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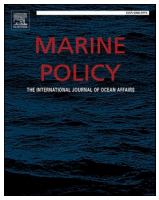

First steps towards untangling the sargassum legal regime in Puerto Rico

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ABSTRACT

A crucial factor limiting the implementation of effective mitigation actions for dealing with massive sargassum influxes is the lack of clarity of the sargassum legal framework. This article aims to clarify the sargassum legal framework in Puerto Rico focusing on sargassum removal from the beach and water, and the placement of sargassum contention barriers. A combination of a literature review, semi-structured interviews and a workshop were conducted to identify U.S. federal and Puerto Rico Commonwealth laws and regulations that apply. Furthermore, obstacles for implementing effective mitigation strategies were identified, and recommendations made to improve the permitting process. A flow chart of the permitting process was co-developed with agencies and academic representatives. Existing legal barriers were identified including lack of information and clarity in the permitting process and the extensive time required for permitting and for government policies to adjust to relevant groups' needs. Recommendations provided by agencies and other social actors include the development of a territory-wide response plan and localized plans for priority areas, and the continuation of meetings with agencies to clarify legal aspects of sargassum mitigation actions including its disposal on land. This study contributes essential information for the improvement of the governmental, private, and civil responses to sargassum events in Puerto Rico and other U.S. jurisdictions.

1. Introduction

Massive, recurrent influxes of floating sargassum seaweed have been reaching the Wider Caribbean Region and West African countries for more than a decade [34]. Pelagic *Sargassum* spp. (*Sargassum natans* and *Sargassum fluitans*, referred to as sargassum from hereon) serve as an important habitat for marine organisms in the open ocean [24]. However, its unprecedented accumulation along shorelines has been detrimental to coastal and marine ecosystems [1,3,28,33,20], coastal communities and their livelihoods, fisheries, tourism, and public health [11,17,27,30]. Most of the impacts of sargassum in the natural and social systems are related to its natural decay when accumulated along the shoreline, affecting the water quality [33], and emanating toxic gases that smell like rotten eggs due to hydrogen sulfide produced as a degradation byproduct [27].

A variety of efforts have been undertaken throughout the region to mitigate the impacts of these events [7,9,11,26], including the installation of floating boom barriers, removal in the ocean and beaches using manual and mechanical means, and finding alternatives for its reuse and valorization. The mitigation of sargassum impacts represents an economic challenge to the nations, states, and territories of the Wider Caribbean Region. Specialized equipment and infrastructure are needed for the containment, removal, transportation, and disposal or use of sargassum. Because sargassum influxes are a relatively new phenomenon, no prior policy frameworks, management plans or regulations exist, and governments have been slow to respond [26,30].

The archipelago of Puerto Rico is an unincorporated territory of the United States and has a complex regulatory and policy regime. The Commonwealth and U.S. federal government share jurisdiction over the coastal and marine resources in Puerto Rico. However, there is a lack of government support and policies to deal with sargassum [12]. Observations by the authors of this article suggest the public is generally unaware that certain sargassum removal actions in the coastal area require permits and reveal that these actions, as well as the placements

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of boom barriers, are being conducted without the required permits. Although the Puerto Rican government wrote a protocol about how to respond to sargassum influxes [9], it did not include the steps to follow to request the permits necessary to conduct those activities. Clarifying the legal framework is crucial for the implementation of effective mitigation measures to foster the development of innovative solutions. The purpose of this study is to describe the sargassum legal framework in Puerto Rico, with a focus on the first steps of the sargassum management process (e.g., on-water and at-beach sargassum removal and placement of sargassum barriers). Specific objectives include clarifying the jurisdiction of federal and Commonwealth agencies with respect to these first steps, clarifying the permits needed for these activities, and identifying obstacles for implementing effective mitigation strategies and potential solutions to facilitate the permit application and authorization process.

2. Method

2.1. Study area

The archipelago of Puerto Rico (18.2208° N, 66.5901° W) is part of the Greater Antilles in the Caribbean Sea. The first documentation of unusual amounts of sargassum in Puerto Rico was in La Parguera, Lajas in 2011 [16], but reports in local media became more frequent from 2014 onwards. Since then, sargassum management actions have mainly focused on sargassum removal from the beach and its disposal in coastal forests, landfills, and vacant lands. These actions are conducted by a variety of entities including the Commonwealth government, coastal municipalities, non-profits, and local communities.

In Puerto Rico, sargassum is used for non-commercial small-scale purposes, including compost, dune and coastal restoration, and for research around innovation alternatives [18]. In addition, aiming to encourage the creation of a new value chain for sargassum in Puerto Rico, in 2022 the economic development organization of Puerto Rico, Invest Puerto Rico, partnered with Newlab, who recruited entrepreneurs and early-stage companies to pilot solutions for sargassum collection and valorization.

2.2. Data collection

The collection of data was conducted using three approaches: reviewing key documents (laws, regulations, and other guidance documents), conducting semi-structured interviews, and conducting a workshop. These approaches, particularly the first two, were not chronological but conducted as necessary.

