARLY THOSE RESIDING WITHIN OR BECOMING ENTANGLED IN THE MATS, MAY BE TRANSPORTED TO NEARSHORE ECOSYSTEMS.

Primarily, sargassum provides a habitat, shelter from predation, and foraging opportunities for associated species. It hosts a variety of epibionts, diverse species of fauna—some endemic to sargassum—juveniles, and migratory species, and indirectly supports other species through facilitating interactions between different communities such as providing hunting areas for commercially important

sport fish like tuna and marlins (**Figure 6**). These sargassum mats function as key ecological habitat and are estimated to support approximately 120 fish species and over 120 invertebrate species (Doyle and Franks, 2015). It is due to the large biodiversity supported within the floating mats of sargassum specifically and its socio-economic and cultural value, that the Sargasso Sea has now been designated an environmentally protected area (Laffoley et al. 2011).

The thalli of sargassum itself provides substrate to host a variety of species that attach and live on the leaves, air bladders or stems of sargassum. These epibionts include both sessile and motile species, which can include bacteria, other species of filamentous algae, and small invertebrates. The most commonly reported epibionts were bryozoans and hydroids (Mendoza-Becerril et al. 2020, Alleyne et al. 2023c, Faria et al. 2025) with host preferences across the morphotypes of sargassum likely due to differences in structures like blade size and density of the cluster (Alleyne et al. 2023c) (**Figure 7**).



**FIGURE 7.** EXAMPLES OF COMMON SESSILE EPIPHYTIC ORGANISMS OBSERVED ON THE THALLUS OF PELAGIC SARGASSUM WHICH INCLUDE BRYOZOANS, HYDROIDS, AND POLYCHAETES.

Of particular interest in recent literature has been the identification and characterization of microscopic organisms comprising and forming the microbiome of sargassum. The presence of epiphytic bacteria on sargassum thalli, while relatively understudied, has been shown to be important contributors

of nitrogen to marine systems via nitrogen fixation (Carpenter 1972, Hanson 1977, Phlips et al. 1986, Phlips and Zeman 1990, Johnson et al. 2023). Due to its large biomass, sargassum has been estimated to be one of the leading contributors of nitrogen fixation in marine systems, comparable to planktonic diazotrophs (Johnson et al. 2023, Léger-Pigout et al. 2024). This nutrient cycling helps to sustain microbial and invertebrate communities within the sargassum habitat (Faria et al. 2025). Stable isotope analysis of sargassum thalli by Léger-Pigout et al. (2024) also showed that the main source of nitrogen is derived from associated nitrogen-fixing diazotrophs. More importantly, Jung et al. (2025) have hypothesized that the combination of excess nitrogen produced by  $N_2$  fixing bacteria associated with the microbiome of sargassum combined with excess phosphorus in regions of upwelling resulting from vertical mixing associated with current patterns, may be the mechanism sustaining the bloom and accounting for annual variability in its biomass across the region. The hypotheses behind the rise in sargassum are discussed in more detail in Section 3. By functioning as a substrate for microbial colonization, sargassum also hosts potentially pathogenic bacteria, including *Vibrio* and *Alteromonas*, with possible implications for human health in adjacent coastal communities (Theirlynck et al. 2023, Mendonça et al. 2024, Abdool-Ghany et al. 2025; see Section 4.3). Additionally, sargassum thalli not only hosts a diverse array of species, but stable isotope analysis by Iporac et al. (2023) showed sargassum to be a direct food source for many invertebrates. This demonstrates the traditional role of sargassum in providing connectivity between ocean and terrestrial communities and its role in refurbishing beaches.

Apart from the thalli hosting a wide variety of species, floating sargassum mats in the open ocean sustain over 150 species of invertebrates, including endemic crustaceans and mollusks, many of which develop camouflage to adapt to their surroundings (Gaskill 2013). Studies have demonstrated that Arthropoda, Annelida, and Mollusca were the most dominant among motile species within sargassum mats (Monroy-Velázquez et al. 2019, Faria et al. 2025). It has been demonstrated that sargassum mats provide not only a habitat for some invertebrates but also protection from predators (Brooks et al. 2007). It is important to note that sargassum can act as a vector for long-distance dispersal of species, transporting epibiotic and other habitat-associated species beyond their historical ranges. Recent surveys have not only documented high species diversity within sargassum mats, but also approximately 11 previously unreported sargassum-associated species in the Azores (Faria et al. 2025) and six newly recorded species in the Mexican Caribbean (Monroy-Velázquez et al. 2019). Many of these newly reported species are considered endemic to the Sargasso Sea but are now being reported outside of their known range of distribution. For instance, the free-living clinging flatworm, *Gnesiocerossargassicola sargassicola*, was reported for the first time in the Mexican Caribbean (Monroy-Velázquez et al. 2019) and more recently, off the coast of Colombia along with another previously unreported species of flatworm, *Chatziplanagrubei grubei*, suggesting a recent range expansion for both species (Mayorga et al. 2025). Additionally, sargassum-associated species have also been reported in areas where pelagic sargassum is not typically observed. For instance, the nudibranch, *Scyllaea pelagica*, was identified on

sargassum fragments washed ashore along the Eastern Shore of Virginia, USA, with hurricane-driven transport proposed as the most likely mechanism (Noonan et al. 2025).

Sargassum mats also provide an essential pelagic habitat for over 81 documented fish species, and can provide food and protection for juvenile fishes, such as the sargassum fish (*Histrio histrio*) that mimics the seaweed through cryptic camouflage (Gaskill 2013). Many of the fish species found within the Mexican Caribbean by Monroy-Velázquez et al. (2019) were juveniles, showing the importance of sargassum mats as a protective habitat. Interestingly, Alleyne et al. (2023d) found 12 fish species associated with sargassum mats in the eastern Caribbean, including economically important species such as the horse-eye jack (*Carangidae latus*) and almaco jacks (*Seriola rivoliana*). However, the overall fish diversity was significantly lower than similar studies from the North Atlantic and Gulf of Mexico. This reduced biodiversity in the eastern Caribbean has been hypothesized to the relatively recent emergence of the GASB as a source region of sargassum, with the possibility that diversity may be increasing through time as sargassum becomes an established event. Conversely, this study also noted a drastic decline (60%) in flying fish (*Hirundichthys affinis*) catches during heavy sargassum influxes—an important observation given that this species historically represented a major component of region fisheries prior to anomalous sargassum landings beginning in 2011 (Alleyne et al. 2023d). Sargassum mats also host megafauna like young loggerhead sea turtles that rely on the mats to protect themselves from predators and as a food source, acting as a critical habitat for these vulnerable species (Gaskill 2013, U.S. Environmental Protection Agency 2025). Migratory organisms like humpback whales (*Megaptera novaeangliae*) and birds also depend on sargassum as a food source (Gaskill 2013), and the threatened Porbeagle shark (*Lamna nasus*) uses the Sargasso Sea as a pupping location (Sapsford 2021). The essential role of sargassum mats in supporting biodiversity demands that any management and mitigation efforts be approached with caution and ecological foresight, particularly in the open ocean.

At the time of writing this review, it is evident that the roles of nutrient availability, and the association of sargassum with nitrogen-fixing microorganisms must be explicitly incorporated into climate change scenario experiments to better resolve nutrients as a driver of the bloom and to improve forecasts of sargassum growth across the Atlantic basin. After more than a decade of sargassum expansion and long-distance transport across the Atlantic region, the globalization of associated fauna is likely already underway and is expected to continue. Consequently, research focused on biodiversity assessment should be further developed but requires rapid establishment and dedicated, long-term financial support of sentinel monitoring programs, as inadequate funding would severely limit the ability to detect species introductions, assess invasion dynamics, and distinguish pre- from post-invasion conditions as the bloom continues.

## Recommendations

- Future studies should aim to advance our understanding of sargassum physiology to better evaluate the hypothesized drivers of bloom formation. More specifically, research is needed to explore the combined effects of temperature and nutrient availability on sargassum's physiological responses. Another underexplored area of research is the role of nutrient enrichment in the accumulation of heavy metals, particularly arsenic, within sargassum tissue and the extent to which these metals leach into the surrounding environment.
- Resolving taxonomic ambiguities among sargassum morphotypes will require further research utilizing nuclear genome sequencing approaches.
- Research should incorporate multiple physiological indicators—such as photosynthetic performance, nutrient uptake, respiration rates, and pigment composition—to better capture the complexity of stress responses.
- Chemical screening for toxic metals, particularly arsenic, should be mandatory before approving the use of sargassum biomass for agricultural, food, or feed applications.
- Programs should be funded to track sargassum morphotypes, biochemical properties, and heavy metal concentrations regionally and seasonally to enhance forecasts and risk assessments.
- Management and mitigation strategies must be flexible, science-driven, and tailored to account for regional and seasonal differences in morphotype distribution, chemical composition, and the biodiversity supported by floating sargassum.
- The development of basin-scale sentinel monitoring programs is important for detecting *Sargassum*-mediated species redistribution, quantifying changes in biodiversity, and informing ecologically responsible management strategies.



# 3

## Formation and Movement of Sargassum

### Highlights

- The 2010 negative NAO event is linked to the emergence of a new sargassum region, while self-sustained proliferation and transport is linked to the interaction of seasonal ocean circulation, nutrient mixing, and wind patterns in the tropical Atlantic.
- Temperature and nutrient availability, alongside nitrogen-fixing bacteria, are detected as major contributors to sargassum growth.
- Remote sensing technologies have improved significantly and facilitated the monitoring of sargassum distribution across the Atlantic. However, challenges related to sunglint, cloud interference, underestimation of smaller patches, and accurate nearshore detection still require improvements.
- Mesoscale cyclonic eddies in the tropical Atlantic play a key role in transporting and aggregating sargassum, linked to emerging evidence of shifting Atlantic-wide sargassum distributions driven by changes in circulation, vertical mixing, and warming ocean conditions.
- Predictive efforts for sargassum movement rely on integrating satellite observations with oceanographic data, and citizen science initiatives.
- Research efforts demonstrate that the bloom distribution, trajectory and massive growth, are symptoms of a planetary problem.

Although massive sargassum inundations have been recurring since 2011, there have been historical records of floating sargassum and its beachings long before. Evidence of sargassum presence dates as early as the Mayan civilization (Godínez-Ortega et al. 2021). Due to sargassum's pelagic nature, ocean currents have acted as boundaries of large, confined sargassum populations within the North

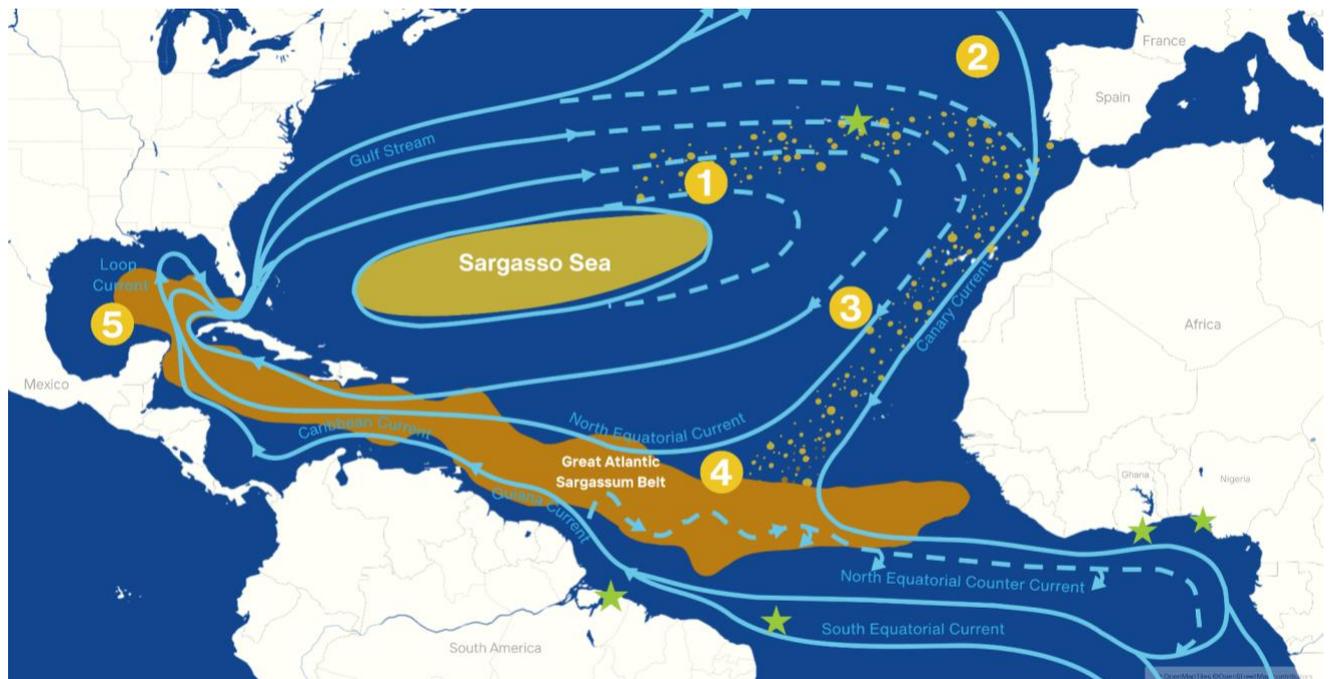
Atlantic, where it has persisted in relatively stable abundances in the Sargasso Sea (Parr, 1939). This characteristic also has made sargassum highly susceptible to local conditions (e.g., SST, salinity, nutrient availability), oceanic forces, and patterns (e.g., waves and surface winds) that dictate its movement (Johns et al. 2020, Putman et al. 2018, Méndez-Tejeda and Rosado Jiménez 2019). Ocean currents, in particular, have acted as pathways for sargassum transport (Johns et al. 2020). This section will address the historical context, environmental drivers, transport mechanisms, and monitoring techniques that govern the formation, movement, and proliferation of pelagic sargassum blooms across the Atlantic basin.

### 3.1 Triggering and establishment of the bloom

In recent decades, ocean currents have facilitated the transport of sargassum populations beyond their traditional boundaries in the Sargasso Sea. It has contributed to a major shift in its spatial and temporal distribution, as documented through satellite observations and field studies (Széchy et al. 2012, Gower et al. 2013, Schell et al. 2015). This shift was evident with the unprecedented increases in biomass that were reported across the Caribbean region in 2011 and again in 2014, where biomass landing was 10 times higher than in 2011 (Franks et al. 2011, Gower et al. 2013, Wang et al. 2019).

The present working hypothesis argues that a severe negative phase of the North Atlantic Oscillation (NAO) in 2009-2010 altered wind and current patterns (Johns et al. 2020). This anomalous climatic event led to the establishment of a new sargassum region as it likely eased ocean current constraints and allowed sargassum to venture into longer distances as eastward winds pushed mats to the eastern Atlantic towards the Gibraltar peninsula (Johns et al. 2020). Later, sargassum fragments traveled southward through the Canary Current in the tropical Atlantic, where they had not been previously abundant (Johns et al. 2020). Due to favorable conditions sargassum successfully proliferated and ultimately sparked the establishment of a new sargassum growing region in the North Equatorial Recirculation Region (NERR), located off the northeast of Brazil, approximately between the equator and 10° N, and from 50° W to 25° W (Johns et al. 2020). The biomass increase reported in the Caribbean was attributed to the emergence of this new source region (**Figure 8**). The role of the extreme negative NAO event was recently confirmed in a separate study conducted by Jouanno et al. (2025a). Their simulations also demonstrated that the negative NAO event caused sargassum to dislocate long distances southward of the Sargasso Sea, transporting rafts into richer tropical waters where pelagic sargassum could grow. Therefore, while the initial bloom in 2011 most likely have been triggered by atypical weather events, satellite data shows that subsequent influxes were linked to the newly identified growing region and now serves as a key source of sargassum biomass (Gower et al. 2013, Franks et al. 2016, Hu et al. 2016). In 2019, the term ‘Great Atlantic Sargassum Belt’ (GASB) for the new bloom region was coined by Wang et al. (2019), where sargassum growth has likely been supported by increasing nutrient

availability through oceanic vertical mixing (Jouanno et al. 2025a). These drivers have plausibly interacted with other factors like wind patterns, temperature, and ocean currents, shaping a complex system that needs further study to understand how these factors interact.



**FIGURE 8.** MAP SHOWING THE DYNAMICS RESPONSIBLE FOR THE EXPANSION OF SARGASSUM FROM THE SARGASSO SEA LEADING TO THE ESTABLISHMENT OF THE SECOND SOURCE REGION, THE GASB. DURING THE NEGATIVE NAO ANOMALOUS EVENT IN THE WINTER OF 2009-2010 (1) WINDS AND CURRENTS FACILITATED THE HORIZONTAL DISPLACEMENT OF SARGASSUM PATCHES LIKELY LED PELAGIC POPULATIONS TO TRAVEL OUT OF THE SARGASSO SEA TOWARDS THE EAST, NEARLY REACHING NORTHWESTERN AFRICA IN SPRING 2010 (2). BETWEEN SPRING 2010 AND SPRING 2011, SARGASSUM RELOCATED SOUTH THROUGH THE CANARY CURRENT AND SOUTHWEST WITH THE NORTH EQUATORIAL CURRENT (3), TO ULTIMATELY SETTLE AS A SARGASSUM GROWTH REGION IN THE EQUATORIAL ATLANTIC DURING THE SUMMER OF 2011 (4). SINCE THEN, THE GUIANA AND CARIBBEAN CURRENT HAVE ACTED AS CONVEYOR BELTS TRANSPORTING TONS OF SARGASSUM YEAR AFTER YEAR, IMPACTING THE GULF OF MEXICO AND CARIBBEAN COASTS THE MOST (5) (JOHNS ET AL. 2020). GREEN STARS REPRESENT LOCATIONS WHERE SARGASSUM HAS OCCURRED OUTSIDE OF THE GULF OF MEXICO AND CARIBBEAN, IN LOCATIONS SUCH AS LAGOS (NIGERIA), AZORES ISLANDS (PORTUGAL), SANZULE (GHANA), BEYIN (GHANA), SALINAS (BRAZIL) AND FERNANDO DE NORONHA (BRAZIL). MODIFIED FROM JOHNS ET AL. 2020.

Although the present working hypothesis has improved the collective knowledge surrounding the sargassum phenomena, increasing evidence will support and will provide a better understanding of how the two sargassum regions are interconnected in a feedback loop, and how impacts such as heatwaves in the Gulf of Mexico (Zhang et al 2025b) might give guidelines to the future of the GASB. Other hypotheses need to be explored, such as whether the GASB is expanding to the whole Atlantic, and the role of floating masses of sargassum reported for African coasts even before 2011. These are possible inferences due to recent sightings of sargassum in the Azores region (Faria et al. 2025), out of its usual stranding locations – possibly indicating another anomaly and/or expansion. Investigations on

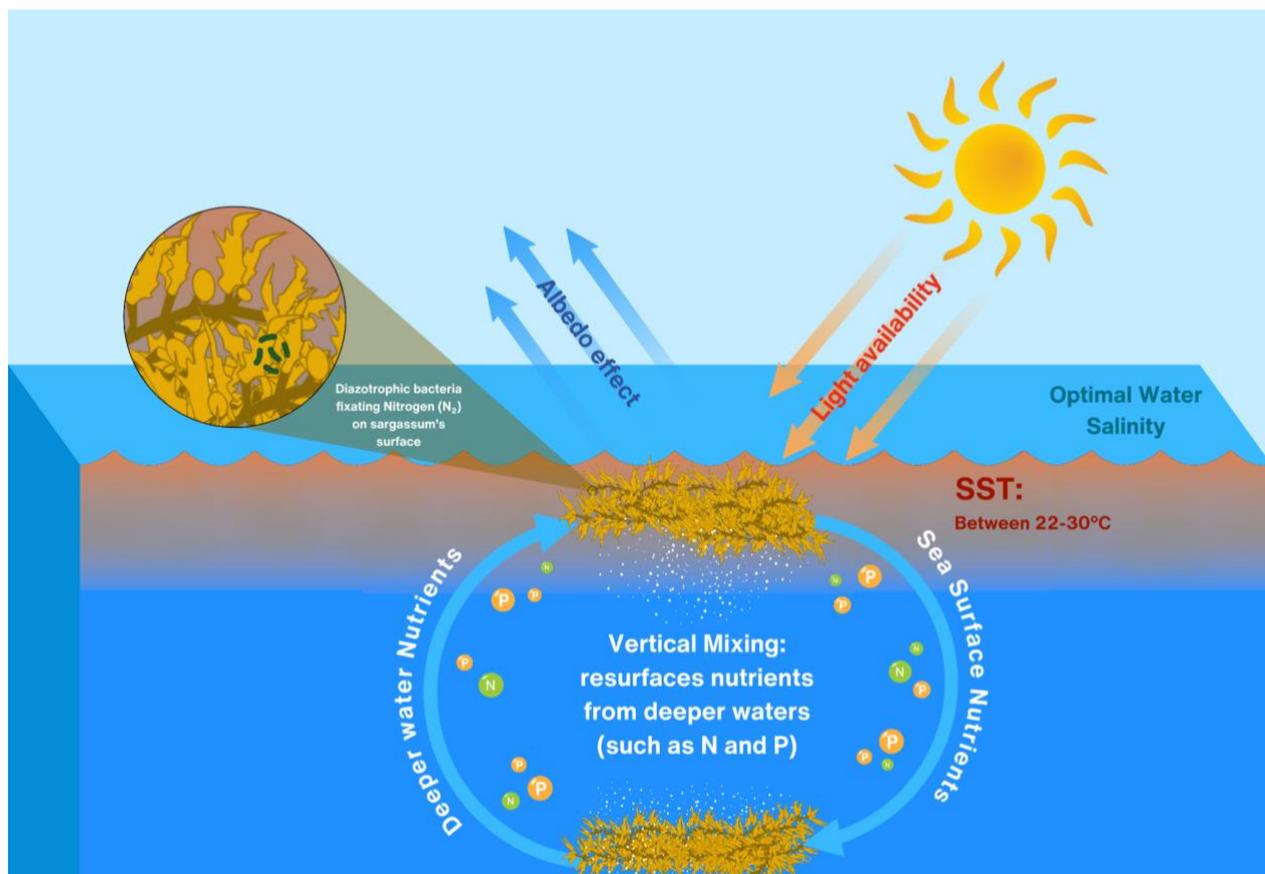
the causes of why other historical NAO events did not result in the inception of a new proliferation region are also needed.

## 3.2 Factors Sustaining the Bloom

The distribution and abundance of pelagic sargassum populations have undergone significant changes over time, influenced by both historical and contemporary environmental factors. Factors related to temperature, salinity, luminosity, alongside the macroalgae's albedo effect (Bach et al. 2021), water turbidity, and nutrient availability have been widely related to the emergence of Harmful Algal Blooms (HABs) (Glibert and Burkholder 2018, Paerl et al. 2018). Through remote sensing data, temperature and nutrient enrichment have been suggested as contributing factors for sargassum blooms (Wang et al. 2018, Wang et al. 2019, Schell et al. 2024). Due to carbon dioxide emissions from anthropogenic activity, global average temperatures have been nearing the threshold of 1.5 °C above pre-industrial levels (Calvin et al. 2023). This rise in global temperatures has also indirectly contributed to average sea surface temperatures increasing, creating favorable conditions for sargassum species growth (Marsh et al. 2023). As mentioned in the previous section (*Section 2.4*), in recent sargassum growth-rate studies performed, pelagic sargassum species were observed to show growth in temperatures between 22-30 °C, with optimal growth around 26 °C, however, excessively high temperatures above 30°C can hinder growth and lead to a decrease in sargassum seed population (**Figure 9**; Corbin and Oxenford 2023, Magaña-Gallegos et al. 2023a, Schell et al. 2024). This was also observed by Wang et al. (2019), as years associated with higher SSTs like 2013 and 2016 saw no blooms or a lack thereof. Milder SST, along with other factors, could have supposedly driven sargassum growth in years such as 2011, 2012, 2015, and 2018 (Wang et al. 2019).

In addition, nutrients have been suggested to also be a blooming trigger of sargassum species. Nutrients are necessary for any primary producer's growth, and thus, favorable environmental conditions are required for it to thrive and proliferate. The enrichment of waterways has long been recognized as linked to human activities. In the case of sargassum blooms, in the past, it has been proposed that N and P inputs could have originated from several sources, including dust deposits from the Sahara Desert, nutrient upwelling from the open ocean, vertical mixing that returns nutrients to the ocean surface, and runoff from significant rivers across the Atlantic basin (Wang et al. 2018, Wang et al. 2019, Lapointe et al. 2021). Among these rivers, the Amazon is often mentioned as a significant contributor to sargassum blooms, as nearly 30% of its total water flows directly into the central tropical Atlantic Ocean, making it one of the largest rivers in the world (Wisser et al. 2010, Aquino et al. 2022). However, river outputs and other sources acting as the primary drivers of the blooms have been reframed by a recent publication that used long-term numerical models to simulate sargassum distribution (Jouanno et al. 2025a). This study strongly argued that rather than nutrient-enriched waters from sources such as the Amazon River,

nutrients from seasonal vertical mixing have a bigger role in recurring blooms and their intensity, provoking the brown algae inundations seen on beaches (Jouanno et al. 2025a).



**FIGURE 9.** KEY ENVIRONMENTAL FACTORS INFLUENCING PELAGIC SARGASSUM GROWTH, INCLUDING OPTIMAL SEA SURFACE TEMPERATURES (22–30 °C) (CORBIN AND OXENFORD 2023, MAGAÑA-GALLEGOS ET AL. 2023), ADEQUATE LIGHT AVAILABILITY MODERATED BY THE SARGASSUM’S ALBEDO EFFECT (BACH ET AL. 2021), OPTIMAL SALINITY CONDITIONS (SCHELL ET AL. 2024), AND NUTRIENT ENRICHMENT FROM DEEPER WATERS DRIVEN BY VERTICAL MIXING PROCESSES (JOUANNO ET AL. 2025A).

Additionally, new research from Jung et al. 2025 also reinforces the link between upwellings to sargassum growth. Using coral-bound nitrogen isotopes and broad data synthesis, it was found an increase of atmospheric  $N_2$  fixed Atlantic wide. Supported by the evidence that diazotrophic bacteria, growing on sargassum, have played a key role in maintaining sargassum biomass production even in nutrient-poor waters (Michotey et al. 2020, Johnson et al. 2023, Léger-Pigout et al. 2024). Combined with an excessive P, made available through equatorial vertical mixing, linked to climate conditions environmental and biological conditions were and are favorable for the development of the massive growth of sargassum since 2011. These findings can help explain the sargassum yearly biomass variability as its blooms are most likely tied to climate-driven changes related to the equatorial upwelling patterns, such as years with strong equatorial upwelling could be producing more sargassum in the GASB. Furthermore, this could indicate that sargassum blooms may be more self-sufficient than

previously thought and that those combined mechanisms support the large biomass of sargassum produced yearly.

A gap that needs to be further addressed, as indicated by Méndez-Tejeda and Rosado Jiménez (2019) and Leemans et al. (2025), is the role of iron (Fe) as it could be a critical cofactor for sargassum growth, authors reported growth increase of *S. fluitans* when Fe was supplemented alongside nitrogen and phosphorus. Their findings indicate that Fe co-limitation is a widespread constraint in many tropical Atlantic regions, particularly where Saharan dust — a primary Fe source — is seasonally low. This Atlantic wide mechanisms need to be explored in conjunction with recent discoveries of Chlorophyll-a reduction in the equatorial region of the Atlantic, Hong et al. (2025) suggest that this decline can be associated with a reduction of N availability for phytoplankton and potential impact of increasing sea surface temperature; these trends can result in disruption of oceanic carbon cycle and trophic interactions, potentially contributing to the massive growth of sargassum (Bach et al. 2021). These very complex yet linked interactions need further collaborative investigations.

Further studies on sargassum morphotypes' physiological response, such as mortality rates, are needed to support distribution models and simulations and improve the reproduction of interannual variation modelling in sargassum biomass. Additionally, understanding the proportion of nutrients derived from nitrogen-fixing bacteria compared to those supplied by vertical mixing remains a research gap. Studies analyzing the global land-use practice at the Atlantic-basin scale are also becoming an urgent need to be able to take global managerial strategies to reduce this recurrent bloom that is still increasing.

### 3.3 Accumulation and Distribution of the Bloom

Oceanic forces and seasonal changes in circulation patterns have affected the distribution of sargassum. The trade winds converging along the Intertropical Convergence Zone (ITCZ) have continued to promote the accumulation and transport of floating sargassum across the tropical Atlantic (Johns et al. 2020). Converging trade winds in the ITCZ force the brown mats to be concentrated into a largely extensive windrow in the Atlantic (Johns et al. 2020). Later, as the Northern Hemisphere transitions from winter to summer, the ITCZ shifts northward, transporting sargassum mats across the latitude of the seasonal North Equatorial Counter Current (NECC) (Johns et al. 2020). Beyond influencing transport pathways, variability in the position of the ITCZ and associated wind convergence can also affect nutrient delivery, by steering floating biomass toward nutrient-rich regions such as the equatorial upwelling zones, thereby highlighting the link between circulation and nutrient availability (Skloris et al. 2022).

In this new location, sargassum fragments were distributed with the help of eastward currents and can reach as far as the coast of West Africa (Johns et al. 2020). The move to the NECC region has

also greatly favored sargassum growth with the intake of nutrients from mainly vertical mixing (Johns et al. 2020, Jouanno et al. 2025a). As the ITCZ weakened and began its southward trajectory, most of the sargassum mass stayed behind – this is when trade winds and the North Equatorial Current (NEC) transported sargassum west towards the Caribbean (Putman et al. 2018, Johns et al. 2020). These pathways have varied by season, as the Guiana Current is associated as a major transport route in the spring, while in summer, the North Brazil Current has been linked to this role (Putman et al. 2018). Together, these circulation features help explain basin-scale sargassum dispersal events, as demonstrated in a study that combined satellite observations with ocean current models. The widespread sargassum observed in 2017 was shown to have been mainly transported by surface currents, underscoring the role of ocean circulation in shaping bloom patterns. (Berline et al. 2020).

Still, in the central tropical Atlantic, some sargassum patches remained (Johns et al. 2020). These remaining mats later became the seed population of sargassum in the following year: the cycle has been observed to restart in the spring as the ITCZ shifts northward and wind activity has caused sargassum to re-aggregate (Johns et al. 2020). This new cycle, paired with favorable environmental conditions and sargassum populations in the central Atlantic, likely resulted in massive inundations on the Caribbean and Gulf of Mexico coasts (Johns et al. 2020).

More than 10 years of basin-wide observations' data, satellite-based biomass estimations from SaWS (Sargassum Watch System) have shown a recurring seasonal pattern in the Western Tropical Atlantic, with sargassum typically increasing in the spring and summer that peak around July, then declining into a low sargassum biomass season from October to February (Wang et al. 2019, Rodríguez-Martínez et al. 2022). Alongside these insights, annual variability was also seen showing general increase in biomass since 2011, with noticeable peak years such as 2015 (Wang et al. 2019, Jung et al. 2025), 2018 (Wang et al. 2019), 2021 (Jung et al. 2025), 2022 (Teyssier et al. 2025).

In the Eastern Tropical Atlantic, sargassum may exhibit seasonal variability that differs from that of the Western Tropical Atlantic. Recent work by Fidai et al. (2025) provides new insight into how sargassum influxes reach this region. Their analysis showed that sargassum does not arrive uniformly along the West African coast: coastal areas from Guinea to Gabon (the North Zone) experienced a primary annual peak in September, whereas coasts from Gabon to Angola (the South Zone) tended to peak earlier, in July or August. Both zones also exhibited a smaller secondary peak between March and May. The study further identified 2017 and 2019 as peak years of sargassum biomass influx in the North and South Zones, respectively. In addition, a statistically significant long-term increase in biomass was observed in the North Zone, suggesting that sargassum peak seasons vary regionally and that influx intensity is increasing over time.

Additionally, tropical cyclones (TC) and mesoscale cyclonic eddies (CE) were recently found to have a substantial role in the aggregation of sargassum (Sosa-Gutierrez et al. 2022, Zhang et al. 2025a).

High-speed winds in tropical cyclones have been observed to impact sargassum aggregation, as it has been seen to cause a decrease of 40-60% in drifting sargassum coverage after a cyclone's event (Sosa-Gutierrez et al. 2022). Meanwhile, satellite data showed that cyclonic eddies retained more sargassum than eddy-free waters and anticyclonic eddies. These insights suggested that tropical cyclones, eddy-driven downwelling in CEs, and wind-eddy interactions have acted as significant physical aggregation and separation mechanisms (Sosa-Gutierrez et al. 2022, Zhang et al. 2025a).

Mesoscale eddies also serve as important transporters of sargassum as seen in a recent study. The results suggest that sargassum accumulation depended on the circulation direction and the region the eddy is located in varying amounts. For the tropical Atlantic, cyclonic eddies are found to be more frequent than anticyclonic eddies (Sosa-Gutierrez et al. 2025). It was also shown that sargassum was more efficiently aggregated in the Caribbean than in the central Atlantic, it is presumed that this difference is due to the presence of weaker eddies and trade winds in the central Atlantic however further research is needed (Sosa-Gutierrez et al. 2025). These findings have supported and extended earlier ideas regarding the ocean circulation's role in shaping sargassum's trajectory, complementing seasonal forces like the ITCZ and NECC shifts.

The broader picture is becoming clearer with the development of more research. Zhang et al. (2025b) document report a dramatic change in sargassum abundance in the Sargasso Sea, suggesting that different trajectories are emerging in response to varying current conditions across the Atlantic Basin. It is also suggested an important hypothesis to consider for future studies: the impact of heatwaves on the reduction of the growing area on the Gulf of Mexico. Collectively, these findings point to a shift in the Atlantic-wide distribution of sargassum.

As Atlantic temperatures continue to rise, sargassum growth may become increasingly limited, while ocean currents and nutrient availability are altered. Recent studies that link the role of vertical mixing with biological characteristics (see Section 2) and distribution patterns before and during the Great Atlantic Sargassum Belt (GASB) surge, explained these potential changes while providing important mechanisms for projecting future scenarios. Consistent with these findings, it is important to consider recent observations that point to reduced phytoplankton biomass in the same region and during the same years. This factor must be incorporated into future models, as nutrient competition may have broader impacts on trophic webs and the oceanic carbon cycles (Henson et al. 2021, Hong et al. 2025).

Thanks to the important advances in understanding sargassum dynamics, significant knowledge gaps are becoming integrated. The specific environmental triggers that initiate large-scale blooms in the NERR are not fully understood, nor is the relative contribution of natural versus human-induced nutrient sources, but mechanisms are starting to become more clear, and we know it is not only one cause, but a global integrated oceanic response. The unpredictable nature of sargassum is still being studied to refine sargassum tracking models. Additionally, the potential adaptation of sargassum populations to varying

environmental conditions in different climate change scenarios remains underexplored, limiting predictions about future bloom patterns. Further research integrating nutrient flux assessments and ocean circulation modeling, including vertical mixes, under different temperature scenarios is needed to refine our understanding of these complex dynamics and improve management strategies and future of the bloom.

### 3.4 Evolution of Monitoring Techniques

Over the past decade, pelagic sargassum monitoring has progressed considerably, becoming one of the most frequently published topics concerning the issue and further developing the discussion on pelagic sargassum (Arita et al. 2023). Early advancements began using the coarse-resolution sensor MERIS (spatial resolution of 300 m) (Gower and King 2008, Gower and King 2011, Gower et al. 2013), which was pivotal in detecting the second sargassum region (Johnson et al. 2012, Gower et al. 2013, Franks et al. 2016). Since then, sargassum monitoring has transitioned to various other sensors. Other coarse-resolution satellites such as MODIS (spatial resolution of 1 km) and VIIRS (spatial resolution of 750 m) have been frequently cited and allow large-scale monitoring of mats (Hu et al. 2016b, Wang and Hu 2016, Wang et al. 2018). However, this spatial resolution has been reported to underestimate smaller patches, submerged strands, and thin or fragmented windrows, as these low-density aggregations go under-detected (Hu et al. 2016b, Lazcano-Hernández et al. 2023). In hopes of surpassing coarse resolution limitations, recently, high-resolution sensors, such as Sentinel-2 MSI (spatial resolution of 10 m) and OLI (spatial resolution of 15-30 m), have been utilized and improved detection accuracy (Gower and King 2020, Wang and Hu 2021). Although, challenges such as atmospheric effects (i.e., sun glint, cloud coverage), difficulty detecting sargassum in near-shore waters, and even underrepresentation of small sargassum clumps still persist (Arellano-Verdejo and Lazcano-Hernandez 2020, Arellano-Verdejo and Lazcano-Hernández 2021); along other barriers like lower temporal frequency and limited coverage with high-resolution sensors (Wang and Hu 2021).

