The Sargasso Sea Stewardship Project:

Findings of the Socio-Ecosystem Diagnostic Analysis

A Summary of the Best Available Science Informing a Strategic Action Programme for the Stewardship of the Sargasso Sea – June 2026

Contents

The Background and History of Conservation and Stewardship in the Sargasso Sea

- ***The Sargasso Sea combines exceptional ecological importance with complex governance challenges.*** The background to conservation and stewardship in the Sargasso Sea reflects a unique convergence of ecological importance and governance complexity. The Sargasso Sea is a globally significant high seas ecosystem defined by ocean circulation rather than political boundaries, supporting exceptional biodiversity, climate regulation functions, and critical life-history stages for numerous migratory and endangered species.

- ***The region has historically lacked comprehensive governance despite its global significance.*** Despite its ecological importance, the Sargasso Sea has historically lacked a dedicated regional governance framework. Most of the area lies beyond national jurisdiction, and no comprehensive regional environmental or overall fisheries management regime exists, resulting in fragmented, sector-specific oversight of activities such as shipping, fishing, and seabed use.

- ***The Sargasso Sea Alliance initiated coordinated stewardship within existing areas beyond national jurisdiction (ABNJ) frameworks.*** The establishment of the Sargasso Sea Alliance in 2010 marked a pivotal step toward coordinated stewardship. By working through existing international and regional sectoral organizations, the Alliance sought to secure recognition of the Sargasso Sea's global significance and to demonstrate the opportunities and limitations of conservation action within existing ABNJ governance structures.

- ***Scientific delineation enabled international recognition of the value of the Sargasso Sea.*** Scientific efforts to define the Sargasso Sea study area and its core ecological features provided a foundation for international recognition. This work culminated in the description of the Sargasso Sea as an Ecologically or Biologically Significant Area under the Convention on Biological Diversity in 2012, strengthening the scientific basis for conservation and stewardship.

- ***The Hamilton Declaration established an innovative cooperative stewardship model.*** The 2014 Hamilton Declaration on Collaboration for the Conservation of the Sargasso Sea established a novel, non-binding governance model. Through the creation of the Sargasso Sea Commission and a defined Geographical Area of Collaboration, participating governments committed to cooperative stewardship, monitoring, and advocacy without creating a new regulatory authority.

- ***Sectoral governance has delivered partial protection but revealed structural limitations***. Experience gained through the Sargasso Sea Commission has highlighted both the potential and limitations of sectoral governance in ABNJ. While existing institutions can deliver targeted protections, the absence of coordination mechanisms, limited application of the ecosystem and precautionary approaches, and lack of tools to address cumulative impacts constrain effective conservation.

- ***Recent initiatives signal a shift toward integrated, ecosystem-based stewardship.*** Recent initiatives, including the UNDP-GEF Sargasso Sea Stewardship Project and alignment with the BBNJ Agreement, represent an evolution toward more integrated and ecosystem-based

governance. These processes aim to strengthen scientific understanding, address cumulative impacts, and develop strategic, cooperative approaches that can serve as a model for conservation and stewardship of other high seas ecosystems.

- ***Cultural and Traditional Significance of the Sargasso Sea Ecosystem***. The Sargasso Sea holds deep cultural, historical, and socio-economic significance, having shaped maritime exploration, supported Atlantic Island communities such as Bermuda, and connected regions across the Atlantic basin through migratory species and ocean processes. It has influenced local livelihoods, traditions, and economies through fisheries, tourism, and the use of *Sargassum*, while also serving as a critical site for scientific discovery and long-term ocean research. The ecosystem continues to link distant communities, including those in the Caribbean and Indigenous populations in North America, through shared ecological benefits and challenges. Its role in supporting migratory species, cultural heritage, and traditional knowledge highlights the importance of integrating human dimensions into conservation and stewardship efforts.

The International Legal and Regulatory Framework for the Sargasso Sea Geographical Area of Collaboration

- ***The international governance of the Sargasso Sea remains complex and fragmented.*** The international legal and regulatory framework governing the Sargasso Sea is complex, disconnected, and largely sectoral, reflecting the broader challenges of ocean governance in areas beyond national jurisdiction. While the 1982 United Nations Convention on the Law of the Sea establishes overarching obligations to protect and preserve the marine environment, implementation in the high seas remains incomplete and uneven.

- ***The Law of the Sea Convention provides a foundation but leaves significant conservation gaps.*** The LOSC provides the foundational legal regime for maritime zones, high seas freedoms, and seabed governance, but leaves significant gaps with respect to the integrated conservation of marine biodiversity. High seas freedoms are conditioned by duties of due regard and environmental protection, yet enforcement relies heavily on 'good-faith' implementation by States and sector-specific institutions.

- ***The BBNJ Agreement marks a major advance in high seas biodiversity governance.*** The adoption of the 2023 Agreement on Biodiversity Beyond National Jurisdiction represents a major step forward in addressing long-standing governance gaps. The BBNJ Agreement introduces new legally binding mechanisms for area-based management tools, environmental impact assessments, and capacity building, offering the first opportunity for internationally recognized marine protected areas on the high seas.

- ***Sectoral engagement is driving meaningful conservation outcomes***. Prior to the BBNJ Agreement, protection of the Sargasso Sea relied on engagement with competent international organizations operating under sectoral mandates. Through sustained engagement, the Sargasso Sea Commission is influencing fisheries management, shipping policy, seabed governance, and biodiversity recognition, demonstrating that progress is possible within existing frameworks, albeit challenging.

- **Regional and global organizations contribute partial protection measures**. Regional and sectoral organizations, including RFMOs and similar fisheries advisory bodies, the International Maritime Organization, the International Seabed Authority, and various biodiversity-related conventions, have adopted measures that partially or indirectly contribute to conservation of the Sargasso Sea. Notably, fisheries closures, vulnerable marine ecosystem protections, and recognition of ecological significance have delivered tangible but incomplete outcomes.