With the guidance of federal and local agency representatives (Table 1), federal and local laws and regulations were collected and interpreted regarding sargassum management actions. This process also served for validating the complexity of the issue and recognizing the current limitation in terms of research resources. Therefore, this study focused on the first steps of the sargassum management regime (e.g., on-water and at-beach sargassum removal and placement of sargassum barriers) where most of the confusion and misunderstanding occurred. In addition, ocean disposal of sargassum was included because of the increasing interest in this topic and the reduced research effort required to examine it. Sargassum disposal on land was not included in this effort because it requires an extraordinarily complex set of regulatory and permitting processes involving many local and federal entities. Land disposal should be addressed in future research focusing specifically on that topic. This article encompasses the first step towards untangling the sargassum legal regime in Puerto Rico.

Table 1
List of agencies that participated in the semi-structured interviews and the workshop.

Agencies	Semi-structured interviews	Workshop
US Army Corps of Engineers (USACE)	✓	✓
National Oceanic and Atmospheric Administration (NOAA)		
National Marine Fisheries Service (NMFS)		
- Protected Resources Division	✓	✓
- Habitat Conservation Division	✓	✓
- Office of General Counsel	✓	
Caribbean Fisheries Management Council (CFMC)	✓	
US Fish and Wildlife Service (USFWS)	✓	✓
US Environmental Protection Agency (EPA)	✓	✓*
Puerto Rico Department of Natural and Environmental Resources (DNER)	✓	

* Attended the first section of the workshop.

Semi-structured interviews with agency representatives and other relevant groups (e.g., coastal community members, non-governmental organizations, and private companies) that have participated in the permitting process for sargassum management activities were conducted. The interview guide comprised open-ended questions on topics including the jurisdiction of each agency in regulating sargassum removal activities and ocean disposal, permits and consultations required by proponents of sargassum management activities, and potential obstacles in the permitting process. With this information, a draft flow chart of the permitting process for sargassum removal, placement of barriers, and ocean disposal was created.

On June 21, 2022, a half day virtual workshop was conducted in collaboration with Sea Grant Puerto Rico, titled "Legal Considerations on the Removal of Sargassum from the Coasts of Puerto Rico." Its purpose was to implement the study objectives by identifying obstacles for implementing effective mitigation strategies, clarifying the jurisdiction and the role of each agency in permit processes, and assessing the need to facilitate the permit application process. In order to accomplish workshop objectives with the resources available, a limited number of workshop participants were identified and a total of 32 email invitations were sent. Aside from the 6 individuals running the workshop, 14 individuals participated, including federal and local agency representatives (Table 1), faculty from Texas A&M University- Corpus Christi and from Universidad Nacional Autónoma de México, and coastal community members, non-governmental organizations, and a private company, all with familiarity with sargassum removal activities. The workshop had three sections (Table 2), an introduction, and two participatory activities, titled 1) sargassum removal permits, and 2) ideas to facilitate requesting permits for sargassum removal. Workshop materials were shared with participants who were encouraged to familiarize themselves with them one week before the workshop. The moderators of the workshop were the study lead and Sea Grant staff that have training in performing this role. The virtual workshop was recorded for research purposes and lasted approximately 4 hours.

After the workshop, another round of semi-structured interviews was conducted to discuss some legal aspects that needed further clarification (e.g., with USFWS, USACE, and EPA), and regarding the permitting process of the DNER, an agency that did not participate in the workshop.

3. Results and discussion

Overall, the study's findings provide insight into the federal and local laws and regulations that apply to sargassum removal and ocean disposal (Table 3), the permitting process for conducting these activities, obstacles for implementing effective mitigation strategies, and potential solutions.

3.1. U.S. Federal jurisdiction

3.1.1. Sargassum removal

Federal agencies directly involved in the permitting process for sargassum removal are the USACE, and in certain circumstances USFWS and NMFS (i.e., Endangered Species Act [ESA, 1973] Section 10 permits;

Table 2
Description of the workshop "Legal Considerations on the Removal of Sargassum from the Coasts of Puerto Rico."

Workshop Sections	Duration	Objective	Approach
Introduction to the workshop	1 h 30 min	Learn about how sargassum is affecting the coasts of Puerto Rico and the legal obstacles some entities experience when implementing or wanting to implement mitigation actions. Learn about the laws and regulations that may apply to sargassum removal and ocean disposal in Puerto Rico.	The study lead provided a presentation about the sargassum situation in Puerto Rico, sargassum removal alternatives, and a description of the workshop including objectives. Representatives from some federal and local agencies (e.g., USACE, EPA, NMFS, and USFWS), and other relevant groups (e.g., Palmas del Mar Homeowners Association, SOS Carbon, and Conservation Opportunity) provided short presentations following a template provided.
Activity #1: Sargassum removal permits	1 h 20 min	Clarify the jurisdiction and role of each agency in the permit process and co-develop a sargassum removal and ocean disposal permitting flowchart to serve as a guide for individuals or entities to identify which permit(s) they need to request for a particular activity.	The study lead described, step-by-step, the draft of the permitting process flowchart and its legal basis. Then, the discussion was open for participants to comment on edits to the diagram as necessary. To validate the edited flowchart, a moderator went through a series of hypothetical scenarios for participants to validate the flowchart and make final adjustments.
Activity #2: Ideas to facilitate the process of requesting permits for sargassum removal	40 min	Provide ideas for overcoming identified obstacles and for facilitating the permitting process.	Participants were divided into two breakout rooms, one group mainly consisting of agency representatives and the other of representatives from other relevant groups. Agency representatives were asked about the possibility of an expedited permit application and representatives from other relevant groups were asked about how to improve access to information on the necessary permits.