Spectral indices, such as MCI, FAI, and AFAI, have been applied to satellite images to spot floating vegetation in open oceans and have been essential for detecting floating sargassum (Gower et al. 2005, Hu 2009, Hu et al. 2016a, Lazcano-Hernández et al. 2023). Currently, the AFAI has been widely used to monitor sargassum distribution in the Atlantic and quantify the sargassum biomass bloom (Hu et al. 2025). However, nearshore detection has remained difficult due to coastal interference and mixed pixel effects (Lazcano-Hernández et al. 2023), resulting in inaccurate sargassum influx data (Hu et al. 2023). These limitations are a bottleneck for translating offshore satellite-derived biomass estimates into coastal sargassum forecasts, for actionable local management mitigation and planning (Hatt et al. 2025b).

In addition to spectral indices and high-resolution sensors, machine learning approaches have been developed to improve coastal detection of sargassum; for example, a deep neural network trained on MODIS imagery achieved around 90% accuracy in classifying floating and accumulated sargassum along Caribbean coastlines, illustrating the potential of AI-assisted methods to augment satellite-based monitoring efforts (Arellano-Verdejo et al. 2019). Advances in deep-learning approaches, such as the U-Net ResNet model, have also been integrated into remote sensing applications to further improve satellite-based monitoring of sargassum (Wang and Hu 2021, Laval et al. 2023, Arellano-Verdejo and Lazcano-Hernandez 2024). However, these approaches still require further development to enhance image resolution and more accurately track sargassum beds. Other studies have addressed this limitation by developing integrated monitoring platforms that combine satellite imagery with drone surveys, in situ sensors, and citizen science observations, demonstrating that multi-source data fusion improves nearshore detection, spatial coverage, and early-warning capacity for sargassum arrivals (Arellano-Verdejo et al. 2025, Hatt et al. 2025b). By filling in data gaps and ensuring cross-sensor continuity, the expectation is to develop multi-sensor sargassum data and provide a more complete picture of sargassum distribution in various scales.

Alternatively, aerial imagery has also contributed to sargassum monitoring as some studies have utilized hyperspectral sensors mounted on aircrafts to assess the distribution of sargassum near-shore arrival (Dierssen et al. 2015, Teyssier et al. 2025). In a recent paper, Teyssier et al. (2025) adopted an innovative approach combining use of aerial monitoring with in situ cameras to analyze the spatiotemporal dynamics of sargassum arriving at Martinique's coastline at a finer scale, this combined method favored the assessment of the coastal exposure to sargassum pressure. However, this approach is disadvantageous for a territorial scale diagnosis for it is very costly to be applied on a daily basis (Teyssier et al. 2025, Hatt. et al. 2025b). Each flight depends on aircraft availability, service provider and equipment used only for data collected to act as a snapshot in time. In situ camera monitoring also presents limitations as brown water and far away objects can be difficult to be detected (Teyssier et al. 2025). Furthermore, camera-based monitoring demands suitable conditions for it to be successful, such as, network connection, appropriate field of vision, and a long-lasting viable energy source to capture images in long periods of time (Teyssier et al. 2025).

Drones equipped with high-resolution cameras have also been applied to capture high-resolution observations of sargassum accumulations on beaches and in open waters (Salter et al. 2020, Hernández et al. 2022, León-Pérez et al. 2023, Fidai et al. 2024). On one hand, it could be advantageous to specially use drones, due to their relatively low cost and ability to capture localized sargassum beachings. On the other hand, drones have limited spatial coverage, which makes them less suitable for large-scale assessments (Hernández et al. 2022). Nonetheless, drones are effective when used as a complementary

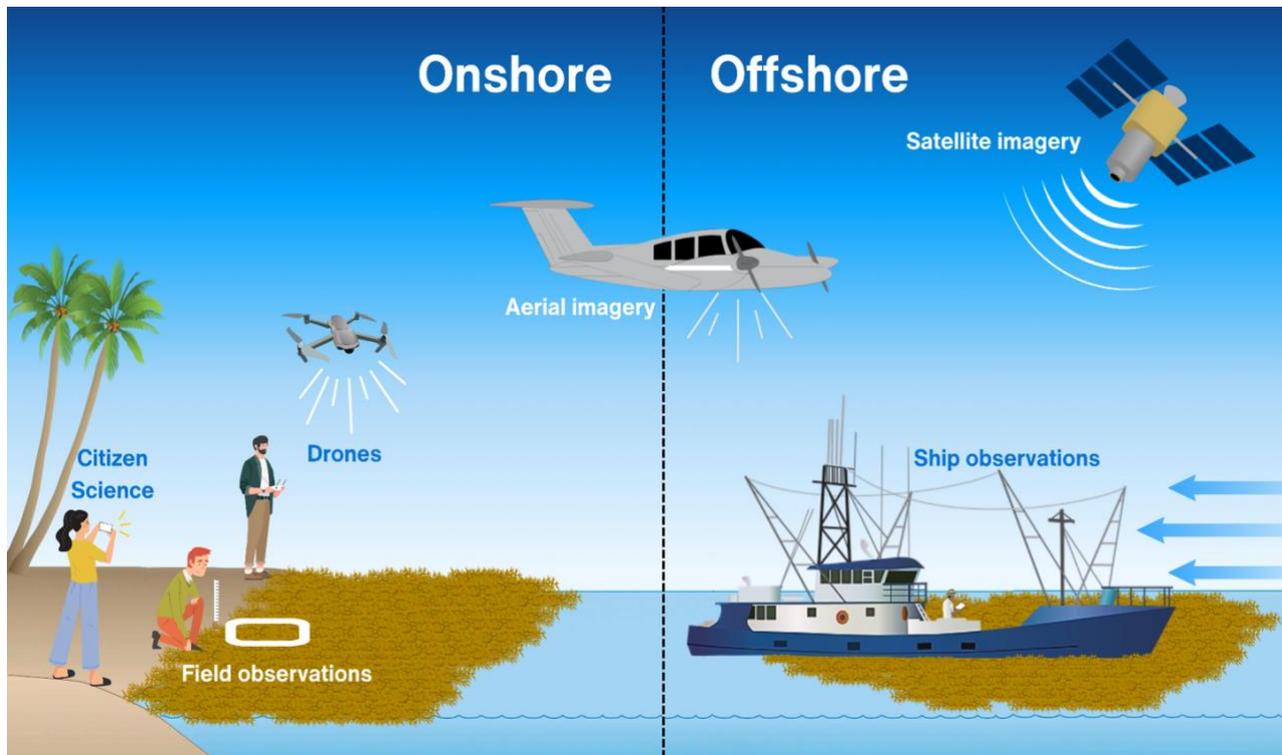
validation tool – particularly for scaling up field-based biomass estimates and for remote sensing validation (Hatt et al. 2025b).

In addition, ship-deck observations— one of the less common approaches in sargassum monitoring— have also been used in academic publications, as this method has provided high-resolution observational data and in situ validation of remote sensing data. This method could be particularly valuable for validating satellite observations, improving detection accuracy, and monitoring beach landings and small-scale mats in high seas that satellite sensors might miss. Some studies combined aerial techniques with other methods, such as satellite imagery (Dierssen et al. 2015, Hu et al. 2016) or in situ monitoring (Fidai et al. 2024). For instance, Ody et al. (2019) adopted ship-deck observations to document the spatial structure and typology of sargassum aggregations— from dispersed clumps to massive circular rafts. The instrumental use in assessing sargassum’s physiological conditions and associated biodiversity is better known, as research cruises have supported the refinement of spectral detection and can reveal fine-scale sargassum aggregation patterns while also improving biomass estimates and enhancing model accuracy (Goodwin et al. 2022).

Another cost-effective approach to local monitoring has been citizen science. By using smartphones to upload geotagged pictures with the current state of their local beach to the website/application, volunteers have easily contributed to projects, such as Big Seaweed Search Mexico, Sargassum Watch (Epicollect5), Sargassum Monitoring, or Seaweed School & Community Network (SargSNAP+) (Iporac et al. 2022, Vázquez-Delfín et al. 2024). This approach allows the collection of data in areas where satellite or aerial imagery may be limited or unavailable (Arellano-Verdejo and Lazcano-Hernández 2021). Furthermore, crowdsourcing data can provide valuable ground-truthing information for validating satellite observations and oceanic models (Putman et al. 2023, Trinanes et al. 2023). When well executed, citizen science initiatives have been observed to engage local communities, support environmental education, and fill spatial and temporal data gaps (Arellano-Verdejo and Lazcano-Hernandez, 2024, Iporac et al. 2022, Putman et al. 2023, Vázquez-Delfín et al. 2024). Challenges may arise, such as maintaining the participation of volunteers, ensuring consistent incoming quality data, and standardizing data collection protocols (Arellano-Verdejo and Lazcano-Hernandez, 2024, Iporac et al. 2022). A recent publication, that pairs a comprehensive review with conversation with selected experts in the field of sargassum-related citizen science, identified insufficient funding to sustain long-term programs, insufficient data processing capacity, and limited integration with other monitoring platforms as key barriers to sustain citizen science programs (Hatt et al. 2025b). However, the inclusion of trained volunteers, educational workshops, and structured identification guides can help

overcome these issues and broaden participation in monitoring efforts (Vázquez-Delfín et al. 2024).

**Figure 10** shows the sargassum monitoring at different scales.



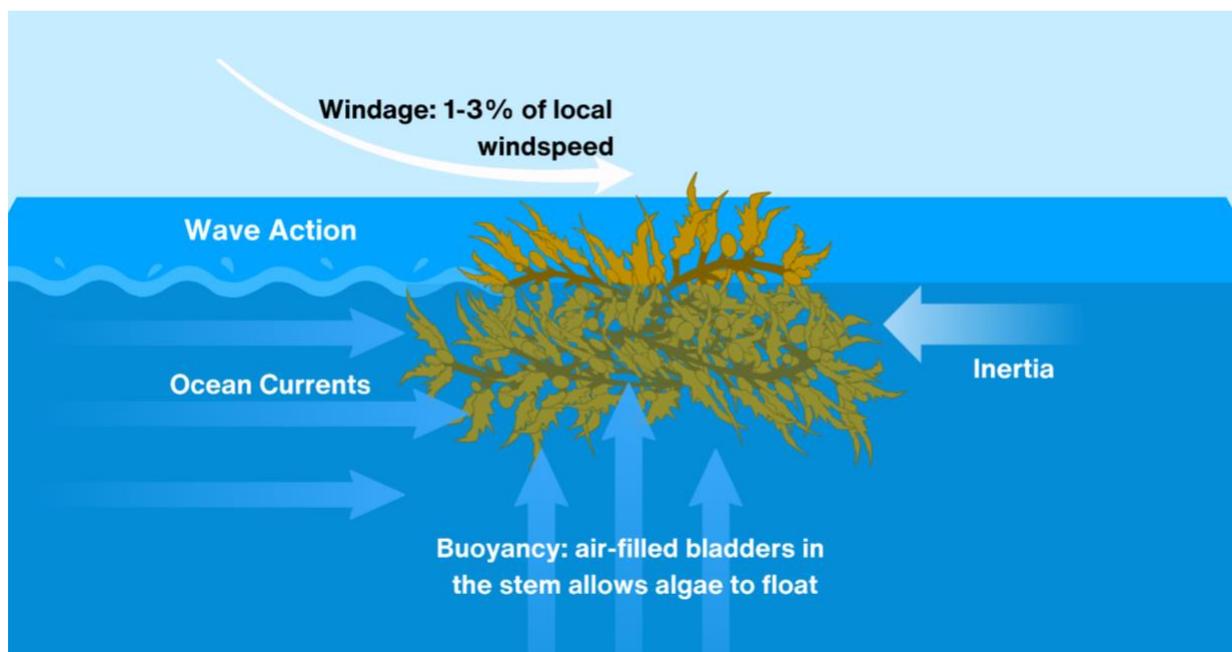
**FIGURE 10.** OVERVIEW OF EXISTING SARGASSUM MONITORING METHODS, RANGING FROM COASTAL (ONSHORE) APPROACHES—SUCH AS CITIZEN SCIENCE INITIATIVES, FIELD OBSERVATIONS, AND DRONE SURVEYS—TO OFFSHORE METHODS SUCH AS SHIP OBSERVATIONS, AND HIGHER-ALTITUDE TECHNIQUES, INCLUDING AERIAL IMAGERY AND SATELLITE REMOTE SENSING.

### 3.5 Trajectory Predictions

Predicting sargassum trajectories requires understanding its physical properties and interactions with environmental forces. Unlike passive particles, sargassum’s buoyancy from air-filled bladders, finite size, and other physical factors cause it to respond differently to ocean currents and winds, influencing drift pathways and accumulation patterns, as shown in **Figure 11** (Beron-Vera et al. 2019, Miron et al. 2020, Marsh et al. 2022, Podlejski et al. 2023). Taking into account that movement sargassum is not instantaneous with the water — due to their size and inertia — changes how models predict their movement. This adjustment is important, as it translates in more accurately tracking sargassum routes. In one study, it helped more precisely predict southward movement from the Sargasso Sea and more retention in the Caribbean and Gulf of Mexico compared to models that treat them like passive particles (Brooks et al. 2020). Thus, further highlighting the importance of including these physical effects in transport predictions. Another publication found – through hydrodynamic modeling – pelagic sargassum does not behave as a passive buoyant object, as drag forces associated with raft structure and morphology cause it to drift more slowly than surrounding surface currents, and that

incorporating this resistance significantly improves trajectory simulations and reduces errors in predicting basin-scale transport and coastal strandings (Podlejski et al. 2023). By contrast, satellite-based tracking of floating mats indicates that observed sargassum features can migrate at velocities comparable to or slightly higher than surface currents (mean  $\sim 0.6 \text{ m s}^{-1}$ ), likely reflecting the combined influence of wind forcing, Stokes drift, and aggregation effects acting at short spatial and temporal scales (Hernández and Euán-Avila, 2025).

Additionally, wind intensity plays a key role in shaping sargassum distribution, as variations in wind strength influence its behavior at the ocean surface. Moderate to low wind speeds tend to promote the aggregation and organization of floating mats along wind-driven pathways, whereas stronger winds enhance dispersion and fragmentation by increasing mixing and separation forces (Laval et al. 2023). Therefore, demonstrating how wind-related processes can either favor aggregation or lead to dispersion. This further shows how sargassum transport emerges from the combined influence of physical structure, wind forcing, and ocean circulation, and underscores the importance of integrating multiple observational and modeling approaches to better represent its drift behavior across spatial and temporal scales.



**FIGURE 11.** VARIOUS OCEANIC FORCES INFLUENCING THE MOVEMENT AND TRANSPORT OF PELAGIC SARGASSUM, INCLUDING WINDAGE EFFECTS (1–3% OF LOCAL WIND SPEED), WAVE ACTION, OCEAN CURRENTS, AND THE MACROALGAE’S INHERENT BUOYANCY AND INERTIA.

To forecast sargassum movement, oceanographic models like HYCOM, ICHTHYOP particle tracking, and Lagrangian drift models have integrated real-time data on currents, wind patterns, and tidal influences (Johnson et al. 2013, Brooks et al. 2018, Franks et al. 2016, Maréchal et al. 2017, Andrade-Canto et al. 2022). These models have helped to better simulate sargassum distribution.

The development of tools like SaWS have provided almost real-time maps of sargassum biomass (Hu et al. 2016b, Maréchal et al. 2017). While the Sargassum Inundation Risk (SIR) index has predicted beaching likelihood by combining remote sensing data with drift models (Trinañes et al. 2021, Putman et al. 2022, Marsh et al. 2023). However, coastal predictions have remained challenging due to various different factors that play in coastal dynamics such as reef barriers, wave intensity, shoreline orientation, cyclonic/anticyclonic gyres and man-made structures (Moreira et al. 2006, Torres-Conde et al. 2021, Lara-Hernandez et al. 2024, Valdés et al. 2025, Rodriguez et al. 2025).

For instance, in Cuba, calmer seas associated with low wave heights (below 1 m) were observed to be linked with sargassum arrival as high waves act as a barrier, keeping mats offshore and reducing beaching (Valdés et al. 2025) and influencing sargassum deposition patterns. And Hernández et al. (2025) demonstrated that eastern Guantánamo, Cuba, experiences higher arrivals where local upwelling and coastal circulation concentrate floating biomass. Areas with persistent upwelling zones tend to accumulate sargassum as the upward-moving waters trap drifting mats in nearshore gyres.

Recent studies further highlight how regional forcing and climate variability shape nearshore sargassum accumulation. Amorim et al. (2025) shows that the Amazon Shelf receives sargassum primarily during the rainy season, when the southward-shifted ITCZ and strong northeasterly winds push offshore sargassum toward the broad Brazilian shelf. Their modeling shows that tides and wave-generated Stokes drift further concentrate sargassum nearshore, creating nutrient-rich and physically conducive conditions for strandings. In contrast, Cuervas et al. (2025) illustrates how difficult it is to determine sargassum pathways when mats are reaching the shore. In the study, buoys were displaced in the Mexican Caribbean to understand sargassum near-coast dispersal and results showed the most inconsistent when less than 20 km away from the beaches. In the Gulf of Mexico, the occurrence and seasonal abundance of pelagic Sargassum have been shown to vary with large-scale climate modes such as the Atlantic Multidecadal Oscillation, North Atlantic Oscillation, and El Niño–Southern Oscillation, with certain climate phase combinations favoring higher Sargassum presence (Sánchez-Rubio et al. 2017). Together, these findings highlight how interactions between regional circulation, coastal processes, and decadal climate variability can modulate basin-scale transport and regional accumulation patterns.

Therefore, integrating local data from sources such as citizen science and smartphone-based monitoring could be valuable assets for validating these predictions, particularly in nearshore environments where satellite observations are limited by spatial resolution or cloud cover (Valentini & Balouin 2020, Putman et al. 2022).

Significant gaps remain in sargassum monitoring, particularly in remote sensing, aerial imagery, and citizen science integration. Coarse-resolution satellites (e.g., MODIS, VIIRS) provide frequent, large-scale coverage but lack the detail to track small patches and nearshore accumulations, while high-

resolution satellites (e.g., Sentinel-2, WorldView-3) offer finer detail but have limited coverage and longer revisit times. Cloud interference further reduces optical sensor reliability, and spectral indices like AFAI struggle with false positives in coastal areas (Wang and Hu, 2016, Descloites et al. 2023, Hu et al. 2023). While deep learning models have improved classification, they require better training datasets and validation across different environments. Aerial imagery from drones and hyperspectral sensors enhances nearshore detection but is constrained by high costs and limited scalability. Citizen science programs provide real-time observations, but data inconsistencies and a lack of automated processing reduce their impact. The lack of multi-source data integration (combining remote sensing, numerical models, aerial surveys, and citizen science reports) remains a major challenge for improving forecasting accuracy and early warning systems.

On the coast, sargassum landing predictions still need improvements. Researchers integrate oceanographic data and models that simulate ocean currents, wind effects, and floating non-fluid particle behavior with satellite imagery research (Putman et al. 2022, Rutten et al. 2021, Trinañes et al. 2021). Models such as Lagrangian drift (Olascoaga et al. 2020, Aguilera-Mendez et al. 2023, Marsh et al. 2022), HYCOM (Johns et al. 2020, Putman et al. 2018), and GPS trackers (Van Sebille et al. 2021, Putman et al. 2020) have been cited in understanding how physical environmental factors (e.g., winds, waves, inertia) influence pelagic sargassum transport in open waters and in forecasting studies. Considering these factors in models is a complex task that can result in more accurate predictions of sargassum accumulations (Sosa-Gutierrez et al. 2022).

Another key element that must be understood to develop accurate sargassum forecasting is the influence of coastal topography and beach dynamics on sargassum arrival, as these factors can determine how much biomass reaches and remains onshore (Moreira et al. 2006, Torres-Conde et al. 2020, Rutten et al. 2021, Lara-Hernandez et al. 2024). As each environment, open waters and nearshore can have different oceanographic processes acting upon each setting, this adds an extra layer of complexity to sargassum modeling and sargassum pathway predictions (Rutten et al. 2021). Factors like reef barriers, shoreline orientation, onshore winds, wave intensity, and man-made structures can modify deposition patterns and create accumulation hotspots (Moreira et al. 2006, Torres-Conde et al. 2021, Rutten et al. 2021, Lara-Hernandez et al. 2024). Continued research is needed to understand and refine nearshore transport models, as few studies were observed to address this subject.

## Recommendations

- Further research is needed to support the current working hypothesis by strengthening the evidence linking the 2009–2010 negative NAO event to the establishment of the second sargassum bloom region. In parallel, studies investigating why earlier extreme negative NAO events did not trigger the formation of a second bloom region prior to 2011 are also recommended. Add more evidence to recent research addressing, interconnectivity between sargassum regions, heatwaves and the possible Atlantic-wide expansion of the GASB.
- Improve our collective understanding of how various basin-wide oceanographic and biochemical factors, such as the potential co-limitation of iron (Fe) from the Saharan desert, influence the growth of pelagic sargassum at sea.
- Understand the link between reported decrease of phytoplankton to sargassum abundance and physiological process and to climate change scenarios including heatwaves in different regions
- More insight into these topics can significantly advance forecasting and biomass estimation efforts, ultimately leading to better coastal management and preparation for future sargassum beaching events.
- Investigations along the West African coast, where sargassum arrival patterns differ markedly from those observed in the Caribbean, and improved regional observations and modeling are necessary to capture these distinct dynamics and support locally management strategies.
- Funding and supporting local coastal monitoring, including citizen science initiatives, are needed to raise community awareness and provide consistent, low-cost data essential for validating and improving sargassum inundation forecasting. Integrating these observations with remote sensing and current oceanographic knowledge will further enhance predictions of sargassum aggregation/separation of individual strands, on trajectory/transport, beaching dynamics.

# 4

## Environmental, Health, and Socioeconomic Impacts

### Highlights

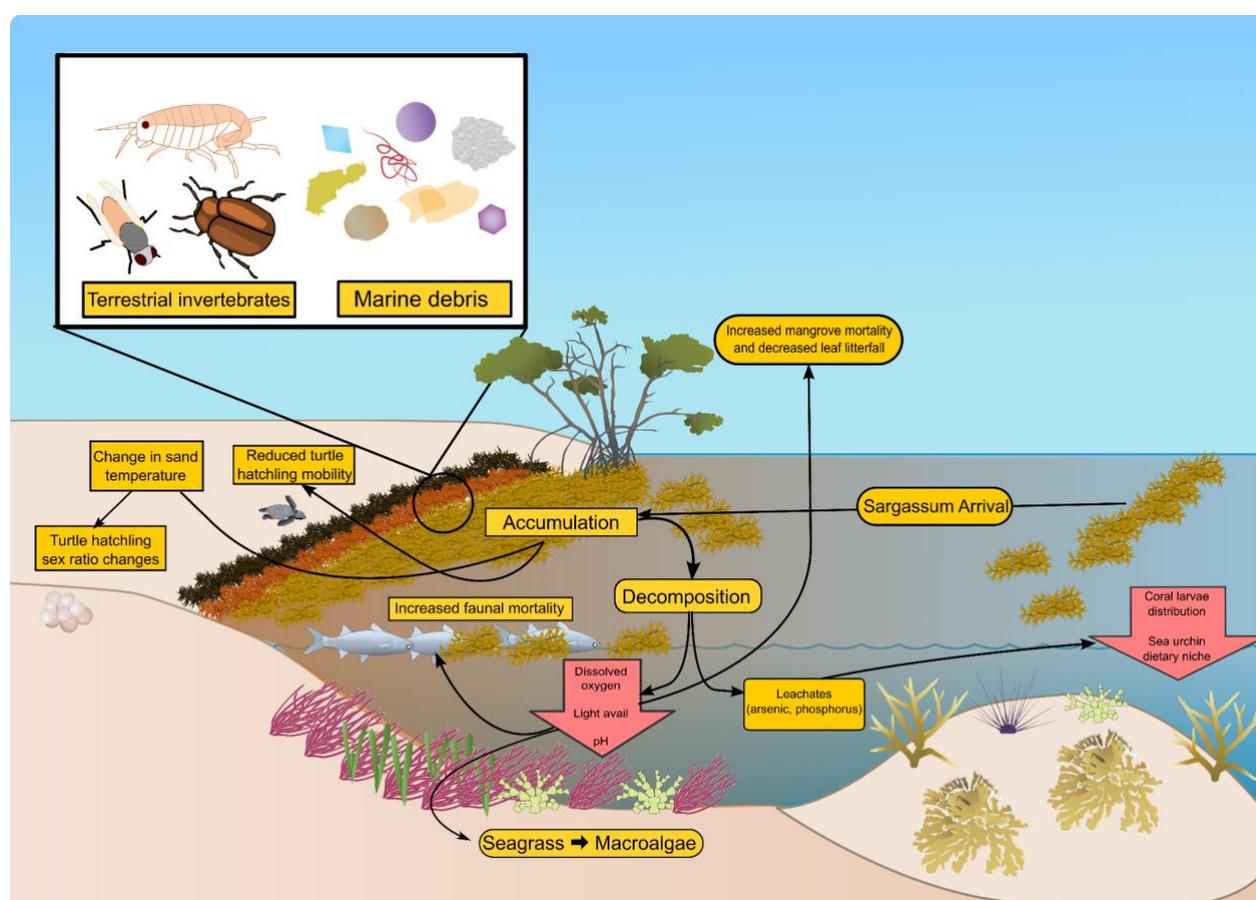
- Pelagic sargassum influxes have both short-term and long-term ecological consequences for coastal ecosystems by decreasing their resilience and compromising their ecosystem services.
- Pelagic sargassum is a public health concern as a vector of pathogenic microbes and release of hydrogen sulfide and arsenic as toxins, potentially triggering long-term debilitating human diseases.
- Pelagic sargassum also diminish local economies by reducing tourism and fishery industries, loss of jobs, with minoritized, low-income communities in exposed areas being more susceptible to socio-economic impacts of sargassum.

Given the intricate biology and oceanographic patterns of sargassum, the effects of its accumulation of excessive biomass are massive and can range from environmental to socioeconomic damage. While sargassum inundations that demonstrate environmental impacts are at a local level through subsequent decomposition and anoxia, the multitude of coastal areas throughout the Caribbean affected by sargassum has ignited both governmental and private efforts to mitigate the impacts caused by sargassum. As of writing this review, new evidence showed many studies concentrated in the Mexican Caribbean and emphasized environmental effects, while other affected areas within the tropical Atlantic region and other sectors were limited in their assessments (Rodríguez-Martínez et. al 2025). In

this section, we review the current state of knowledge of the impacts of sargassum inundations, including environmental, economic, socio-cultural, and public health impacts of sargassum.

## 4.1 Environmental Impacts

Repeated, local sargassum inundations and subsequent decomposition have overall detrimental impacts on nearshore systems, including seagrass beds, coral reefs, and beaches (Figure 12). In seagrass beds, sargassum inundations were shown to cause anoxic conditions due to excessive decomposition of sargassum, leading to the release of organic matter in the water column, decreased light availability for local benthic flora, and decreased oxygen availability.



**FIGURE 12.** ENVIRONMENTAL EFFECTS OF SARGASSUM INUNDATIONS ON DIFFERENT COASTAL AND NEARSHORE SYSTEMS.

A series of sargassum events between 2015-2019 in the Mexican Caribbean sargassum events revealed local nearshore flora shifting from seagrass-dominated ecosystems to macroalgae-dominated ecosystems (van Tussenbroek et al. 2017), as well as the fragmentation of seagrass beds in affected areas (Ávila-Mosqueda et al. 2025). Additional satellite imagery analyses showed water color associated with sargassum-brown-tide events surpassing the size of actual beach-cast sargassum (Ávila-Mosqueda et al. 2025). A similar shift was reported in Turks and Caicos in 2018-2019, where *Thalassia*-dominated

seagrass beds shifted to a mixed *Halodule*-macroalgae bed. (Bartlett and Elmer 2021). Seagrass beds are an essential component for shoreline stability and nursery provision for many ecologically and economically important fishery species. These changes in benthos can negatively affect habitat provisions and ecosystem functioning at large on an ecosystem level.

Many washed-up faunal mortality onshore during those influx events include fauna from nearby coral reef ecosystems. In 2014, massive accumulations of sargassum also had thousands of dead sardines mixed in with the algal biomass (Cruz-Rivera et al. 2015). Rodríguez-Martínez et al. (2019) collected faunal mortality observations from the 2018 sargassum event in the Mexican Caribbean; the majority of fauna was associated with nearby coral reef systems in the Mexican Caribbean that were likely affected by anoxic conditions from excessive sargassum decomposition. Aside from faunal mortality, sargassum inundations can also release leachates that can reduce the swimming behavior and growth rates of coral larvae, such as those of *Acropora*, thereby reducing coral larval distribution and genetic diversity (Antonio-Martínez et al. 2020, Olguin-Maciel et al. 2022, Lankes et al. 2025). However, recent laboratory trials assessing effects of sargassum and ocean acidification scenarios on coral physiology showed that sargassum does not raise seawater pH, but has contributed to increased photosynthetic efficiency of *Acropora* (Lankes et al. 2025). The herbivorous sea urchin *Diadema antillarum* was shown to have reduced dietary niches due to the modified availability of vegetation from sargassum leachates and organic matter released into coral reef environments (Cabanillas-Terán et al. 2019). The combination of faunal mortality, reduced coral larval settlement, and reduced ecological niches can lead to reduced coral reef ecosystem functioning as a long-term consequence of sargassum accumulations. However, more laboratory studies need to be conducted to evaluate interactions and effects between specific coral reef biota and sargassum.

Sargassum accumulation effects in other nearshore ecosystems show similar, detrimental trends in environmental impact. The 2019 sargassum event in Belize showed a 99.5% reduction in dissolved oxygen levels and lower pH levels compared to typical seawater (Zuñiga et al. 2019). In Puerto Rico, sargassum influxes were associated with phytoplankton changes during the 2015 event (Sastre et al. 2023). A decrease in litterfall and increased red mangrove (*Rhizophora mangle*) mortality were reported during the 2019 event (Perez Perez 2022). Monitoring between 2022-2023 in Jobos Bay, Puerto Rico showed sargassum brown tides having deleterious effects at the nearshore level while midshore and offshore effects were more diffuse. Sargassum brown tide events coincided with increased chlorophyll *a* and decreased dissolved oxygen concentrations in the water column, increased total suspended solids, higher turbidity, and lower pH, and changes in submerged aquatic vegetation cover (Black et al. 2025). In sandy beaches, an increase in sargassum accumulations and decomposition was associated with increased terrestrial faunal detritivores (Iporac et al. 2023) and increased input of carbonate sediment onto coastlines (Salter et al. 2020). It is unknown what the long-term effects of sargassum would be on

sandy beach systems, given their rapid dynamics. However, based on the effects of seagrass and mangrove systems that stabilize coastlines, it is likely that beach erosion will continue. Any ecosystem functions that sargassum would provide on beaches would be overdriven by the massive abundance of sargassum biomass and secondary compounds that would deter some detritivores (Martínez-Cano et al. 2024), unless rapidly and properly managed.

Sargassum influxes were also shown to alter the life histories of sea turtle populations. Several studies have shown sargassum accumulations altering the sand temperature that would affect the sex of incubating sea turtle eggs (Maurer et al. 2022) and inhibit the number of hatchlings that would cross from their nest into the open ocean (Maurer et al. 2021, Gavio et al. 2018, Schiariti et al. 2022). However, neither sargassum inundations nor sargassum management strategies affected nesting preferences of sea turtles in the Mexican Caribbean (Rodríguez-Martínez et al. 2021). In a recent study conducted with hatchlings of three turtle species, hatchlings venturing through landed sargassum demonstrated increased crawling time to get to the end of the beach. However, there does not seem to be immediate physiological effects by righting responses nor blood glucose levels (Appelt and Milton 2025). Sargassum mats offshore in Suriname were shown to be utilized by green sea turtles as habitat, but the utility of sargassum as foraging mats by the megafaunal community is unclear (de Boer et al. 2020).

Sargassum is known to accumulate high concentrations of inorganic arsenic in its tissue content (Oyesiku and Egunyomi 2014, Addico et al. 2016, Nielsen et al. 2021, Bauta et al. 2024, Hatt et al. 2024). The amount of arsenic seemed to have very little seasonal or morphotype variability (Cipolloni et al. 2024), nor does it seem to vary by oceanic sub-origin or transport pathways (Alleyne et al. 2023d). However, the presence of epibionts on sargassum would be associated with higher arsenic content (Hatt et al. 2024). Fresh sargassum was also reported to have the highest concentration of arsenic in its body tissue, with 65% of the total arsenic being lixiviated from recently arrived sargassum that would later be lost as sargassum decomposes (Chavez-Vergara et al. 2025). The amount of inorganic arsenic in sargassum tissues is well above international guidelines (Ortega-Flores et al. 2023), potentially adding another impact to the beaches should arsenic and other heavy metals in sargassum would be released in the environment at high concentrations (Devault et al. 2022a).

Sargassum collected from Senegal, West Africa in 2022 contained low amounts of arsenic but higher levels of cadmium, mercury, and palladium (Bouso et al. 2024). Sargassum was also shown to accumulate high concentrations of chlordecone, often associated with contaminated river mouths downstream from agricultural uses from studies in Guadeloupe and Martinique (Devault et al. 2022a). Both studies show the ability of sargassum to intake local pollutants and work as a local indicator for some elements and potentially use it as a bioremediator.

Compared to other macroalgae, pelagic sargassum demonstrated high phosphorus limitation owing to its predominantly oceanic offshore habitat (Lapointe 1995). However, sargassum samples

collected from the GASB showed higher amounts of arsenic and phosphorus compared to sargassum collected from the Sargasso Sea, suggesting a strong association between these two elements (McGillicuddy et al. 2024), as mentioned in Section 2.3 of this white paper. Sargassum in phosphorus-limited environments would uptake more arsenic due to competition of the phosphate transporter between these two elements (Gobert et al. 2022). Furthermore, secondary compounds in sargassum, such as copper, alginates, and uronic acids, further facilitated the high arsenic content in sargassum (Ortega-Flores et al. 2022). This mechanism enables sargassum to have high concentrations of arsenic, making valorization efforts very challenging for private initiatives. The use of sargassum as fertilizers or other consumptive uses needs proper procedures to reduce arsenic content in sargassum tissues and leachates (Cisneros-Ramos et al. 2024).

Sargassum influxes are also associated with increased concentrated influxes of microplastics and other hazardous biota. There were multiple accounts of plastic waste being found associated with sargassum accumulations (Jocelyn et al. 2023, Osorio-Ruiz et al. 2024), suggesting that sargassum is a potential vector for increased plastic pollution (Aldana Arana et al. 2024). Proximity of sargassum to plastic pollution as a vector to arsenic also facilitated arsenic's different forms into sargassum that would then either be complexed into the algal cells or be excreted (del Real et al. 2025). Sargassum accumulations were also reported to be associated with the presence of the hydrozoa Portuguese man o' war (*Physalia physalis*), although these occurrences were associated with a negative average magnitude of the Arctic Oscillation Index that favors cold fronts and northerly winds, and the origins of these associations are from the North Atlantic Subtropical Gyre rather than the GASB (Torres-Conde et al. 2022). As a potential avenue for further study, sargassum influxes will be studied in tandem with other drifting marine debris or other hazardous pelagic fauna.

## 4.2 Economic Impacts

Sargassum influxes caused sizable losses in tourism, fishery, and recreational industries across the Caribbean (Hamel et al. 2024). The initial impacts of sargassum were very apparent in fisheries, such as difficulties accessing fisheries resources and fishing gear tangled by sargassum as bycatch (Franks et al. 2011, Solarin et al. 2014). The Barbados fishery particularly was most affected by sargassum in the post-harvest phase of their fishery (Ramlogan et al. 2017). In Nigeria, sargassum inundations prevented access to fishing grounds, reduced catches, increased mortalities of economically-relevant fish such as barracuda and shiny nose fish, and increased clogging and tearing of equipment, thus affecting their fishers' livelihoods by reduced income (Areola et al. 2025). Additionally, steel used in marine infrastructure can be eroded by sargassum, with corrosion rates ranging from 0.1mm/y (SS) to 9mm/yr (CS) (Bénuffé et al. 2025).

During the 2019 sargassum event in the Mexican Caribbean, local economic activity experienced contractions with reduced exchanges of the Mexican Peso, although the decrease in economic activity was not traced to the tourism sector (Espinosa and Li 2020). Personal testimonies by tourist guides have noted that tourist agencies received little economic support from the government while hoteliers had more resources to invest in sargassum cleanup on their properties (Pachauri et al. 2025). An analysis of GIS observations from 2016 - 2019 showed reduced nighttime light intensity, suggesting reduced gross local product. This reduction in gross local product can have lagged effects that would be detected after 12 months due to reputational changes associated with sargassum influxes (Schling et al. 2022). In the short term, seasons with high sargassum influxes led to decreased beach occupancy and increased use of inland tourist destinations such as cenotes (caves with freshwater pools, often used as tourist sites). Cenotes during the summer were highly littered and overused by tourists, such that they had to be closed by government orders (Pachauri et al. 2025). A recent study conducted by Jin et al. (2025) compared economic impacts of sargassum between three affected U.S. areas (USVI, Puerto Rico, and Florida). When considering the total economic impact of sargassum using 2019 economic data adapted to 2025 inflation, southeastern Florida faced an annual expected total impact of \$5 billion USD, Puerto Rico faced an annual expected total impact of \$782 billion USD, and USVI faced an annual expected total impact of \$50 million USD (Jin et al. 2025).