- ***Persistent governance gaps constrain ecosystem-scale management.*** Despite these advances, significant governance gaps remain, particularly in addressing cumulative impacts, emerging activities, and ecosystem-scale management. The absence of binding coordination mechanisms across sectors has constrained the effectiveness of existing legal instruments and further sustained fragmented decision-making.

- **Overall, effective stewardship will depend on coordinated implementation of emerging legal tools**. Overall, the evolving international legal framework presents both challenges and opportunities for the conservation of the Sargasso Sea. Effective stewardship will depend on the implementation of the BBNJ Agreement, strengthened cooperation among sectoral bodies, and strengthened leadership to translate legal obligations into coherent, ecosystem-based management across the high seas.

Physical Oceanography

- **The Sargasso Sea is a defining subtropical gyre system with global significance.** The Sargasso Sea is a large, oligotrophic, anticyclonic gyre bounded by major Atlantic currents and embedded within the Atlantic Meridional Overturning Circulation (AMOC). Its circulation regulates heat, carbon and nutrient transport at basin and planetary scales, making it climatically and ecologically important.

- **Long-term observations reveal rapid and accelerating climate-driven change**. Sustained measurements since the 1950s show significant warming of the upper ocean (~1.2 °C since the 1970s), increased salinity, rising heat content, ocean acidification, and altered seasonality. Summers are lengthening, winters are shortening, and recent changes exceed historical variability.

- **Upper-ocean stratification is strengthening, with consequences for productivity.** Increased surface warming and reduced winter mixing are limiting nutrient replenishment of the euphotic zone. While productivity increased prior to ~2010, primary production has declined by ~30% since then, signalling a shift in biogeochemical functioning with uncertain ecosystem consequences.

- **The North Atlantic Oscillation strongly modulates interannual variability**. NAO phase controls winter storm activity, mixing depth, nutrient supply and biological responses in the Sargasso Sea. Its variability interacts with longer-term warming trends, complicating attribution but amplifying ecosystem sensitivity to climate forcing.

- **Subtropical Mode Water formation is declining, with system-wide implications.** STMW formation rates have roughly halved in the past decade. Because STMW stores heat, carbon,

oxygen, and nutrients and influences gyre circulation, this decline may affect future productivity, carbon sequestration, and links between the subtropical gyre and the AMOC.

- **Mesoscale eddies are a dominant driver of variability and biological hotspots.** Eddies generated mainly from the Gulf Stream strongly regulate nutrient delivery, primary production, plankton communities, and predator behaviour. They may account for up to 35–50% of new production and structure ecosystem dynamics from the surface to the deep sea and seabed.

- **Extreme events increasingly shape short-term dynamics.** Hurricanes and winter storms can rapidly alter temperature, mixing, nutrient supply, and *Sargassum* distribution, triggering short-lived productivity pulses and deep-ocean impacts. Evidence suggests that storm intensity and frequency are increasing with climate change.

- **Deep-ocean changes reflect distant climate forcing and long-range teleconnections.** Intermediate and deep waters originate at high latitudes and reach the Sargasso Sea after ~10 years, carrying climate signals from the Labrador Sea and the Southern Ocean. Observed cooling and freshening at depth contrasts with surface warming, highlighting the importance of full-depth monitoring.

- **The Sargasso Sea is a critical natural observatory for global change.** Few ocean regions have comparable multi-decadal, full-depth observations. These records demonstrate that the Sargasso Sea is already outside its historical physical and chemical envelope, underscoring its value for detecting, understanding, and anticipating climate-driven ocean change.

Chemical Oceanography

- ***The Sargasso Sea is undergoing profound, climate-driven chemical transformation.*** Long-term observations show clear trends of ocean warming, increased stratification, deoxygenation, and ocean acidification. These changes are driven primarily by anthropogenic CO_2 uptake and climate forcing, with interacting physical, chemical, and biological feedback reshaping regional biogeochemistry.

- ***Nutrient availability remains the dominant control on biological productivity.*** The Sargasso Sea is persistently oligotrophic, relying on winter mixing to supply macronutrients to surface waters. However, revised understanding of nitrogen cycling, including *in situ* nitrification and nitrogen fixation, reveals a greater complexity in nutrient pathways and challenges traditional estimates of new production and export.

- ***Increasing stratification is altering nutrient supply and ecosystem function.*** Surface warming and reduced winter mixing are limiting nutrient replenishment to the euphotic zone. While primary production increased from the late 1980s to around 2010, it has declined by more than 25% since then, indicating a shift in biogeochemical functioning with uncertain long-term ecological consequences.

- ***Ocean deoxygenation is substantial and not explained by warming alone.*** Dissolved oxygen concentrations have declined by approximately 8% over the past four decades. Only a small

fraction of this loss is attributable to reduced solubility from warming, with most losses driven by changes in circulation, ventilation, and biological oxygen consumption. The oxygen minimum zone is expanding and shoaling, increasing ecological risk at depth.

- ***Trace elements and atmospheric inputs are critical to sustaining productivity.*** Micronutrients such as iron, supplied largely through atmospheric deposition, play a key role in regulating phytoplankton growth. Evidence of widespread nutrient co-limitation highlights increasing ecosystem sensitivity to changes in atmospheric chemistry, dust transport, and nutrient supply pathways.

- ***The Sargasso Sea is highly productive despite its oligotrophic nature.*** Although nutrient-poor, the Sargasso Sea exhibits primary productivity rates comparable to highly productive regions such as the Bering Sea. This challenges traditional assumptions about productivity in oligotrophic systems and highlights the efficiency of biological processes in this region.