Marine Mammal Protection Act [MMPA, 1972] incidental harassment authorization or letter of authorization). Federal agencies engaged in actions such as granting permits may be required to meet the ESA section 7 consultation requirements and the National Environmental Policy Act (NEPA, 1970) requirements. All federal agencies funding, authorizing, or carrying out a federal action must comply with NEPA, which was created to ensure that federal agencies assess the environmental consequences of their decisions and actions before they are made and taken. Depending on the action, some may qualify as a categorical exclusion, where no significant environmental impact is expected, or may require an environmental assessment (EA) or environmental impact statement (EIS). However, categorical exclusions do not mean that permits, authorizations, and consultations under laws such as ESA and MMPA are not required.

The USACE has regulatory authority under the Rivers and Harbors Act (RHA, 1899), which prohibits the unauthorized obstruction or alteration of navigable waters of the U.S. (i.e., from the mean high-water line to the limit of the Exclusive Economic Zone [EEZ]) without an RHA Section 10 permit, and under the Clean Water Act (CWA, 1977), which prohibits the unauthorized discharge of dredge or fill material into waters of the United States, including wetlands. Under Section 10 of the RHA, any mechanized work that will change the bottom elevation (e.g., discharges or dredge or filled material, or dredging) of navigable waters of the U.S., and the placement of structures in navigable waters of U.S. will require a permit from USACE. In the case of sargassum removal, mechanized work includes, for example, the use of heavy machinery, conveyor-based machines, and pumping devices operated seaward of the mean high-water line that may modify the elevation of the seafloor. The placement of structures refers to any obstacle or obstruction to navigable waters of the U.S., including the placement of a boom barrier to retain sargassum away from the shoreline. Some of these actions may also require authorization under Section 404 of the CWA, for example, if they involve fill placement.

The ESA and the MMPA play a role in the sargassum legal regime. ESA administration is a shared responsibility between USFWS and NOAA's NMFS. Section 7 establishes that Federal agencies must consult with USFWS and NMFS when any action the agency carries out, funds, or authorizes may affect listed threatened or endangered species or their designated critical habitat. Sargassum removal activities could be conducted in areas where ESA-listed species are present and/or in areas of designated critical habitats (Table 4). Therefore, federal agencies may need to consult with NMFS and USFWS before granting a federal permit for these purposes. In the case of non-federal actions (e.g., an activity that does not involve federal funds, a federal agency, or a federal permit), ESA's Section 10 provides a mechanism for NMFS and USFWS to issue permits to protect individuals or private citizens from being criminally charged for incidentally taking (as defined in the ESA) a federally-listed endangered species or a threatened species as part of an otherwise lawful activity. NMFS and USFWS also share responsibility for implementing the MMPA to conserve and manage marine mammals. Taking of marine mammals (e.g., harassment, hunting, capturing, collecting, or killing) is prohibited under the MMPA, with certain exceptions. Therefore, a proponent of a sargassum removal activity and/or its disposal in the ocean, will need to establish measures to prevent harassing, injuring or killing marine mammals during these activities and may require authorization for harassment, likely Level B harassment, of marine mammals if it cannot be prevented due to sargassum removal or disposal activities. MMPA defines Level B Harassment as "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act from hereon, 1976) is the primary law that governs fisheries management in the U.S. EEZ. It provides for the establishment of eight regional fisheries management councils, of which some have developed fisheries management plans that include sargassum as an essential fish habitat (EFH). EFH consultations are required for all federal actions that may adversely affect EFH regardless

Table 3
Federal and Commonwealth laws and regulations that apply to sargassum removal and ocean disposal. See the references section for full law citations.