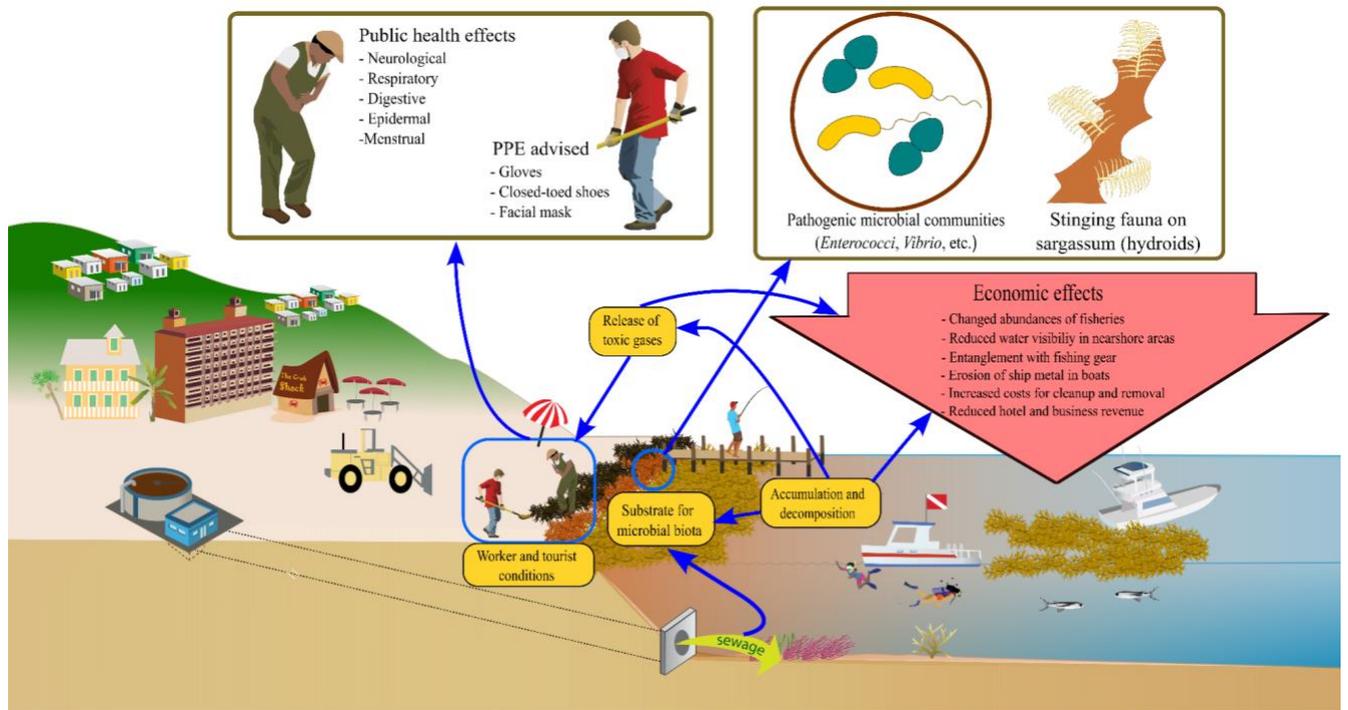
Efforts to clean up and dispose of sargassum in affected areas can be very costly. One study estimated the cost of cleaning up the sargassum inundations across the Caribbean to be \$120 million (Milledge and Harvey 2016). In a thorough study in the Mexican Caribbean, the price of cleaning one cubic meter of sargassum can range from US\$ 19.00 - 85.00 annually, based on adjusting for inflation to December 2022, and varied based on management studies of those areas (Rodríguez-Martínez et al. 2023a), though costs were more effective at hotels than municipalities. At a municipality level, cost per kilometer ranged from US\$ 0.8 - 1.5M in years and US\$ 10,186 - 100,446 over months (Rodríguez-Martínez et al. 2023a). It is currently unknown if similar economic costs for cleanup and disposal are reflected in other sargassum-affected countries or even the costs of inaction (López-Contreras et al. 2021). Each country's economic analysis should be evaluated to determine optimal public and private sector approaches to sargassum cleanup, disposal, and valorization.

Many entrepreneurial initiatives that would attempt to valorize sargassum are challenged by the toxic chemical pollutants in sargassum thalli tissues. Due to heavy metal content, sargassum could not be used for nutritional purposes unless there is a mechanism for arsenic and other heavy metal removal (Cisneros-Ramos et al. 2024). However, high carbohydrate contents may make sargassum a variable resource for microbial production of ethanol or bioplastics (Davis et al. 2020). More research needs to be done to determine optimal uses and valorizations of sargassum biomass and compounds (Abdool-Ghany et al. 2023).

## 4.3 Health Impacts

Sargassum as a public health concern is most notable for its release of hydrogen sulfide emissions and heavy metal exposure (Resiere et al. 2018, Rodríguez-Martínez et al. 2024). Clinical trials in the 2018 sargassum influx event in Martinique revealed that patients were exposed to > 5 ppm of hydrogen sulfide (H<sub>2</sub>S) produced by sargassum decomposition for an average of 50 days. Symptoms reported for acute H<sub>2</sub>S exposure include respiratory, digestive, and neurological disorders (Resiere et al. 2020). One study conducted in Martinique found that pregnant women close to areas with sargassum inundations (< 2km) had earlier onset times of preeclampsia, which can be a life-threatening condition for pregnant women (de Lanlay et al. 2022). Other nauseous gases released by sargassum decomposition include methane (CH<sub>4</sub>) and ammonia (NH<sub>3</sub>) (Sevilla et al. 2025). Methane is an odorless greenhouse gas that is harmless in small amounts, but large quantities can displace oxygen, leading to nausea, memory loss, and mood swings (Sevilla et al. 2025, Pachauri et al. 2025). Ammonia can cause respiratory and dermatological issues, even causing lung irritation and death (Sevilla et al. 2025). Workers tasked with manually cleaning sargassum from beaches reported using protective gear as a precaution against toxins or harmful gases released by sargassum (Pachauri et al. 2025). Public health is one of the least attended problems with a very high impact at different scale and exposures time that need to be addressed urgently (Rodríguez-Martínez et al. 2025).

Decomposing sargassum also provides an additional substrate for potentially pathogenic microbial communities (**Figure 13**). One instance is fecal bacteria, such as enterococci, originating from local human waste and sewage sources on local beaches to use sargassum as a substrate (Tomenchok et al. 2021, Abdool-Ghany et al. 2022). According to one set of health guidelines by the state of Florida, beaches with fecal bacteria levels at or above 71 enterococci per 100 ml of marine water are considered poor quality for recreational purposes (Florida Department of Health, 2024). Other potentially pathogenic bacteria, such as *Vibrio* spp., naturally occur in sargassum in the Sargasso Sea, but were recently observed using plastic marine debris as a substrate (Mincer et al. 2023), and decomposing sargassum demonstrated higher abundances of Vibrionales bacteria (Mendonça et al. 2024, Theirlynck et al. 2023).



**FIGURE 13.** ECONOMIC AND PUBLIC HEALTH EFFECTS OF SARGASSUM ON LOCAL COMMUNITIES.

*Vibrio* bacteria have been known to cause marine-related vibriosis through exposure to seawater and consumption of seafood (Baker-Austin et al. 2018). As a public health concern for coastal communities, sargassum inundations can be a potential vector of pathogenic bacteria, necessitating further study and monitoring of the sargassum microbiome.

Sargassum seems to be a source of micropollutant bioaccumulation on Caribbean beaches that can be released during decomposition, potentially affecting the surrounding environment (Devault et al. 2022b). High arsenic content in sargassum can lead to various health complications, such as skin irritation (Hatt et al. 2024), or even potential carcinogenic effects when consumed through food or drinking water (Modestin et al. 2022, Alleyne et al. 2023a). However, the extent to which sargassum's release of heavy metals and other leachates is a public health issue is largely unclear.

Sargassum can also be a source of epibiotic hydroids that can release toxins through their nematocysts, causing stings and dermal lesions that can irritate human skin (Mendoza-Becerril 2020). It is unclear if the hydroid envenomation is species-specific or is characteristic of many hydroids associated with sargassum. One particular hydroid species found on Sargassum, *Obelia dichotoma*, is considered an invasive species in Mexico, while other common species of hydroids, such as *Aglaophenia latecarinata* do not exhibit venomous effects on humans (Mendoza-Becerril et al. 2020). The potential effects stinging epifauna on sargassum would have on beachgoers is currently understudied, which can have implications as a public health concern.

## 4.4 Socio-cultural Impacts

In the early years of sargassum influxes, local communities in Western Ghana perceived the sargassum problems to be caused by periodic oil and gas companies (Ackah-Baidoo 2013). This misperception also led to perceiving the local communities as powerless against sargassum (Yaw Atiglo et al. 2024). While sargassum is a phenomenon that has multiple causes and factors, such complexities are seldom communicated to communities that were most affected by the influxes.

Government efforts to manage sargassum through a policy level must incorporate minoritized communities within those nations. One program in Saint Lucia, known as ‘Voice of the Invisible,’ aimed to increase participation in public input on a draft sargassum national management plan. Through this program, poor, disabled, women, and minority groups were able to have their opinions inputted through participatory videos to communicate vulnerability levels of sargassum influxes that may not be captured through conventional government methods (Thomas and Cumberbatch 2024). In an interview study, local Mayans in the Mexican Caribbean highlighted how areas for sargassum management and cleaning were prioritized towards touristic beach areas that they otherwise do not have access to due to the costs of access (Rosellón-Druker et al. 2023). The responses to sargassum influxes by local and national governments often highlight local and regional inequities between local stakeholders. It also seems that determining key stakeholders, availability of financial funds, and communities most affected by sargassum are what drives principal action to sargassum management (Semeleer, 2021).

It is evident that there is a lack of peer-reviewed studies addressing the public health and sociocultural challenges associated with sargassum inundations (Rodríguez-Martínez et al. 2025), the majority of impacts remain in anecdotes or newspaper news criticizing different stakeholders, therefore, evidence-based studies are urgently needed to assess the public health and sociocultural and economic impacts of sargassum and prepare managerial strategies to address and support local communities that have been suffering these impacts for 14 years as of this review.

## Recommendations

- There is a need for more systematic, long-term, peer-reviewed studies of health, social, and economic effects of sargassum influxes. These studies can be complemented with other available resources such as websites and protocols.
- There is a need for long-term clinical studies on the effects of sargassum on human health, and these findings translate to best practices for addressing sargassum as a public health issue.
- There needs to be a more thorough assessment of how sargassum influxes affect different social groups at both the local and regional level. This includes groups that are marginalized by class, race, and other socioeconomic factors and backgrounds.
- There is a need to increase management strategies that will reduce the impacts to ecosystems, protect biodiversity and local communities.

# 5

## Legal and Governance Considerations

### Highlights

- Many smaller countries, especially those situated in the eastern Caribbean region close to the GASB, have some sort of sargassum adaptive management plan. However, many other Caribbean countries lack a sargassum management plan or are starting to integrate it into their broader coastal or fishery management plan.
- Regional-level conventions, such as the Cartagena Convention, the OECS, CARICOM, and UNEP, can provide a solid foundation for region-level coordination of sargassum among different countries along the tropical Atlantic, while allowing flexibility in national governance to their management and policy approaches.
- Sargassum cannot be reduced to a single issue or solution. Sargassum can have multiple geographical contexts, such as between oceanic or coastal areas, and within legal contexts, such as within the Economic Exclusive Zone or in zoned protected areas.
- Sargassum can be designated as an essential habitat, an exploitable resource in the Exclusive Economic Zone (EEZ) and international waters, or a resource and a problem within territorial waters.
- The long-term ecological consequences of large-scale offshore sargassum harvesting within EEZ or international waters remain uncertain, particularly concerning carbon sequestration and its effect on marine ecosystems.

It is imperative that international cooperation be an essential part of navigating the global aspect of the sargassum phenomenon. As sargassum events increasingly affect coastal economies and

ecosystems, their management has evolved beyond the existing policies and strategies framework, needing a multidimensional policy regarding the geopolitical and spatial planning implication. The emphasis of impact studies on the Mexican Caribbean and the US leaves a lot to be desired for how other affected areas around the tropical Atlantic were impacted by sargassum. This can translate into one-size-fits-all approaches to sargassum that may not be suitable for particular geographic areas. This section will address the current state of geopolitical and land-use strategies that would determine the mitigation and use of sargassum, and provide recommendations for policy strategies and understudied areas of sargassum impacts.

## 5.1 Geopolitical and Land-use Strategies

Perceptions of the threat of sargassum influxes vary between countries affected by sargassum, often related to their proximity to the Great Atlantic Sargassum Belt (Rosellón-Druker et al. 2023). Areas closer to water currents transporting sargassum from the GASB are more likely to see sargassum as a disaster than other areas that receive less sargassum from the GASB (Hamel et al. 2024). Furthermore, government officials need to have a thorough understanding of sargassum via education and research to address concerns of their constituents effectively (Ackah-Baidoo 2013).

Efforts to develop policies and best practices for the management of sargassum would then vary by country and proximity to the GASB and currents that transport it. Polycentric governance, as opposed to centralized, top-down governance, has been used to increase international cooperation and address sargassum management. Polycentric governance is used both on a regional and a local level. While increased cooperation greatly benefits polycentric governance, the national capacities among Caribbean countries affected by sargassum vary heavily (van der Plank et al. 2022).

At a regional level, private and public state stakeholders play a role in multinational cooperation by holding workshops and distributing information using listservs and policy briefs. In the short term, private and local initiatives to address sargassum seem more prompt than government-wide policies. However, long-term solutions to sargassum management and adaptation require governmental policies and plans with a clear source of funding and resource sustainability (van der Plank et al. 2025). An assessment of policies between sovereign, independent states, and small non-sovereign island jurisdictions (SNIJs) has shown that at least half of each of those types of nations have some policy plan to address sargassum management (van der Plank et al. 2025). While there were guidelines for sargassum management and adaptation for states that have a management plan, there doesn't seem to be a review of local land-use strategies, such as zoning and coastal restoration, as another means to mitigate the impacts of sargassum (van der Plank et al. 2025). Part of this seems to be the variation of severity of sargassum. In the continental eastern U.S., sargassum crossing the EEZ was treated as essential fish habitat rather than as a threat, with the Sargasso Sea in the North Atlantic Ocean being observed in areas

that have recently become part of the EEZ (200 nautical miles) of continental eastern (Vital et al. 2024), Ardron et al. 2011). With the rise of sargassum as a natural disaster, the National Oceanic and Atmospheric Administration (NOAA) identified this major gap in policy and proposed a sargassum workshop to develop an intra-agency group specifically for large-scale sargassum nearshore inundations (Vital et al. 2024).

As of this year, there have been major advances in regional-scale governance of sargassum. The United Nations Environmental Programme hosted a workshop to develop the sargassum working group that would operate under the Specially Protected Areas and Wildlife (SPAW) protocol of the Cartagena Convention (United Nations Environmental Programme, 2025). In 2019, the sargassum working group started out as an ad hoc committee developed during the 15th Conference of the Parties (COP) of the Cartagena Convention in Roatan, Honduras. The goal of the sargassum working group is to develop a regionally coordinated and harmonized effort to address sargassum using the Cartagena Convention as the foundation for best policies and practices (Perera-Valderrama et al. 2026). Given the prior analyses of polycentric governance, it seems that there is varied adherence to international policies that would reconcile sargassum management and monitoring while also upholding conventions and laws surrounding marine conservation. For instance, U.S. territories such as Puerto Rico and U.S. Virgin Islands lack the federal-level urgency of sargassum needed for a federal framework, and instead have localized emergency plans and interagency efforts that can inform other non-sovereign territories under the convention on dealing with sargassum (Perera-Valderrama et al. 2026). The Cartagena Convention can provide the foundation for more coordinated efforts to regionally address sargassum, such as standardized protocols for monitoring and management (including ecological impact assessments), increased data sharing and more consistent monitoring efforts, increased public awareness and engagement, and consideration of sargassum towards management of specially protected areas.

Given the variation of national and regional capacities to address sargassum policies, the burden of coordination often falls on nations or stakeholders with the least amount of resources (van der Plank et al. 2022). However, with the increased development of open-access knowledge hubs and sharing of best practices and data, it is imperative that all sargassum-affected nations need to have either a national management plan to address sargassum or be part of a coordinated polycentric approach, a multinational effort to respond to sargassum effectively (Almela et al. 2023a). Developing legal and policy frameworks to address the sargassum as a potential resource in high waters, compared with EEZ and Territorial waters, is a developing area that will require attention at all levels, including the development of international, national, and local agreements and conventions.

## 5.2 Governance of Sargassum Habitats

The complex and dynamic nature of sargassum, along with its seasonality of accumulation events, complicates removal efforts, as well as its use and valorization as a resource. Sargassum floating patches have a long trajectory from the North Equatorial Current within the Great Atlantic Sargassum Belt to various coastlines, moving from high water to exclusive economic zones (EEZs) and territorial waters defined in the United Nations Convention on the Law of the Sea (UNCLOS)(United Nations 1982). As a natural phenomenon, it has been designated as an essential fish habitat (EFH) by the National Oceanic and Atmospheric Administration (NOAA) in the U.S. and the European Common Fisheries Policy as it is a part of the waters and substrate essential for fish reproduction, feeding, and growth (Vital et al. 2024; NOAA Southeast and Caribbean Regional Team 2024). These areas are chosen based on their ecological importance, vulnerability to stress and human activity, and rarity of the habitat for many marine organisms (Vital et al. 2024).

It is important to note that the EFH designation of pelagic sargassum under Fishery Management Plans (FMPs) does not prohibit harvesting but does require consultations with the National Marine Fisheries Service if agency action may “adversely affect” its status as an EFH (16 U.S.C. 1855 Sec 305(b)) (Vital et al. 2024). The Magnuson-Stevens Fishery Conservation and Management Act (MSA) established FMPs with the objectives of preventing overfishing, rebuilding depleted fish stocks, conserving EFH for federally managed species, and promoting the long-term sustainability of the U.S. seafood supply while also maximizing associated economic and social benefits. This approach was also implemented in Mexico earlier this year, with the recognition of sargassum as ‘fish stock’ under the National Fisheries Act, thus implementing harvest rules of sargassum within its EEZ and setting an annual quota of ~1 million tonnes of sargassum (NOM-010-STPS-2014). This recognition of sargassum as a fish stock also complemented the management plan made specifically for sargassum and was released two years prior (Rodriguez-Martinez et al. 2023b). Therefore, sargassum can be designated as an essential habitat, an exploitable resource depending on where in its trajectory it is found and the capacity and techniques for collection for its use; or a problem as it accumulates and washes ashore, it can cause ecological damage to corals and beaches, as well as economic damage by affecting jobs, tourism and fisheries, and public health issues as mentioned in the above section.

Although no universally accepted measurements strictly define the boundary between offshore and onshore sargassum, some characterize offshore collections by their ability to be an EFH (Vital et al. 2024). Sargassum occurring beyond the limits of U.S. territorial waters, defined as 12 nautical miles (22 km) from the baseline coast, may also be designated as Essential Fish Habitat (EFH) under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act. Harvesting sargassum within EFH-designated areas does not restrict the removal of sargassum from state or territorial waters;

however, because it is a critical habitat for sea turtles, an incidental take permit or NMS is necessary or could be subject to persecution. For example, in the states of North Carolina and South Carolina in the United States, there is a harvest limit of up to 2,268 kg (5,000 lbs) of wet biomass per year. The designation of EFH does not apply to sargassum washing onshore or once the floating patches no longer offer the EFH ecosystem service. Evidently, the existing regulations in the United States are limited to its national coasts, but can serve as a guideline to explore in other countries and adjust to each nation's legal framework and needs. There is an urgent need to use existing international agreements with a comprehensive integral governance including a public-private structure designed following legal frameworks, environmental regulations, management policies and technologies, industrial operation, and financial and commercial mechanisms are needed. Regional collaboration will facilitate the success of such plans.

## Recommendations

- Legal and policy frameworks regarding sargassum are urgently needed, including the characterization of sargassum as a debris or resource to determine best practices while implementing scientifically-sound regulations.
- Implications of these policy frameworks at the international, national, and local levels must be explored, and should consider both physical geographical and geopolitical conditions.
- A comprehensive integral governance plan including a public-private structure designed following legal frameworks, environmental regulations, management policies and technologies, industrial operation, and financial and commercial mechanisms are needed.
- Empowerment of local communities, and regional growth, should be the major goal of the integral governance plan.
- Addressing land-use and different legal and economic zones at the international, Atlantic basin level are essential for a more holistic approach to a complex, international problem.



# Collection, Management, and Valorization of Sargassum

## Highlights

- Sustainable collection methods, such as the use of hand tools, help minimize sand loss, while targeted precautions protect sensitive wildlife, including sea turtle nests and coastal vegetation. But mechanized cleanup methods may be used to supplement highly inundated sites with environmental monitors to assess conditions and identify wildlife and fragile habitats.
- Progress in sustainable processing is hindered by the lack of standardized safety protocols, inconsistent raw material quality, and inadequate funding. However, there is an increasing interest in its use as a sustainable, multi-purpose resource, presenting an opportunity for job creation and the development of new technologies to collect, process, and convert sargassum into high-value products.
- Despite these challenges, sargassum is being developed into diverse products, including bioplastics, wood materials, cement, animal feed, fertilizer, biofuel, mud bricks, and ash. Meanwhile, its biosorption properties show promise for removing heavy metals and improving compost-based soil.
- Regional planning and best practices designs are needed to ensure ecological and community friendly scaling-up of commercial and industrial initiatives.

As the influx of sargassum in coastal and offshore environments intensifies each year, it has prompted the development of management strategies in both offshore and onshore habitats. Monitoring and removal methods have been proposed to efficiently prevent the accumulation of tons of biomass in

coastal ecosystems, while aiming to minimize ecological disruption. Beyond collection, innovative treatment and recovery processes are being explored to transform sargassum into valuable products that both expand on sustainability efforts and provide economic value. However, these approaches still face technical challenges and concerns about the feasibility, with significant gaps in knowledge that underscore the need for continued research and interdisciplinary collaboration. This section will address the existing policies and comprehensive strategies for managing sargassum influxes, emphasizing the best practices for removal and environmental protection, as well as the value that sargassum adds as various products.

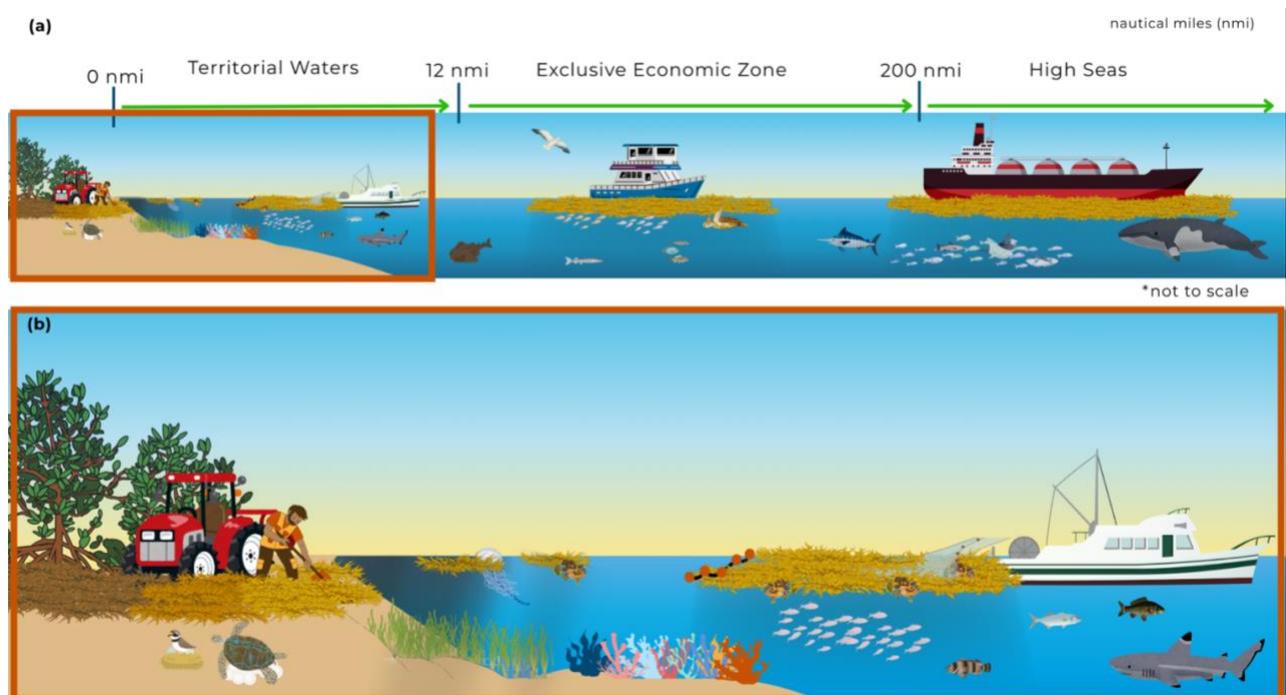
## 6.1 Distinctions Between Onshore vs. Offshore Management

As time has passed, advancements have been made in monitoring and managing sargassum, particularly following the unprecedented influx of sargassum in 2011 across the eastern Caribbean. However, as the landing events continue to inundate coastal communities, the need for standardized protocols has become more evident. Improving sargassum influx forecasts would better aid the development of optimal management methods for different ocean conditions (Robledo et al. 2021). Often, these predictive forecasts lack recognition of spatial movement patterns, as well as landing location and accumulation. This information depends on local satellite imagery and monitoring programs to improve accuracy (Uribe-Martínez et al. 2022, Putman et al. 2023). As research and development of collection procedures advance, a need arises to define when sargassum transitions from a habitat to a hazard.

Offshore floating sargassum management can serve as a preventive measure when large blooms approach coastal shorelines, and with proper adaptation to local needs, environmental impacts and economic costs can be minimized. The collection frequency depends on local conditions, including the volume of the influx, the availability of resources to allocate to management, and environmental conditions. In developing mechanized methods for offshore sargassum harvesting, designs must protect the environment and associated fauna, preserve tourism for the dependent economic sectors of coastal communities, and mitigate health concerns. Mechanized collection techniques can efficiently collect large volumes of sargassum while minimizing environmental impact and operational costs (Gold Standard Foundation 2023). Methods of managing and collecting sargassum can also vary based on its status as an EFH and its location within the water column (**Figure 14**).

While the sargassum maintains its status as an EFH when floating in the ocean, floating barriers known as “booms” firmly secured to the seafloor act as physical barriers that prevent floating and decomposing sargassum from landing on coastlines (Oxenford et al. 2021). As it accumulates, the sargassum may need to be removed by specialized harvesting boats. In Guadeloupe, innovations include specialized barges with automated treadmills capable of collecting up to 10 tons of sargassum from the

upper water column (0-2 meters), which are best suited for calm waters like bays and lagoons (Hinds et al. 2016). Hydraulic suction pumps are used to remove floating mats directly from the upper water column (2-10 m below the ocean surface) near the shore, with powerful hydraulic suction pumps attached to an amphibious vehicle (Chereau, 2019). Other vessels are fitted with pumps, along with skimmers, that guide the sargassum for collection. Organizations like © SOS Carbon have also developed Littoral Collection Modules (LCMs), which are manually operated devices attached to small boats with netting to tow through sargassum mats and quickly collect a high density of sargassum (Gray et al. 2021). They have also developed and utilized a pump-to-depth system that pumps sargassum down to 150-200 m below the sea surface, where it continues to sink due to ocean pressure, serving as a method of disposal and sequestration (Gray et al. 2021).



**FIGURE 14. THE VARIABILITY IN COLLECTION METHODS – WITH NO UNIVERSALLY ACCEPTED BOUNDARIES – MAY DEPEND ON DISTANCE FROM THE SHORELINE AND THE GOVERNANCE OF SARGASSUM HABITATS**

It is important to note that while these innovations mark progress in managing sargassum, several questions still need to be addressed before it can be considered a reliable management method. Although the pump-to-depth system can facilitate carbon sequestration, this approach does not account for the dependence on fossil fuels to power the vessels, which may hinder achieving a truly net carbon-negative outcome. Additionally, it does not ensure that sargassum will not resurface due to coastal upwelling, which can occur from depths much greater than where the sargassum is pumped (He and Mahadevan 2021). Furthermore, while an alternative method has been proposed by the group of releasing coastal sargassum into open water to allow it to continue its lifecycle based on forecasting, as previously discussed in Section 3.3, the use of predictive modeling in this context remains challenging and prone to inaccuracies. There is also no reference to the potential harm to marine fauna that may get trapped in

the nets or the risk of pollution if these nets disintegrate into debris. Moreover, the ecological ramifications of sinking sargassum must be taken into account, as it provides habitat for various wildlife and helps maintain ecosystem balance.

Offshore sargassum harvesting faces significant challenges related to bycatch, as it often leads to biodiversity loss (Oxenford et al. 2021). The in-water mats serve as a habitat for associated organisms, including juvenile sargassum fish (*Histrio histrio*) and sea turtles, and harvesting of the mats can remove entangled marine life from the environment (Oxenford et al. 2021). As a result, there needs to be an effort to mitigate bycatch. Studies are required to develop tested protocols for avoiding the capture or release of associated fauna, as well as laws specifying the distance from the shoreline at which harvesting methods can be used. Consideration must be given to the equipment cost, especially in local manufacturing or when considering subsidies. Operational expenses associated with using boats, barges, and hydraulic pumps for offshore collection also pose a challenge (Oxenford et al. 2021). Combined with the seasonality of sargassum influxes, which makes it difficult to establish consistent harvesting operations and the effort required to process and store collections, the economic viability of the fluxes becomes a greater issue for local efforts (Robledo et al. 2021).

Additionally, little is known about the long-term ecological impacts of large-scale offshore harvesting on marine ecosystems and associated species, as these innovations are relatively novel (Robledo et al. 2021). The photosynthetic capabilities of sargassum allow it to sequester carbon, creating a potential method to reduce carbon dioxide through sinking (Pries et al. 2023, Ricart et al. 2022). Ocean afforestation is a similar method of carbon sequestration, involving the cultivation of fast-growing algae and their subsequent sinking; it has been suggested that this may lead to lower oxygen concentrations, or hypoxia in deep waters (Ross et al. 2022). Hypoxia results from increased oxygen consumption during the decomposition of organic materials. While monitoring the impact of benthic communities would be difficult, it may be possible to mitigate the effect if they were placed in hypoxic regions that already have low biodiversity (Ross et al. 2022). However, little is known about the long-term environmental consequences, and further studies are needed before this can become a dependable method as complex mechanisms linking sargassum large biomasses with C and N availability can result in a competition of those nutrients between phytoplankton and sargassum, impacting trophic interaction and full carbon cycle beyond oxygen reduction of deep waters (Pries et al. 2023, Ricart et al. 2022, Bach et al. 2021).

## 6.2 Collection from Shorelines

The first recorded efforts to control sargassum landing on shorelines date back to 1935 in Galveston, Texas, where workers attempted to load barges with sargassum and tow them offshore, but were unsuccessful (Webster and Linton, 2013). Since then, and particularly in response to the substantial influx of events of 2011, targeted removal efforts have developed with the formulation of protocols,

guidelines, and best management practices in general. The methods for management and removal should include best practices for removal that mitigate damage to coastal ecosystems (Figure 15). As mentioned in the previous section about the ecological impact (Section 4.1), sargassum starts to decay and no longer functions as an EFH, and it can affect food availability and habitat resources for various marine species, potentially leading to changes in community structure and biodiversity (US EPA 2025a). Lack of management or mismanagement of sargassum in affected areas can also lead to environmental effects being passed to adjacent areas due to high water turbidity and transportation of organic matter (de Almeida et al. 2025).

Best practice removal utilizes hand tools, such as rakes, and other manual methods to minimize the amount of sand removed while cleaning up the sargassum and to avoid disturbing local wildlife (Dutch Caribbean Nature Alliance 2019). Restricting the use of heavy machinery to avoid ecologically sensitive zones, while ideal, may not always be possible due to the heavy accumulation of sargassum. Estimates of the annual amount of sargassum accumulating on approximately 100 km of coastline can reach 100,000 tons, and in the Tropical Atlantic alone, the biomass can exceed 20 million tons (Jouanno et al. 2025b). In this case, it is generally advised to use mechanized methods that are both effective and environmentally responsible for collecting large volumes of landed sargassum (Hinds et al. 2016). Mechanized cleanup methods can be effectively combined with manual cleanup in sensitive areas, allowing environmental monitors to assess conditions and identify wildlife and fragile habitats.

Management Method	Frequency	Summary
Manual Beach Removal	Daily	Workers collect stranded sargassum using tools like rakes and shovels
Mechanized Beach Removal	Daily	Heavy machinery removes large volumes; often early morning operations
Hydraulic Suction Pumps	Daily	Extract sargassum nearshore; often combined with floating booms for guidance
Offshore Specialized Barges	Daily/Weekly	Collect floating mats using conveyor belts; limited to calm waters
Deep-Sea Disposal (controversial)	Intermittent	Pump-to-depth systems sink collected biomass; used based on disposal needs

**FIGURE 15.** THE VARIABILITY IN MECHANIZED CLEANUP METHODS, INCLUDING THEIR USAGE FREQUENCY AND TYPICAL APPLICATIONS

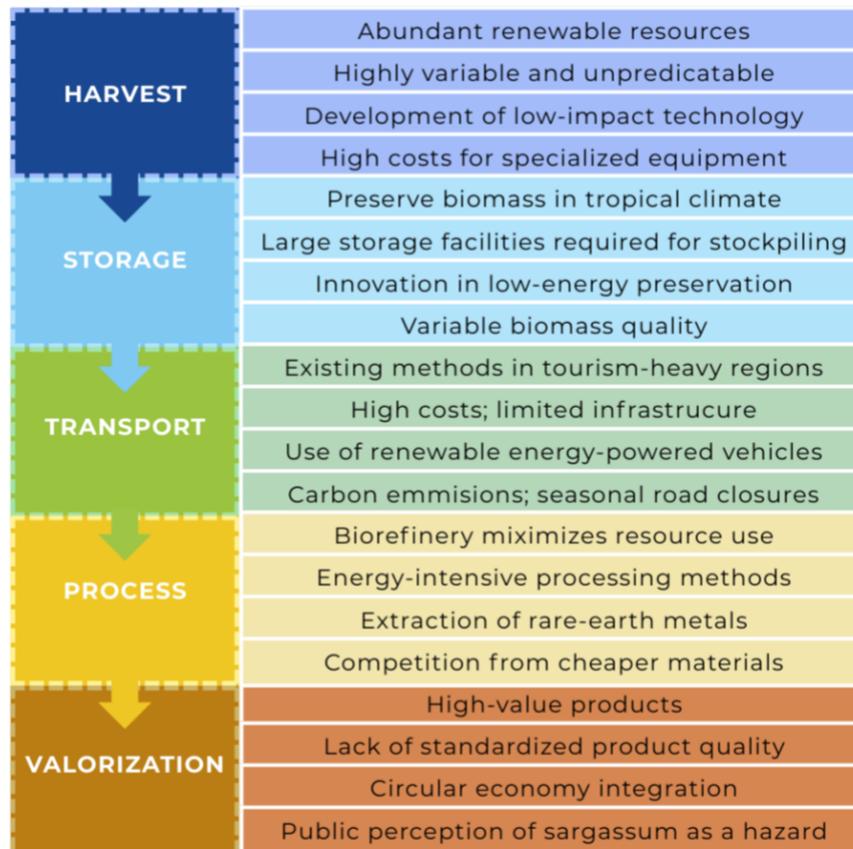
Some of the most effective mechanized methods for collecting sargassum include tractor-towed mechanical beach rakes. These are designed for large-scale removal and minimal sand removal and are especially effective when the sargassum is freshly landed and not yet compacted, and are best used on wide beaches with firm sand (Irvine et al. 2023, Chereau 2019). Front-end loaders for tractors, equipped with wide, soft tires and specialized rakes, have also been effective in removing the top layers of sargassum without damaging the ecosystem and disturbing the sand (Hinds et al. 2016, Irvine et al. 2023). The large tires also effectively distribute the tractor's weight, minimizing sand compaction, which can be beneficial at sites with turtle nests and other sensitive fauna (Hinds et al. 2016, Irvine et al. 2023). There is also space for repurposing available machinery, such as cane loaders, which are initially intended for sugar cane harvesting (Hinds et al. 2016, Chereau 2019). This method is used in Guadeloupe and can be especially effective for removing sargassum that is piled high, although it may be most suitable for beaches that can support heavy machinery (Hinds et al. 2016, Chereau 2019). It may also be best used to supplement other machinery, such as long-arm excavators and mechanical diggers, as both can load sargassum collected into transport vehicles (Hinds et al. 2016, Chereau 2019).