- ***The biological carbon pump plays a major role in global carbon sequestration.*** Primary producers such as phytoplankton and *Sargassum* convert atmospheric CO_2 into organic carbon, which is subsequently transported to the deep ocean through the biological carbon pump. The global ocean as a whole sequesters approximately 25% of anthropogenic CO_2 and stores vastly more carbon than the atmosphere, with the Sargasso Sea acting as a significant contributor to this process.

- ***The Sargasso Sea is a significant net sink for atmospheric CO_2.*** While seasonal outgassing occurs during summer, this is outweighed by strong CO_2 uptake in winter, making the region a net carbon sink. Remarkably, the Sargasso Sea contributes roughly 7% of the global biological carbon pump despite its relatively small size, underscoring its global importance in carbon cycling.

- ***The biological carbon pump has shown resilience despite major surface changes.*** Although primary production has declined in recent decades, particulate organic carbon export to the deep ocean has remained remarkably stable. Shifts in plankton community structure, food-web interactions, and export pathways appear to buffer deep-ocean carbon sequestration against surface variability.

- ***Anthropogenic CO_2 uptake has fundamentally altered ocean carbon chemistry***. Surface dissolved inorganic carbon and anthropogenic carbon concentrations have nearly doubled since the 1980s. Ocean acidity has increased by approximately 30%, pushing present-day pH and carbonate conditions beyond the range of recent geological history and affecting calcification and ecosystem processes.

- ***Long-term observations reveal chemical conditions outside historical bounds***. Time-series data from BATS and Hydrostation S demonstrate that modern chemical states of the Sargasso Sea now exceed historical variability. These records are essential for detecting trends, constraining models, and understanding future trajectories of ocean carbon cycling and ecosystem change.

- ***The Sargasso Sea serves as a globally significant chemical observatory***. With one of the world's longest continuous open-ocean biogeochemical records, the Sargasso Sea provides critical insight

into how anthropogenic forcing is reshaping ocean chemistry, carbon sequestration, and climate feedback at basin and global scales.

Biological Oceanography

- ***Holopelagic* Sargassum *is the central biological structuring element of the Sargasso Sea surface ecosystem***. The biological oceanography of the Sargasso Sea is organized around the presence of holopelagic *Sargassum*, which forms a distinctive floating habitat in an otherwise oligotrophic environment. This macroalgal system supports diverse communities spanning motile epifauna, nekton, seabirds, and migratory megafauna, and plays a critical role in shaping surface–ocean food web structure. Its ecological importance is governed by abundance, aggregation state, and morphotype-specific architecture, each of which influences habitat complexity and trophic interactions.

- ***Long-term records show that* Sargassum *abundance is naturally variable on interannual to decadal timescales***. Observational data demonstrates pronounced fluctuations in *Sargassum* biomass that predate the emergence of the Great Atlantic Sargassum Belt (GASB), indicating that recent changes occur within a long-standing pattern of natural variability. Nevertheless, shifts in seasonal timing, regional distribution, and morphotype composition suggest that large-scale circulation changes and climate forcing are increasingly influencing contemporary dynamics.

- ***The Sargasso Sea is an unlikely candidate for the origin of the GASB.*** The most recent research points to a different origin in the coastal waters of West Africa, particularly around the Gulf of Guinea and Senegal. The study suggests that the first major GASB event developed from small existing concentrations of *Sargassum* in these waters that expanded rapidly under favourable environmental conditions, supporting the view that the GASB *Sargassum* is biologically distinct from the traditional *Sargassum* populations of the Sargasso Sea.

- ***The aggregation state of* Sargassum *strongly regulates its ecological function and faunal associations***. Windrows and mats consistently support higher abundances of fishes and megafauna than dispersed fragments, while even small clumps provide essential refuge and foraging opportunities. Because dispersed fragments and diffuse windrows dominate most observations in the Sargasso Sea, a large proportion of the biological value of the ecosystem is associated with habitat that is poorly resolved by satellite remote sensing alone.

- ***Morphological differences among* Sargassum *varieties translate into measurable differences in habitat quality and food web structure***. Architecturally complex forms, particularly *Sargassum fluitans III*, support greater abundance and diversity of motile epifauna than less complex varieties such as *Sargassum natans VIII*. Long-term comparisons reveal marked shifts in epifaunal community composition, including reduced evenness and increasing dominance by a small number of taxa, indicating a reorganization of the surface-ocean food web with potential implications for higher trophic levels.

- ***Environmental tolerances differ among* Sargassum *varieties, linking climate forcing to future ecosystem structure***. Experimental and field evidence shows that temperature and salinity exert

variety-specific controls on growth, health, and survival, implying that continued ocean warming and hydrographic change will differentially affect *Sargassum* composition, aggregation frequency, and transport pathways. While *Sargassum* is expected to remain a defining feature of the Sargasso Sea, changes in morphotype balance are likely to influence habitat quality and ecosystem functioning.

- ***The biological dynamics of the Sargasso Sea reflect tight coupling between physical forcing,* Sargassum *ecology, and pelagic food webs.*** Long-term observational programmes, together with advances in remote sensing, genomics, and experimental ecology, have been essential for resolving these linkages and identifying ecosystem-scale change. Sustained observations remain critical for detecting future biological responses and for understanding how this unique open-ocean ecosystem will evolve under continued climate-driven transformation.

Deep-Sea Ecosystems

- ***The deep-sea ecosystems of the Sargasso Sea GAC form an extensive, vertically structured system that dominates the region's volume and ecological functioning***. These ecosystems span the mesopelagic, bathypelagic, and abyssopelagic water column and deep seafloor, occupying the majority of the Sargasso Sea GAC and play a fundamental role in biodiversity maintenance, biogeochemical cycling, and long-term carbon sequestration. Despite their remoteness, they are integral components of the wider ocean system and are tightly linked to surface and physical processes.