U.S. Federal Laws
Clean Water Act (1977)
Coastal Zone Management Act (1972)
Endangered Species Act (1973)
Magnuson-Stevens Fishery Conservation and Management Act (1976)
Marine Mammal Protection Act (1972)
Marine Protection, Research, and Sanctuaries Act (1972)
National Environmental Policy Act (1970)
National Historic Preservation Act (1966)
Ports and Waterways Safety Act (1972)
Rivers and Harbors Act (1899)
Robert T. Stafford Disaster Relief and Emergency Assistance Act (1988)
Puerto Rico Commonwealth Laws
Coastal Management Program for the Commonwealth of Puerto Rico (1978)
Constitution of the Commonwealth of Puerto Rico (1952)
Dock and Harbor Law of Puerto Rico (1968)
Environmental Public Policy Act (2004)
Procedures in Emergency Situations or Events Act (2000)
Puerto Rico Public Safety Department Act (2017)
Organic Act of the Department of Natural and Environmental Resources (1972)
Puerto Rico Permits Process Reform Law (2009)
Regulation for the Use, Surveillance, Conservation and Management of the Territorial Waters, Submerged Lands Thereunder and the Maritime Zone (1992)
Regulations for the Environmental Assessment Process (2016)

Table 4
Main listed species and designated critical habitats under the ESA that could be affected by sargassum mitigation actions on the coast of Puerto Rico.

Listed Species	Status	NMFS	USFWS	Critical Habitat	Critical Habitat Location
Antillean manatee (*Trichechus manatus manatus*)	threatened		✓		
Leatherback sea turtle (*Dermochelys coriacea*)	endangered	✓ (in water)	✓ (on land)		
Hawksbill sea turtle (*Eretmochelys imbricata*)	endangered	✓ (in water)	✓ (on land)	✓	Coastal waters extending seaward 3 nm from the mean high-water line of Mona and Monito Islands, Puerto Rico Beachfronts from mean high tide to a point 150 m from shore along certain areas within Mona Island, Culebra Island, Cayo Norte, and Isla Culebrita.
Green sea turtle (*Chelonia mydas*)	threatened	✓ (in water)	✓ (on land)	✓	Coastal waters extending seaward 3 nm from the mean high-water line of Culebra Island, Puerto Rico and its surrounding islands and cays Proposed by NMFS: nearshore areas from the mean high-water line to 20 m depth of: Culebra Island, and certain areas of Mona Island, Vieques Island, Maunabo and Guayama Municipalities, and the northern coast of Puerto Rico Island Proposed by USFWS: beaches and coastal vegetation along shorelines in the Guayama, Maunabo, and Vieques Municipalities, and in Mona Island
Olive Ridley sea turtle (*Lepidochelys olivacea*)	threatened	✓ (in water)	✓ (on land)		
Elkhorn coral (*Acropora palmata*)	threatened	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from the line of mean low water to 30 m depth
Staghorn coral (*Acropora cervicornis*)	threatened	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from the line of mean low water to 30 m depth
Pillar coral (*Dendrogyra cylindrus*)	threatened*	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from 1 to 25 m depth
Rough cactus coral (*Mycetophyllia ferox*)	threatened	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from 5 to 90 m depth
Lobed star coral (*Orbicella annularis*)	threatened	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from 0.5 to 20 m depth
Mountainous star coral (*Orbicella faveolata*)	threatened	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from 0.5 to 90 m depth
Boulder star coral (*Orbicella franksi*)	threatened	✓		✓	Coastal waters surrounding the archipelago of Puerto Rico from 0.5 to 90 m depth
Nassau grouper (*Epinephelus striatus*)	threatened	✓		✓ (proposed)	Proposed by NMFS: waters off certain areas within Mona Island, Desecheo Island, southwest and northeast coasts of Puerto Rico Island, Vieques Island, and Culebra Island
Scalloped Hammerhead Shark (*Sphyrna lewini*)	threatened	✓			
Yellow-shouldered blackbird (*Agelaius xanthomus)*	endangered		✓	✓	Coastal areas in the east and southwest of Puerto Rico and Mona Island
Queen conch (*Aliger gigas*)	NMFS issued a proposed rule to list as threatened	✓			

* NMFS issued a proposed rule to change the status from threatened to endangered (88 FR 59501).

of where the activity takes place (e.g., territorial or federal waters). In the South Atlantic Region, a sargassum Fishery Management Plan was approved in 2003 that imposes harvest limitations on the commercial harvest of sargassum, prohibits harvest in certain areas including within 100 miles of shore, requires observers onboard any vessel harvesting sargassum, and implements gear specifications for conducting this activity. Some of these restrictions were because floating mats of sargassum are part of the designated critical habitat for certain life stages of loggerhead sea turtle. In 2019, pelagic sargassum was included as an EFH within the U.S. Caribbean EEZ (i.e., from mean high water to the outer boundary of the U.S. EEZ) in the Comprehensive Fishery Management Plan for the Puerto Rico Exclusive Economic Zone [5], but regulations are not yet approved. A consultation with NMFS is required whenever a federal action could adversely affect an EFH.

Other federal laws may apply in the case of federal actions (e.g., granting a federal permit for sargassum removal or disposal in the ocean), including the National Historic Preservation Act (1966), which requires federal agencies to identify and assess the effects of its actions on historic properties, and the Ports and Waterways Safety Act (1972) under the statutory responsibility of the U.S. Coast Guard, which promotes the safety of ports, harbors, waterfront areas, and navigable waters of the U.S.