Environmental risks arise from the destruction of vegetation and habitats, which can destabilize the sand and disturb the habitat of local wildlife, as well as directly harm organisms that rely on the beach ecosystem (Hinds et al. 2016). It is important to protect local wildlife and vegetation, check for sea turtle and bird nests, avoid trampling beach vegetation, and remove only minimal amounts of sand when using heavy machinery (Dutch Caribbean Nature Alliance 2019). The health of the workers removing the algae should also be considered, given the risk it poses to health, so an effort is made to remove it quickly before it is heavily decomposed, due to the associated health risks mentioned in Section 4.3. As a result, efforts are made to remove the algae promptly, before they undergo advanced decomposition, to minimize adverse effects (Dutch Caribbean Nature Alliance 2019). Depending on how much biomass accumulates and the accessibility of sites, selective removal practices can be used, and the sargassum can be left alone or moved to sand dunes or areas of the beach with signs of erosion (Hinds et al. 2016, CRFM 2016).

## 6.3 Monitoring and Management

The management of sargassum involves an interconnected supply chain that includes harvesting, storage, transportation, processing, and opportunities for valorization (**Figure 16**). Effective coordination across these stages is necessary to ensure safe handling, reduce environmental and health risks, and support sustainable valorization. Tools for sargassum monitoring and management, including measurement techniques and technological applications, are made accessible through protocols such as those of the CERMES (Centre for Resource Management and Environmental Studies) (Alleyne et al. 2022). Notably, the group has developed a standard protocol for monitoring and mapping sargassum

using drones with their “SargAdapt Drone Monitoring Protocol,” teaching groups how to conduct drone flights for monitoring (Baldwin et al. 2022). Recent monitoring using gyrocopters and in situ cameras in Martinique showed that areas most susceptible to sargassum inundation were the innermost parts of the bay, with low hydrodynamic conditions and high exposure to prevailing winds, and that seagrass beds were especially vulnerable to brown water during heavy rainfall (Teyssier et al. 2025). They have also created the “Sargassum Management Brief” to help stakeholders, including policymakers, managers, and residents, quickly understand sargassum issues and potential solutions (Hinds et al. 2016).



**FIGURE 16.** SUMMARY OF KEY STAGES IN SARGASSUM MANAGEMENT, FROM HARVEST THROUGH STORAGE, TRANSPORT, AND PROCESSING, TO POTENTIAL VALORIZATION AND PRODUCT DEVELOPMENT.

In line with these management guidelines, removal and disposal should be handled with care, as decomposing sargassum produces hydrogen sulfide and ammonia, as previously mentioned in Section 4.3. Leaving large amounts of sargassum stranded on beaches can also lead to excessive eutrophication of the water, resulting in hypoxia and increased levels of organic matter, hydrogen sulfide, ammonia, and phosphorus (da Silva Parente et al. 2024, García-Uitz and Cruz-Arguello 2024). Leachates from decomposition also contain high concentrations of heavy metals, pesticides, and other pollutants, leading to soil and groundwater contamination, particularly when disposed of in landfills (US EPA 2023b, Leal-Bautista et al. 2024). Disposal also poses a challenge, as many coastal communities have limited landfill capacity, making the transportation and disposal of collected sargassum expensive (US EPA 2023b).

Efforts are being made to quantify greenhouse gas emissions from the collection and transportation processes to avoid carbon-intensive methods, including the mode of transportation and the emission costs of transporting several tonnes of sargassum (Gold Standard 2023). For collection labor, transportation of sargassum to processing facilities, and disposal as waste, the current estimated cost is €1241.60 (\$1412) per ton of material (Almela et al. 2023). When considering the nearly 20 million tons of biomass accumulating, this could cost coastal communities an estimated €25 billion (\$28 billion). This does not include the additional costs of other preventive management methods, such as forecasting arrival events, physical barriers, and boats that use nets to capture sargassum in offshore areas, which would further escalate costs when multiplied by the tons of landed biomass (Almela et al. 2023).

There is a need for more research on the ecological impacts of sargassum removal in the coastal zone to inform the interpretation and enforcement of laws that allow for ecologically sound removal practices (Vital et al. 2024). Studies are needed to determine the long-term effects of sargassum removal on ecosystem recovery and resilience, to identify the accumulation threshold, and to determine whether removal is necessary or if allowing natural processes to occur is sufficient (WECAFC 2023). Current systems also lack a regulatory framework for innovative sargassum-derived products. There is a need for standards and procedures for harvesting and product development, especially when considering arsenic levels for international markets, so that entrepreneurs can contribute to local economies (Speede et al. 2024, Oxenford et al. 2021).

## 6.4 Treatment, Recovery, and Valorization

The valorization of sargassum has the potential to contribute to the economy and mitigate environmental impacts by transforming it into a multifunctional resource (González Fernández et al. 2023). Research is still needed due to the highly unpredictable supply and technical challenges associated with a lack of regulatory frameworks. However, there is considerable potential, as it is an abundant and renewable biomass source for coastal regions affected. There is an increasingly growing interest in its use as a sustainable material, presenting an opportunity for job creation and the development of new technologies to collect, process, and convert sargassum into high-value products (**Figure 17**). This highlights the need for investment in bioremediation, given the regulatory and health concerns associated with heavy metal content, as well as funding enterprises researching its use as a biofuel, fertilizer, and construction material.

Numerous entrepreneurial initiatives aim to develop technologies for the cleanup and disposal of sargassum, as well as to optimize its valorization. An evaluation of sargassum's calorific value determined its unit energy cost to range from \$0.007 to \$0.011 MJ (MegaJoules), depending on the washing mechanism used to harvest the biomass (Sosa Olivier et al. 2022). In the Caribbean, the valorization solutions of sargassum currently being explored and supported as recommended

investments include biogas, biochar, and compost and fertilizer chains (Bennett et al. 2025). These economic and practical solutions can address large biomass volumes while also requiring lower technological capacity and quick financial returns, with an estimated maximum payback period of 15 months and a predicted net present value (NPV) over 10 years of at most \$142 million USD (Bennett et al. 2025).



**FIGURE 17.** VISUALIZATION OF POTENTIAL PRODUCTS DERIVED FROM SARGASSUM, ILLUSTRATING POSSIBLE APPLICATIONS AND USES

There are biotechnological applications, with scientists attempting to engineer salt-tolerant microorganisms to ferment sargassum and convert its sugars into valuable products such as jet fuel precursors, cosmetics ingredients, and pharmaceutical compounds (Poore 2024). Scientists are also using these same salt-tolerant strains for anaerobic digestion, where microorganisms feed directly on decomposing sargassum in the absence of oxygen to produce methane-rich biogas and nutrient-rich fertilizers (Poore 2024). Researchers are also exploring thermochemical treatments to convert sargassum into biofuels, including converting it into a crude-like oil and bio-hydrogen, as well as mineral carbonates for use as building materials (Poore 2024). Biofuels are a form of renewable energy made from organic matter over a short period of time; algae used in the production of biofuels use relatively small amounts of land, have a high growth rate, and a high carbohydrate content that allows for the production of biogas through anaerobic digestion (Amador-Castro et al. 2021).

The use of organic raw materials in civil construction is also being explored as a sustainable measure, as sargassum can be ashed and used as reinforcement in cement composites or as asphalt in road construction (Lyra et al. 2024, Bilba, Onésippe Potiron, and Arsène 2023, Escobar-Medina et al.

2021). Efforts to create sustainable cement composites with sargassum come arise to address the environmental challenges of sargassum, with a need for research in the mechanical performance of sargassum as at its current stage it might not be suitable as reinforcement or filler for cement (Closse et al. 2025). The benefits alone can be a good investment, as it can decarbonize buildings and alleviate the carbon dioxide emissions from the manufacturing process, while also decreasing the electricity demand as a low thermal conductivity product (Rosas-Diaz et al. 2025, López-Sosa et al. 2024). Sargassum-based concrete can be scaled to utilize an estimated 586,000 m<sup>3</sup> of sargassum, an equivalent of 323 million building blocks, and reduce the the energy consumption resulting in annual energy savings of 67 GWh or an equivalent of USD\$33,000 (Rosas-Diaz et al. 2025, López-Sosa et al. 2024).

Alternatively, the alginates in the sargassum lend to a crosslinking mechanism in other cementitious materials like magnesium oxychloride cement (MOC), allowing for a more compact microstructure and improved moisture stability, though still needing improvements in the mechanical performance resulting from the high surface area and lower pore size (Mellado-Lira et al. 2025). There has also been the use of sargassum fibers as an additive in panels, pavements, particle boards, and adobe bricks (Rossignolo et al. 2022, Bauta et al. 2024), and the sodium alginate from sargassum can be used in the production of eco-friendly bioplastics (Mohammed et al. 2023). Sargassum has been incorporated into compost piles with other materials, such as food waste and wood chips, producing high-quality compost with good organic matter content and nutrient levels (Walsh and Waliczek 2020). Composting sargassum can be a cost-effective alternative to landfill disposal as demonstrated by Ft. Lauderdale, Florida, USA, with upfront equipment and land-access constraints composing only 20% to total beach-cleaning costs, and still saving around \$326,000 USD by using a compost facility rather than disposing in a landfill (Blare, Abdool-Ghany & Solo-Gabriele 2025). The Sargassum compost can also offset beach cleaning and composting costs, and potentially generate revenue while also serving as a product used by homeowners, landscapers, and agriculturalists (Blare, Abdool-Ghany & Solo-Gabriele 2025). Regarding the concerns about the heavy metal content, treatments are being developed to extract and separate critical metals, including rare earth elements that can be used for batteries (Poore 2024).

Producing organic liquid biofertilizer from sargassum and livestock feed has also been shown to be successful in improving agricultural practices (Caribbean Agricultural Research and Development Institute [CARDI]). Application of fertilizer derived from *S. fluitans* and *S. natans* has yielded mixed results but can, overall, increase the growth rate of plants, particularly beach dunes (Amador-Castro et al. 2021, Williams and Feagin 2010). The production of nutrient-rich liquid biofertilizer through anaerobic fermentation has shown to contain essential macronutrients and significantly reduced heavy metal content that make it safe for agricultural use; the anaerobic fermentation involved in the processing allows for the maintenance of a diverse microbial community that supports plant development (Rodríguez-Rodríguez et al. 2025). Applications in water bioremediation are also being examined due

to the biosorption and biofiltering abilities of Sargassum, allowing it to remove heavy metals and add further to the valorization of algae (Amador-Castro et al. 2021). Optimizing the biofiltering capabilities of sargassum in real-world conditions can further promote its use as a valuable resource, thereby increasing the efforts to harvest it and support its use as a sustainable, low-cost water treatment method (García-Trejo et al. 2025).

With the information that is currently available, there are still some significant gaps regarding the treatment and recovery processes for sargassum use, particularly in the chemical composition of sargassum and how it varies spatially and temporally. There are constraints in determining the suitable application and processing methods for sargassum-based products, especially considering how unpredictable the quality of sargassum as a raw material can be with factors like condition and contamination (Oxenford et al. 2021). In the case of contamination, there is a need for established quality and safety standards for sargassum-based products, which affects their commercialization and utilization. Without specific policy or governance frameworks, there is also an absence of protocols for harvesting and processing sargassum-based products. Except in a few countries, there are no clear national or regional guidelines regarding harvesting or management, creating uncertainty for innovations using sargassum as a raw material (Oxenford et al. 2021). Limiting funds supporting and exploring the possibilities of sargassum valorization slows the development of sustainable and effective treatment and recovery processes (Oxenford et al. 2021).

## Recommendations

- Supplementing manual clean-up efforts with machinery, while also expanding on innovations that are cost-effective and mechanized, which can safely and effectively preserve the ecosystem to remove the millions of tons that accumulate on coastlines annually.
- Funding studies on the ecological impact of sargassum removal to inform environmentally sound management practices, including studies on long-term ecosystem recovery, resilience, and accumulation thresholds, as well as the development of regulatory frameworks, standards, and procedures for harvesting and creating sargassum-derived products that meet international safety requirements.
- Establishing quality and safety standards, national and regional governance frameworks for harvesting and processing, and increased funding to support sustainable innovations in sargassum valorization.
- Drafting legislation that specifies permissible uses and data collection practices based on the stage of its development, as well as the capabilities and methods available to each stakeholder or nation.



# Integration and Synthesis: The Sargassum Phenomenon—Timeline, Responses, and the Role of Science Diplomacy for a Roadmap Design to Advance Sargassum Solutions

## Highlights

- Transitioning from reactive management to integrated management, including norms and regulations.
- Increase our understanding of core concepts related with origin, trajectory and supportive mechanisms of sargassum bloom.
- Improvements in ocean current prediction and modeling.
- Strengthening monitoring systems.
- Assessing loss of biodiversity, environmental, fisheries, economic, tourism and health impacts.
- Addressing significant knowledge gaps regarding the economic impacts.
- Promoting valorization and scaling up pilot initiatives.
- Bring real solutions to local communities.
- Recognize sargassum as a symptom of a planetary problem.

The sargassum phenomenon has persisted for fourteen years as of this review. Understanding its present status and possible future directions requires a historical perspective, an integration of all lessons learned and roadmaps guiding next steps. This section makes a historical analysis of the different phases

the community has gone through, followed by a description of the role of institutions securing funds, using examples of the Caribbean. A proposal to use science diplomacy principles to design comprehensive roadmaps is presented.

## 7.1 Historical context and timeline of events

In 2011, the Caribbean, northern Brazil, and Africa were unexpectedly impacted by massive influxes of brown algae, catching all affected communities off guard. Although the timeline of events differs among countries and regions, the three main stages observed in the Eastern Caribbean Islands broadly apply throughout the region. These three phases established by Alleyne et al. (2025), are the initial period of surprise and reactive responses (2011–2014); a second phase marked by a learning curve across all sectors (2015–2022); and a third phase involving valorization and efforts to transform the bloom into opportunity (2022 to present) (Alleyne et al. 2025). Notably, these phases are not strictly sequential; in many locations, all three may be present simultaneously even today, depending on local conditions and vulnerability to sargassum influxes and landings (Jouanno et al 2025b).

The first phase (**Figure 18**), dominated by the surprise and reactive management response, had a relatively small number of local stakeholders, mainly local business owners and other representatives such as taxi drivers and tourist guides, government and local organizations, economic sectors, and local scientists (see section 4 for further details). Those stakeholders had a temporal seasonal response with great uncertainty about the duration, frequency, and persistence of the phenomenon. During this phase, we learned the importance of communication and identification of stakeholders who could offer early guidance, such as those producing pamphlets on best practices, which was a significant step toward minimizing misinformation regarding the causes and management of this new threat. International associations, including the Association of Marine Laboratories of the Caribbean (ALMC) and the Gulf and Caribbean Fisheries Institute (GCFI), played a critical role in bringing together scientists from across the region. However, knowledge about sargassum was extremely limited at all levels—from biology and oceanography to forecasting and management. Most general knowledge at the time was derived from studies in the Sargasso Sea, where sargassum was perceived as a normal part of coastal and beach ecosystems, typically appearing during winter (Parr 1939, Gower and King 2011, Huffard et al. 2014). While scientists started to organize research groups, practical sargassum management remained a major challenge, which was largely dependent on local support. Collection, disposal, and initial stages towards storing massive amounts of biomass, were characterized by improvised practices and, in some cases, unregulated dumping of biological materials behind the scenes (see section 6 for further details).

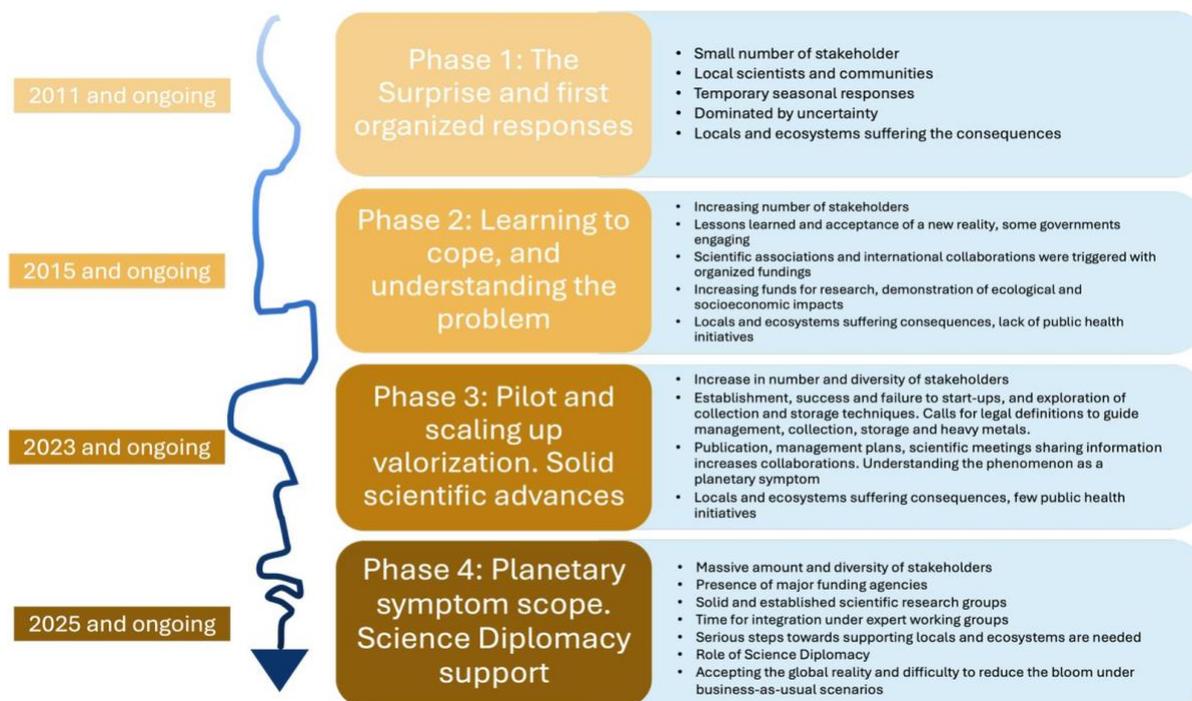
The second phase (**Figure 18**), the deep learning curve, was characterized by a few international organizations funding collective international research groups. Research was showing important impacts of sargassum influxes on ecosystems by local scientists, and the number of stakeholders addressing the

sargassum issue increased. While valorization has been present since early years, the second phase sees increasing efforts to understand the role of heavy metals, and methods to decrease their abundance within sargassum tissue, along with collection and storage challenges. Significant advances occurred when diverse stakeholders capable of influencing the collective became engaged in their respective areas of expertise. For instance, collaborative efforts between United Nations representatives in the Caribbean (such as SPAW-RAC), the scientific community (GCFI), and research institutions (for example, CERMES, UNAM, and INTEC) led to the development of early management protocol models (Almela et al. 2023a). During these formative years, a relatively small but dedicated group of stakeholders worked—often in isolation—to devise solutions and provide tools for affected communities. It is during the learning curve that the discussion forum, International Sargassum Network (SargNet), was established within a university context, reaching at present time more than 500 members interchanging information from seminars to publications. These efforts facilitated information exchange and spurred the creation of initiatives such as the ongoing Sargassum Podcast Series, made publicly available through social media and platforms such as YouTube (<https://www.youtube.com/channel/UCZreM59YNCzlm-C7Zdra2PXg>). The publication of the first white paper on the subject, supported by UNEP, and first made publicly available in 2018 and revised in 2021, marked a significant advancement capturing the state of the knowledge at the time. This white paper made possible the understanding of sargassum being a seasonal event in which we would need to learn to live with. Important knowledge gaps were identified, and various impacts—such as those on the economy and health—were acknowledged (United Nations Environment Programme - Caribbean Environment Programme, 2021).

The third phase (**Figure 18**) involves increased efforts, early-stage pilot programs focused on scaling up, and exploration of collection and storage technologies. This phase reveals that such progress is challenging and requires greater investment. In the third phase, local communities are still in the dark dealing with health and pollution as well as losses of jobs and fisheries (see sections 4, 5, and 6), and while barriers and different collection methods were established, although ecosystems and local populations living outside touristic places were not attended.

The sargassum process transitioning from a surprise to a learning to cope, followed by pilot initiatives for valorization, and improvements in forecasting, into a maturation phase of our understanding of sargassum, reflected in the present review, with more than 500 publications from 2011 to September 2025 and more coming up rapidly. Just in the last four months of 2025, important integrative publications came out demonstrating a more complex yet clarifying understanding of the mechanisms sustaining the sargassum bloom. This greater understanding has grown alongside expanded research capacity, with numerous established and early-career scientists now conducting research programs worldwide. Responses are now more thoroughly planned, and in some areas, preparations for peak season have already been made (see sections 5 and 6).

A new phase is underway, the fourth phase (**Figure 18**) marked by integrated efforts and a generation that has only known sargassum on their coasts, while both young and old continue to seek local solutions. Although many stakeholders are engaged in various facets of the issue, there are understandable signs of stakeholder fatigue. Ecosystems continue to decline, biodiversity loss remains to be fully assessed, and evaluating challenges posed by newly introduced species is essential. Managerial responses in some places have clear plans, while other sites, depending on the government involvement and resources available, are put in place and well-managed, health issues remain in the early stages, with a lack of strong groups and government public health teams facing a potentially large number of locals starting to show symptoms to long-term exposure (10-14 years) to sargassum (see section 5). Tourism industries in some places, such as the Mexican Caribbean and Dominican Republic, have invested in equipment, tools and development of response plans, positioning themselves to deal with the seasonal arrivals (see section 6). While scientific research advances through collaboration, valorization is a different process, where collaboration and competition coexist. The number of start-ups established, successful or not, is difficult to follow, an important challenge developed in the third phase that needs to be addressed in the fourth phase to direct funding based on lessons learned. In the fourth phase regulations and norms that are starting to be defined, such as the case of Mexico, and other countries that created a series of general definitions and guidelines for sargassum uses (see section 5), will be tested in practice, as interpretation and enforcement of such regulations evolve.

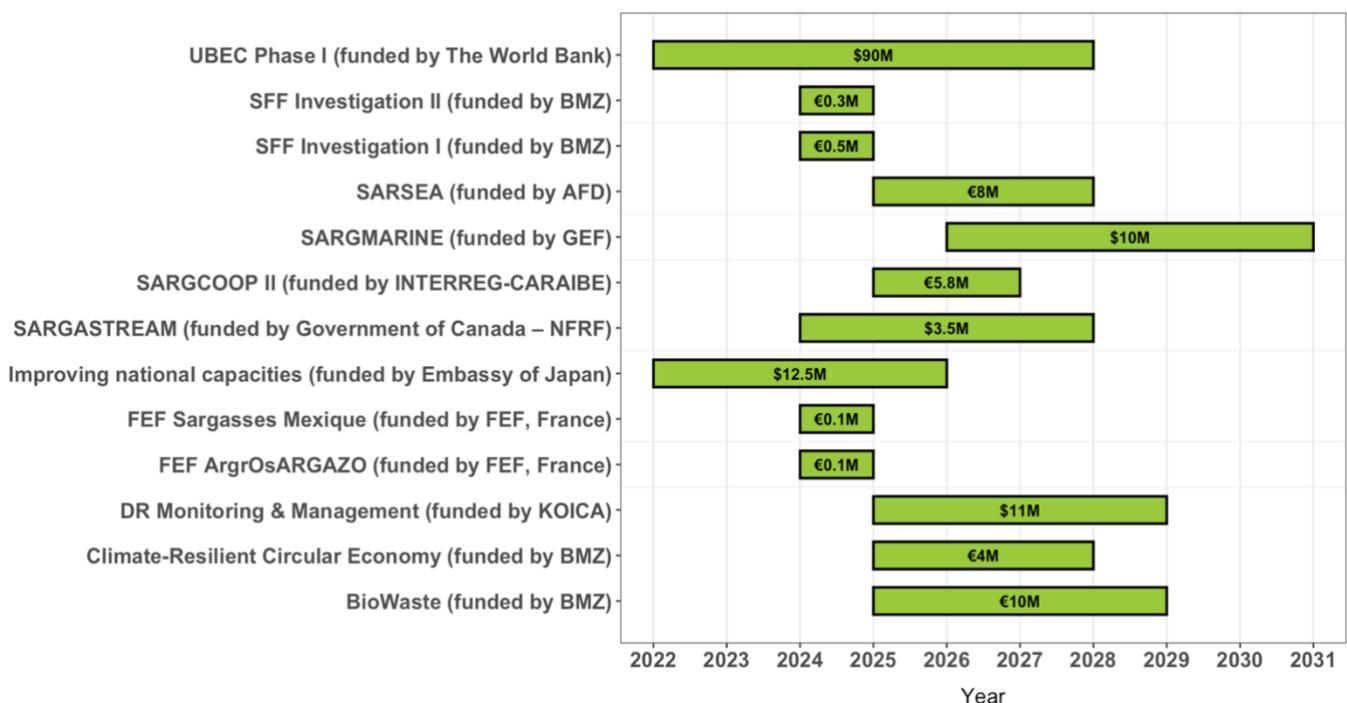


**FIGURE 18.** TIMELINE AND EVOLVING PHASES OF THE SARGASSUM PHENOMENON, MODIFIED AND INSPIRED FROM ALMELA ET AL. (2023A) AND ALLEYNE ET AL. (2025). THE WAVY TIMELINE ARROW SHOWS THAT THE PROCESS HAS NOT BEEN LINEAR, AND THE OPEN END TIMES SHOW THE FACT THAT ALL PHASES ARE STILL OCCURRING IN DIFFERENT REGIONS WITH DIFFERENT LEVELS OF DEVELOPMENT.

At this moment, principles of integrated coastal management in tandem with a coherent system based on a comprehensive governance of sargassum including a public-private architecture that articulates legal frameworks, environmental regulations, management policies and technologies, as well as industrial operation, and financial and commercial mechanisms are needed. The fourth sargassum era needs complex integrative efforts to move forward and address problems by providing science-based solutions.

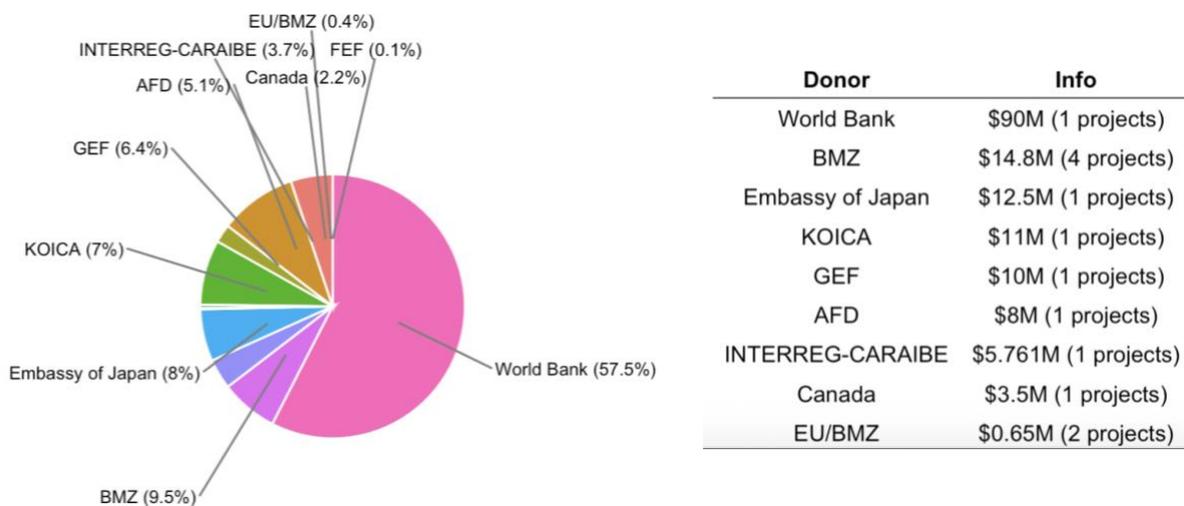
## 7.2 Evolution of regional and international funding response

From 2015 onward, national and supranational agencies began organizing and providing resources and guidance to local and regional communities. Efforts in the eastern Caribbean islands differed from those in Mexico, Puerto Rico, and the Dominican Republic. Funding universities, research centers, donors, governments need to be mapped. Countries and institutions involved in the process are diverse, some examples are: France (ARN, AFD), Brazil (FAPSP), Netherlands (NWO)), UK (SeaSINC), Canada (NFRF), Japan (through UNDP), Korea (KOICA), Germany (BIZ), Spain (AECID) and EU (Global Gateway Investment Agenda) among many others; equally important are the institutions conducting research with international, or local support: Mexico (UNAM, CINVESTAV), West Indies,



**FIGURE 19.** TIMELINE AND BUDGET ALLOCATION OF MAJOR SARGASSUM-RELATED PROJECTS OCCURRING WITHIN THE CARIBBEAN REGION. EACH HORIZONTAL BAR REPRESENTS A PROJECT'S DURATION, WITH THE TOTAL BUDGET IN MILLIONS OF EUROS (€) OR US DOLLARS (\$). PROJECTS INCLUDE REGIONAL MONITORING, MANAGEMENT, AND RESEARCH INITIATIVES INVOLVING VARIOUS TECHNICAL AND PARTNER ORGANIZATIONS

(CERMES), USA (FIU, UM, SFU), INTEC (Dominican Republic), Netherlands (NIOZ), Brazil (USP), and many others that are producing data and publications as well as training new scientists and managers in the topic. All of the above have been important contributors supporting the advance of knowledge, valorization, and management strategies. **Figures 19 and 20** are examples that need to be completed by a systematic collection of information. Initiatives such as the Caribbean Programme for Sargassum and SARGCOOP marked a shift toward international, multi-agency funding programs that advanced collaborative science and fostered the creation of robust international groups. This momentum is reflected in the significant increase in scientific publications two years after 2019, and a boom of publications and reviews in 2025. Mapping objectives, goals, localities and receptors of those fundings is of utmost importance to organize future endeavors (**Figure 19 and 20**). While all fundings are welcomed, overlapping and lack of communication among donors, even from the same countries, reflects the lack of an international organization that facilitates the communication and development of funding strategies that will sustain collaborative working groups and provide real solutions where most needed.



**FIGURE 20.** DISTRIBUTION OF MAJOR DONOR CONTRIBUTIONS TO SARGASSUM-RELATED PROJECTS IN THE CARIBBEAN ISLANDS. THE PIE CHART SHOWS EACH DONOR’S RELATIVE PERCENT CONTRIBUTION TO THE TOTAL FUNDING. THE TABLE BELOW PROVIDES ADDITIONAL INFORMATION, INCLUDING THE TOTAL FUNDING AMOUNT AND THE NUMBER OF PROJECTS ASSOCIATED WITH EACH DONOR. BMZ= GERMANY’S FEDERAL MINISTRY FOR ECONOMIC COOPERATION AND DEVELOPMENT, KOICA= KOREA INTERNATIONAL COOPERATION AGENCY, GEF= GLOBAL ENVIRONMENT FACILITY AFD= AGENCE FRANÇAISE DE DÉVELOPPEMENT, FEF= FONDS ÉQUIPE FRANCE, EU= EUROPEAN UNION

## 7.3 Science diplomacy as a tool to develop a roadmap

As we enter the fourth era of the sargassum issue, integrative frameworks are needed to develop comprehensive roadmaps and governance architectures that take into consideration the multidimensional problem at all levels, while supporting local and regional development.

### 7.3.1 Creating sustainable solutions through integration

Addressing the sargassum crisis requires mobilizing the now large and diverse number of stakeholders, financial resources, and promoting cooperation while managing ecological, health, and socioeconomic realities hitting local communities hard. The fourth era we are entering demands a legal framework that can guide environmental regulations to protect biodiversity and ecosystems, ensure people get the health services, advance the management technologies and industrial operations, and establish financial mechanisms—all while supporting local economies and navigating international jurisdictions. As an international problem with local impacts, sargassum sits at the intersection of science and diplomacy, where advances in science diplomacy can help create a roadmap for integrating stakeholders and delivering lasting solutions.

### 7.3.2 Definition of science diplomacy

Science diplomacy (**Figure 21**) is using scientific collaboration and knowledge exchange to build international relationships, address global challenges, and inform policy decisions that transcend national borders during normal times, as well as maintain dialogue during political tensions (Ruffini 2020). Science diplomacy operates where science meets foreign policy; it enables researchers, institutions, and governments to tackle shared problems like climate change, pandemics, and ocean conservation that no single country can handle alone. The framework encompasses three interconnected dimensions: **diplomacy for science** (facilitating international research collaborations), **science in diplomacy** (using scientific expertise to inform foreign policy), and **science for diplomacy** (improving international relations through scientific cooperation). This ancient practice recognizes that pressing challenges require coordinated international efforts beyond any single nation's capacity—clearly applicable to the Atlantic-wide sargassum problem.

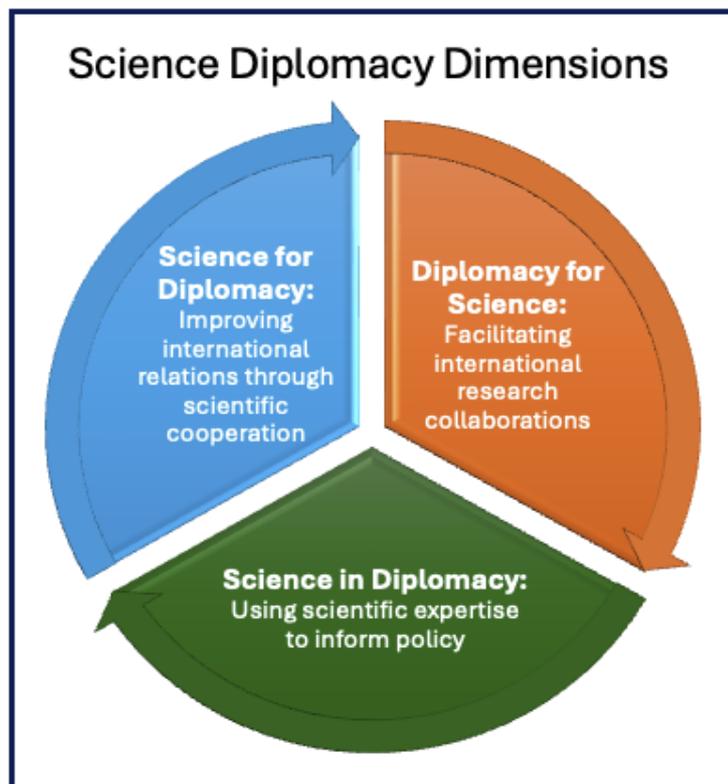


FIGURE 21. THE THREE DIMENSIONS OF SCIENCE DIPLOMACY.

### 7.3.3 Science diplomacy in the sargassum context

The sargassum bloom crisis exemplifies science diplomacy in action, affecting nations across the Caribbean, Gulf of Mexico, West Africa, and Brazil, ranging from understanding the triggers, origins, and maintenance of this regional bloom through time to local management practices. Avoiding international conflicts and supporting ecologically friendly practices have required a deep scientific understanding of this planetary-level problem. The recognition of the scope has been slow; however, it is becoming clear that sargassum is a symptom of a planetary problem that needs coordinated international action, within local contexts. Science diplomacy can tackle this through several coordinated mechanisms.

### 7.3.4 Diplomacy for Science: Facilitating international research collaborations

The sargassum bloom characteristics make cross-border collaboration indispensable. Diplomatic channels and international agreements should facilitate essential research collaborations. Efforts should secure multilateral funding by framing sargassum as a shared regional challenge rather than isolated national problems, enabling collaborative solutions beyond individual countries' capacities. Therefore,

diplomatic efforts are important to focus on finding funds directed towards critical needs detected for this fourth era. Creating a group to make a diagnostic of funding sources-research nodes will help organize the needs within the four axes to address the sargassum problem (basic knowledge, monitoring, socio-economic and cultural, health issues, and legal frames). Recognizing and learning from previous experiences on the role of agencies such as ANR, EU, GEF, GIZ, and many others, will help design the next steps for diplomatic efforts (**Figure 22**). International organizations like UNESCO's Intergovernmental Oceanographic Commission and UNEP's Caribbean Environment Program, OECS, serve as platforms to bring diplomatic efforts into the international realm. The combination of efforts at the national, regional, and international channels will enable scientists to access funding, share data, coordinate research, and publish collaborative findings, as well as provide best practices for management and local solutions. Bilateral agreements, visiting scholar programs, and joint research centers, have and will facilitate researcher's mobility. These mechanisms can facilitate scientists' access to international funds and projects, expedite the ability to share critical data, and coordinate efforts across national and international research institutions beyond political boundaries.