- ***Large-scale circulation associated with the Atlantic Meridional Overturning Circulation exerts a primary control on deep-sea environmental conditions***. Northward-flowing upper waters, southward-flowing North Atlantic Deep Water, and northward penetration of Antarctic Bottom Water structure temperature, oxygen, and nutrient distributions throughout the deep Sargasso Sea. These flows link surface and deep ecosystems and contribute to relatively stable but spatially extensive environmental conditions at depth.

- ***Geological features introduce habitat heterogeneity and influence both pelagic and benthic ecosystem structure***. Abyssal plains, the Bermuda Rise, and extensive seamount chains modify deep currents, generate turbulence, and provide hard-substrate habitats that support distinct biological assemblages. These features also influence mesoscale circulation and play a role in structuring ecological connectivity across the region.

- ***Deep pelagic ecosystems are strongly coupled to surface productivity through episodic and seasonal vertical fluxes of organic matter***. Although the Sargasso Sea is oligotrophic, cyclonic and anticyclonic eddies, winter storms, and tropical cyclones generate pulses of primary production that are rapidly transferred to depth via sinking phytodetritus, faecal pellets and other components of marine snow. Most organic material is remineralized in the water column, yet sufficient flux reaches depth to sustain deep pelagic and benthic food webs.

- ***Mesopelagic communities dominate biomass and play a central role in active carbon transport and trophic connectivity***. Vertically migrating fishes, cephalopods, crustaceans, and gelatinous

organisms transport organic carbon from surface waters into the ocean interior through respiration, excretion, and predation at depth. These communities form a critical prey base for higher trophic levels and constitute a major, but still poorly quantified, component of the ocean carbon pump.

- ***Bathypelagic and abyssopelagic ecosystems host specialized and poorly known faunal communities adapted to extreme environments***. Species richness and biomass decline with depth, but deep communities represent a vast reservoir of biodiversity characterized by physiological and ecological adaptations to darkness, pressure, and food limitation. Limited sampling means that species composition, distribution, and ecosystem functioning in these zones remain incompletely understood.

- ***Seamounts and mesoscale eddies act as organizing features that enhance ecological connectivity and predator–prey interactions***. These structures modify physical conditions, aggregate mesopelagic prey, and provide foraging opportunities for large pelagic predators including tunas, sharks, and cetaceans. Their role in linking surface, midwater, and deep ecosystems underscores the importance of physical–biological coupling in the Sargasso Sea.

- ***Benthic ecosystems are sustained by the episodic delivery of organic material from surface and midwater processes***. Seasonal phytodetritus fluxes, faecal pellets, vertical migration, and the sinking of macroalgae such as *Sargassum* provide pulses of food to the deep seafloor, supporting scavengers, deposit feeders, and microbial communities. Although spatially patchy, these inputs form the primary energetic link between surface production and abyssal life.

- ***Benthic biodiversity shows patterns typical for elsewhere in the deep sea.*** There is a decline in biomass and abundance of benthic fauna with increasing depth. Species richness shows a parabolic pattern with depth, with peak diversity occurring at mid-slope depths. Areas of physical disturbance, for example from benthic storms, typically show reduced biodiversity but increased biomass and abundance.

- ***Overall, deep-sea ecosystems of the Sargasso Sea are tightly coupled to surface dynamics, circulation, and geological structure, yet remain poorly explored***. Their ecological and biogeochemical importance contrasts with substantial gaps in knowledge of biodiversity, connectivity, and sensitivity to climate-driven change, highlighting the need for sustained observations and targeted exploration to inform effective conservation and management of the Sargasso Sea GAC.

The Sargasso Sea ABNJ Ecosystem

- ***Sargasso Sea ABNJ ecosystems represent a globally significant mosaic of open-ocean habitats***. The Sargasso Sea ABNJ ecosystem represents a rare and ecologically significant mosaic of habitats within the open ocean, supporting exceptionally high biodiversity and a wide range of ecosystem functions despite its oligotrophic setting. Thousands of species spanning dozens of phyla have been recorded in the region, including endemic taxa associated with floating *Sargassum* habitats, migratory megafauna, deep-sea communities, and globally important populations of birds, fishes, and invertebrates.

- ***The region fulfills critical life-history functions for numerous species of high conservation value***. The Sargasso Sea supports essential spawning, feeding, development, and migratory functions for a wide range of species, including eels, sea turtles, whales, pelagic fishes, and seabirds. The presence of reef-forming cold-water corals, vulnerable marine ecosystem indicator taxa, and seamount-associated communities further underscores the ecological importance of the region.

- ***International assessments consistently recognize the Sargasso Sea as an area of global ecological importance.*** Designations including EBSAs (Ecologically or Biologically Significant Areas), VMEs (Vulnerable Marine Ecosystems), IBAs (Important Bird Areas), and KBAs (Key Biodiversity Areas) reflect the concentration of sensitive habitats and species and provide a strong scientific foundation for conservation prioritization.

- ***Substantial gaps remain in knowledge of biodiversity, population status, and ecological connectivity***. Only a small proportion of recorded species have undergone formal conservation assessments, with many taxa classified as data deficient. These gaps constrain understanding of ecosystem vulnerability to climate change, fisheries interactions, vessel traffic, and other cumulative pressures.

- ***Available evidence indicates extensive overlap between critical habitats and the ABNJ feature***. Habitat suitability modelling and spatial analyses suggest that large areas of the Sargasso Sea ABNJ simultaneously support multiple species of conservation concern, emphasizing its role as a shared ecological space linking national jurisdictions and the high seas.

- ***Overall, the Sargasso Sea ABNJ warrants continued recognition and coordinated international stewardship***. The ecosystem is characterized by high biodiversity, strong ecological connectivity, and multiple overlapping designations of international significance. Existing evidence supports its status as critical habitat requiring improved monitoring, enhanced data collection, and sustained international cooperation to inform future conservation and management.