3.1.2. Sargassum ocean disposal

The Marine Protection, Research, and Sanctuaries Act (MPRSA, 1972) prohibits the dumping of harmful materials into the ocean and requires a permit for transportation and disposal of others, including dredged material. The USACE is the granting agency for Section 103 permits of ocean dumping of dredged material following EPA's environmental criteria. However, the removal of sunken sargassum accumulated on the sea floor would not constitute dredging, unless the sargassum removal activities are conducted in a manner that would result in the mechanized removal of sea bottom sediments, which would change the bottom elevations and would require authorization from the Corps (D. Cedeño, USACE, pers. comm.). Therefore, the disposal of fresh floating sargassum and sunk decaying sargassum (without more than the incidental inclusion of sediments) may be considered ocean disposal of non-dredged material for which EPA is the granting agency. In the case of discharge of dredged material (e.g., seabed sediments and/or sunk decaying sargassum with more than the incidental inclusion of sediments) into waters of the U.S., including wetlands, such actions are regulated under Section 404 of the Clean Water Act (CWA, 1977), although EPA might require separate management of sargassum (M. Reiss, EPA, pers. comm.). The USACE issues these permits using the Environmental Protection Agency's (EPA) environmental criteria.

Notably, the MPRSA allows for issuance of emergency permits, but the applicant must sufficiently describe the material in terms of its composition and properties, the material to be disposed of should not float or remain in suspension in the ocean (40 C.F.R. 227 Subpart B: [15] and there has to be a demonstrated marked urgency requiring dumping of materials that pose an unacceptable risk to human health for which no other feasible solutions exist. Because currently there has not been an emergency permit request, the application of the law to sargassum events, including circumstances that might justify an emergency permit, is unclear.

3.1.3. Stafford declaration

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act from hereon, 1988) was enacted to provide assistance by the federal government to state and local governments in the case of an emergency or major disaster. For the first time in history, in July 2022, the U.S. Virgin Islands declared a state of emergency and President Biden approved the emergency declaration, enabling the Federal Emergency Management Agency to provide emergency aid to the Territory, due to unprecedented influx of sargassum affecting the territory's water supply. For Stafford Act federal assistance to be provided the following criteria must occur [21]: 1) an emergency or major disaster has occurred, 2) the needs resulting from the emergency or major disaster exceed local government capabilities and resources, 3) the local government has exhausted its emergency plan, dedicated it resources to respond, and agreed to cost-sharing requirements with the federal government. An emergency is defined as "…any occasion or instance for which… federal assistance is needed to supplement State and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe…" The Stafford Act also provides for major disaster declarations, which are defined as "…any natural catastrophe…., or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this chapter to supplement the efforts and available resources of states, tribes, territories, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby." A major disaster has never been declared for sargassum influx events.

The Stafford Act could provide needed assistance in the absence of or limitation on Commonwealth resources to deal with sargassum influxes. As an example, in 2017, Puerto Rico received billions of dollars earmarked by the federal government to help mitigate impacts of Hurricane María (FEMA, 2019). Although immediate assistance may be necessary in some circumstances, such as in the U.S. Virgin Islands case described above, sargassum influxes have become the new norm and funds that are limited to returning to status quo are not sufficient to deal with the situation. Stepping beyond emergency responses and providing forward-thinking approaches for implementing long-term sustainable solutions is needed.

3.2. Commonwealth of Puerto Rico jurisdiction

Different from most U.S. states, as a legacy of Spanish law, in Puerto Rico beaches are held in public trust by the Commonwealth government and its jurisdiction extends to 9 nautical miles offshore. The Puerto Rico Law of Waters (1976) established that all waters and bodies of water of Puerto Rico are the property and wealth of the people of Puerto Rico. The publicly-owned maritime terrestrial zone (MTZ) is defined as "the space of the coast that bathe the sea in its ebb and flow, including the space influenced by the tides and areas not influenced by the tides but where the largest waves during storms may reach, and also includes lands reclaimed by the sea and the margins of the rivers up to the place where they are navigable or influenced by the tides" (Dock and Harbor Law of Puerto Rico, 1968). Recent court cases also influenced the legal interpretation of the MTZ (Buono Correa v. Srio. Departamento de Recursos Naturales y Ambientales, 177 DPR 415, 2009; and Michel J. Godreau Robles, Mareas, Playas, Manglares y Bienes de Dominio Público: La Zona Marítimo Terrestre y la Protección del Ambiente post Buono v. Vélez Arocho, 81 REV. JUR. UPR 1215, 2012). In practical terms, the demarcation line between private property and the public domain is the point of transition between the inland and coastal vegetation and, in the case of dunes, the base of the landward side of the dune (E. Díaz, Tetra Tech, pers. comm.).