### Diplomacy for Science: Facilitating international research collaborations

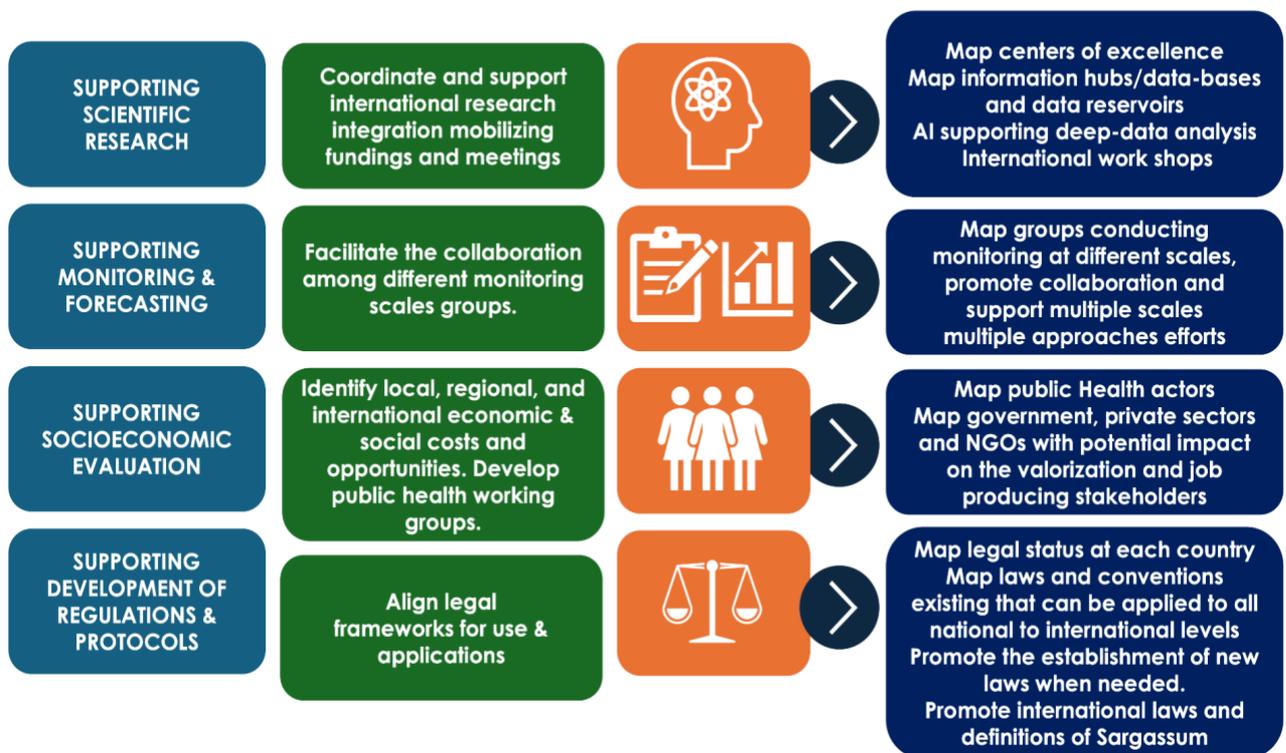


FIGURE 22. 'DIPLOMACY FOR SCIENCE' ROADMAP.

## 7.3.5 Science in Diplomacy: Using scientific expertise to inform policy

Scientific evidence and expert advice inform foreign policy decisions and diplomatic negotiations. Addressing sargassum requires government officials and diplomats to understand the complex science behind the sargassum bloom. Advances in our understanding of the links between climate change, oceanographic circulation patterns, and nutrient loading triggering and maintaining the bloom, as well as ecosystem consequences of managerial or valorization practices, are extraordinarily complex scientific concepts. Scientific advisors must collaborate with diplomats. Creating scientific expert groups to support the four axes to address the sargassum problem will ensure diplomats will make the best and scientific-based decision (**Figure 23**). Scientists can help negotiators to recognize that sargassum management requires coordinated action, bloom predictions need multinational monitoring networks, and solutions like biomass harvesting or barrier systems have ecological and economic trade-offs. The presence of scientists supporting diplomats at international climate conferences ensures that scientific evidence showing sargassum as a symptom of global oceanic changes driven by rising temperatures, altered nutrient cycles,

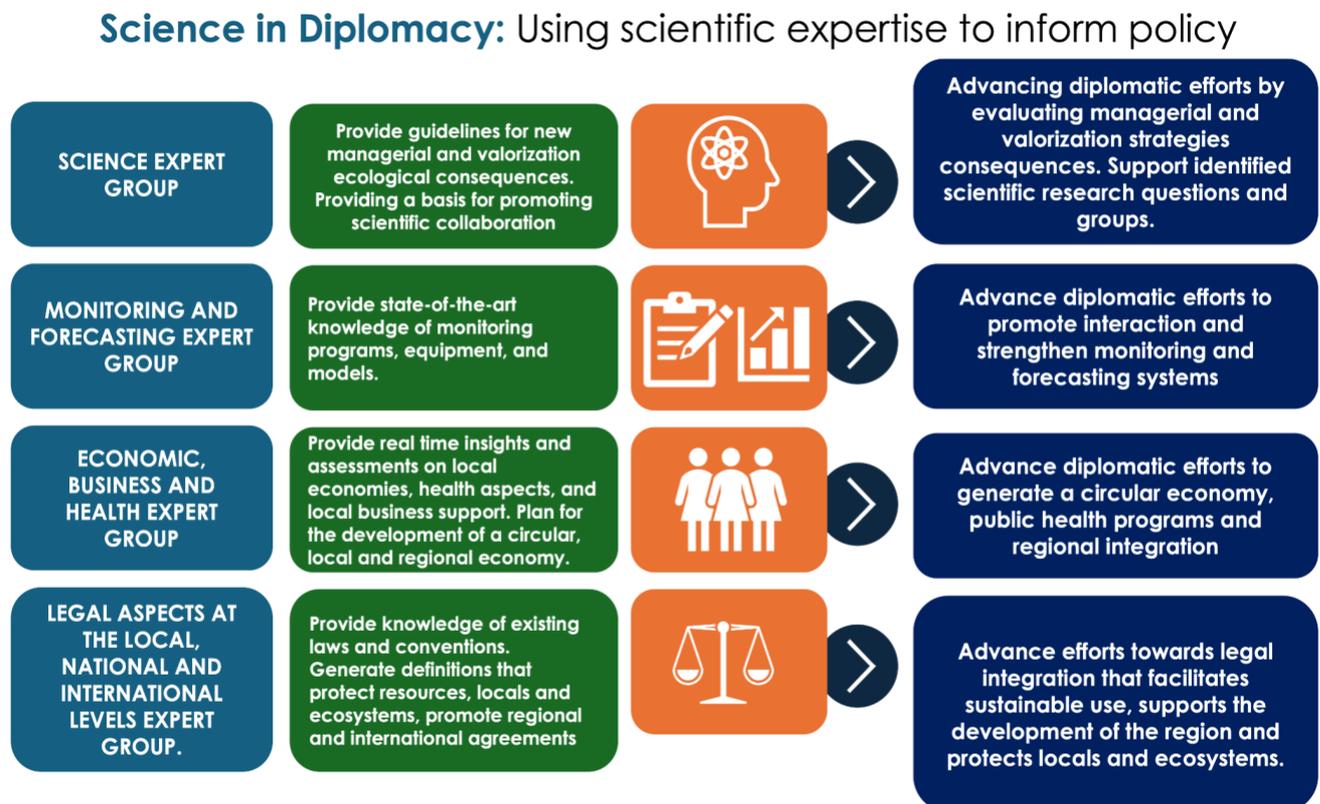


FIGURE 23. ‘SCIENCE IN DIPLOMACY’ ROADMAP.

and shifting currents will be understood. Understanding complex mechanisms will help frame the sargassum as a climate issue deserving of international attention and funding. Scientific documentation of economic losses, ecological impacts, and public health concerns justifies resource allocation when Caribbean nations negotiate with international funding agencies. Expert testimony demonstrates that immediate draconic solutions such as sinking of massive amounts of sargassum, while politically appealing, may prove less effective than investing in early warning systems and long-term adaptation strategies. In the end, this aspect guarantees that policy decisions are based on ecological facts instead of being driven by political expediency.

### 7.3.6 Science for Diplomacy: Improving international relations through scientific cooperation

Scientific cooperation builds trust, improves relationships, and fosters dialogue between nations. Sargassum has created unexpected diplomatic opportunities across Latin American countries and the Caribbean, uniting countries with complicated histories—colonial histories, ecological, economic, and language diversity, and with different governance systems—around a common environmental threat. Networks like SargNet provide neutral platforms where researchers, managers, and policymakers can communicate freely about monitoring and management, regardless of language or other differences. Scientists are facilitating communication across countries of the impacted region with different online resources such as the Sargassum Hub keeping the community informed with an open-access website (<https://sargassumhub.org/>), the Sargassum Monitoring site providing open information of landings from citizen's pictures (<https://sargassummonitoring.com/en/>), and the Sargassum Watch System Bulletin providing open access forecasting information used by all communities involved (<https://optics.marine.usf.edu/projects/saws.html>). Joint research expeditions have facilitated person-to-person connections, international conferences and stakeholders' meetings have encouraged collective solutions, and collaborative publications have demonstrated mutual respect and shared goals. The crisis strengthens regional identity as nations recognize their ecological and economic interdependence in ways they might not have before. The challenge has elevated smaller Caribbean nations in international forums, giving them a voice in global ocean governance and creating partnerships with larger nations and organizations (see sargassum Declaration at the UNOC 13). This common ground extends to other regional issues like fisheries management, climate adaptation, and marine conservation.

### 7.3.7 Three interconnected dimensions working in concert

Science diplomacy can help move forward the solution to the sargassum crisis integrating all three dimensions **Diplomacy for science** promotes collaboration by securing funding and promoting collaborative research addressing the four axes of knowledge to address the sargassum problem, establishing data-sharing agreements, facilitating researcher mobility, and creating frameworks for coordinated basic knowledge gaps, monitoring, socioeconomic, health, and legal joint research across multiscale multinational research groups. **Science in diplomacy** ensures evidence-based decisions through expert advisors informing negotiations and scientists providing data that justifies funding, and shapes policy language (such as sargassum as a symptom of a planetary problem) at forums like climate conventions, UNEP meetings, and other international forums. **Science for diplomacy** builds human relationships that make cooperation possible. Platforms like SargNet and Sargassum Hub allow stakeholders with different backgrounds to build relationships and work together on shared environmental challenges, fostering trust and strengthening regional solidarity. Together, these dimensions prove the crisis cannot be solved by governments, or private sector or science or diplomacy alone—it requires integration where scientific knowledge informs policy, diplomatic mechanisms enable collaboration, and scientific cooperation builds relationships necessary for coordinated regional responses to this unprecedented environmental challenge. We are in a fourth sargassum era, where the problem-to-opportunity is quite beyond valorization and economy, but an opportunity for the impacted nations to build long-lasting relationships for a new regional perspective and a unified Caribbean.

## Recommendations

- This is a global problem linked to climate change and requires action plans that integrate both global and local scales.
- Incorporate concepts and guidelines from Science Diplomacy practices.
- There is a need to map different sectors, as donors from various countries are duplicating efforts and often lack engagement with local communities.
- Identification and mapping of leading start-ups already making progress in the field is necessary.
- It is important to map the specific vocations and needs of the different islands within the affected region.
- An international task force composed of specialists and decision-makers should be established to provide ongoing evaluation of current knowledge and solutions, facilitate data sharing, and foster collaborations for collective understanding and management of the issue.

# Conclusions and Final Recommendations

The scientific advances since 2011 are significant, however important gaps in knowledge to allow us to better understand the bloom needs attention. While studies on impact and management are present there are only a few, managers are busy managing. Agreements and protocols at international, regional, and national level are needed to better manage, protect and empower stakeholders and citizens at large. At the basic scientific level, research combining genetic, biochemical and physiological traits and morphological taxonomy of morphotypes should be encouraged. Prioritize studies on sargassum physiology, its microbioma's role, particularly stress responses to temperature, salinity, and nutrient availability in multifactorial experiments are needed to inform predictive models. Those studies will allow for a better understanding of the links between global change (climate and nutrients enrichment of oceans) and permanence and persistence of the bloom. To strengthen monitoring and forecasting systems, we suggest addressing satellite data limitations related to cloud cover, sun glint, and detection of small patches. Funding regional monitoring programs that track sargassum morphotypes and integrate remote sensing technologies with citizen science to enhance nearshore detection and trajectory modeling are encouraged. At impact and management levels we suggest promoting multidisciplinary and international groups to define the legal status of sargassum—waste or resource—at international, national, and local levels. These groups should include UN agencies, conventions and laws, such as the UNCLOS. We suggest including in the conversations the Sargasso Sea Commission and Alliance, to benefit from their long history and lessons learned. Systematic evaluations of public health and economic losses are urgent needs requiring direct funding and active search for experts in the field, a lack of studies in this area is felt as an abandonment of local communities directly impacted and that after 14 years, have not yet seen any improvements in their livelihood and health. Valorization of sargassum as well as potential opportunities including analysis of supply chain and marketing should be analyzed between different sectors of the society, including private sector, academia and government. The valorization must go hand in hand with standardized protocols for safe harvesting and processing of sargassum for commercial use, particularly regarding toxic metal screening (e.g., arsenic). Involving the private sector to support innovations in mechanized and manual collection technologies tailored to sensitive ecosystems is important and should go in tandem with funding research on long-term ecological impacts of large-scale removal and develop resilience thresholds. All different managerial strategies and protocols will need to take into consideration any public health consequences of any proposed practice. Finally, a long-lasting transformation will require the empowerment of local communities and the

fostering of regional cooperation. Investing in a co-capacity building, including the local knowledge with the international and regional knowledge within an inclusive framework, will allow for self-sustained practices with clear benefits for all.

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# Appendix A

## Abbreviations

- AFAI:** Alternative Floating Algae Index
- FAI:** Floating Algae Index
- GASB:** Great Atlantic Sargassum Belt
- HAB:** Harmful Algal Blooms
- HYCOM:** Hybrid Coordinate Ocean Model
- ITCZ:** Intertropical Convergence Zone
- MCI:** Maximum Chlorophyll Index
- MERIS:** Medium Resolution Imaging Spectrometer
- NERR:** North Equatorial Recirculation Region
- SST:** Sea Surface Temperature
- VIIRS:** Visible Infrared Imaging Radiometer Suite

# Appendix B

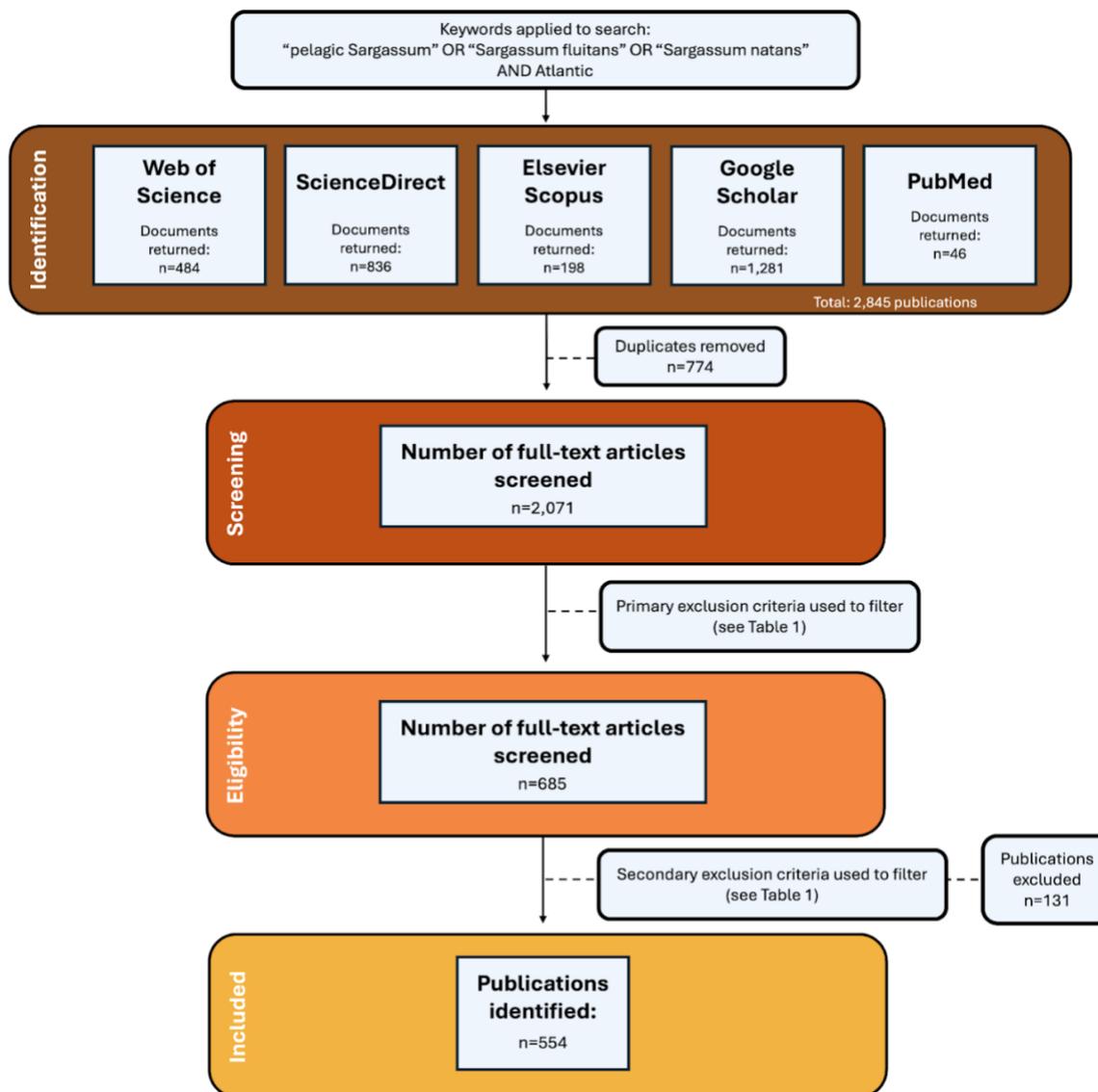
## Glossary

- Biofuels:** renewable fuels made from organic materials (algae, plants, animal fats, etc.)
- Bioplastics:** plastics derived from renewable sources, like plants, rather than petroleum.
- Bioremediation:** the process of using microorganisms, such as bacteria, to clean up contaminated soil and groundwater
- Biosorption:** a method that utilizes biological substances to extract contaminants from water and other solutions
- Bycatch:** the unwanted capture of marine creatures during commercial fishing for other species
- Elastic:** ability of a material to deform under stress and then return to its original shape.
- Intertropical Convergence Zone (ITCZ):** it is a band of low pressure near the equator, where northeast and southeast trade winds converge, affecting wind, current, and wave activity in its elastic region.
- Holopelagic:** to spend the entire lifecycle in the open sea
- HYCOM (Hybrid Coordinate Ocean Model):** simulate large-scale ocean currents affecting sargassum transport
- Hypoxia:** the dissolved oxygen levels in a body of water are too low to support the majority of aquatic life
- Inertia:** the tendency of an object to resist changes in its velocity.
- Lagrangian models:** predict the movement of floating particles by integrating windage, waves, and current data
- Particle Tracking:** Virtual simulation of the release of sargassum “particles” and track their movement over time
- Stokes drift:** movement induced by waves.
- Windage:** influence of partial winds on sargassum mats

## Appendix C

### Methodology Used to Conduct Systematic Review

Five databases were used to identify and analyze empirical published research papers focused on pelagic species of *Sargassum* in the Atlantic: Web of Science, Scopus, ScienceDirect, Google Scholar, and PubMed. The systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A broad literature search was conducted in each database using the search query design and keywords shown in Table C1 below to filter publications solely focused on detailing aspects of pelagic *Sargassum* in the Atlantic. Keywords were used to search published articles' titles, keywords, and abstract sections. Search results were restricted to research articles published in English, Spanish, or Portuguese between January 2011 and September 2025. The initial search contained 2,845 publications. A further systematic review of the literature was conducted using the filtering processes outlined in Figure C1 (shown below) to ensure the removal of duplicates and to ensure that the evidence was focused on pelagic species of *Sargassum* within the Atlantic. Eligibility assessments based on criteria detailed in Table C1 were performed independently in an unblinded standardized manner by two reviewers. Disagreements between reviewers were resolved by discussion between the two reviewers; if no agreement could be reached, a third reviewer was used. There were 685 publications selected for pelagic *Sargassum* in the Atlantic in our initial review. A secondary filter was applied to this collection to determine the state of the research conducted since the onset of the 2011 bloom. The final analysis contained approximately 554 published articles which are listed in Appendix D.



**Figure C1.** Flow diagram detailing article selection process for scientific systematic review

**Table C1.** Criteria of inclusion and exclusion used to filter and select eligible published articles for scientific systematic review presented within this review.

<b>Primary filtering criteria</b>	
<b>Inclusion criteria</b>	<b>Exclusion criteria</b>
<ul style="list-style-type: none"> <li>● Studies focused on pelagic species of the genus <i>Sargassum</i>.</li> <li>● Studies focused on <i>Sargassum</i> on the east and west coasts of the tropical Atlantic. This includes the Sargasso Sea, Caribbean, Gulf of Mexico, North America, South America, and/or West Africa.</li> <li>● Scientific journal articles, empirical studies, and/or book chapters with empirical studies.</li> <li>● Articles that mention the chosen keywords in the Methods and/or Results section.</li> </ul>	<ul style="list-style-type: none"> <li>● Studies focused on sargassum not located in the Atlantic region.</li> <li>● Studies focused only on benthic <i>Sargassum</i> species.</li> <li>● Theoretical/bibliographical studies, encyclopedias, doctoral and master's theses, book chapters without empirical studies (if there are no data).</li> <li>● Articles that do not mention the chosen keywords in the Methods and/or Results section of the study. i.e. Articles that only describe Sargassum in the Introduction, Discussion and/or Conclusion section of the study.</li> </ul>
<b>Secondary filtering criteria</b>	
<b>Inclusion criteria</b>	<b>Exclusion criteria</b>
<ul style="list-style-type: none"> <li>● Articles collected from the first step of filtering will be further filtered to include articles published between January 2011 to September 2025.</li> </ul>	<ul style="list-style-type: none"> <li>● Articles collected from the first step of filtering that were not published between January 2011 to September 2025.</li> </ul>

**\*Important note:** Although the included articles listed here were selected following standard scientific review protocols, certain excluded materials—such as papers published before 2011, topical review articles, and gray literature (e.g., governmental reports)—may still be cited within the text to ensure that the broader state of research is accurately represented.

## Appendix D

### Peer-reviewed scientific literature identified in the systematic review process

**Table D1.** A chronological list of the 554 published peer-reviewed articles focused on pelagic species of *Sargassum* selected during the systematic literature review process listed in Appendix C.

Number	Year	Authors	Publication title
1	2011	Marmorino, GO; Miller, WD; Smith, GB; Bowles, JH	Airborne Imagery of a Disintegrating <i>Sargassum</i> Drift Line
2	2011	Gower, JFR; King, SA	Distribution of Floating <i>Sargassum</i> in the Gulf of Mexico and the Atlantic Ocean Mapped Using MERIS
3	2011	van Ginneken, VJT; Helseper, JFPG; de Visser, W; van Keulen, H; Brandenburg, WA	Polyunsaturated Fatty Acids in Various Macroalgal Species from North Atlantic and Tropical Seas
4	2011	Sargasso Sea Alliance	The Protection and Management of the Sargasso Sea
5	2012	Wei, Chih-Lin; Rowe, Gilbert T.; Nunnally, Clifton C.; Wicksten, Mary K.	Anthropogenic “Litter” and Macrophyte Detritus in the Deep Northern Gulf of Mexico
6	2012	SE Ballard, CF Rakocinski	Flexible Feeding Strategies of Juvenile Gray Triggerfish ( <i>Balistes Capricus</i> ) and Planehead Filefish ( <i>Stephanolepis Hispidus</i> ) Within <i>Sargassum</i> Habitat
7	2012	E Rothäusler, L Gutow, M Thiel	Floating Seaweeds and Their Communities
8	2012	Moser, ML; Lee, DS	Foraging Over <i>Sargassum</i> by Western North Atlantic Seabirds
9	2012	CO Bennice	Habitat Selection Among Fishes and Shrimp in the Pelagic <i>Sargassum</i> Community: the Role of Habitat Architecture
10	2012	SS Alliance	Submission of Scientific Information to Describe Ecologically or Biologically Significant Marine Areas Name of Area
11	2012	JS Franks, DR Johnson, DS Ko, G Sanchez-Rubio...	Unprecedented Influx of Pelagic <i>Sargassum</i> Along Caribbean Island Coastlines During Summer 2011
12	2012	de Széchy M.T.M.; Guedes P.M.; Baeta-Neves M.H.; Oliveira E.N.	Verification of <i>Sargassum natans</i> (Linnaeus) Gaillon (Heterokontophyta: Phaeophyceae) From the Sargasso Sea off the Coast of Brazil, Western Atlantic Ocean

13	2012	Witherington, B; Hirama, S; Hardy, R	Young Sea Turtles of the Pelagic <i>Sargassum</i> -Dominated Drift Community: Habitat Use, Population Density, and Threats
14	2013	J Gower, E Young, S King	A Triumph for Meris: Monitoring of Blooms and Vegetation Using the Global Meris Mci Data Set
15	2013	Fleury, AG; Drazen, JC	Abyssal Scavenging Communities Attracted to <i>Sargassum</i> and Fish in the Sargasso Sea
16	2013	R DeVictor, RE Crabtree, J Froeschke, R Malinowski...	Generic Amendment to the Fishery Management Plans for the Gulf of Mexico and South Atlantic Regions for Modifications to Federally Permitted Seafood Dealer Reporting Requirements, Including Environmental Assessment, Social Impact Statement/Fishery Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis
17	2013	A Moreira, An Alfonso	Inusual Arribazón De <i>Sargassum fluitans</i> (Børgesen) Børgesen En La Costa Centro-Sur De Cuba
18	2013	Powers, SP; Hernandez, FJ; Condon, RH; Drymon, JM; Free, CM	Novel Pathways for Injury From offshore Oil Spills: Direct, Sublethal and Indirect Effects of the Deepwater Horizon Oil Spill on Pelagic <i>Sargassum</i> Communities
19	2013	J Gower, E Young, S King	Satellite Images Suggest a New <i>Sargassum</i> Source Region in 2011
20	2013	Calder, DR	Some Shallow-Water Hydroids (Cnidaria: Hydrozoa) From the Central East Coast of Florida, USA
21	2014	Caamal-Fuentes, E; Chale-Dzul, J; Moo-Puc, R; Freile-Pelegrin, Y; Robledo, D	Bioprospecting of Brown Seaweed (Ochrophyta) From the Yucatan Peninsula: Cytotoxic, Antiproliferative, and Antiprotozoal Activities
22	2014	Sehein, T; Siuda, ANS; Shank, TM; Govindarajan, AF	Connectivity in the Slender <i>Sargassum</i> Shrimp ( <i>Latreutes fucorum</i> ): Implications for A Sargasso Sea Protected Area
23	2014	KL Mansfield, J Wyneken...	First Satellite Tracks of Neonate Sea Turtles Redefine the 'Lost Years' Oceanic Niche
24	2014	D Freestone	Governance of Areas Beyond National Jurisdiction: An Unfinished Agenda of the 1982 Convention?
25	2014	OO Oyesiku, A Egunyomi	Identification and Chemical Studies of Pelagic Masses of <i>Sargassum natans</i> (Linnaeus) Gaillon and <i>S. fluitans</i> (Borgessen) Borgesen (Brown Algae), Found offshore in Ondo State, Nigeria
26	2014	BB Solarin, DA Bolaji, OS Fakayode...	Impacts of An Invasive Seaweed <i>Sargassum hystrix</i> var. <i>fluitans</i> (Børgesen 1914) on the Fisheries and Other Economic Implications for the Nigerian Coastal ...

27	2014	Huffard, CL; von Thun, S; Sherman, AD; Sealey, K; Smith, KL	Pelagic <i>Sargassum</i> Community Change Over A 40-Year Period: Temporal and Spatial Variability
28	2014	Cottrell, Barbara A.; Gonsior, Michael; Timko, Stephen A.; Simpson, andré J.; Cooper, William J.; van der Veer, Wytze	Photochemistry of Marine and Fresh Waters: A Role for Copper–Dissolved Organic Matter Ligands
29	2014	LL Dubbs, M Piehler	Preliminary Research on the Potential Effects of Gulf Stream Energy Turbines on Rates of Productivity and Nutrient Cycling in Pelagic <i>Sargassum</i> Communities
30	2014	Lapointe, BE; West, LE; Sutton, TT; Hu, CM	Ryther Revisited: Nutrient Excretions by Fishes Enhance Productivity of Pelagic <i>Sargassum</i> in the Western North Atlantic Ocean
31	2014	D Freestone	the Sargasso Sea Alliance: Working to Protect the" Golden Gloating Rainforest of the Ocean"
32	2015	E Cruz-Rivera, M Flores-Díaz...	A Fish Kill Coincident with Dense <i>Sargassum</i> Accumulation in A Tropical Bay
33	2015	BE Luckhurst	A Preliminary Food Web of the Pelagic Environment of the Sargasso Sea with A Focus on the Fish Species of Interest To ICCAT
34	2015	Dubbs, LL; Piehler, M; Colby, J	An Examination of Pelagic <i>Sargassum</i> Community Primary Productivity and Nutrient Cycling in the Face of Gulf Stream Based Energy
35	2015	T MORITZ	Fishes of A Stranded <i>Sargassum</i> Meadow at Punta Cana, Dominican Republic
36	2015	Dierssen, H.M.; Chlus, A.; Russell, B.	Hyperspectral Discrimination of Floating Mats of Seagrass Wrack and the Macroalgae <i>Sargassum</i> in Coastal Waters of Greater Florida Bay Using Airborne Remote Sensing
37	2015	Gavio, B; Rincón-Díaz, MN; Santos-Martínez, A	Massive Quantities of Pelagic <i>Sargassum</i> on the Shores of San Andres Island, Southwestern Caribbean
38	2015	O Camacho, L Mattio, S Draisma...	Morphological and Molecular Assessment of <i>Sargassum</i> (Fucales, Phaeophyceae) From Caribbean Colombia, Including the Proposal of <i>Sargassum Giganteum</i> Sp. Nov ...
39	2015	JM Schell, DS Goodwin, ANS Siuda	Recent <i>Sargassum</i> Inundation Events in the Caribbean: Shipboard Observations Reveal Dominance of a Previously Rare Form
40	2015	Hu, CM; Feng, L; Hardy, RF; Hochberg, EJ	Spectral and Spatial Requirements of Remote Measurements of Pelagic <i>Sargassum</i> Macroalgae
41	2015	Russell, BJ; Dierssen, HM	Use of Hyperspectral Imagery to Assess Cryptic Color Matching in <i>Sargassum</i> Associated Crabs

42	2016	Bula-Meyer G.; Dfaz-Pulido G.; Rincón A.C.	Additions To Macroalgae from the Coral Reefs of the Rosario Islands, With New Records for the Colombian Caribbean and the Atlantic; [Adiciones a las macroalgas de los arrecifes coralinos de las islas del rosario, con nuevos registros para el caribe colombiano y el atlantico]
43	2016	RE Rodríguez-Martínez, B van Tussenbroek...	Afluencia Masiva De Sargazo Pelágico a La Costa Del Caribe Mexicano (2014–2015)
44	2016	MNA Ramdwar, VA Stoute...	An Evaluation of <i>Sargassum</i> Seaweed Media Compositions on the Performance of Hot Pepper ( <i>Capsicum Chinense</i> Jacq.) Seedling Production
45	2016	JE Martinelli-Filho, LM Morais...	Can the Invertebrate Fauna Associated to Pelagic <i>Sargassum</i> Landings in the Brazilian Amazon Coast Aid Us to Understand its Origin and Dispersion
46	2016	C Hinds, H Oxenford, J Cumberbatch, F Fardin...	Golden Tides: Management Best Practices for Influxes of <i>Sargassum</i> in the Caribbean with A Focus on Clean-Up.
47	2016	Waliczek, T; Walsh, K	Investigating A Composting Management System for Brown Algae ( <i>Sargassum fluitans</i> and <i>Sargassum natans</i> )
48	2016	MT Brooks, V Coles, RR Hood...	Linking Satellite Observations with Coupled Bio-Physical Models of <i>Sargassum</i>
49	2016	Wang, MQ; Hu, CM	Mapping and Quantifying <i>Sargassum</i> Distribution and Coverage in the Central West Atlantic Using MODIS Observations
50	2016	C Secretariat	Model Protocol for the Management of Extreme Accumulations of <i>Sargassum</i> on the Coasts of CRFM Member States
51	2016	LM Martin	Pelagic <i>Sargassum</i> and its Associated Mobile Fauna in the Caribbean, Gulf of Mexico, and Sargasso Sea
52	2016	JS Franks, DR Johnson, DS Ko	Pelagic <i>Sargassum</i> in the Tropical North Atlantic
53	2016	GND Addico, KAA deGraft-Johnson	Preliminary Investigation into the Chemical Composition of the Invasive Brown Seaweed <i>Sargassum</i> Along the West Coast of Ghana
54	2016	Hu, CM; Hardy, R; Ruder, E; Geggel, A; Feng, L; Powers, S; Hernandez, F; Graettinger, G; Bodnar, J; McDonald, T	<i>Sargassum</i> Coverage in the Northeastern Gulf of Mexico During 2010 From Landsat and Airborne Observations: Implications for the Deepwater Horizon Oil Spill Impact Assessment
55	2016	C Hinds, H Oxenford, J Cumberbatch, F Fardin...	<i>Sargassum</i> Management Brief
56	2017	Maréchal J.-P.; Hellio C.; Hu C.	A Simple, Fast, and Reliable Method to Predict <i>Sargassum</i> Washing Ashore in the Lesser Antilles

57	2017	F Fernández, CJ Boluda, J Olivera, LA Guillermo...	Análisis Elemental Prospectivo De La Biomasa Algal Acumulada En Las Costas De La República Dominicana Durante 2015
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59	2017	Rhein-Knudsen, Nanna; Ale, Marcel Tutor; Ajalloueian, Fatemeh; Meyer, Anne S.	Characterization of Alginates from Ghanaian Brown Seaweeds: <i>Sargassum</i> spp. and <i>Padina</i> spp.
60	2017	Amaral-Zettler, LA; Dragone, NB; Schell, J; Slikas, B; Murphy, LG; Morrall, CE; Zettler, ER	Comparative Mitochondrial and Chloroplast Genomics of a Genetically Distinct Form of <i>Sargassum</i> Contributing to Recent Golden Tides in the Western Atlantic
61	2017	Torralba, MG; Franks, JS; Gomez, A; Yooseph, S; Nelson, KE; Grimes, DJ	Effect of Macondo Prospect 252 Oil on Microbiota Associated with Pelagic <i>Sargassum</i> in the Northern Gulf of Mexico
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63	2017	L Adet, GN Nsofor, KO Ogunjobi, B Camara	Knowledge of Climate Change and the Perception of Nigeria's Coastal Communities on the Occurrence of <i>Sargassum natans</i> and <i>Sargassum fluitans</i>
64	2017	Godavarthi, S; Kumar, KM; Vélez, EV; Hernandez-Eligio, A; Mahendhiran, M; Hernandez-Como, N; Aleman, M; Gomez, LM	Nitrogen Doped Carbon Dots Derived from <i>Sargassum fluitans</i> As Fluorophore for DNA Detection
65	2017	S Djakouré, M Araujo, A Hounsou-Gbo...	on the Potential Causes of the Recent Pelagic <i>Sargassum</i> Blooms Events in the Tropical North Atlantic Ocean
66	2017	Wang, MQ; Hu, CM	Predicting <i>Sargassum</i> Blooms in the Caribbean Sea from MODIS Observations
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73	2018	A Lucette	Climate Change and its Impact on Occurrence of <i>Sargassum natans</i> and <i>Sargassum fluitans</i> on Coastline of Lagos and its Environ
74	2018	HA Oxenford, I Monnereau, M Barange...	Climate Change Impacts, Vulnerabilities and Adaptations: Western Central Atlantic Marine Fisheries
75	2018	Russell, BJ; Dierssen, HM	Color Change in the <i>Sargassum</i> Crab, <i>Portunus Sayi</i> : Response to Diel Illumination Cycle and Background Albedo
76	2018	Sembera, JA; Meier, EJ; Waliczek, TM	Composting As an Alternative Management Strategy for <i>Sargassum</i> Drifts on Coastlines
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78	2018	LT Kell, BE Luckhurst	Extending the Indicator-Based Ecosystem Report Card to the Whole Ecosystem: A Preliminary Example Based on the Sargasso Sea
79	2018	Brooks, MT; Coles, VJ; Hood, RR; Gower, JFR	Factors Controlling the Seasonal Distribution of Pelagic <i>Sargassum</i>
80	2018	B Gavio, A Santos-Martinez	Floating <i>Sargassum</i> in Serranilla Bank, Caribbean Colombia, May Jeopardize the Race to the Ocean of Baby Sea Turtles
81	2018	West, LE; Brooks, WR	Host Location and Selection by the Symbiotic <i>Sargassum</i> Crab <i>Portunus Sayi</i> : the Role of Chemical, Visual and Tactile Cues
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88	2018	Wang, MQ; Hu, CM	On the Continuity of Quantifying Floating Algae of the Central West Atlantic Between Modis and Viirs
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91	2018	GR Alliance, GEO Blue Planet Initiative	<i>Sargassum</i> and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions Workshop, México Df, México 2–4 May 2018.
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93	2018	Sherman, MT; Blaylock, R; Sullivan, C; Lucas, K; Moscicki, Z; Capron, ME; Tsukrov, I; Stewart, JR; Swift, MR; DiMarco, SF; Chambers, MD; Thyng, K; James, SC; Hetland, R; Brooks, M; Kim, MH; von Herzen, B; Jones, A; Piper, D	Seaweed paddock: Initial Modeling and Design for A <i>Sargassum</i> Ranch
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96	2018	Innocenti, Rachel A.; Feagin, Rusty A.; Huff, Thomas P.	The Role of <i>Sargassum</i> Macroalgal Wrack in Reducing Coastal Erosion
97	2019	AF Govindarajan, L Cooney, K Whittaker, D Bloch...	The Distribution and Mitochondrial Genotype of the Hydroid <i>Aglaophenia Latecarinata</i> Is Correlated with its Pelagic <i>Sargassum</i> Substrate Type in the Tropical and Subtropical Western Atlantic Ocean
98	2019	P Zuñiga, W Riley, R Waters...	Browning of the Golden Tide: Impacts of Accumulated <i>Sargassum</i> on Sea Water Quality in Ambergris Caye, Belize