Shipping

- ***International shipping is a pervasive and growing human activity across the Sargasso Sea***. International shipping is a prevalent and expanding human activity across the Sargasso Sea, with multiple major trans-Atlantic routes intersecting the GAC. Cargo and tanker vessels dominate traffic volume and spatial extent, while passenger vessels concentrate along narrower seasonal corridors. Shipping activity is persistent throughout the year, with pronounced seasonal peaks and increasing vessel speeds, reflecting broader global trends in maritime transport.

- ***The spatial overlap between shipping lanes and ecologically important habitats creates cumulative environmental risks***. The intersection between high-density shipping lanes and ecologically important habitats raises concerns regarding cumulative environmental impacts. Vessel traffic contributes significantly to underwater noise pollution, which degrades the acoustic environment and interferes with communication, foraging, and migration of marine species, particularly those sensitive to low-frequency sound.

- ***Ship strikes pose a potentially significant but poorly quantified threat to large marine vertebrates***. Ship strikes represent a further risk to large marine vertebrates. While direct evidence linking ship strikes in the Sargasso Sea to specific traffic patterns remains limited, the strong spatial overlap between shipping corridors and critical habitats suggests elevated interaction risk. Underreporting of strike events and the lack of systematic monitoring in high seas areas constrain robust assessment of this threat.

- ***Shipping activity introduces pollution risks through operational discharges and accidental releases***. Shipping also poses pollution risks through operational discharges, accidental spills, and illicit activities such as bilge dumping. Satellite-based detection demonstrates that oil slicks occur within the broader Sargasso Sea region, although the frequency, composition, and ecological consequences of these events remain poorly quantified.

- ***Ballast water discharge presents a pathway for the introduction of non-native and invasive species***. Ballast water discharge presents an additional pathway for the introduction of non-native and invasive species. High concentrations of introduced taxa in the North Atlantic are likely linked to intense shipping activity, although limited reporting data restrict the ability to directly associate ballast discharge events with biological invasions.

- ***Physical disturbance from vessels may affect sensitive habitats such as floating* Sargassum *mats.*** Physical disturbance from vessel operations may affect sensitive habitats such as floating *Sargassum* mats. Given the central ecological role of *Sargassum* structure in the Sargasso Sea ecosystem, potential degradation from repeated vessel disturbance represents an emerging concern, although empirical evidence remains limited.

- ***Governance mechanisms for managing shipping impacts in the Sargasso Sea remain limited.*** Despite the ecological significance of the region, no Particularly Sensitive Sea Areas have been designated in or adjacent to the Sargasso Sea. Governance of shipping impacts in this high seas area remains fragmented, and substantial data gaps persist regarding underwater noise levels, ship strike incidence, waste disposal practices, and cumulative impacts of increasing vessel speed and density.

- ***Overall, shipping represents a significant and intensifying anthropogenic pressure on the Sargasso Sea ecosystem.*** While existing data identify clear pathways of risk, significant uncertainties limit comprehensive impact assessment, highlighting the need for improved monitoring, enhanced reporting, and coordinated international management approaches.

Marine Fisheries

- ***Marine fisheries represent a direct anthropogenic pressure on biodiversity in the Sargasso Sea***. Marine fisheries constitute a direct human pressure on biodiversity in the Sargasso Sea, operating across both areas beyond national jurisdiction and adjacent EEZs. Although the overall contribution of the region to global high seas fisheries landings and value is relatively small, fishing activity targets ecologically important and highly migratory pelagic species, most of which

are high trophic-level predators. The implications from these species interactions through highly connected food webs extend well beyond the geographic boundaries of the Sargasso Sea.

- ***Large pelagic species dominate fisheries catches and are targeted by a small number of distant-water fleets***. Fisheries operating in the region primarily target large pelagic species, including tunas, swordfish, billfishes, and sharks, with yellowfin tuna and albacore tuna historically accounting for among the largest proportions of catch. High seas fishing effort is dominated by a number of distant-water pelagic longline fleets, including those flagged to Taiwan, Spain, and the United States, underscoring the importance of international cooperation in fisheries management.

- ***Stock status assessments reveal contrasting outcomes among commercially important species***. Stock assessments indicate mixed outcomes across key target and bycaught species. Recent ICCAT assessments indicate generally favourable status for several Sargasso-associated stocks, with some albacore stocks, skipjack tuna and North Atlantic swordfish currently assessed as not overfished and not subject to overfishing, and North Atlantic blue shark assessed as relatively healthy. In contrast, species such as blue marlin, white marlin, sailfish, and North Atlantic shortfin mako sharks, remain overfished and/or subject to ongoing overfishing, highlighting persistent management challenges.

- ***Bycatch of vulnerable species remains a key ecological concern constrained by data limitations***. Bycatch of endangered, threatened, and protected species represents a significant ecological concern, particularly for sea turtles and oceanic sharks. Limited observer coverage, inconsistent reporting, and data deficiencies constrain the ability to accurately quantify bycatch rates and assess population-level impacts, especially within the Sargasso Sea itself. Uncertainties related to the actual definition of bycatch further complicate bycatch assessment.

- ***Risk Associated with Potential Mesopelagic Fisheries in the Sargasso Sea***
  The ocean twilight zone contains up to 90% of global fish biomass and plays a critical role in marine food webs and carbon sequestration, yet major uncertainties remain regarding mesopelagic biomass, ecosystem functions, and sustainable harvest levels. Mesopelagic fish are key prey for tuna and swordfish and are vulnerable to overfishing due to their biological characteristics and poorly understood population dynamics. Evidence from other regions shows that industrial-scale mesopelagic fishing has already removed substantial midwater biomass through often under-reported catches, raising concerns that similar fisheries in the Sargasso Sea could disrupt food webs, carbon export, and fisheries sustainability, particularly given current regulatory gaps and weak management frameworks.