In accordance with the provisions of Article VI, Section 19 of the Constitution of the Commonwealth of Puerto Rico (1952), "It shall be the public policy of the Commonwealth to conserve, develop and use its natural resources in the most effective manner possible for the general welfare of the community…" Therefore, in 1972, the DNER was established with, among other purposes, "to exercise surveillance and see to the conservation of territorial waters, submerged lands thereunder and the MTZ, to grant franchises, permits and licenses of public nature for its use and exploitation and to establish through regulations the fees to be paid by same" (Organic Act of the Department of Natural and Environmental Resources, 1972). DNER has the duty to guarantee the conservation, protection, and management of the territorial waters and MTZ where sargassum accumulates.

Furthermore, in 1978, the Commonwealth adopted a Coastal Zone Management Program (PRCZMP; [25]) under the federal Coastal Zone Management Act (CZMA, 1972), which encourages coastal states and territories to develop and implement programs for managing their coastal zones. The PRCZMP provides certain benefits to Puerto Rico, including annual management funds and federal consistency provisions requiring many federal actions be consistent with the PRCZMP. The agency responsible for implementing the PRCZMP is DNER, while the Puerto Rico Planning Board is responsible for administering the federal consistency requirements. When the removal or disposal of sargassum in the ocean is part of a federal action (e.g., a federal permit is required), and the activity will take place in the Puerto Rico coastal zone, a federal consistency certificate will be required as part of the permitting process. The coastal zone of Puerto Rico is defined by the PRCZMP as the: "Strip of coastal land one thousand linear meters (1000 m) inland, measured from the coastline, as well as additional distances needed to include key coastal natural systems. It also includes territorial waters of Puerto Rico and the marine or ocean floor (three marine leagues, nine nautical miles or 10.35 land miles), the islands of Vieques, Culebra, Mona, Monito, Desecheo, Caja de Muertos and all the keys and islets within them."

Pursuant to its authority, DNER developed the Protocol for the Handling of Extreme Accumulations of Sargassum on the Coasts of Puerto Rico [9]. The document specifies the steps to follow in the event of extreme accumulations of sargassum and recommends management practices for their removal, but it does not specify the permitting process to be followed for these management actions. An update in 2023 included a brief mention of the jurisdictions of federal and Commonwealth governments for sargassum monitoring, and manual and mechanical removal [10]. According to the Regulation for the Use, Surveillance, Conservation and Management of the Territorial Waters, Submerged Lands Thereunder and the Maritime Zone (Reg. 4860, 1992), “any dredging or extraction of aggregates, or dredging within property in the maritime public domain” (Article 8), as well as “commercial activities which require temporary placement of movable property on property in the maritime public domain” (Article 9), shall be previously authorized by DNER and consistent with the PRCZMP. Reg. 4860 Article 16 also allows for the approval of emergency actions to impede or eliminate serious threats to health, safety, life, property, or the natural environment. In the case of a sargassum influx event being declared an emergency under an Executive Order by the Governor of Puerto Rico or by the President of the United States of America, the Procedures in Emergency Situations or Events Act (Law 76, 2000) and the Puerto Rico Public Safety Department Act (Law 20, 2017) establish the procedures to follow and the jurisdiction of local agencies.

Similar to NEPA, Puerto Rico also has the Environmental Public Policy Act (2004) and the Regulations for the Environmental Assessment Process (Reg. 8858, 2016), with the purpose of establishing a procedure to assess the environmental consequences of all government actions and their decisions.

Finally, the Puerto Rico Permits Process Reform Law of 2009 establishes the legal and administrative framework and agencies’ jurisdiction for the application, evaluation, granting, and denial of permits by the Government of Puerto Rico.

3.3. Sargassum removal and ocean disposal permitting process in Puerto Rico

The overlap of the U.S. federal and Commonwealth jurisdictions described is evident in the required permit process for sargassum removal and ocean disposal in Puerto Rico. This permitting process is represented in Fig. 1 as a flow chart that can be used as a general guide for proponents of these activities to verify which federal and/or Commonwealth permits they need to secure. It is important to note that each proponent should individually consult with agencies because the need for some permits is evaluated on a case-by-case basis. The Fig. 1 diagram consists of two main sections: the left one, permits required for sargassum removal actions conducted in the dry part of the beach, and the right one, permits required for sargassum removal and ocean disposal in the water.

Regarding sargassum removal activities in the dry part of the beach, landward of the Mean High-Water Line (MHW), it is required to have authorization from DNER under Reg. 4860. Regardless of the entity conducting the activity, all applications must show proof of insurance in case of accident (L. Sierra and J. Ramos, DNER, pers. comm.). If the removal activity is not carried out for economic benefit purposes, the applicant can request a waiver of the filing and occupation fee. Reg. 4860 does not cover the proponent from an incidental take of an ESA endangered species (e.g., sea turtles) while removing sargassum from the beach. Therefore, the applicant may request technical assistance from the FWS to determine whether a permit is needed under Section 10 (a)(1)(b) of the ESA. ESA and regulations set forward at 50 CFR §17.21 (c)(5) and 50 CFR §17.31(b) also provide the possibility for officially designated agents of the State to be exempt from Section 10 permit requirements if the activity is part of a species conservation program.