99	2019	Arellano-Verdejo, J; Lazcano-Hernandez, HE; Cabanillas-Terán, N	Erisnet: Deep Neural Network for <i>Sargassum</i> Detection Along the Coastline of the Mexican Caribbean
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101	2019	KT Walsh	Examining the Quality of a Compost Product Derived from <i>Sargassum</i> ( <i>Sargassum fluitans</i> and <i>Sargassum natans</i> )
102	2019	Rodríguez-Martínez, RE; Medina-Valmaseda, AE; Blanchon, P; Monroy-Velázquez, LV; Almazán-Becerril, A; Delgado-Pech, B; Vásquez-Yeomans, L; Francisco, V; García-Rivas, MC	Faunal Mortality Associated with Massive Beaching and Decomposition of Pelagic <i>Sargassum</i>
103	2019	F Ménez	From “Poisoned Gold” To “A Dazzling Gold”
104	2019	Ody, A; Thibaut, T; Berline, L; Changeux, T; andré, JM; Chevalier, C; Blanfuné, A; Blanchot, J; Ruitton, S; Stiger-Pouvreau, V; Connan, S; Grelet, J; Aurelle, D; Guéné, M; Bataille, H; Bachelier, C; Guillemain, D; Schmidt, N; Fauvelle, V; Guasco, S; Ménard, F	From in Situ to Satellite Observations of Pelagic <i>Sargassum</i> Distribution and Aggregation in the Tropical North Atlantic Ocean
105	2019	Brooks, MT; Coles, VJ; Coles, WC	Inertia Influences Pelagic <i>Sargassum</i> Advection and Distribution
106	2019	R Mendez-Tejeda, GA Rosado Jiménez	Influence of Climatic Factors on <i>Sargassum</i> Arrivals to the Coasts of the Dominican Republic
107	2019	D Bernard, B Emmanuel, N Sekkat, R Chery...	Massive Stranding of Pelagic <i>Sargassum</i> Seaweeds on the French Antilles Coasts: Analysis of Observed Situations with Operational Mercator Global Ocean Analysis and ...
108	2019	Monroy-Velázquez, LV; Rodríguez-Martínez, RE; van Tussenbroek, B; Aguiar, T; Solís-Weiss, V; Briones-Fourzán, P	Motile Macrofauna Associated with Pelagic <i>Sargassum</i> in A Mexican Reef Lagoon
109	2019	DCN Alliance	Prevention and Clean-Up of <i>Sargassum</i> in the Dutch Caribbean.
110	2019	Martin, LM; Schell, JM; Siuda, ANS	<i>Probopyrinella Latreuticola</i> Parasite Infestation Frequencies in Pelagic <i>Sargassum</i> -Associated Shrimp, <i>Latreutes Fucorum</i>
111	2019	CE Johnson, LL Dubbs...	Rates of Nitrogen Fixation by the Pelagic <i>Sargassum</i> Community in the Gulf Stream off North Carolina
112	2019	Cabanillas-Terán, N; Hernández-Arana, HA; Ruiz-Zárate, MA; Vega-Zepeda, A; Sanchez-Gonzalez, A	<i>Sargassum</i> Blooms in the Caribbean Alter the Trophic Structure of the Sea Urchin <i>Diadema Antillarum</i>

113	2019	Powers, LC; Hertkorn, N; McDonald, N; Schmitt-Kopplin, P; Del Vecchio, R; Blough, NV; Gonsior, M	<i>Sargassum</i> Sp. Act as A Large Regional Source of Marine Dissolved Organic Carbon and Polyphenols
114	2019	Boisnoir, A; Pascal, PY; Cordonnier, S; Lemée, R	Spatio-Temporal Dynamics and Biotic Substrate Preferences of Benthic Dinoflagellates in the Lesser Antilles, Caribbean Sea
115	2019	AC Kemp, CH Vane, NS Khan, J Ellison, SE Engelhart...	Testing the Utility of Geochemical Proxies to Reconstruct Holocene Coastal Environments and Relative Sea Level: A Case Study from Hungry Bay, Bermuda
116	2019	Govindarajan, AF; Cooney, L; Whittaker, K; Bloch, D; Burdorf, RM; Canning, S; Carter, C; Cellan, SM; Eriksson, FAA; Freyer, H; Huston, G; Hutchinson, S; McKeegan, K; Malpani, M; Merkle-Raymond, A; Ouellette, K; Petersen-Rockney, R; Schultz, M; Siuda, ANS	The Distribution and Mitochondrial Genotype of the Hydroid <i>Aglaophenia</i> <i>Latecarinata</i> Is Correlated with its Pelagic <i>Sargassum</i> Substrate Type in the Tropical and Subtropical Western Atlantic Ocean
117	2019	Wang, MQ; Hu, CM; Barnes, BB; Mitchum, G; Lapointe, B; Montoya, JP	The Great Atlantic <i>Sargassum</i> Belt
118	2019	Acton, Leslie; Campbell, Lisa M.; Cleary, Jesse; Gray, Noella J.; Halpin, Patrick N.	What Is the Sargasso Sea? The Problem of Fixing Space in A Fluid Ocean
119	2020	Rosado-Espinosa, LA; Freile-Pelegri, Y; Hernández-Núñez, E; Robledo, D	A Comparative Study of <i>Sargassum</i> Species from the Yucatan Peninsula Coast: Morphological and Chemical Characterisation
120	2020	FJ Beron-Vera, P Miron	A Minimal Maxey–Riley Model for the Drift of <i>Sargassum</i> Rafts
121	2020	López-Sosa, LB; Alvarado-Flores, JJ; Corral-Huacuz, JC; Aguilera-Mandujano, A; Rodríguez-Martínez, RE; Guevara-Martínez, SJ; Alcaraz-Vera, JV; Rutiaga-Quñones, JG; Zárate-Medina, J; Avalos-Rodríguez, ML; Morales-Máximo, M	A Prospective Study of the Exploitation of Pelagic <i>Sargassum</i> spp. As A Solid Biofuel Energy Source
122	2020	Mohammed, A; Rivers, A; Stuckey, DC; Ward, K	Alginate Extraction from <i>Sargassum</i> Seaweed in the Caribbean Region: Optimization Using Response Surface Methodology
123	2020	EG Torres-Conde, B Martínez-Daranas	Análisis Espacio-Temporal Y Oceanográfico De Las Arribazones De <i>Sargassum</i> Pelágico En Las Playas Del Este De La Habana, Cuba
124	2020	Häder, Donat-P.; Banaszak, Anastazia T.; Villafaña, Virginia E.; Narvarte, Maite A.; González, Raúl A.; Helbling, E. Walter	Anthropogenic Pollution of Aquatic Ecosystems: Emerging Problems with Global Implications
125	2020	G Arencibia-Carballo, JMI Batallán...	Arribazones De <i>Sargassum</i> En La Costa Norte Occidental De Cuba
126	2020	M Wang, C Hu	Automatic Extraction of <i>Sargassum</i> Features from Sentinel-2 Msi Images

127	2020	P McConney, HA Oxenford	Caribbean <i>Sargassum</i> Phenomenon
128	2020	Doh, Hansol; Dunno, Kyle D.; Whiteside, William Scott	Cellulose Nanocrystal Effects on the Biodegradability with Alginate and Crude Seaweed Extract Nanocomposite Films
129	2020	A Thomas, A Baptiste, R Martyr-Koller...	Climate Change and Small Island Developing States
130	2020	Miron, P; Olascoaga, MJ; Beron-Vera, FJ; Putman, NF; Triñanes, J; Lumpkin, R; Goni, GJ	Clustering of Marine-Debris- and <i>Sargassum</i> -like Drifters Explained by Inertial Particle Dynamics
131	2020	E Glize, MJ Huguet, M Lucas, M Sutton...	Clustering <i>Sargassum</i> Mats from Earth Observation Data
132	2020	J Arellano-Verdejo, HE Lazcano-Hernandez	Crowdsourcing for <i>Sargassum</i> Monitoring Along the Beaches in Quintana Roo
133	2020	Mohammed, Akeem; Rivers, Arianne; Stuckey, David.C.; Ward, Keeran	Datasets on the Optimization of Alginate Extraction from <i>Sargassum</i> Biomass Using Response Surface Methodology.
134	2020	Thompson, TM; Young, BR; Baroutian, S	Efficiency of Hydrothermal Pretreatment on the Anaerobic Digestion of Pelagic <i>Sargassum</i> for Biogas and Fertiliser Recovery
135	2020	LA Espinosa, J Li	El Riesgo Del Sargazo Para La Economía Y Turismo De Quintana Roo Y México
136	2020	Rodríguez-Martínez, RE; Roy, PD; Torrescano-Valle, N; Cabanillas-Terán, N; Carrillo-Domínguez, S; Collado-Vides, L; García-Sánchez, M; van Tussenbroek, BI	Element Concentrations in Pelagic <i>Sargassum</i> Along the Mexican Caribbean Coast in 2018-2019
137	2020	Mendoza-Becerril, MA; Serviere-Zaragoza, E; Mazariegos-Villarreal, A; Rivera-Perez, C; Calder, DR; Vázquez-Delfín, EF; Freile-Pelegrín, Y; Agüero, J; Robledo, D	Epibiont Hydroids on Beachcast <i>Sargassum</i> in the Mexican Caribbean
138	2020	López-Miranda, JL; Silva, R; Molina, GA; Esparza, R; Hernandez-Martinez, AR; Hernandez-Carteño, J; Estévez, M	Evaluation of A Dynamic Bioremediation System for the Removal of Metal Ions and Toxic Dyes Using <i>Sargassum</i> spp.
139	2020	Walsh, KT; Waliczek, TM	Examining the Quality of a Compost Product Derived from <i>Sargassum</i>
140	2020	PJ Lopez, V Hervé, J Lambourdière...	From the Sea to the Land: Dynamic of the <i>Sargassum</i> Tide Holobiont in the Caribbean Islands
141	2020	Gouvêa, LP; Assis, J; Gurgel, CFD; Serrao, EA; Silveira, TCL; Santos, R; Duarte, CM; Peres, LMC; Carvalho, VF; Batista, M; Bastos, E; Sissini, MN; Horta, PA	Golden Carbon of <i>Sargassum</i> Forests Revealed as An Opportunity for Climate Change Mitigation

142	2020	Chale-Dzul, J; de Vaca, RPC; Quintal-Novelo, C; Olivera-Castillo, L; Moo-Puc, R	Hepatoprotective Effect of a Fucoïdan Extract from <i>Sargassum fluitans</i> Borgesen Against Ccl4-Induced Toxicity in Rats
143	2020	Berline, Léo; Ody, Anouck; Jouanno, Julien; Chevalier, Cristèle; andré, Jean-Michel; Thibaut, Thierry; Ménard, Frédéric	Hindcasting the 2017 Dispersal of <i>Sargassum</i> Algae in the Tropical North Atlantic
144	2020	Putman, NF; Lumpkin, R; Olascoaga, MJ; Trinanes, J; Goni, GJ	Improving Transport Predictions of Pelagic <i>Sargassum</i>
145	2020	Qi, Lin; Hu, Chuanmin; Mikelsons, Karlis; Wang, Menghua; Lance, Veronica; Sun, Shaojie; Barnes, Brian B.; Zhao, Jun; Van der Zande, Dimitry	in Search of Floating Algae and Other Organisms in Global Oceans and Lakes
146	2020	Michotey, V; Blanfuné, A; Chevalier, C; Garel, M; Diaz, F; Berline, L; Le Grand, L; Armougom, F; Guasco, S; Ruitton, S; Changeux, T; Belloni, B; Blanchot, J; Ménard, F; Thibaut, T	in Situ Observations and Modelling Revealed Environmental Factors Favouring Occurrence of <i>Vibrio</i> in Microbiome of the Pelagic <i>Sargassum</i> Responsible for Strandings
147	2020	Thompson, TM; Young, BR; Baroutian, S	Influence of Hydrothermal Pretreatment on the Anaerobic Digestion of Pelagic <i>Sargassum</i> for Biogas and Fertiliser Recovery (Vol 279, 118527, 2020)
148	2020	Doh, H; Whiteside, WS	Isolation of Cellulose Nanocrystals from Brown Seaweed, <i>Sargassum fluitans</i> , for Development of Alginate Nanocomposite Film
149	2020	Antonio-Martínez, F; Henaut, Y; Vega-Zepeda, A; Ceron-Flores, AI; Raigoza-Figueras, R; Cetz-Navarro, NP; Espinoza-Avalos, J	Leachate Effects of Pelagic <i>Sargassum</i> spp. on Larval Swimming Behavior of the Coral <i>Acropora Palmata</i>
150	2020	LAR Iporac, S Olszak, D Burkholder...	Lessons and Challenges in Piloting “ <i>Sargassum</i> Watch,” A Citizen Science Program to Monitor Pelagic <i>Sargassum</i> Landings in South Florida
151	2020	S Van der Plank, J Corbett, J Cumberbatch, B Thomas...	Management of <i>Sargassum</i> Influxes in the Caribbean: National and Regional Governance of a Transboundary Marine Species
152	2020	MN de Boer, JT Saulino	Marine Megafauna (Cetaceans, Turtles, Seabirds & Elasmobranchs) Associate with Pelagic <i>Sargassum</i> off Suriname
153	2020	Chávez, V; Uribe-Martínez, A; Cuevas, E; Rodríguez-Martínez, RE; van Tussenbroek, BI; Francisco, V; Estévez, M; Celis, LB; Monroy-Velázquez, LV; Leal-Bautista, R; Alvarez-Filip, L; García-Sánchez, M; Masia, L; Silva, R	Massive Influx of Pelagic <i>Sargassum</i> spp. on the Coasts of the Mexican Caribbean 2014-2020: Challenges and Opportunities

154	2020	Gonzalez-Nieto, D; Oliveira, MC; Resendiz, MLN; Dreckmann, KM; Mateo-Cid, LE; Senties, A	Molecular Assessment of the Genus <i>Sargassum</i> (Fucales, Phaeophyceae) From the Mexican Coasts of the Gulf of Mexico and Caribbean, With the Description of <i>S. Xochitlae</i> sp. nov.
155	2020	Salter, MA; Rodríguez-Martínez, RE; Alvarez-Filip, L; Jordán-Dahlgren, E; Perry, CT	Pelagic <i>Sargassum</i> as An Emerging Vector of High-Rate Carbonate Sediment Import to Tropical Atlantic Coastlines
156	2020	Johnson, DR; Franks, JS; Oxenford, HA; Cox, SAL	Pelagic <i>Sargassum</i> Prediction and Marine Connectivity in the Tropical Atlantic
157	2020	Paraguay-Delgado, F; Carreño-Gallardo, C; Estrada-Guel, L; Zabala-Arceo, A; Martinez-Rodriguez, HA; Lardizábal-Gutierrez, D	Pelagic <i>Sargassum</i> spp. Capture CO <sub>2</sub> and Produce Calcite
158	2020	Doh, Hansol; Lee, Min Hyeock; Whiteside, William Scott	Physicochemical Characteristics of Cellulose Nanocrystals Isolated from Seaweed Biomass
159	2020	Doh, Hansol; Dunno, Kyle D.; Whiteside, William Scott	Preparation of Novel Seaweed Nanocomposite Film from Brown Seaweeds <i>Laminaria Japonica</i> and <i>Sargassum natans</i>
160	2020	Milledge, JJ; Maneein, S; López, EA; Bartlett, D	<i>Sargassum</i> Inundations in Turks and Caicos: Methane Potential and Proximate, Ultimate, Lipid, Amino Acid, Metal and Metalloid Analyses
161	2020	García-Sánchez, M; Graham, C; Vera, E; Escalante-Mancera, E; Alvarez-Filip, L; van Tussenbroek, BI	Temporal Changes in the Composition and Biomass of Beached Pelagic <i>Sargassum</i> Species in the Mexican Caribbean
162	2020	Gower, J; King, S	the Distribution of Pelagic <i>Sargassum</i> Observed With OLCI
163	2020	Johns, EM; Lumpkin, R; Putman, NF; Smith, RH; Muller-Karger, FE; Rueda-Roa, DT; Hu, CM; Wang, MQ; Brooks, MT; Gramer, LJ; Werner, FE	the Establishment of a Pelagic <i>Sargassum</i> Population in the Tropical Atlantic: Biological Consequences of a Basin-Scale Long Distance Dispersal Event
164	2020	P Miron, MJ Olascoaga, FJ Beron-Vera, N Putman...	Trajectories of Drifters of Different Shapes Released at Four Locations Across the Atlantic Ocean
165	2020	L Collado-Vides, P Cifuentes, N Bally...	Variability of Nutrients and Trace Metals Tissue Content in Two Pelagic <i>Sargassum</i> (Ochrophyta, Phaeophyceae) Species from South Florida Compared with Global ...
166	2020	Waliczek, TM; Wagner, NC; Guney, S	Willingness To Pay for A Specialty Blend Compost Product Developed from Brown Seaweed Harvested from Coastal Regions in Texas
167	2021	JL Godínez-Ortega, JV Cuatlán-Cortés...	A Natural History of Floating <i>Sargassum</i> Species (Sargasso) From Mexico
168	2021	Jouanno, J; Benshila, R; Berline, L; Soulié, A; Radenac, MH; Morvan, G; Diaz, F; Sheinbaum, J; Chevalier, C; Thibaut, T; Changeux, T; Menard, F; Berthet, S; Aumont, O; Ethé, C; Nabat, P; Mallet, M	A NEMO-Based Model of <i>Sargassum</i> Distribution in the Tropical Atlantic: Description of the Model and Sensitivity Analysis (NEMO-Sarg1.0)

169	2021	Francoeur, Marckens; Ferino-Pérez, Anthuan; Yacou, Christelle; Jean-Marius, Corine; Emmanuel, Evens; Chérémond, Yvens; Jauregui-Haza, Ulises; Gaspard, Sarra	Activated Carbon Synthetized from <i>Sargassum</i> (Sp) for Adsorption of Caffeine: Understanding the Adsorption Mechanism Using Molecular Modeling
170	2021	LR Ponce Rey, I Spengler Salabarría, I Rodeiro Guerra...	Antiviral Activity of <i>Sargassum fluitans</i> Seaweed Against Echovirus 9, Coxsackievirus A16 and Coxsackievirus A24
171	2021	Rodríguez-Muñoz, R; Muñiz-Castillo, AI; Euán-Avila, JI; Hernández-Núñez, H; Valdés-Lozano, DS; Collí-Dulá, RC; Arias-González, JE	Assessing Temporal Dynamics on Pelagic <i>Sargassum</i> Influx and its Relationship with Water Quality Parameters in the Mexican Caribbean
172	2021	Ávalos-Betancourt C.A.; López-Sosa L.B.; Morales-Máximo M.; Aguilera-Mandujano A.; Corral-Huacuz J.C.; Rodríguez-Martínez R.E.	Assessment of the Energy Potential as A Solid Biofuel of <i>Sargassum</i> spp. Considering Sustainability Indicator
173	2021	Rutten, J; Arriaga, J; Montoya, LD; Mariño-Tapia, IJ; Escalante-Mancera, E; Mendoza, ET; Tussenbroek, BI; Appendini, CM	Beaching and Natural Removal Dynamics of Pelagic <i>Sargassum</i> in A Fringing-Reef Lagoon
174	2021	Ranguin, R; Delannoy, M; Yacou, C; Jean-Marius, C; Feidt, C; Rychen, G; Gaspard, S	Biochar and Activated Carbons Preparation from Invasive Algae <i>Sargassum</i> spp. for Chlordecone Availability Reduction in Contaminated Soils
175	2021	Davis, D; Simister, R; Campbell, S; Marston, M; Bose, S; McQueen-Mason, SJ; Gomez, LD; Gallimore, WA; Tonon, T	Biomass Composition of the Golden Tide Pelagic Seaweeds <i>Sargassum fluitans</i> and <i>S. natans</i> (Morphotypes I and VIII) To Inform Valorisation Pathways
176	2021	Gray, LA; León, AGB; Rojas, FE; Veroneau, SS; Slocum, AH	Caribbean-Wide, Negative Emissions Solution to <i>Sargassum</i> spp. Low-Cost Collection Device and Sustainable Disposal Method
177	2021	Oxenford, HA; Cox, SA; van Tussenbroek, BI; Desrochers, A	Challenges of Turning the <i>Sargassum</i> Crisis into Gold: Current Constraints and Implications for the Caribbean
178	2021	Nielsen, BV; Milledge, JJ; Hertler, H; Maneein, S; Al Farid, MM; Bartlett, D	Chemical Characterisation of <i>Sargassum</i> Inundation from the Turks and Caicos: Seasonal and Post Stranding Changes
179	2021	Hendy, Ian W.; Woolford, Katherine; Vincent-Piper, Alice; Burt, Owen; Schaefer, Martin; Cragg, Simon M.; Sanchez-Navarro, Paul; Ragazzola, Federica	Climate-Driven Golden Tides Are Reshaping Coastal Communities in Quintana Roo, Mexico
180	2021	Arellano-Verdejo, J; Lazcano-Hernández, HE	Collective View: Mapping <i>Sargassum</i> Distribution Along Beaches
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182	2021	Resiere, Dabor; Mehdaoui, Hossein; Banydeen, Rishika; Florentin, Jonathan; Kallel, Hatem; Nevière, Rémi; Mégarbane, Bruno	Effets Sanitaires De La Décomposition des Algues Sargasses Échouées Sur Les Rivages des Antilles Françaises

183	2021	Thompson, TM; Young, BR; Baroutian, S	Enhancing Biogas Production from Caribbean Pelagic <i>Sargassum</i> Utilising Hydrothermal Pretreatment and Anaerobic Co-Digestion with Food Waste
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186	2021	C Hu	Hyperspectral Reflectance Spectra of Floating Matters Derived from HICO Observations
187	2021	Tejada-Tejada, P; Rodríguez-Rodríguez, Y; de Francisco, LER; Paíno-Perdomo, O; Boluda, CJ	Lead, Chromium, Nickel, Copper and Zinc Levels in <i>Sargassum</i> Species Reached the Coasts of Dominican Republic During 2019: A Preliminary Evaluation for the Use of Algal Biomass as Fertilizer and Animal Feeding
188	2021	M Ambiente, R Naturales	Lineamientos Técnicos Y De Gestión Para La Atención De La Contingencia Ocasionada Por Sargazo En El Caribe Mexicano Y El Golfo De México.
189	2021	Chávez-Guerrero, L; Toxqui-Terán, A; Rivera-Haro, JA; Lozoya-Márquez, LA; Lara-Banda, M	Management of Pelagic <i>Sargassum</i> spp. Landings to Atlantic Coastlines Through Direct Combustion and Further Synthesis of Highly Pure Calcium Carbonate Using the Residual Ashes
190	2021	P Tejada-Tejada, Y Rodríguez-Rodríguez...	Niveles De Plomo, Cromo, Níquel, Cobre Y Zinc En Especies De <i>Sargassum</i> Llegadas a Las Costas De República Dominicana Durante 2019: Una Evaluación Preliminar ...
191	2021	Hernández-Bolio, GI; Fagundo-Mollineda, A; Caamal-Fuentes, EE; Robledo, D; Freile-Pelegrin, Y; Hernández-Núñez, E	NMR Metabolic Profiling of <i>Sargassum</i> Species Under Different Stabilization/Extraction Processes
192	2021	Beron-Vera, FJ	Nonlinear Dynamics of Inertial Particles in the Ocean: From Drifters and Floats to Marine Debris and <i>Sargassum</i>
193	2021	Lapointe, BE; Brewton, RA; Herren, LW; Wang, M; Hu, C; McGillicuddy, DJ; Lindell, S; Hernandez, FJ; Morton, PL	Nutrient Content and Stoichiometry of Pelagic <i>Sargassum</i> Reflects Increasing Nitrogen Availability in the Atlantic Basin
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199	2021	Alzate-Gaviria, L; Domínguez-Maldonado, J; Chablé-Villacís, R; Olguin-Maciel, E; Leal-Bautista, RM; Canché-Escamilla, G; Caballero-Vázquez, A; Hernández-Zepeda, C; Barredo-Pool, FA; Tapia-Tussel, R	Presence of Polyphenols Complex Aromatic Lignin in <i>Sargassum</i> spp. From Mexican Caribbean
200	2021	Javed, K; Umer, A; Afzal, S; Ullah, N	Process Optimization for the Extraction of Alginate, Derived from <i>Sargassum fluitans</i>
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202	2021	Hu, Chuanmin	Remote Detection of Marine Debris Using Satellite Observations in the Visible and Near Infrared Spectral Range: Challenges and Potentials
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204	2021	Marx, UC; Roles, J; Hankamer, B	<i>Sargassum</i> Blooms in the Atlantic Ocean - From A Burden to An Asset
205	2021	Hervé, V; Lambourdière, J; René-Trouillefou, M; Devault, DA; Lopeç, PJ	<i>Sargassum</i> Differentially Shapes the Microbiota Composition and Diversity at Coastal Tide Sites and Inland Storage Sites on Caribbean Islands
206	2021	López-Miranda, JL; Esparza, R; González-Reyna, MA; España-Sánchez, BL; Hernandez-Martinez, AR; Silva, R; Estévez, M	<i>Sargassum</i> Influx on the Mexican Coast: A Source for Synthesizing Silver Nanoparticles with Catalytic and Antibacterial Properties
207	2021	Rodríguez-Martínez, RE; Quintana-Pali, G; Trujano-Rivera, K; Herrera, R; García-Rivas, MD; Ortíz, A; Castañeda, G; Maldonado, G; Jordán-Dahlgren, E	<i>Sargassum</i> Landings Have Not Compromised Nesting of Loggerhead and Green Sea Turtles in the Mexican Caribbean
208	2021	Adelv García, Jcr Reyes...	<i>Sargassum natans</i> (Linnaeus) Gaillon (Ocrophyta: Phaeophyceae), Nueva Adición Para La Ficoflora De Venezuela.

209	2021	D Resiere, H Mehdaoui, J Florentin, P Gueye...	<i>Sargassum</i> Seaweed Health Menace in the Caribbean: Clinical Characteristics of a Population Exposed to Hydrogen Sulfide During the 2018 Massive Stranding
210	2021	Wang, MQ; Hu, CM	Satellite Remote Sensing of Pelagic <i>Sargassum</i> Macroalgae: the Power of High Resolution and Deep Learning
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212	2021	R Marsh, KA Addo, PN Jayson-Quashigah...	Seasonal Predictions of Holopelagic <i>Sargassum</i> Across the Tropical Atlantic Accounting for Uncertainty in Drivers and Processes: the SARTRAC Ensemble ...
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214	2021	Pareja-Rodríguez, Raúl; Freile-Pelegrín, Yolanda; Robledo, Daniel; Ruiz-Gómez, Miguel; Martínez-Flores, Rocio; Rodríguez-Gattorno, Geonel	Self-Generated Active Sites in Graphene Oxide-Like Materials by Controlling the Oxidative Decomposition Reactions of <i>Sargassum</i>
215	2021	Vázquez-Delfín, E; Freile-Pelegrín, Y; Salazar-Garibay, A; Serviere-Zaragoza, E; Méndez-Rodríguez, LC; Robledo, D	Species Composition and Chemical Characterization of <i>Sargassum</i> Influx at Six Different Locations Along the Mexican Caribbean Coast
216	2021	A Minghelli, C Chevalier, J Descloitres, L Berline...	Synergy Between Low Earth Orbit (LEO)—MODIS and Geostationary Earth Orbit (GEO)—GOES Sensors for <i>Sargassum</i> Monitoring in the Atlantic Ocean
217	2021	Thompson, TM; Ramin, P; Udugama, I; Young, BR; Gernaey, KV; Baroutian, S	Techno-Economic and Environmental Impact Assessment of Biogas Production and Fertiliser Recovery from Pelagic <i>Sargassum</i> : A Biorefinery Concept for Barbados
218	2021	Bach, LT; Tamsitt, V; Gower, J; Hurd, CL; Raven, JA; Boyd, PW	Testing the Climate Intervention Potential of Ocean Afforestation Using the Great Atlantic <i>Sargassum</i> Belt
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231	2022	Devault, DA; Massat, F; Baylet, A; Dolique, F; Lopez, PJ	Arsenic and Chlordecone Contamination and Decontamination Toxicokinetics in <i>Sargassum</i> Sp.
232	2022	AS Maurer, K Gross, SP Stapleton	Beached <i>Sargassum</i> Alters Sand Thermal Environments: Implications for Incubating Sea Turtle Eggs
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234	2022	Olivier, JAS; Canepa, JRL; Zarate, DG; Díaz, AG; Jaramillo, DAF; García, HKO; López, BE	Bioenergetic Valorization of <i>Sargassum fluitans</i> in the Mexican Caribbean: the Determination of the Calorific Value and Washing Mechanism
235	2022	Nielsen, BV; Maneein, S; Anghan, JD; Anghan, RM; Al Farid, MM; Milledge, JJ	Biosorption Potential of <i>Sargassum</i> for Removal of Aqueous Dye Solutions

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239	2022	Bernard, D; Biabiany, E; Cécé, R; Chery, R; Sekkat, N	Clustering Analysis of the <i>Sargassum</i> Transport Process: Application to Beaching Prediction in the Lesser Antilles
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241	2022	Martínez-Molina, EC; Abud-Archila, M; Freile-Pelegri, Y; Luján-Hidalgo, MC; Gutiérrez-Miceli, FA; Ovando-Chacón, SL	Coatings Based on Sodium Alginate Extracted from <i>Sargassum fluitans</i> and Silver Nanoparticles to Prolong the Shelf Life of Papaya ( <i>Carica Papaya</i> L.)
242	2022	Iporac, LAR; Hatt, DC; Bally, NK; Castro, A; Cardet, E; Mesidor, R; Olszak, S; Duran, A; Burkholder, DA; Collado-Vides, L	Community-Based Monitoring Reveals Spatiotemporal Variation of Sargasso Inundation Levels and Morphotype Dominance Across the Caribbean and South Florida
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249	2022	Olguin-Maciel, E; Leal-Bautista, RM; Alzate-Gaviria, L; Domínguez-Maldonado, J; Tapia-Tussell, R	Environmental Impact of <i>Sargassum</i> spp. Landings: An Evaluation of Leachate Released from Natural Decomposition at Mexican Caribbean Coast

250	2022	Hunn, D; Blanar, C; Kerstetter, DW	Evidence of Spatial Stability in Core Fauna Community Structure of Holopelagic <i>Sargassum</i>
251	2022	Abdool-Ghany, Afeefa A.; Sahwell, Peter J.; Klaus, James; Gidley, Maribeth L.; Sinigalliano, Christopher D.; Solo-Gabriele, Helena M.	Fecal Indicator Bacteria Levels at A Marine Beach Before, During, and After the COVID-19 Shutdown Period and Associations with Decomposing Seaweed and Human Presence
252	2022	Podlejski, W; Descloitres, J; Chevalier, C; Minghelli, A; Lett, C; Berline, L	Filtering Out False <i>Sargassum</i> Detections Using Context Features
253	2022	Dassie, EP; Gourves, PY; Cipolloni, O; Pascal, PY; Baudrimont, M	First Assessment of Atlantic Open Ocean <i>Sargassum</i> spp. Metal and Metalloid Concentrations
254	2022	López-Fuerte, FO; Beltrones, DAS; Martínez, YJ; Altamirano-Cerecedo, MD	Floristics and Biogeographical Affinity of Diatoms Attached to <i>Sargassum fluitans</i> (Borgesen) Borgesen and <i>Sargassum natans</i> (Linnaeus) Gaillon Arriving on Mexico's Caribbean Coasts
255	2022	R Marsh, HA Oxenford, SAL Cox...	Forecasting Seasonal <i>Sargassum</i> Events Across the Tropical Atlantic: Overview and Challenges
256	2022	CM Duarte, JP Gattuso, K Hancke...	Global Estimates of the Extent and Production of Macroalgal Forests
257	2022	Alleyne, KST	How Is Pelagic <i>Sargassum</i> -Associated Biodiversity Assessed? Insights From the Literature
258	2022	Soto-Morales, S; Martinez-Rodriguez, LI; Serviere-Zaragoza, E; Martinez-Salcido, AI; Soto-Jiménez, MF	Identification of Li as A Reference Element in <i>Sargassum</i> Bioaccumulation of Conservative-Type Elements (Mg, Mo, Sb, Cs and U)
259	2022	JP Schiariti, M Salmon	Impact of <i>Sargassum</i> Accumulations on Loggerhead ( <i>Caretta caretta</i> ) Hatchling Recruitment in SE Florida, USA
260	2022	Sosa-Gutierrez, R; Jouanno, J; Berline, L; Descloitres, J; Chevalier, C	Impact of Tropical Cyclones on Pelagic <i>Sargassum</i>
261	2022	J Perez Perez	Impacts of Floating <i>Sargassum</i> Accumulation on the Fringing Mangrove Rhizophora Mangle in Southwestern Puerto Rico: A Case Study
262	2022	Chikani-Cabrera, KD; Fernandes, PMB; Tapia-Tussell, R; Parra-Ortiz, DL; Hernández-Zárate, G; Valdez-Ojeda, R; Alzate-Gaviria, L	Improvement in Methane Production from Pelagic <i>Sargassum</i> Using Combined Pretreatments
263	2022	L Schamberger, A Minghelli, M Chami, F Steinmetz	Improvement of Atmospheric Correction of Satellite Sentinel-3/OLCI Data for Oceanic Waters in Presence of <i>Sargassum</i>
264	2022	Xu, HB; Morell, J; Roarly, H; Chardon, P; Canals, M; Evens, C	Improvement of <i>Sargassum</i> Seaweed Tracking in Puerto Rico and Virgin Islands Using High-Resolution FVCOM
265	2022	Goodwin, DS; Siuda, ANS; Schell, JM	in Situ Observation of Holopelagic <i>Sargassum</i> Distribution and Aggregation State Across the Entire North Atlantic From 2011 To 2020

266	2022	Conde, EGT	Is Simultaneous Arrival of Pelagic <i>Sargassum</i> and <i>Physalia Physalis</i> a New Threat to the Atlantic Coasts?
267	2022	Alvarado Flores, José Juan; Alcaraz Vera, Jorge Víctor; Ávalos Rodríguez, María Liliana; Rutiaga Quiñones, José Guadalupe; Valencia, Jaime Espino; Guevara Martínez, Santiago José; Ríos, Edgar Tututi; Zarraga, Roberto Aguado	Kinetic, Thermodynamic, FT-IR, and Primary Constitution Analysis of <i>Sargassum</i> Spp from Mexico: Potential for Hydrogen Generation
268	2022	Nava-Jiménez, IA; Tejeda-Vega, S; Cortina-Ramírez, GE; Zarazúa-Ortega, G; Berriozabal-Islas, C; Sánchez-Hernández, H	Macro and Microelement Analysis of <i>Sargassum fluitans</i> and <i>Sargassum natans</i> Arriving in the Coastal Zone of Cancun, Quintana Roo, Mexico
269	2022	OA Cipolloni, J Gigault, ÉP Dassié, M Baudrimont...	Metalloids Concentrations in Three Genotypes of Pelagic <i>Sargassum</i> from the Atlantic Ocean Basin-Scale., 2022, 178
270	2022	Cipolloni, OA; Gigault, J; Dassié, ÉP; Baudrimont, M; Gourves, PY; Amaral-Zettler, L; Pascal, PY	Metals and Metalloids Concentrations in Three Genotypes of Pelagic <i>Sargassum</i> from the Atlantic Ocean Basin-Scale
271	2022	E Salgado-Hernández, ÁI Ortiz-Ceballos...	Methane Production of <i>Sargassum</i> spp. Biomass from the Mexican Caribbean: Solid-Liquid Separation and Component Distribution
272	2022	Devault, DA; Massat, F; Lambourdière, J; Maridakis, C; Dupuy, L; Péné-Annette, A; Dolique, F	Micropollutant Content of <i>Sargassum</i> Drifted Ashore: Arsenic and Chlordecone Threat Assessment and Management Recommendations for the Caribbean
273	2022	Uribe-Martínez, A; Berriel-Bueno, D; Chávez, V; Cuevas, E; Almeida, KL; Fontes, JVH; van Tussenbroek, B; Mariño-Tapia, I; Liceaga-Correa, MD; Ojeda, E; Castañeda-Ramírez, DG; Silva, R	Multiscale Distribution Patterns of Pelagic Rafts of Sargasso ( <i>Sargassum</i> spp.) in the Mexican Caribbean (2014-2020)
274	2022	Qi, L; Wang, MH; Hu, CM; Holt, B	on the Capacity of Sentinel-1 Synthetic Aperture Radar in Detecting Floating Macroalgae and Other Floating Matters
275	2022	Chávez-Guerrero, L; Toxqui-Terán, A; Pérez-Camacho, O	One-Pot Isolation of Nanocellulose Using Pelagic <i>Sargassum</i> spp. From the Caribbean Coastline
276	2022	JG Orozco-González, F Amador-Castro...	Opportunities Surrounding the Use of <i>Sargassum</i> Biomass as Precursor of Biogas, Bioethanol, and Biodiesel Production
277	2022	Francoeur, Marckens; Yacou, Christelle; Jean-Marius, Corine; Chérémont, Yvens; Jauregui-Haza, Ulises; Gaspard, Sarra	Optimization of the Synthesis of Activated Carbon Prepared from <i>Sargassum</i> (Sp.) and its Use for Tetracycline, Penicillin, Caffeine and Methylene Blue Adsorption from Contaminated Water
278	2022	HU Castañeda-Serna, G Calderón-Domínguez...	Pelagic <i>Sargassum</i> as A Source of Micro- and Nanocellulose for Environmentally Sustainable Plastics