- ***Strong ecological connectivity links Sargasso Sea fisheries with adjacent national jurisdictions***. Fisheries in the Sargasso Sea are ecologically connected to coastal and island State fisheries, with the majority of catches of Sargasso Sea-associated species occurring within national jurisdictions. This connectivity reinforces the need for coordinated management across RFMOs, other fisheries advisory bodies, and coastal States to ensure the sustainability of shared stocks.

- ***Fish stocks provide critical ecosystem functions beyond their commercial value***. Beyond their economic value, fish stocks in the Sargasso Sea play essential ecological roles as forage species,

apex predators, and key contributors to carbon export and ecosystem resilience. Effective fisheries management must therefore adopt an ecosystem-based approach that accounts for trophic interactions, biodiversity conservation, and the cumulative impacts of fishing pressure.

- ***Overall, fisheries impacts are ecologically significant despite modest catch volumes***. Overall, while fisheries contribute modestly to global catch volumes, their ecological footprint in the Sargasso Sea may be disproportionately large relative to their modest catch volumes, particularly due to bycatch of vulnerable species and interactions with highly connected food web. Persistent data gaps, particularly relating to bycatch, spatial fishing effort, and cumulative impacts, limit comprehensive assessment. Strengthening monitoring, observer coverage, and international governance is essential to safeguarding the ecological integrity of the Sargasso Sea while supporting sustainable fisheries.

Fisheries for Catadromous Species

- ***Catadromous eel fisheries are multinationally connected to the Sargasso Sea through panmictic life histories***. Fisheries targeting American (*Anguilla rostrata*) and European (*Anguilla anguilla*) eels represent a small but potentially ecologically and socioeconomically significant interaction between human activity and the Sargasso Sea ecosystem. Both species are panmictic, long-lived, and dependent on the Sargasso Sea as their sole known spawning ground in the Atlantic, making fisheries impacts across their ranges relevant to the integrity of this ecosystem.

- ***International demand for eels drives persistent fishing pressure across multiple Range States***. Global demand for anguillid eels is primarily driven by aquaculture and consumption markets in East Asia, with glass eels constituting the most valuable life stage. Because captive breeding is not yet commercially viable, eel farming remains entirely dependent on wild-caught juveniles, creating sustained fishing pressure on early life stages across multiple Range States.

- ***Management effectiveness varies widely across American eel Range States***. American eel fisheries exhibit wide geographic variation in scale and management effectiveness. While Canada and the United States have implemented increasingly stringent regulatory frameworks, including quotas, licensing, and traceability systems, fisheries in parts of the Caribbean remain weakly regulated or unmanaged. Overall, there is an increasing risk of overexploitation and illegal trade across Range States.

- ***European eel fisheries remain unsustainable despite extensive regulatory controls.*** The European eel fisheries have experienced long-term population declines and the stock status is of concern, reflecting cumulative impacts from overfishing, habitat loss, barriers to migration, pollution, climate change, and illegal exploitation. Despite extensive regulatory measures in the European Union and across its range, including fishing closures and trade bans, the species remains critically depleted, and illegal harvesting and trafficking persist.

- ***Illegal fishing and trade undermine conservation and management efforts***. Illegal, unreported, and unregulated fishing and trade represent a major challenge for both American and European eels. High market values, complex international supply chains, and weak enforcement in some

Range States facilitate laundering of illegal catch and undermine conservation and management efforts.

- ***Fisheries impacts interact with multiple non-fisheries threats across eel life cycles***. The impacts of eel fisheries are closely additive to a range of non-fisheries threats, including river fragmentation, hydropower-related mortality, habitat degradation, and climate-driven changes in oceanic and freshwater systems. Addressing fisheries impacts in isolation is therefore insufficient to ensure population recovery.

- ***Catadromous fisheries pose an ecological threat requiring coordinated international action***. Overall, catadromous eel fisheries pose a threat to species that are biologically vulnerable and globally connected to the Sargasso Sea. Effective conservation will require coordinated international management across all life stages, strengthened monitoring and enforcement, reduction of illegal trade, and integration of fisheries measures with broader ecosystem-based management approaches.

Other Seabed Activities

- ***Other seabed activities currently represent a limited but emerging pressure in the Sargasso Sea ABNJ***. Other seabed activities in the Sargasso Sea ABNJ are limited at present but represent a potentially significant future pressure on deep-sea ecosystems. These activities fall under the mandate of the International Seabed Authority and include deep seabed mineral exploration and the installation and maintenance of submarine communications cables.

- ***The Sargasso Sea overlaps with areas containing mineral deposits of potential economic interest***. The Sargasso Sea region overlaps with areas known to contain mineral deposits of potential economic interest, including polymetallic sulphides associated with the Mid-Atlantic Ridge and cobalt-rich ferromanganese crusts on seamounts. While no commercial extraction is currently underway, existing exploration contracts and extended continental shelf claims indicate that future mining interest could expand into or adjacent to the Sargasso Sea.

- ***Deep seabed mining poses significant and potentially long-lasting ecological risks***. Deep seabed mining has the potential to cause extensive and long-lasting impacts on benthic and benthopelagic ecosystems. Physical removal and disturbance of seabed habitats, generation of sediment plumes, release of toxic substances, and increased noise and light pollution could affect biological communities well beyond the immediate footprint of mining operations, with recovery expected to be slow or uncertain.

- ***Submarine telecommunications cables constitute the primary existing seabed infrastructure***. Submarine telecommunications cables represent the most widespread existing seabed infrastructure in the Sargasso Sea. Although their footprint is relatively narrow, cable installation, burial, repair, and removal disturb seabed sediments and associated fauna, particularly in areas where cables are ploughed or jetted into the seabed.