If the sargassum removal activity will take place in the wet part of the beach (seaward of the MHW), the first step is to ask whether the activity will require the use of mechanical means that may alter the seafloor elevation (deposition or removal of sediments) or if the activity involves the placement of a structure, in order to determine if a Section 10 RHA permit will be required and potentially a 404 CWA authorization depending on the use of the equipment or structure/anchor type and method for installation. This permit is requested through a USACE Joint Permit application submitted to DNER. The Joint Permit application allows other federal and Commonwealth agencies to evaluate the permit request at the same time and provide other consultations, certification, and/or permits needed. If the activity does not involve mechanical means and/or the placement of a structure a federal authorization would not be required, and the applicant must request a Reg. 4860 authorization from DNER and potentially request technical assistance from NMFS to determine whether an incidental take permit under Section 10 (a)(1)(b) of the ESA is needed.

Ocean disposal of sargassum requires a permit under Section 1412 of the MPRSA and an authorization from DNER under Reg. 4860 if conducted in Puerto Rico territorial waters. However, there are currently many unknowns about the impacts and behavior of sargassum when disposed in the ocean preventing EPA from providing special or general permits under Section 1412. Therefore, at this time, EPA can only evaluate research permit applications from research programs aimed at clarifying these research questions (M. Reiss, EPA, pers. comm.). Applicants aiming to collect sargassum that accumulates on the seafloor and dispose of it in the ocean should avoid the collection of sediments. The collection of sediments that could modify the bathymetry may be considered dredging by USACE. The transportation and discharge of dredged sediments requires Section 1412 MPRSA, and Section 404 CWA permits from USACE.

3.4. Obstacles for implementing effective mitigation strategies

During the semi-structured interviews and the workshop, obstacles to the sargassum removal and ocean disposal permitting process came to light. One of the main concerns identified early on, and one of the reasons behind conducting this study, is the fact that sargassum removal activities are being conducted in coastal areas of Puerto Rico without the required authorizations from the relevant Commonwealth and federal government agencies. Some of the reasons for this identified by this study are that entities: lack knowledge and interest about the permits they need, believe agencies are not clear as to which permits are needed, and believe excessive time and effort is required for permits to get approved.

Currently, there are no guidelines as to which types of permits proponents need to request for sargassum management actions in Puerto Rico. For example, a coastal community experiencing sargassum