279	2022	Machado, CB; Maddix, GM; Francis, P; Thomas, SL; Burton, JA; Langer, S; Larson, TR; Marsh, R; Webber, M; Tonon, T	Pelagic <i>Sargassum</i> Events in Jamaica: Provenance, Morphotype Abundance, and Influence of Sample Processing on Biochemical Composition of the Biomass
280	2022	Skliris, N; Marsh, R; Addo, KA; Oxenford, H	Physical Drivers of Pelagic <i>Sargassum</i> Bloom Interannual Variability in the Central West Atlantic Over 2010-2020
281	2022	S Van Der Plank, SA Cox, J Cumberbatch...	Polycentric Governance, Coordination and Capacity: The Case of <i>Sargassum</i> Influxes in the Caribbean
282	2022	Aquino, R; Noriega, C; Mascarenhas, A; Costa, M; Monteiro, S; Santana, L; Silva, I; Prestes, Y; Araujo, M; Rollnic, M	Possible Amazonian Contribution to <i>Sargassum</i> Enhancement on the Amazon Continental Shelf
283	2022	C Hu	Potential Impacts of Tropical Cyclones on Pelagic <i>Sargassum</i>
284	2022	Schamberger, L; Minghelli, A; Chami, M	Quantification of Underwater <i>Sargassum</i> Aggregations Based on A Semi-Analytical Approach Applied to Sentinel-3/OLCI (Copernicus) Data in the Tropical Atlantic Ocean
285	2022	Muttin, F.	<i>Sargassum</i> Algae Containment by Moored Barrier, Structural and Hydrodynamic Challenges
286	2022	AM López-Contreras, PN Valenzuela, BC García...	<i>Sargassum</i> in Mexico: From Environmental Problem to Valuable Resource
287	2022	W Podlejski, J Descloitres, C Chevalier...	<i>Sargassum</i> Observations From MODIS: Using Aggregations Context to Filter False Detections
288	2022	Bam, W; Swarzenski, PW; Maiti, K; Vassileva, E; Orani, AM; Blinova, O; McGinnity, P; Adhikari, PL; Haughton, M; Webber, M	Scavenging of Select Radionuclides and Trace Elements by Pelagic <i>Sargassum</i> in the Caribbean Sea
289	2022	Putman, NF; Hu, CM	Sinking <i>Sargassum</i>
290	2022	Rodriguez-Martinez, RE; Jordan-Dahlgren, E; Hu, CM	Spatio-Temporal Variability of Pelagic <i>Sargassum</i> Landings on the Northern Mexican Caribbean
291	2022	Castañeda-Serna, HU; Calderón-Domínguez, G; García-Bórquez, A; Salgado-Cruz, MD; Rebollo, RRF	Structural and Luminescent Properties of Cqds Produced by Microwave and Conventional Hydrothermal Methods Using Pelagic <i>Sargassum</i> as Carbon Source
292	2022	A Outtara, K Yao, K Komoe, WB Kpan...	Teneur En Composés Phénoliques Et Activités Antioxydantes De <i>Sargassum fluitans</i> Et <i>Sargassum natans</i> , Deux Algues Brunnes Invasives des Côtes Ivoiriennes
293	2022	M Schling, RG Compeán, N Pazos, A Bailey, K Arkema...	the Economic Impact of <i>Sargassum</i> : Evidence from the Mexican Coast

294	2022	M Schling, R Guerrero Compeán, N Pazos, A Bailey...	the Impact of <i>Sargassum</i> : Evidence from the Mexican Coast
295	2022	HSJ Roe, D Freestone, F Sapsford	the Sargasso Sea High Seas EBSA After Ten Years: Is It Still Relevant and How Has It Helped Conservation Efforts?
296	2022	Ortega-Flores, PA; Serviere-Zaragoza, E; De anda-Montañez, JA; Freile-Pelegrín, Y; Robledo, D; Méndez-Rodríguez, LC	Trace Elements in Pelagic <i>Sargassum</i> Species in the Mexican Caribbean: Identification of Key Variables Affecting Arsenic Accumulation in <i>S. fluitans</i>
297	2022	Gobert T.; Gautier A.; Connan S.; Rouget M.-L.; Thibaut T.; Stiger-Pouvreau V.; Waeles M.	Trace Metal Content from Holopelagic <i>Sargassum</i> spp. Sampled in the Tropical North Atlantic Ocean: Emphasis on Spatial Variation of Arsenic and Phosphorus
298	2022	Ayala-Mercado, ID; Weber, B; Durán-García, MD	Use of Hydrothermal Pretreatment to Enhance Biogas Production from Pelagic <i>Sargassum</i>
299	2022	Hernández, WJ; Morell, JM; Armstrong, RA	Using High-Resolution Satellite Imagery to Assess the Impact of <i>Sargassum</i> Inundation on Coastal Areas
300	2022	Gordillo Sierra, Angela R.; Amador-Castro, Luis Fernando; Ramírez-Partida, andré E.; García-Cayuela, Tomás; Carrillo-Nieves, Danay; Alper, Hal S.	Valorization of Caribbean <i>Sargassum</i> Biomass as A Source of Alginate and Sugars for De Novo Biodiesel Production
301	2022	Molina, Gustavo A.; González-Reyna, Marlen A.; Loske, Achim M.; Fernández, Francisco; Torres-Ortiz, Daniela Alejandra; Estevez, Miriam	Weak Shock Wave-Mediated Fucoxanthin Extraction from <i>Sargassum</i> spp. and its Electrochemical Quantification
302	2023	Alleyne, KST; Neat, F; Oxenford, HA	A Baseline Assessment of the Epiphytic Community Associated with Pelagic <i>Sargassum</i> in the Tropical Atlantic
303	2023	Silva, Thamires Moraes; Waked, Dunia; Bastos, Ana Clara; Gomes, Gabriel Leandro; Veras Closs, José Guilherme; Tonin, Fernando Gustavo; Rossignolo, João Adriano; do Valle Marques, Karina; Veras, Mariana Matera	A Custom, Low-Cost, Continuous Flow Chamber Built for Experimental <i>Sargassum</i> Seaweed Decomposition and Exposure of Small Rodents to Generated Gaseous Products
304	2023	Pries, A; Netburn, AN; Batchelor, H; Hermanson, VR	A Little Bit of <i>Sargassum</i> Goes a Long Way: Seafloor Observations of <i>Sargassum fluitans</i> and <i>Sargassum natans</i> in the Western Atlantic Ocean
305	2023	Pixa, C; Manganini, K; Myers, A; Michel, APM	A Low-Cost Entangling Drifter for <i>Sargassum</i> Tracking: Design and Experimental Evaluation
306	2023	P Zongo, C Kenne, R Dorville	A Metapopulation Model for Pelagic <i>Sargassum</i> Blooms Events with Action of Hurricanes
307	2023	Podlejski, W; Nerini, D; Doglioli, A; Lett, C	A New <i>Sargassum</i> Drift Model Derived from Features Tracking in MODIS Images

308	2023	Carral-Murrieta, CO; Marques, AC; Serviere-Zaragoza, E; Estrada-González, MC; Cunha, AF; Fernandez, MO; Mazariegos-Villarreal, A; León-Cisneros, K; López-Vivas, J; Agüero, J; Mendoza-Becerril, MA	A Survey of Epibiont Hydrozoans on <i>Sargassum</i>
309	2023	López-Torres, MI; Sosa-Olivier, JA; Laines-Canepa, JR; Padilla-Rivera, A; Santiago-Cortez, I; Jiménez-Hernández, FJ	Aerobic Biotransformation of <i>Sargassum fluitans</i> in Combination with Sheep Manure: Optimization of Control Variables
310	2023	Le Loeuff, J; Boy, V; Morançais, P; Hardouin, K; Bourgougnon, N; Lanoisellé, JL	Air Drying of Brown Algae <i>Sargassum</i> : Modelling and Recovery of Valuable Compounds
311	2023	Alleyne, KST; Neat, F; Oxenford, HA	An Analysis of Arsenic Concentrations Associated with <i>Sargassum</i> Influx Events in Barbados
312	2023	Avila-Romero, Marisol; María García-Bores, Ana; Garduño-Solorzano, Gloria; Guillermo Avila-Acevedo, José; Serrano-Parrales, Rocío; Orozco-Martínez, Julieta; Meraz-Martínez, Samuel; Peñalosa-Castro, Ignacio; Antonio Estrella-Parra, Edgar; Valencia-Quiroz, Israel; Hernandez-Delgado, Tzasna	Antimicrobial Activity of Some Macroalgae of the Veracruzano Reef System (SAV), Mexico
313	2023	Fagundo-Mollineda, A; Robledo, D; Vásquez-Elizondo, RM; Freile-Peegrín, Y	Antioxidant Activities in Holopelagic <i>Sargassum</i> Species from the Mexican Caribbean: Temporal Changes and Intra-Thallus Variation
314	2023	JG Méndez-Covarrubias	Aplicación Del <i>Sargassum</i> Sp. Para La Producción De Vermicomposta Utilizando Lombriz De Tierra, Eisenia Foetida (Lombriz Roja Californiana)
315	2023	L Piedra-Castro...	Arribo Masivo De Sargazo ( <i>Sargassum natans</i> ) A La Costa Del Caribe Sur De Costa Rica Durante El 2022.
316	2023	Velázquez-Hernández, Amalinalli; Aguillón-Martínez, Javier E.	Aspen Plus Simulation of <i>Sargassum</i> for Quality Synthesis Gas
317	2023	Corbin, M; Oxenford, HA	Assessing Growth of Pelagic <i>Sargassum</i> in the Tropical Atlantic
318	2023	Abdool-Ghany, AA; Pollier, CGL; Oehlert, AM; Swart, PK; Blare, T; Moore, K; Solo-Gabriele, HM	Assessing Quality and Beneficial Uses of <i>Sargassum</i> Compost
319	2023	Abdool-Ghany, Afeefa A.; Blare, Trent; Solo-Gabriele, Helena M.	Assessment of <i>Sargassum</i> spp. Management Strategies in Southeast Florida
320	2023	Pak, T; Gomari, KE; Bose, S; Tonon, T; Hughes, D; Gronnow, M; Macquarrie, D	Biochar From Brown Algae: Production, Activation, and Characterisation
321	2023	Roche, S; Yacou, C; Marius, CJ; Ranguin, R; Francoeur, M; Taberna, PL; Passe-Coutrin, N; Gaspard, S	Carbon Materials Prepared from Invading Pelagic <i>Sargassum</i> for Supercapacitors' Electrodes

322	2023	Liranzo-Gómez, Rolando Esteban; Gómez, Aris Mendis; Gómez, Bolívar; González-Hernández, Yusmel; Jauregui-Haza, Ulises Javier	Characterization of <i>Sargassum</i> Accumulated on Dominican Beaches in 2021: Analysis of Heavy, Alkaline and Alkaline-Earth Metals, Proteins and Fats
323	2023	RM Paredes-Camacho, S González-Morales...	Characterization of <i>Sargassum</i> spp. From the Mexican Caribbean and its Valorization Through Fermentation Process
324	2023	Iporac, Lowell andrew R.; James, W. Ryan; Collado-Vides, Ligia	Characterizing Potential Resource Use of Sargasso-Dominant Sea Wrack by Terrestrial Invertebrate Fauna During Sargasso Influxes in South Florida
325	2023	N Kergosien, S Cérantola, G Simon, S Connan...	Chemical Structures of Phlorotannins from Abundant Brown Seaweeds Along Tropical and Temperate Atlantic Coasts and Their Associated Activities
326	2023	Marsh R.; Skliris N.; Tompkins E.L.; Dash J.; Dominguez Almela V.; Tonon T.; Oxenford H.A.; Webber M.	Climate- <i>Sargassum</i> Interactions Across Scales in the Tropical Atlantic
327	2023	Melchor-Martínez, Elda M.; Reyes, Ana G.; Morreeuw, Zoé P.; Flores-Contreras, Elda A.; Araújo, Rafael G.; Ramírez-Gamboa, Diana; Sosa-Hernández, Juan Eduardo; Iqbal, Hafiz M.N.; González-Meza, Georgia María; Bonaccorso, Alfredo Damiano; Peña-Rodríguez, Alberto; Parra-Saldívar, Roberto	Comparative Study on the Valorization of <i>Sargassum</i> from the Mexican Caribbean Coast and Gulf of California as An Ingredient on Healthy Diets for Shrimp Farming
328	2023	M Liu, M Wang, Y Sun, ZB Li	Deep-Learning-Based Cloud Masking on Multispectral Ocean Color Imagery for Floating Macroalgae Monitoring
329	2023	H Zhang, J Liu, X Ye, Y Bai, D Sun...	Detecting <i>Sargassum</i> Bloom Directly from Satellite Top-of-Atmosphere Reflectance with High-Resolution Images
330	2023	Laval, M; Belmouhcine, A; Courtrai, L; Descloîtres, J; Salazar-Garibay, A; Schamberger, L; Minghelli, A; Thibaut, T; Dorville, R; Mazoyer, C; Zongo, P; Chevalier, C	Detection of <i>Sargassum</i> from Sentinel Satellite Sensors Using Deep Learning Approach
331	2023	Liu, YJ; Xiao, J; Fan, SL; Miao, XX; Yuan, C; Zang, Y; Wang, ZL; Zhang, BT; Ma, XJ; Zhang, XL	Distribution and Diversity of the Sympatric Macroalgae of the Pelagic <i>Sargassum</i> <i>Horneri</i> in the Yellow and East China Seas
332	2023	Theirlynck, T; Mendonça, IRW; Engelen, AH; Bolhuis, H; Collado-Vides, L; van Tussenbroek, BI; García-Sánchez, M; Zettler, E; Muyzer, G; Amaral-Zettler, L	Diversity of the Holopelagic <i>Sargassum</i> Microbiome from the Great Atlantic <i>Sargassum</i> Belt to Coastal Stranding Locations
333	2023	Canul-Ku, LA; Sanginés-García, JR; Urquizo, EA; Canul-Solís, JR; Valdivieso-Pérez, IA; Vargas-Bello-	Effect of Pelagic <i>Sargassum</i> on in Vitro Dry Matter and Organic Matter Degradation, Gas Production, and Protozoa Population

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334	2023	Jelani, F; Walker, G; Akunna, J	Effects of Thermo-Chemical and Enzymatic Pre-Treatment of Tropical Seaweeds and Freshwater Macrophytes on Biogas and Bioethanol Production
335	2023	Salgado-Hernández, E; Ortiz-Ceballos, AI; Alvarado-Lassman, A; Martínez-Hernández, S; Rosas-Mendoza, ES; Velázquez-Fernández, JB; Dorantes-Acosta, AE	Energy-Saving Pretreatments Affect Pelagic <i>Sargassum</i> Composition and DNA Metabarcoding Reveals the Microbial Community Involved in Methane Yield
336	2023	Velázquez-Ochoa, R; Enríquez, S	Environmental Degradation of the Mexican Caribbean Reef Lagoons
337	2023	C Schmidt	Escape From Sargasso Sea: Tremendous <i>Sargassum</i> Blooms Challenge Caribbean and Atlantic Communities
338	2023	Shahrier, J; Rasul, G; Afrin, F; Islam, R; Shah, AKMA	Extension of Shelf Life of Nile Tilapia ( <i>Oreochromis Niloticus</i> ) Fillets Using Seaweed Extracts During Refrigerated Storage
339	2023	LM Piedra Castro, MA Ramírez-Vargas	First Record of Massive Arrival of Pelagic <i>Sargassum</i> ( <i>Sargassum</i> Sp.) Into Costa Rica's South Caribbean Shore During 2022
340	2023	González-Muñoz, R; Sánchez-Rodríguez, J; Simoes, N; Tello-Musi, JL; Acuña, FH	First Record of the Epiphyte Sea Anemone <i>Bunodeopsis Pelagica</i> in the Mexican Atlantic
341	2023	Alleyne, KST; Small, M; Corbin, M; Valles, H; Oxenford, HA	Free-Swimming Fauna Associated with Influxes of Pelagic <i>Sargassum</i> : Implications for Management and Harvesting
342	2023	Magaña-Gallegos, E; García-Sánchez, M; Graham, C; Olivos-Ortiz, A; Siuda, ANS; van Tussenbroek, BI	Growth Rates of Pelagic <i>Sargassum</i> Species in the Mexican Caribbean
343	2023	Gulick, AG; Constant, N; Bolten, AB; Bjorndal, KA	Holopelagic <i>Sargassum</i> Aggregations Provide Warmer Microhabitats for Associated Fauna
344	2023	Putman, NF; Beyea, RT; Iporac, LAR; Triñanes, J; Ackerman, EG; Olascoaga, MJ; Appendini, CM; Arriaga, J; Collado-Vides, L; Lumpkin, R; Hu, C; Goni, G	Improving Satellite Monitoring of Coastal Inundations of Pelagic <i>Sargassum</i> Algae with Wind and Citizen Science Data
345	2023	G Bonner, FJ Beron-Vera, MJ Olascoaga	Improving the Stability of Temporal Statistics in Transition Path Theory with Sparse Data
346	2023	Sánchez, A; Gonzalez-Jones, P; Camacho-Cruz, KA; Anguas-Cabrera, D; Ortiz-Hernández, MC; Rey-Villiers, N	Influence of Pelagic <i>Sargassum</i> Influxes on the $\delta^{15}N$ in <i>Thalassia Testudinum</i> of the Mexican Caribbean Coastal Ecosystem
347	2023	Ortega-Flores, Paulina Annette; Gobert, Tristan; Méndez-Rodríguez, Lía Celina; Serviere-Zaragoza, Elisa; Connan, Solène; Robledo, Daniel; Freile-Pelegrín,	Inorganic Arsenic in Holopelagic <i>Sargassum</i> spp. Stranded in the Mexican Caribbean: Seasonal Variations and Comparison with International Regulations and Guidelines

		Yolanda; anda Montañez, Juan Antonio de; Waeles, Matthieu	
348	2023	Arita, JT; Iporac, LAR; Bally, NK; Fujii, MT; Collado-Vides, L	Integrative Literature Analysis of Holopelagic <i>Sargassum</i> (Sargasso) in the Western Atlantic (2011-2022): Status, Trends, and Gaps
349	2023	Bilba, K; Potiron, CO; Arsène, MA	Invasive Biomass Algae Valorization: Assessment of the Viability of <i>Sargassum</i> Seaweed as Pozzolan Material
350	2023	Pérez-Posada, I; Cabanillas-Terán, N; Rosas-Luis, R; Hernández-Arana, HA; Sánchez-Gonzalez, A	Isotopic Niche Shift in the Sea Urchins <i>Echinometra</i> <i>Lucunter</i> and <i>E. Viridis</i> After Massive Arrivals of <i>Sargassum</i> in the Mexican Caribbean
351	2023	Cipolloni, OA; Baudrimont, M; Simon-Bouhet, B; Dassié, ÉP; Gigault, J; Connan, S; Pascal, PY	Kinetics of Metal and Metalloid Concentrations in Holopelagic <i>Sargassum</i> Reaching Coastal Environments
352	2023	López-Aguilar, HA; Morales-Durán, B; Quiroz-Cardoza, D; Pérez-Hernández, A	Lag Phase in the Anaerobic Co-Digestion of <i>Sargassum</i> spp. and Organic Domestic Waste
353	2023	Bueno, C; Rossignolo, JA; Gavioli, LM; Sposito, CCA; Tonin, FG; Veras, MM; de Moraes, MJB; Lyra, GP	Life Cycle Assessment Applied to End-of-Life Scenarios of <i>Sargassum</i> spp. for Application in Civil Construction
354	2023	Rosellon-Druker, J; McAdam-Otto, L; Suca, JJ; Seary, R; Gaytan-Caballero, A; Escobar-Briones, E; Hazen, EL; Muller-Karger, F	Local Ecological Knowledge and Perception of the Causes, Impacts and Effects of <i>Sargassum</i> Massive Influxes: A Binational Approach
355	2023	Hu, CM; Zhang, S; Barnes, BB; Xie, YY; Wang, MQ; Cannizzaro, JP; English, DC	Mapping and Quantifying Pelagic <i>Sargassum</i> in the Atlantic Ocean Using Multi-Band Medium-Resolution Satellite Data and Deep Learning
356	2023	Cox, DD; Parsons, RJ; Van Mooy, BAS; Valentine, DL	Methylphosphonate Is Utilized by Commensal Microbiota of Macroalgae in the Oligotrophic Sargasso Sea
357	2023	Lestrade, OL; Hernandez, F	Microdebris Abundance, Distribution, and Ingestion by <i>Sargassum</i> -Associated Juvenile Fishes in the Gulf of Mexico
358	2023	Lambert, P; Said-Ahmed, M; Jama, C; Lebrini, M	Molecules From <i>Sargassum</i> Algae as Green Inhibitor for C38 in Hcl Medium: Extraction, Characterization and Electrochemical Study
359	2023	de la Barreda-bautista, B; Metcalfe, SE; Smith, G; Sjögersten, S; Boyd, DS; Cerdeira-Estrada, S; López-Ramírez, P; Magaldi, A; Ressler, R; Perera-Valderrama, S; Caballero-Aragón, H; Siordia, OS; Couldridge, J; Gray, P; Silva, R; Van Tussenbroek, BI; Escalante-Mancera, E; Foody, G	Monitoring Holopelagic <i>Sargassum</i> spp. Along the Mexican Caribbean Coast: Understanding and Addressing User Requirements for Satellite Remote Sensing
360	2023	Trinanes, J; Putman, NF; Goni, G; Hu, C; Wang, M	Monitoring Pelagic <i>Sargassum</i> Inundation Potential for Coastal Communities
361	2023	OFL Dixon, AJ Gallagher, AV Towner	Novel Aerial Observations of a Group of Killer Whales <i>Orcinus Orca</i> in the Bahamas

362	2023	Aguilera-Méndez, JM; Juárez-Toledo, C; Tapia-Fabela, JL; Martínez-Carrillo, I; Hernández-Grajales, RV	Numerical Modeling of Pelagic <i>Sargassum</i> Trajectory Using Brownian Equations with Application to the Waters of Yucatan Peninsula, Mexico
363	2023	Mcgillicuddy, DJ; Morton, PL; Brewton, RA; Hu, CM; Kelly, TB; Solow, AR; Lapointe, BE	Nutrient and Arsenic Biogeochemistry of <i>Sargassum</i> in the Western Atlantic
364	2023	F Elmer, M Fernández-Méndez...	Open-Ocean Aquafarming of the Pelagic Seaweed <i>Sargassum</i> for Carbon Dioxide Removal
365	2023	Buentello-Montoya, DA; Armenta-Gutiérrez, MA; Maytorena-Soria, VM	Parametric Modelling Study to Determine the Feasibility of the Co-Gasification of Macroalgae and Plastics for the Production of Hydrogen-Rich Syngas
366	2023	Rodríguez-Martínez, RE; Torres-Conde, EG; Jordán-Dahlgren, E	Pelagic <i>Sargassum</i> Cleanup Cost in Mexico
367	2023	Olascoaga, MJ; Beron-Vera, FJ; Beyea, RT; Bonner, G; Castellucci, M; Goni, GJ; Guigand, C; Putman, NF	Physics-Informed Laboratory Estimation of <i>Sargassum</i> Windage
368	2023	Jocelyn, Tapia-Fuentes; Areanely, Cruz-Salas Arely; Carolina, Martínez-Salvador; Sara, Ojeda-Benítez; Alethia, Vázquez-Morillas; Carlos, Álvarez-Zeferino Juan	Presence of Microplastics Deposited in <i>Sargassum</i> Sp. on Sandy Beaches
369	2023	ST Tiwa, K Bilba, CO Potiron, MA Arsene	Production and Characterisation of Biodegradable Multi-Layer Composites Materials from Pelagic <i>Sargassum</i> spp., Leaf Sheaths ...
370	2023	IB Shakhovskoy	Quantitative Distribution of the Flying Fish (Exocoetidae), Marine Mammals, Birds, and Sea Turtles in the Northern Part of the Central Atlantic Ocean (Results Obtained in the Research Cruises Nos. 43–45 of the R/V “Akademik Nikolaj Strakhov”)
371	2023	Johnson, C; Dubbs, LL; Piehler, M	Reframing the Contribution of Pelagic <i>Sargassum</i> Epiphytic N <sub>2</sub> Fixation
372	2023	Mincer TJ, Bos RP, Zettler ER, Zhao S, Asbun AA, Orsi WD, Guzzetta VS, Amaral-Zettler LA.	Sargasso Sea <i>Vibrio</i> Bacteria: Underexplored Potential Pathovars in A Perturbed Habitat
373	2023	Azcorra-May, KJ; Olguin-Maciel, E; Leal-Bautista, RM; Canche-Escamilla, G; Alzate-Gaviria, L; Toledano-Thompson, T; Tapia-Tussell, R	<i>Sargassum</i> Delignification: A First Step to Mitigate the Socio-Economic and Environmental Impacts in the Caribbean Through its Sustainable Exploitation
374	2023	Mohammed, Akeem; Gaduan, andre; Chaitram, Pooran; Pooran, Anaadi; Lee, Koon-Yang; Ward, Keeran	<i>Sargassum</i> Inspired, Optimized Calcium Alginate Bioplastic Composites for Food Packaging
375	2023	Hernández-Navarro, Carolina; Pérez, Sebastián; Flórez, Elizabeth; Acelas, Nancy; Muñoz-Saldaña, Juan	<i>Sargassum</i> Macroalgae From Quintana Roo as Raw Material for the Preparation of High-Performance Phosphate Adsorbent from Aqueous Solutions

376	2023	P McConney, J Cumberbatch, C Hinds...	<i>Sargassum</i> Seaweed Challenges from Local to National Level in the Caribbean: A Policy Cycle Perspective
377	2023	Almela, VD; Addo, KA; Corbett, J; Cumberbatch, J; Dash, J; Marsh, R; Oxenford, H; Tonon, T; van der Plank, S; Webber, M; Tompkins, EL	Science and Policy Lessons Learned from A Decade of Adaptation to the Emergent Risk of <i>Sargassum</i> Proliferation Across the Tropical Atlantic
378	2023	Alleyne, KST; Johnson, D; Neat, F; Oxenford, HA; Vallès, H	Seasonal Variation in Morphotype Composition of Pelagic <i>Sargassum</i> Influx Events Is Linked to Oceanic Origin
379	2023	Jouanno, J; Morvan, G; Berline, L; Benshila, R; Aumont, O; Sheinbaum, J; Ménard, F	Skillful Seasonal Forecast of <i>Sargassum</i> Proliferation in the Tropical Atlantic
380	2023	León-Pérez, MC; Reisinger, AS; Gibeaut, JC	Spatial-Temporal Dynamics of Decaying Stages of Pelagic <i>Sargassum</i> spp. Along Shorelines in Puerto Rico Using Google Earth Engine
381	2023	Ocaña, Frank A.; Olmos-García, Ricardo E.; de Jesús-Carrillo, Rosa M.; Noreña-Barroso, Elsa; Guerra-Castro, Edlin	Spatiotemporal Patterns of Macrophyte Subsidies to Sandy Beaches of Yucatán, Mexico
382	2023	Chandler, CJ; avila-Mosqueda, SV; Salas-Acosta, ER; Magana-Gallegos, E; Mancera, EE; Reali, MAG; de la Barreda-bautista, B; Boyd, DS; Metcalfe, SE; Sjoogersten, S; van Tussenbroek, B; Silva, R; Foody, GM	Spectral Characteristics of Beached <i>Sargassum</i> in Response to Drying and Decay Over Time
383	2023	Mazoudier, Samuel Q.; Kingsford, Michael J.; Strickland, Jessica K.; Pitt, Kylie A.	Stable Isotopes Reveal <i>Sargassum</i> Rafts Provide a Trophic Subsidy to Juvenile Pelagic Fishes
384	2023	Torres-Conde, EG; van Tussenbroek, BI; Rodríguez-Martínez, RE; Martínez-Daranas, B	Temporal Changes in the Composition of Beached Holopelagic <i>Sargassum</i> spp. Along the Northwestern Coast of Cuba
385	2023	Magaña-Gallegos, E; Villegas-Muñoz, E; Salas-Acosta, ER; Barba-Santos, MG; Silva, R; van Tussenbroek, BI	The Effect of Temperature on the Growth of Holopelagic <i>Sargassum</i> Species
386	2023	A Mohammed, K Ward, KY Lee, V Dupont	The Environmental Impact and Economic Feasibility Assessment of Composite Calcium Alginate Bioplastics Derived from <i>Sargassum</i>
387	2023	Cox, D; Brooks, WR	The Role of Chemical Cues in Locating the Host Pelagic <i>Sargassum</i> spp. By the Symbiotic Fish <i>Stephanolepis Hispidus</i>
388	2023	Fidai, YA; Dash, J; Marsh, R; Oxenford, HA; Biermann, L; Martin, N; Tompkins, EL	Tracking and Detecting <i>Sargassum</i> Pathways Across the Tropical Atlantic
389	2023	Lee, MC; Yeh, HY; Chang, CM; Liou, YF; Nan, FH; Wungen-Sani, J	Tracking and Utilizing <i>Sargassum</i> , An Abundant Resource from the Caribbean Sea
390	2023	Changeux, T; Berline, L; Podlejski, W; Guillot, T; Stiger-Pouvreau, V; Connan, S; Thibaut, T	Variability in Growth and Tissue Composition (Cnp, Natural Isotopes) of the Three Morphotypes of Holopelagic <i>Sargassum</i>

391	2024	Kar, Tathagata; González-Escobar, Cecilia; Ramos-Hernández, José Juan; Casales-Díaz, Maura; Flores-Rodríguez, María Fernanda; Pérez, Ramiro; Kesarla, Mohan Kumar	A Comprehensive Analysis of <i>Sargassum natans</i> Derived Inorganic Carbon Composite for Electrochemical Charge Storage
392	2024	Peoples LM, Gerringer ME, Weston JNJ, León-Zayas R, Sekarore A, Sheehan G, Church MJ, Michel APM, Soule SA, Shank TM.	A Deep-Sea Isopod That Consumes <i>Sargassum</i> Sinking from the Ocean's Surface
393	2024	C Hu	A Depth-Invariant Index to Map Floating Algae: A Conceptual Design
394	2024	Payne, K; Greene, K; Oxenford, HA	A Parallelized Climatological Drifter-Based Model of <i>Sargassum</i> Biomass Dynamics in the Tropical Atlantic
395	2024	E Salgado-Hernández, ÁI Ortiz-Ceballos...	Adaptation of A Microbial Consortium to Pelagic <i>Sargassum</i> Modifies its Taxonomic and Functional Profile That Improves Biomethane Potential
396	2024	Cobacho, Sara P.; Leemans, Luuk H.; Weideveld, Stefan T.J.; Fu, Xitong; van Katwijk, Marieke M.; Lamers, Leon P.M.; Smolders, Alfons J.P.; Christianen, Marjolijn J.A.	Addition of Iron Does Not Ameliorate Sulfide Toxicity by <i>Sargassum</i> Influx to Mangroves but Dampens Methane and Nitrous Oxide Emissions
397	2024	M Guilbaud, P Zongo, D Borne, R Dorville	An Experimental Approach to Investigate the Growth of <i>Sargassum</i> Species in Their Natural Habitat
398	2024	LA Villalobos Robles, K Kuroda	An Investigation into the Pelagic <i>Sargassum</i> Incurion Phenomenon: A Study of Seaweed Coastal Influxes on Cozumel Island, Mexico
399	2024	JJ Hernández Ayala, R Méndez-Tejeda	Analyzing Trends in Saharan Dust Concentration and its Relation to <i>Sargassum</i> Blooms in the Eastern Caribbean
400	2024	González-Garrido, JA; Gómez-García, JA; Hernández-Abreu, OI; Olivares-Corichi, IM; Pereyra-Vergara, F; García-Sánchez, JR	Anticancer Activity of <i>Sargassum fluitans</i> Extracts in Different Cancer Cells
401	2024	Degia, AK; Small, M; Oxenford, HA	Applying the Disaster Risk Assessment Framework to <i>Sargassum</i> Inundation in Barbados
402	2024	Elizalde-Mata, A; Trejo-Caballero, ME; Yáñez-Jiménez, F; Bahena, D; Esparza, R; López-Miranda, JL; Estevez, M	Assessment of Caribbean <i>Sargassum</i> Species for Nanocellulose Foams Production: An Effective and Environmentally Friendly Material to Water-Emerging Pollutants Removal
403	2024	Leal-Bautista, RM; Rodríguez-García, JC; Chablé-Villacis, R; Acosta-González, G; Bautista-García, JE; Tapia-Tussell, R; Ortega-Camacho, D; Olguín-Maciél, E; López, GG	Assessment of Leachate Generated by <i>Sargassum</i> spp. in the Mexican Caribbean: Part 2, Mobility of Metals

404	2024	Leal-Bautista, RM; Rodriguez-Garcia, JC; Acosta-Gonzalez, G; Chable-Villacis, R; Tapia-Tussell, R; Bautista-Garcia, JE; Olguin-Maciél, E; Alzate-Gaviria, L; Gonzalez-Lopez, G	Assessment of Leachate Generated by <i>Sargassum</i> spp. in the Mexican Caribe: Part 1 Spatial Variations
405	2024	L Biermann, A Kurekin, N Martin...	Automated Detection of <i>Sargassum</i> Invasions in the Caribbean Using Sentinel-1 Sar
406	2024	van Tussenbroek, BI; Monroy-Velázquez, LV; García-Sánchez, M; Ruiz-Fernández, AC; Valencia-Castañeda, G; Paéz-Osuna, F; Arenas, P; Rojas-González, RI; Gracia, A	Biochemistry and Associated Fauna of Holopelagic <i>Sargassum</i> spp. in the Caribbean Sea
407	2024	Machado, CB; Marsh, R; Hargreaves, JK; Oxenford, HA; Maddix, GM; Webber, DF; Webber, M; Tonon, T	Changes in Holopelagic <i>Sargassum</i> spp. Biomass Composition Across an Unusual Year
408	2024	Bonner, G; Beron-Vera, FJ; Olascoaga, MJ	Charting the Course of <i>Sargassum</i> : Incorporating Nonlinear Elastic Interactions and Life Cycles in the Maxey-Riley Model
409	2024	Yolanda, FP; Daniel, R; Cresencia, CQ; Vazquez-Delfín, E; Hugo, PC; Gilles, B; Nathalie, B	Chemical Composition and Carbohydrate Characterization of Beach-Cast Marine Macrophytes from the Mexican Caribbean: Implications for Potential Bioethanol Production
410	2024	MJB de Moraes, GP Lyra, CCA Spósito, LM Gavioli...	Cleaner and Circular Bioeconomy
411	2024	Corbin, M; Alleyne, K; Oxenford, HA; Vallès, H	Clinging Fauna Associated with Nearshore Pelagic <i>Sargassum</i> Rafts in the Eastern Caribbean: Implications for Coastal in-Water Harvesting
412	2024	Rosas-Medellín, D.; Martínez-Urbizu, S.; Barbosa, R.; Alonso-Lemus, I.L.; Escobar, B.	Co-Pyrolysis of Two Environmental Issues: Face Mask and <i>Sargassum</i> spp. for Efficacious Solid Waste Management and its Aemfc Applications
413	2024	Hatt, DC; Bally, NK; Iporac, LAR; Olszak, S; Campbell, JE; Collado-Vides, L	Comprehensive Analysis of Biomass, Nutrient, and Heavy Metal Contributions of Pelagic <i>Sargassum</i> Species (Phaeophyceae) Inundations in South Florida
414	2024	Sun, Yue; Wang, Mengqiu; Liu, Mingqing; Li, Zhongbin B.; Chen, Zhaotong; Huang, Bowen	Continuous <i>Sargassum</i> Monitoring Across the Caribbean Sea and Central Atlantic Using Multi-Sensor Satellite Observations
415	2024	V Jeanne-Rose, F Goudou-Rosnel, Y Alvarez...	Conversion and Valorization of Tropical Macroalgae
416	2024	Bauta, J; Vaca-Medina, G; Raynaud, CD; Simon, V; Vandebossche, V; Rouilly, A	Development of A Binderless Particleboard from Brown Seaweed <i>Sargassum</i> spp.
417	2024	Pérez-Pech, Wilbert andrés; de Jesús-Navarrete, Alberto; Vargas-Espositos, Abel Abraham	Does <i>Sargassum</i> Contribute to Meiofauna Dispersal? the Case of Tardigrades and Nematodes in the Mexican Caribbean
418	2024	Podlejski, W; Berline, L; Jouanno, J; Barrier, N; Lett, C	Drivers of Growth and Decay of <i>Sargassum</i> in the Tropical Atlantic: A Lagrangian Approach