- ***Cable-related impacts are generally localized but may be cumulative over time***. Compared to other seabed activities, the ecological impacts of submarine cables are generally localized and less severe than those associated with deep seabed mining. However, repeated maintenance over the operational lifespan of cables may cause cumulative disturbance to benthic habitats that have partially recovered following initial installation.

- ***Overall, precautionary management is essential to address future seabed activities***. Overall, seabed activities other than fishing currently pose a low but potentially increasing risk to the ecological integrity of the Sargasso Sea. Anticipated future expansion of mineral exploration underscores the need for precautionary management, improved baseline data on deep-sea ecosystems, and coordinated international governance to ensure that seabed activities do not compromise this globally important high seas environment.

Major Global Impacts on Sargasso Sea

- ***Major global impacts exert pervasive and interacting pressures on the Sargasso Sea ecosystem.*** Major global impacts, including climate change, habitat alteration, and pollution, represent pervasive and intensifying pressures on the Sargasso Sea ecosystem. These stressors operate at basin-wide and global scales, interacting with regional oceanographic processes to influence ecosystem structure, productivity, and biodiversity.

- ***Climate change is an emerging dominant driver of physical and ecological change***. Climate change is emerging as a dominant driver of ecological change in the Sargasso Sea. Model projections indicate that the region is a hotspot for ocean warming, with increasing sea surface temperatures and more frequent and intense marine heatwaves. These changes are expected to alter physical and biogeochemical conditions, disrupt life-history cues for sensitive species, and affect the integrity of key habitats such as floating *Sargassum* mats.

- ***Climate-driven biogeochemical shifts may restructure productivity and food webs***. Climate-driven changes in temperature, salinity, stratification, and ocean chemistry are likely to influence primary productivity and trophic structure. Shifts in phytoplankton communities and productivity may cascade through food webs, affecting recruitment success and biodiversity across pelagic and benthic ecosystems. Strong physical connectivity within the North Atlantic gyre suggests that such changes may have consequences well beyond the immediate boundaries of the Sargasso Sea.

- ***Habitat alteration threatens the persistence of vulnerable deep-sea ecosystems***. Habitat alteration and loss present additional risks, particularly for deep-sea ecosystems. Habitat suitability models suggest that some cold-water coral species may persist under future climate scenarios, while others are unlikely to survive, indicating potential restructuring of benthic habitats and associated communities. Changes in deep-water mass properties further complicate projections of ecosystem response.

- ***Pollution, particularly plastics, is widespread despite the region's remoteness***. Pollution remains a significant and persistent pressure despite the remote location of the Sargasso Sea. Floating marine debris, particularly plastics and microplastics, accumulates in the subtropical gyre and is

now ubiquitous throughout the region. Long-term observations reveal high concentrations of microplastics, increasing trends over recent decades, and extensive spatial variability driven by ocean circulation.

- ***Oil-derived pollutants persist despite long-term regulatory improvements***. Oil-derived pollutants, including tar balls, remain present in the Sargasso Sea despite substantial declines following the introduction of international regulations such as MARPOL (International Convention for the Prevention of Pollution from Ships). While regulatory measures have reduced inputs, episodic pollution events continue to occur, and the ecological consequences for *Sargassum*-associated and pelagic communities remain poorly understood.

- ***Marine debris increases ecological risks through species transport and invasion***. Marine debris also facilitates the transport of rafting organisms, increasing the risk of species introductions and potential invasions. Durable plastic materials provide long-lived substrates that enhance long-distance dispersal of coastal species into open-ocean environments, creating novel ecological interactions with uncertain consequences.

- ***Global impacts require precautionary and coordinated international responses***. Overall, major global impacts pose complex, interacting threats to the Sargasso Sea ecosystem. Persistent data gaps, particularly those relating to subsurface pollution, ecosystem-level effects, and cumulative impacts, limit predictive capacity. Addressing these challenges will require sustained monitoring, improved baseline data, precautionary management, and coordinated international action to mitigate global pressures on this globally significant open-ocean ecosystem.

Connectivity Within and Beyond the Sargasso Sea

- ***Connectivity underpins ecological processes within and beyond the Sargasso Sea***. Connectivity is a defining feature of the Sargasso Sea, driving ecological processes within the region and linking it to adjacent coastal waters and distant oceanic systems. Both structural and functional connectivity operate across horizontal and vertical dimensions, shaping species distributions, population dynamics, food webs, and ecosystem resilience across areas beyond national jurisdiction and neighbouring exclusive economic zones.

- ***Ocean circulation provides the structural framework for large-scale connectivity***. Ocean circulation features, including the North Atlantic subtropical gyre, mesoscale eddies, and major current systems, provide the structural framework that drives ecological connectivity. These processes facilitate the transport of nutrients, organisms, and energy across vast distances, linking the Sargasso Sea to surrounding marine environments and supporting its role as a central node in North Atlantic connectivity.

- **Vertical connectivity links surface production to deep-sea ecosystems.** Vertical connectivity between surface waters and the deep ocean is particularly important in the Sargasso Sea. Primary production in the epipelagic zone sustains mesopelagic, bathypelagic, and benthic ecosystems through the sinking and active transport of organic material, episodic food pulses, and diel vertical migration, creating strong trophic linkages throughout the water column and to the seafloor.

- ***Migration and dispersal create strong functional connectivity across jurisdictions.*** Functional connectivity is further reinforced through the migration and dispersal of highly mobile species, including sharks, tunas, sea turtles, cetaceans, and catadromous fishes. Tagging and tracking studies demonstrate that many species use the Sargasso Sea as a migratory corridor, foraging area, spawning ground, or nursery habitat, crossing multiple jurisdictional boundaries and highlighting the transboundary nature of ecological processes.

- ***Seamounts and eddies enhance ecological connectivity and predator–prey interactions***. Seamounts and mesoscale eddies act as focal points for connectivity by aggregating prey, enhancing productivity, and supporting foraging by large pelagic predators and cetaceans. These features promote vertical and horizontal linkages between pelagic and deep-sea communities and may also function as stepping-stones for dispersal over evolutionary timescales.

- ***Genetic evidence reveals complex patterns of population connectivity***. Genetic studies indicate varying degrees of population connectivity among deep-sea organisms, with some species exhibiting broad gene flow across the Sargasso Sea and others showing fine-scale genetic structuring related to depth, life history, and habitat associations. These patterns underscore the complexity of connectivity processes and the need to consider multiple spatial and temporal scales in management.

- ***Overall, connectivity is central to effective conservation and management.*** Essentially, connectivity is fundamental to the ecological integrity of the Sargasso Sea and its role within the wider Atlantic Ocean. However, significant knowledge gaps remain, particularly regarding deep-sea connectivity, larval dispersal, and long-term responses to climate-driven change. Effective conservation and management will require explicit integration of connectivity into area-based management tools, strategic planning, systematic conservation planning and international governance frameworks.

A Note on Stakeholder Engagement during Development of the SEDA

The SEDA includes a short description of how the UNDP GEF Sargasso Sea Project developed a broad and inclusive stakeholder engagement strategy to support both the Scientific and Ecosystem Diagnostic Analysis (SEDA) and the subsequent Strategic Action Programme (SAP). It explains that stakeholders were grouped into ‘Guardians’, ‘Users’, and ‘Beneficiaries’, with engagement tailored to their roles, expertise, and interests in the Sargasso Sea ecosystem.

The description emphasizes that effective conservation and management of areas beyond national jurisdiction depend heavily on early, inclusive, and voluntary stakeholder cooperation, since no single state has authority over the high seas. It concludes that building a long-term ‘community of practice’ across sectors is essential for the future stewardship and conservation of the Sargasso Sea and its connected ecosystems.

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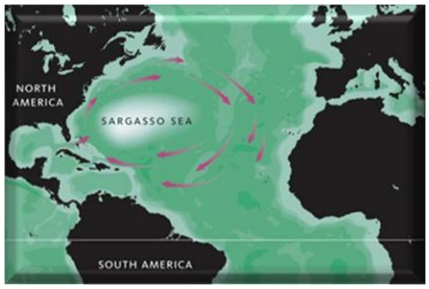
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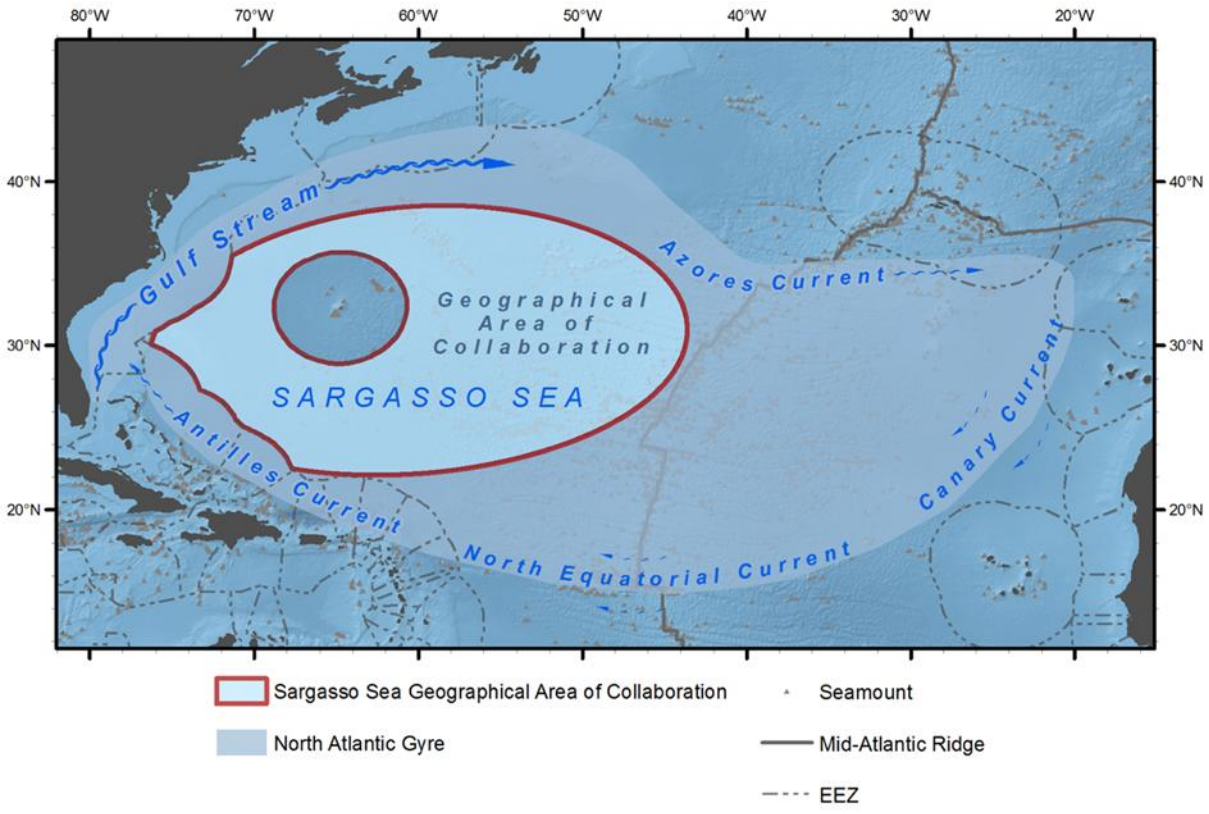
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Gulf Stream
Azores Current
Geographical Area of Collaboration
SARGASSO SEA
Antilles Current
Canary Current
North Equatorial Current
Sargasso Sea Geographical Area of Collaboration
North Atlantic Gyre
Seamount
Mid-Atlantic Ridge
EEZ