419	2024	Stanislas, TT; Bilba, K; Potiron, CO; Arsene, MA	Effect of Desalination of <i>Sargassum</i> Algae on its Potential Use as A Stabilizer in Sustainable Earth-Based Bricks
420	2024	R Paletta, R Girimonte, YA Castro, JA De Frias...	Effect of Particle Size on the Biomethanation Kinetics of Mechanically Pretreated <i>Sargassum</i> spp. Biomass
421	2024	Martínez-Cano, M; Dorantes-Acosta, AE; Lara-González, R; Salgado-Hernández, E; Ortiz-Ceballos, AI	Effect of <i>Sargassum</i> on the Behavior and Survival of the Earthworm <i>Eisenia Fetida</i>
422	2024	Briones, FM; Frutis-Murillo, M; López-Miranda, JL; Meza, JEL; Rosas, G; Estevez, M; Esparza, R	Effect of <i>Sargassum</i> -Mediated Synthesis on Hemolytic Activity of Au Nanoparticles
423	2024	R Paletta, P Filippelli, S Candamano...	Efficient Reuse of <i>Sargassum</i> spp. Biomass and Organic Fraction of Municipal Solid Waste by Anaerobic Co-Digestion in the Dominican Republic: Evaluation of ...
424	2024	Y Sánchez-Borroto...	Evaluación Del Proceso De Secado De Biomasa Algal Utilizando Un Secador Solar Diseñado Al Efecto
425	2024	Molza, A; Cesaire, T; Bercion, Y; Thomas, P	Experimental Investigations of Friction Properties of Carbon Particles Derived from <i>Sargassum</i> Algae
426	2024	P Lambert, F Radouani, MS Ahmed...	Extract From <i>Sargassum fluitans</i> Iii: A Promising Valuable Resource of Anti-Bacterial Metabolites
427	2024	Osorio-Ruiz, A; Vargas-Solano, SV; Martínez-Velarde, R; Rodríguez-González, F; Tapia-Maruri, D; Pacheco-Vargas, G; Solorza-Feria, J	Extraction and Identification of Plastic Debris in <i>Sargassum</i> spp. From the Beaches of Cancun and Cozumel, Mexico
428	2024	León-Pérez, Mariana C.; McLaughlin, Richard J.; Gibeaut, James C.; Carrubba, Lisamarie; Colón-Rivera, Ricardo J.; Esteves, René	First Steps Towards Untangling the <i>Sargassum</i> Legal Regime in Puerto Rico
429	2024	O Ali, MA Arsene, A Ramsubhag, J Jayaraman	From Beach Nuisance to An Organic Agricultural Input: The <i>Sargassum</i> Story
430	2024	KI Cisneros-Ramos, M Gutiérrez-Castañeda...	From Inundations to Golden Opportunity: Turning Holopelagic <i>Sargassum</i> spp. Into A Valuable Feed Ingredient Through Arsenic Removal
431	2024	Peniche-Pavía, HA; Tzuc-Naveda, JD; Rosado-Espinosa, LA; Collí-Dulá, RC	Ftir-Atr Chemometric Analysis on Pelagic <i>Sargassum</i> Reveals Chemical Composition Changes Induced by Cold Sample Transportation and Sunlight Radiation
432	2024	Stiffler, AK; Hesketh-Best, PJ; Varona, NS; Zagame, A; Wallace, BA; Lapointe, BE; Silveira, CB	Genomic and Induction Evidence for Bacteriophage Contributions to <i>Sargassum</i> -Bacteria Symbioses

433	2024	B Thomas, J Cumberbatch	Giving Voice to the Invisible Through the Use of Participatory Videos to Communicate Community-Level Vulnerability to Pelagic <i>Sargassum</i> Influxes in the ...
434	2024	Bauta, J; Calbrix, E; Capblancq, S; Cecutti, C; Peydecastaing, J; Raynaud, CD; Rouilly, A; Simon, V; Vaca-Medina, G; Vandenbossche, V; Vedrenne, E; De Caro, P	Global Chemical Characterization of <i>Sargassum</i> spp. Seaweeds from Different Locations on Caribbean Islands: A Screening of Organic Compounds and Heavy Metals Contents
435	2024	Gabriel, D; Maridakis, C; Fredericq, S	Gone With the Wind: An Unexpected <i>Sargassum</i> Inundation in the Mid-Atlantic Azores Archipelago
436	2024	Vásquez-Elizondo, RM; Vásquez-Delfin, E; Robledo, D	Growth and Photosynthetic Physiology of Holopelagic <i>Sargassum</i> (Phaeophyceae) Under Laboratory Conditions
437	2024	da Silva Parente, Igor Machado; Lyra, Gabriela Pitolli; Bueno, Cristiane; Tonin, Fernando Gustavo; Rossignolo, João Adriano	Holistic Evaluation of Ceramic Clay Properties with <i>Sargassum</i> spp. Ash Replacement
438	2024	Bazrafshan H.; Menze K.; Kokaliaris I.; Satrio J.	Hydrothermal Pyrolysis of <i>Sargassum</i> Marine Macroalgae: "Synthesis and Characterization of Products"
439	2024	Wijers, T; van Herpen, B; Mattijssen, D; Murk, AJ; Patterson, JT; Hylkema, A	Implications of Changing Caribbean Coral Reefs on <i>Diadema Antillarum</i> Larvae Settlement
440	2024	Rey, LDP; Pliego-Cortes, H; Marty, C; Araujo, EC; Resik, S; Guerra, IR; Bodet, PE; Picot, L; Bourgougnon, N	<i>In Vitro</i> Antiherpetic Activity of Compounds Extracted from <i>Sargassum fluitans</i> (Børgesen) Børgesen. Identification and in Silico Evaluation of Potential Antiviral Molecules in A Hydroalcoholic Extract
441	2024	AK Stiffler, P Hesketh-Best, NS Varona, A Zagame...	Inducible Prophages Modulate Symbiotic Phenotypes in <i>Sargassum</i> -Associated Bacteria
442	2024	Fidai, YA; Machado, CB; Almela, VD; Oxenford, HA; Jayson-Quashigah, PN; Tonon, T; Dash, J	Innovative Spectral Characterisation of Beached Pelagic <i>Sargassum</i> Towards Remote Estimation of Biochemical and Phenotypic Properties
443	2024	Mulatier, M; Duchaudé, Y; Lanoir, R; Thesnor, V; Sylvestre, M; Cebrián-Torrejón, G; Vega-Rúa, A	Invasive Brown Algae ( <i>Sargassum</i> spp.) As A Potential Source of Biocontrol Against <i>Aedes Aegypti</i>
444	2024	Melyon, S; Rodrigo, PR; Sénard, M; Brelle, L; Sylvestre, M; Gaspard, S; Valencia, DP; Cebrian-Torrejon, G	Investigating the Inhibitory Effect of <i>Sargassum natans</i> and <i>Sargassum fluitans</i> Extracts on Iron Corrosion in 1.00 Mol L <sup>-1</sup> Hcl Solution
445	2024	T Gobert, S Connan, B Châtelain, ML Rouget...	La Soufrière Volcanic Eruption in 2021 Was Not Responsible for the High Fe, Al, Or Mn Concentrations Found in Stranded <i>Sargassum</i> spp.
446	2024	Vázquez-Delfin, Erika; Galindo-De Santiago, Carmen; Paredes-Chi, Arely; Ríos-Vázquez, Ameyalli;	Marine Macrophyte Strandings in the Yucatán Peninsula: Citizen Science as A Potential Tool for Long-Term Monitoring

		Benavides-Lahnstein, Ana; Khatun, Kaysara; Brodie, Juliet	
447	2024	Mendonça, IRW; Theirlynck, T; Zettler, ER; Amaral-Zettler, LA; Oliveira, MC	Microbiome Changes in A Stranding Simulation of the Holopelagic Macroalgae <i>Sargassum natans</i> and <i>Sargassum fluitans</i>
448	2024	Atiglo, DY; Jayson-Quashigah, PN; Sowah, W; Tompkins, EL; Addo, KA	Misperception of Drivers of Risk Alters Willingness to Adapt in the Case of <i>Sargassum</i> Influxes in West Africa
449	2024	RL Scott, NF Putman, RT Beyea, HC Repeta...	Modeling Transport and Feeding of Juvenile Kemp's Ridley Sea Turtles on the West Florida Shelf
450	2024	van Tussenbroek, BI; Monroy-Velázquez, LV; Rodríguez, D; Suescún-Bolívar, LP; Thomé, PE; Cerqueda-García, D; García-Maldonado, JQ; Martínez-López, IG; López-Portillo, JA; Barba-Santos, MG; Gomez-Real, MA; Escalante-Mancera, JE	Monitoring Drift and Associated Biodiversity of Nearshore Rafts of Holopelagic <i>Sargassum</i> spp. in the Mexican Caribbean
451	2024	N Kergosien, M Helias, F Le Grand, S Cérantola...	Morpho- and Chemotyping of Holopelagic <i>Sargassum</i> Species Causing Massive Strandings in the Caribbean Region
452	2024	Siuda, ANS; Blanfuné, A; Dibner, S; Verlaque, M; Boudouresque, CF; Connan, S; Goodwin, DS; Stiger-Pouvreau, V; Viard, F; Rousseau, F; Michotey, V; Schell, JM; Changeaux, T; Aurelle, D; Thibaut, T	Morphological and Molecular Characters Differentiate Common Morphotypes of Atlantic Holopelagic <i>Sargassum</i>
453	2024	López-Sosa, LB; Rodríguez-Torres, GM; Rodríguez-Martínez, RE; Herrera-Ramírez, M; Corral-Huacuz, JC; García, CA; Morales-Máximo, M	Multifunctional Characterization of Cement- <i>Sargassum</i> Composites for Application as Bioconstruction Materials
454	2024	D Álvarez-Canali, M Sansón, C Sangil...	Multigene Phylogenetics of <i>Sargassum</i> (Phaeophyceae) Revealed Low Molecular Diversity in Contrast to High Morphological Variability in the NE Atlantic Ocean
455	2024	V Vital, M Brown, J Galloway, K Egan, F Martinez	Nearshore <i>Sargassum</i> Management: Policy Analysis and Agency Gaps Assessment
456	2024	W Navarro, J Horstmann...	On the Capacity of a Shipboard X-Band Marine Radar in Detecting Free-Floating <i>Sargassum</i> Seaweed
457	2024	Martínez-Molina, EC; Freile-Pelegrín, Y; Ovando-Chacón, SL; Gutiérrez-Miceli, FA; Luján-Hidalgo, MC; Ruiz-Cabrera, MA; Grajales-Lagunes, A; Abud-Archila, M	Osmodehydrated Papaya Coated with <i>Limosilactobacillus Fermentum</i> and Sodium Alginate Extracted from <i>Sargassum fluitans</i>
458	2024	Ferreira, SJ; Kaufmann, M; Wirtz, P; Berimbau, L; Araújo, R	Pelagic <i>Sargassum</i> and Some Associated Mobile Fauna: New Records for the Archipelago of Madeira (Subtropical Eastern Atlantic)

459	2024	Arana, DA; Cortés, TPG; Escalante, VC; Rodríguez-Martínez, RE	Pelagic <i>Sargassum</i> as A Potential Vector for Microplastics into Coastal Ecosystems
460	2024	Zhang, YJ; Hu, CM; McGillicuddy, DJ Jr; Barnes, BB; Liu, YG; Kourafalou, VH; Zhang, S; Hernandez, FJ	Pelagic <i>Sargassum</i> in the Gulf of Mexico Driven by Ocean Currents and Eddies
461	2024	Canul-Ku, LA; Sanginés-García, JR; Valdivieso-Pérez, IA; Casanova-Lugo, F; Urquizo, EA; Canul-Solís, JR; Vargas-Bello-Pérez, E; Alvarado-López, C; Piñeiro-Vázquez, AT	Pelagic <i>Sargassum</i> : A Nutritional Alternative for Tropical Livestock in Southeastern Mexico
462	2024	Hamel, K; Garcia-Quijano, C; Jin, D; Dalton, T	Perceived <i>Sargassum</i> Event Incidence, Impacts, and Management Response in the Caribbean Basin
463	2024	V Hervé, P Sabatier...	Pesticide Upsurge, Cross-Contamination and Biodiversity: Case Studies from the Caribbean Coast Human-Environment Observatory
464	2024	Darko, CNS; Premarathna, AD; Humayun, S; Agyei-Tuffour, B; Goosen, NJ; Tuvikene, R	Physico- and Biochemical Properties of Alginates Extracted from <i>Ecklonia Maxima</i> and <i>Sargassum fluitans</i> Using a Simple Cascade Process
465	2024	Leger-Pigout, M; Navarro, E; Menard, F; Ruitton, S; Le Loc'h, F; Guasco, S; Munaron, JM; Thibault, D; Changeux, T; Connan, S; Stiger-Pouvreau, V; Thibaut, T; Michotey, V	Predominant Heterotrophic Diazotrophic Bacteria Are Involved in <i>Sargassum</i> Proliferation in the Great Atlantic <i>Sargassum</i> Belt
466	2024	Schell, JM; Goodwin, DS; Volk, RH; Siuda, ANS	Preliminary Explorations of Environmental Tolerances and Growth Rates of Holopelagic <i>Sargassum</i> Morphotypes
467	2024	Lambert, P; Said-Ahmed, M; Lescop, B; Rioual, S; Lebrini, M	Protection Against Atmospheric Corrosion of Zinc in Marine Environment Rich in H <sub>2</sub> S Using Self-Assembled Monolayers Based on <i>Sargassum fluitans</i> III Extract
468	2024	Cipolloni, OA; Simon-Bouhet, B; Couture, P; Pascal, PY	Reduced Transfer of Metals and Metalloids from Pelagic <i>Sargassum</i> spp. Accumulated in Artificial Floating Barrier
469	2024	RE Liranzo-Gómez, A Torres-Valle, UJ Jauregui-Haza	Risk Perception Assessment of <i>Sargassum</i> Blooms in Dominican Republic
470	2024	Carral-Murrieta, CO; Serviere-Zaragoza, E; Rivero, FRC; Marques, AC; Mendoza-Becerril, MA	<i>Sargassum</i> Species as Hydrozoans Substrates: Key Patterns of Association or Just Availability?
471	2024	Ramdin, TM; Ali, O; Ramsuhag, A; Jayaraman, J	<i>Sargassum</i> spp. and Ascophyllum Nodosum Seaweed Extract Formulations Improve Plant Growth and Alter the Bacterial Dynamics in Hydroponically Cultivated Lettuce
472	2024	CE González-Penagos...	<i>Sargassum</i> spp. Ethanolic Extract Elicits Toxic Responses and Malformations in Zebrafish ( <i>Danio Rerio</i> ) Embryos

473	2024	Lara-Hernández, JA; Enriquez, C; Zavala-Hidalgo, J; Cuevas, E; van Tussenbroek, B; Uribe-Martínez, A	<i>Sargassum</i> Transport Towards Mexican Caribbean Shores: Numerical Modeling for Research and Forecasting
474	2024	FJ Osorno-Covarrubias, JP Molina...	Scientific Geovisualization of the Dynamics of <i>Sargassum</i> Dispersion and Landfall in the Caribbean, Based on Satellite Imagery and Numerical Forecasts.
475	2024	Durand, L; Sundberg, J; Rodriguez-Martinez, RE	Seaweed Blooms in Paradise: Ecological Reflexivity, Governance and the <i>Sargassum</i> Crisis in the Mexican Caribbean
476	2024	de Moraes, Maria Júlia Bassan; Lyra, Gabriela Pitolli; Spósito, Camila Cassola Assunção; Gavioli, Letícia Missiatto; Parente, Igor Machado da Silva; Bueno, Cristiane; Savastano Junior, Holmer; Rossignolo, João Adriano	Seaweed Waste in Eco-Friendly Construction Materials: Valorization of <i>Sargassum</i> Ash as A Mineral Addition in Fiber Cements
477	2024	Gobert, T; Connan, S; Salaün, P; Eikelboom, M; Riso, RD; Stiger-Pouvreau, V; Waeles, M	Simple and Rapid Voltammetric Method Using a Gold Microwire Electrode to Measure Inorganic Arsenic in Holopelagic <i>Sargassum</i> (Fucales, Phaeophyceae)
478	2024	F Pompoli, I Dicarlantonio, J Hernandez...	Sound-Absorbing Sustainable Material from Pelagic <i>Sargassum</i> Seaweed: Experimental Investigation, Modelling and Panels ...
479	2024	I Ahmad, A Turkistani	Sustainable Aquaculture Feeds: The Potential of <i>Sargassum</i> Brown Seaweeds as Carbohydrate Sources
480	2024	Rodríguez-Martínez, Rosa E.; Gómez Reali, Miguel Ángel; Torres-Conde, Eduardo Gabriel; Bates, Michael N.	Temporal and Spatial Variation in Hydrogen Sulfide (H <sub>2</sub> S) Emissions During Holopelagic <i>Sargassum</i> spp. Decomposition on Beaches
481	2024	E Vázquez-Delfín, D Robledo...	Temporal Characterization of <i>Sargassum</i> (Sargassaceae, Phaeophyceae) Strandings in A Sandy Beach of Quintana Roo, Mexico: Ecological Implications for ...
482	2024	Cipolloni, OA; Couture, P; Cordonnier, S; Pascal, PY	Temporal Fluctuation of Metallic Trace Elements Concentrations in Three Morphotypes of Floating Holopelagic <i>Sargassum</i> from the Caribbean Coast (Guadeloupe, French West Indies)
483	2024	AJ Duran, GP Lyra, LE Campos Filho, C Bueno...	the Potential Use of the Pelagic Seaweed <i>Sargassum</i> spp. As An Alternative Lignocellulosic Raw Material for Particleboards: Technical Viability and Life Cycle ...
484	2024	Duran, AJFP; Lyra, GP; Campos, LE; Bueno, C; Rossignolo, JA; Alves-Lima, C; Fiorelli, J	The Use of Sargasso Seaweed as Lignocellulosic Material for Particleboards: Technical Viability and Life Cycle Assessment
485	2024	GP Lyra, AL Colombo, AJFP Duran, IMS Parente...	The Use of <i>Sargassum</i> spp. Ashes Like a Raw Material for Mortar Production: Composite Performance and Environmental Outlook

486	2024	Arellano-Verdejo, J; Lazcano-Hernandez, HE	Towards Sustainable Coastal Management: Aerial Imagery and Deep Learning for High-Resolution <i>Sargassum</i> Mapping
487	2024	Bouso N.C.; Brehmer P.; Ndiaye W.; Stiger-Pouvreau V.; Kane C.; Gautier M.; Faye M.; Fricke A.; Diadhiou H.D.; Aroui Boukbida H.; Weinberger F.; Ramasamy B.; Diedhiou F.; Diop M.S.; Balde B.S.; Simon G.; Quack B.	Unusual Holopelagic <i>Sargassum</i> Mass Beaching in Northwest Africa: Morphotypes, Chemical Composition, and Potential Valorisation
488	2025	López-Miranda, J.L., González-Reyna, M.A., Elizalde-Mata, A., Mares-Briones, F., Esparza, R., Molina, G.A., Estévez, M.	A green approach for biomedical and photocatalytic applications using sargassum-derived nanocellulose foams decorated with MO nanoparticles (M = Zn, Cu)
489	2025	E Yudiati, N Azhar, MJ Achmad...	Alginate poly and oligosaccharide (AOS) from <i>Sargassum</i> sp. as immunostimulant in gnotobiotic artemia challenge tests and antibacterial diffusion disc assay against ...
490	2025	Jouanno, J; Berthet, S; Müller-Karger, F; Aumont, O; Sheinbaum, J	An extreme North Atlantic Oscillation event drove the pelagic <i>Sargassum</i> tipping point
491	2025	van der Plank, S; Cumberbatch, J; Thomas, B; Corbett, J; Tompkins, EL	Analysis of the Real-Time Phases of Adaptation Through the Lens of an Emergent Risk: <i>Sargassum</i> Adaptation Policy Analysis in the Caribbean
492	2025	R Hernández-Turcás, R López-Lee...	Arribazón de Sargazos en el extremo oriental de la provincia Guantánamo en el período 2021–2024
493	2025	Teyssier, M; Desrosiers, C; Hellio, C; Kerninon, F	Assessing <i>Sargassum</i> pressure on coastal habitats using a spatial and temporal approach at the territorial scale
494	2025	Rodríguez-Rodríguez, Y., Soldevilla-Hernández, L.I., Guevara, M.Á., Gandini, G., Jáuregui-Haza, U.J.	Assessment of a <i>Sargassum</i> -based liquid biofertilizer for enhanced banana cultivation in small-scale family farms
495	2025	A Closse, CO Potiron, MA Arsene, K Bilba	Attempt to The Valorization of Brown Algae <i>Sargassum</i> sp. in Cement Mortar Composites for Housing or Building Purposes
496	2025	E Martínez-Martínez, AH Slocum, ML Ceballos...	Beyond the Bloom: Invasive Seaweed <i>Sargassum</i> spp. as a Catalyst for Sustainable Agriculture and Blue Economy—A Multifaceted Approach to ...
497	2025	F Rosas-Diaz, CA Juárez-Alvarado, M Chen...	Biomass-based concrete could effectively decarbonize buildings in Mexico
498	2025	EA Mellado-Lira, E Luevano-Hipolito...	Brown algae: <i>Sargassum</i> sp. and Lobophora sp. incorporation in magnesium oxychloride cement
499	2025	Pérez, S; Ramírez-Muñoz, A; Díaz-Real, JA; Flórez, E; Acelas, N; Hernández-Navarro, C; González-Hernández, J; Muñoz-Saldaña, J	Calcium-rich <i>Sargassum</i> derived adsorbents for phosphorus removal from urine: A step toward a circular economy

500	2025	SV Ávila-Mosqueda, BI van Tussenbroek...	Changes in Seagrass Landscape Configuration in a Caribbean Reef Lagoon Indicate an Ecosystem Shift After Repeated Disturbances
501	2025	Yolanda, F.-P., Daniel, R., Cresencia, C.-Q., Vázquez-Delfín, E., Hugo, P.-C., Gilles, B., Nathalie, B.	Chemical Composition and Carbohydrate Characterization of Beach-Cast Marine Macrophytes from the Mexican Caribbean: Implications for Potential Bioethanol Production
502	2025	Colorado-Ríos, J; Restrepo-Espinosa, DC; Restrepo-Moná, Y; Monsalve, JD; Márquez-Fernández, DM; Castellanos, L; Martínez-Martínez, A	Chemical Exploration of Polysaccharides, Fatty Acids, and Antioxidants as Functional Ingredients from Colombian Macroalgae <i>Acanthophora spicifera</i> , <i>Sargassum ramifolium</i> , and <i>Sargassum fluitans</i>
503	2025	Peniche-Pavía, H.A., Rosado-Espinosa, L.A., Collí-Dulá, R.C.	Comparative 1H NMR metabolomics analysis of fresh pelagic <i>Sargassum</i> reveals biochemical changes caused by under cryogenic and non-cryogenic sample transportations
504	2025	Rosas-Díaz, F; Arreguin, AM; Hernández, JC; Juárez-Alvarado, CA; Galindo-Rodríguez, SA; García-Hernández, DG	Compatibility study of <i>Sargassum</i> -based aggregate in Portland cement-based cementitious matrix
505	2025	AM Rodríguez, JB Torres, RL Lee...	Condiciones meteorológicas favorables para los arribos de sargazos en Cuba
506	2025	CE Valdés, MH González, RL Lee	Condiciones oceánicas favorables para el arribo de sargazos a las costas cubanas
507	2025	Ramírez-Pinto, C.A., Cruz, J.C., Escobar, B., García-Uitz, K., Nahuat-Sansores, J.R., Alvarez, T., Gurrola, M.P.	Development of <i>Sargassum</i> spp. ash as filler material on cement composites with low carbon dioxide production
508	2025	Y Alcántara-De Tejada...	Efecto de cuatro formulaciones y tres temperaturas de proceso en la producción de bioplásticos con sargazo deshidratado
509	2025	BA Salazar-Cruz, G Hernández-Zamora...	Effect of time on the rheological behavior of asphalt mixtures modified with <i>Sargassum</i> and SBS compounds of varying vinyl content
510	2025	Paletta, R., Candamano, S., Bruno, M.D.L., Desiderio, G., Castro, Y.A.	Effect of unconventional pretreatments on the morphology and biochemical methane potential of <i>Sargassum</i> spp.
511	2025	RV González, MYV Gómez, JS Mendoza, JYV Gómez...	Enhanced extraction of calcium alginate and 2D nanocellulose from brown algae ( <i>Sargassum</i> spp.)
512	2025	Quintanar-Orozco, ET; Azcorra-May, KJ; Olguin-Maciel, E; Alzate-Gaviria, L; Tapia-Tussell, R	Environmental assessment of process to valorize <i>Sargassum</i> in the Caribbean
513	2025	Mayorga, JIM; Quiroga, SY; Posada, I; García-Ramos, KA	Free-living clinging flatworms (Rhabditophora, Polycladida) associated with <i>Sargassum</i> from the Caribbean Coast of Colombia

514	2025	Santiago Guerrero-Higareda, Danay Carrillo-Nieves	Green extraction cascade of UV-absorbing compounds, alginate, and fucoidan from <i>Sargassum</i> using ethanol and natural deep eutectic solvents
515	2025	Antonio-Hernández, C; Pacio-Castillo, M; Pacio-Castillo, A; Valdez-Hernández, M; Serrano-de-la-Rosa, LE; Osorio-de-la-Rosa, E	Harnessing <i>Sargassum</i> seaweed for the next generation of supercapacitors: a sustainable approach to advanced energy storage solutions
516	2025	Canul-Ku, LA; Casanova-Lugo, F; Aguilar-Urquizo, E; Valdivieso-Pérez, I; Arcos-Alvarez, D; Canul-Solís, J; Castillo-Sánchez, L; Chay-Canul, A; Dzib-Castillo, B; Pineiro-Vázquez, A	In Vitro Fermentation Characteristics of Pelagic <i>Sargassum</i> for Inclusion in Integral Diets for Ruminants
517	2025	Leemans, L., Magaña-Gallegos, E., van Katwijk, M.M., Lamers, L.P.M., Smolders, A.J.P., Bouma, T.J., Christianen, M.J.A., van Tussenbroek, B.I.	Iron co-limitation of <i>Sargassum fluitans</i>
518	2025	G Pitolli Lyra, AJFP Duran...	Life Cycle Assessment of Lightweight Ceramic Clay Aggregates Sintered in a Microwave Oven with the Incorporation of <i>Sargassum</i> spp. Particles
519	2025	Gauyat, C; Gautier, A; Connan, S; Hellio, C; Reyes, AG; Stiger-Pouvreau, V; Kraffe, E	Lipid composition and biomass utilisation prospects of holopelagic <i>Sargassum</i> species in the French West Indies
520	2025	Diana BÃ©nuffÃ©, Fatima Radouani, Maxence Quemener, Olivia Ozier, Marilyne Fauchon, Yannick Toueix, Fabienne FaÓ±, Anthony Magueresse, Benoit Lescop, StÃ©phane Rioual, Pascal Zongo, Christophe Roos, Claire Hellio, Paule Salvin	Multifactorial accelerated marine corrosion of immersed steels influenced by washed ashore <i>Sargassum</i> rafts
521	2025	López-Sosa, L.B., Rodríguez-Torres, G.M., Rodríguez-Martínez, R.E., Herrera-Ramírez, M., Corral-Huacuz, J.C., García, C.A., Morales-Máximo, M.	Multifunctional characterization of cement- <i>Sargassum</i> composites for application as bioconstruction materials
522	2025	Sanabria Pérez, F.J., Solis Maldonado, C., Luna Sánchez, R.A., Ortíz Silos, N., Cristóbal-Salas, A., Sandoval-Rangel, L., Rivera de la Rosa, J., Dimas-Rivera, G.L., Atehortua Garcés, L.	Natural and Calcined Clinoptilolite as Catalyst for Co-pyrolysis of <i>Sargassum</i> and HDPE: Characterization and Application of Byproducts
523	2025	Theirlynck, T; Staat, L; Servania, D; Engelen, AH; van Tussenbroek, BI; Muyzer, G; Visser, PM; Amaral-Zettler, L	Nutrient-driven growth and microbiome shifts in the brown alga <i>Sargassum fluitans</i> III
524	2025	Molina-Cora, PN; Morell, JM; Martell-Bonet, L; Rodriguez-Matos, LR; Morell, JE; Vélez-Rivera, M	Observations of <i>Sargassum</i> carbon influx and biogeochemical impact in La Parguera Marine Reserve

525	2025	E Cuevas, A Uribe-Martínez, N Arias-Martínez...	Ocean drifters' displacement compared to <i>Sargassum</i> spp. distribution in the Mexican Caribbean
526	2025	Shakhovskoy, IB; Malikova, DY	On Pelagic Fishes Captured in Oceanic Waters of the Northern Part of the Central Atlantic Ocean in Autumn 2019 (Results of the 44-45th Research Cruises of the R/V Akademik Nikolaj Strakhov)
527	2025	Nancy Cabanillas-Terán, Isabella Pérez-Posada, Rigoberto Rosas-Luis, Rosa E. Rodríguez-Martínez, Diego J. Lizcano, Alejandro A. Aragón-Moreno	Overlapping niches among sea urchin species reveal <i>Sargassum</i> -induced degradation at Caribbean shallow coral reefs
528	2025	Sullivan, S; Hu, CM; Barnes, BB; Qi, L	Pelagic <i>Sargassum</i> in the Florida Keys: assessment using high-resolution remote sensing
529	2025	Owusu, WA; Marfo, SA; Osei, H; Supap, T; Idem, R	Pelagic <i>Sargassum</i> waste as an excellent feedstock for bioethanol production: hydrolysis optimisation and kinetics
530	2025	Saha, B; Ateia, M; Fernando, S; Rodríguez-Martínez, RE; Iskander, SM	PFAS in pelagic <i>Sargassum</i> : A growing concern for the mexican caribbean coastline
531	2025	CJ English, R Parsons, K Yongblah...	Photooxidation removes biologically recalcitrant dissolved organic carbon released by the macroalga <i>Sargassum natans</i>
532	2025	Hatt, D.C., Nauer, F., Collado-Vides, L., Campbell, J.E.	Physiological Responses of Pelagic <i>Sargassum</i> (Phaeophyceae) to Thermal Stress Vary by Species and Morphotype
533	2025	AEP Del Real, D Vantelon, C Catrouillet, I Khatib...	Plastic debris accumulated on <i>Sargassum</i> algae stranded biomass are vectors for different As (V) and As (III) forms
534	2025	LRP Rey, SR Aguirre, G del Barrio Alonso, IR Guerra	Potencialidades de la biomasa del <i>Sargassum</i> como fuente de compuestos bioactivos en el contexto global de la emergencia de enfermedades virales
535	2025	M Bennett, A March, H Li, P Lallemand...	Qualitative and quantitative assessment of <i>Sargassum</i> valorisation solutions for the Caribbean
536	2025	Lankes, JD; Page, HN; Quasunella, A; Torkelson, JF; Lemaire, C; Nowicki, RJ; Blasius, L; Hall, ER	Quantifying coral-algal interactions in an acidified ocean: <i>Sargassum</i> spp. exposure mitigates low pH effects on <i>Acropora cervicornis</i> health
537	2025	Gómez-Matos, M; Martínez-Balmori, D; Coll-García, Y; Baró-Robaina, Y; Mirabal-Gallardo, Y	Recycling <i>Sargassum</i> spp. Biomass for Sustainable Biocontrol in Agriculture: A Circular Approach
538	2025	LR de Almeida, SV Ávila-Mosqueda...	Relationships between Spatiotemporal Variation of Nearshore Seagrass Cover and Shoreline Position in a Mexican Caribbean Reef Lagoon
539	2025	Fidai, YA; Dash, J; Tompkins, E; Atiglo, DY; Jayson-Quashigah, PN; Sowah, WNA; Addo, KA	<i>Sargassum</i> Biomass Movement and Proliferation in the Eastern Tropical Atlantic
540	2025	Black, JT; Whitmire, SL; Smith, EM; Scaroni, AE; Van Bloem, SJ	<i>Sargassum</i> brown tide impacts nearshore water quality and seagrasses in Jobos Bay, Puerto Rico

541	2025	Zhang, YJ; Barnes, BB; Mcgillicuddy , DJ Jr; Hu, CM	<i>Sargassum</i> Enrichment in Mesoscale Eddies of the Great Atlantic <i>Sargassum</i> Belt
542	2025	Sosa-Gutierrez, R; Jouanno, J; Berline, L	<i>Sargassum</i> spp. accumulation and transport by mesoscale eddies
543	2025	Amorim, J.P.M.D., Carmo, A.M.C.D., Martinelli Filho, J.E.	<i>Sargassum</i> transport to the Amazon Coast: Explaining the stranding through meteorological and oceanographic conditions
544	2025	López-Miranda, JL; Molina, GA; Elizalde-Mata, A; Esparza, R; Silva, R; Estevez, M	<i>Sargassum</i> -based biosorption for glyphosate removal: A green, efficient, and sustainable approach
545	2025	Jouanno, J; Almar, R; Muller-Karger, F; Morvan, G; van Tussenbroek, B; Benshila, R; Marchesiello, P; Addo, KA	Socio-ecological vulnerability assessment to <i>Sargassum</i> arrivals
546	2025	León-Martínez, F.M., Medina-Torres, L., Soto-Castro, D., Castellanos-León, F., Hernández-Plancarte, C., Cano-Barrita, P.F.D.J.	Sodium Alginate from Playa del Carmen <i>Sargassum</i> : Extraction, Characterization, and Rheological Analysis of Solutions and Hydrogels
547	2025	Tamayo-Rincón, VM; Colorado-Ríos, J; Alvarez-Bustamante, DJ; Urrea-Victoria, V; Márquez-Fernández, DM; Salamanca, CH; Dall'Acqua, S; Castellanos-Hernandez, L; Martínez-Martínez, A	Sustainable Extraction of Prospective Cosmetic Ingredients from Colombian Marine Macroalgae Using Natural Deep Eutectic Solvents
548	2025	F Rosas-Díaz, E Valles-Capetillo...	Taguchi experimental matrix optimization of two plant-based concretes with <i>Sargassum</i> ( <i>Sargassum fluitans</i> ) and peanut shell ( <i>Arachis hypogaea</i> ) ...
549	2025	D García-Trejo, JAS Meza, SL Rosales-Silvestre...	Tertiary Water Treatment with <i>Sargassum</i> spp. Filter: Pollutant Hydraulic Loss Coefficient and Removal Capacity
550	2025	F Areola, O Osanyinlusi, O Soyinka	The Benefits and Challenges of <i>Sargassum</i> Seaweed to the Local Fishing Communities in Nigeria
551	2025	Pérez-Posada, I; Cabanillas-Terán, N; Carrera-Parra, LF; Lizcano, DJ; Sánchez, A	Trophic ecology of Caribbean polychaetes: responses to environmental changes driven by massive <i>Sargassum</i> arrivals
552	2025	Abdool-Ghany, AA; Babler, KM; Bogumil, D; Pollock, S; Li, JY; Manning, SR; Solo-Gabriele, HM	Use of Deep Sequencing to Evaluate Transitions in Microbial Communities in Stranded <i>Sargassum</i>
553	2025	Villafán-Vidales, HI; López, A; Okoye, PU; Lizarraga, DA; Arreola-Ramos, CA; Chávez, V; Silva, R	Valorization of <i>Sargassum fluitans</i> III from the Mexican Caribbean: Solar Drying and Pyrolysis
554	2025	Hernández-Nuñez, H; Euán-Avila, JI	Velocity of <i>Sargassum</i> Migration in the Caribbean Observed with Landsat 8/9 and Sentinel 2 A/B Imagery



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