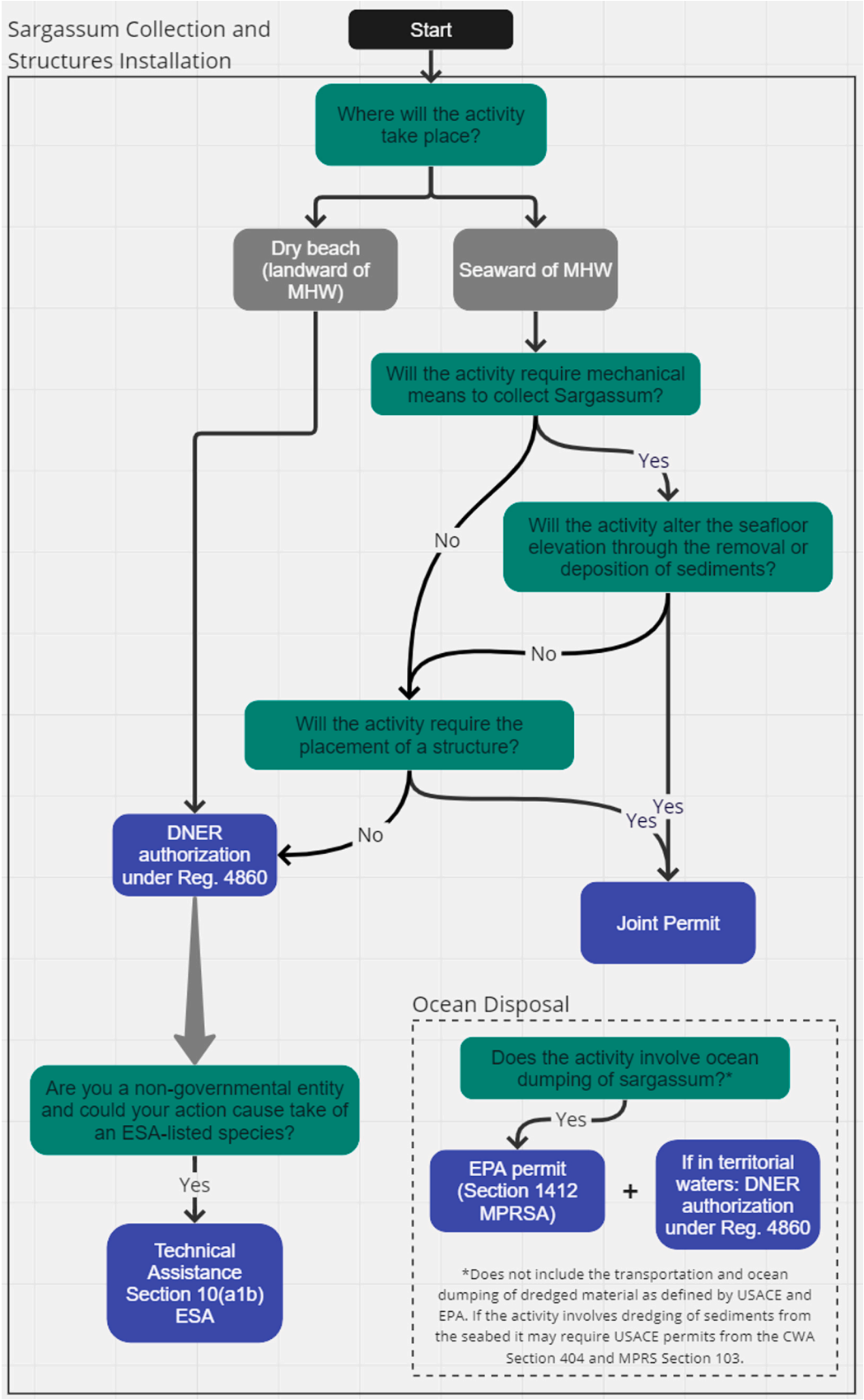

Fig. 1. Sargassum removal and ocean disposal permitting flowchart for Puerto Rico. Additional information is included in the text.

impacts may notify local authorities (e.g., municipal government and/or DNER local office), who may or may not know the permitting process and, in the absence of a timely response, the community may start to remove sargassum with the resources and capacity they have, unaware of the permitting process that may be necessary for those actions. On the other hand, others may simply have no interest in requesting permits, mainly because of a lack of trust in government processes and the popular knowledge that laws are not well enforced and that legal consequences will not be enough to be worth the effort to obtain approval.

Interviews also revealed that there are discrepancies in agency personnel's understanding of the permits and processes that apply to sargassum removal. A participant mentioned that, for example, DNER has experienced employee layoffs and changes in employee duties and responsibilities within the agency, which impacts institutional memory. One of the discrepancies encountered was that some DNER agency representatives deduced that having a section 6 collaborative agreement with USFWS and granting a state permit implies that the permit applicant is covered by the ESA. However, the reality is that the Commonwealth would have to explicitly state they are designating those permit applicants or contractors conducting the activity as their agents for the activities proposed, and the activity must be part of a species conservation plan for them to be covered under the ESA (50 CFR §17.21(c)(5) and 50 CFR §17.31(b)). Some DNER representatives misunderstood that federally-funded projects must submit a Joint Permit application only when there is USACE jurisdiction (e.g., Section 10 of the RHA, Section 404 of the CWA, and Section 103 of the MPRSA). These discrepancies not only interfere with the permitting process for sargassum projects but with other permits as well. It has been more than a decade since major sargassum influx events started, but the workshop conducted for this study was the first time that agencies met with the purpose of clarifying the sargassum management regime in Puerto Rico. Although agencies found common ground in certain permitting processes, they expressed that every project should be evaluated on a case-by-case basis.

Another obstacle that some participants brought up is that there is often a time lag between the urgency of relevant groups' needs and the development of government policies to address those needs, which is a common obstacle in public policy [19,4]. Oxenford et al. [26] pointed out how governments in the region have been slow to respond to the sargassum phenomena, and this is also the case for Puerto Rico [12]. In the case of sargassum mitigation, there are certain situations where immediate action is needed. For example, in the summer of 2021, energy production was interrupted at two power plants in Puerto Rico after a massive sargassum influx event clogged the condenser water pipes and filters [29]. Although emergency events like this may need a quick response, an agency representative mentioned that entities should plan beforehand and obtain the necessary permits knowing that the permitting process takes time. Many entities stated that an expedited permit application process, such as a USACE Regional General Permit (RGP), would be of great benefit. RGPs aim to alleviate the burden to the agency of multiple permit requests, and although the volume of sargassum permit requests is currently low, the number of requests for guidance has been increasing (D. Cedeño, USACE, pers. comm.). RGPs can authorize certain activities in a specific geographic area that cause only minimal individual and cumulative environmental impacts [31]. Another potential mechanism to expedite the processing of permit applications is USACE Nationwide Permits (NP), which are general permits issued every five years that authorizes certain activities across the U.S.

3.5. Context within the regional level approaches

Prior to 2011, there were no sargassum policies to guide adaptation in the WCR [22] and early efforts for sargassum removal were ad hoc with little coordination between actors [14]. It took between four to ten years for the development of sargassum management plans, policies, and guidance documents [14]. Puerto Rico was a pioneer developing, in 2015, the Protocol for the Handling of Extreme Accumulations of Sargassum on the Coasts of Puerto Rico, which served as the basis for the development of other sargassum management protocols in the WCR [8]. Contrastingly, this protocol had minimal implementation locally, highlighting limitations in the institutional capacity of the DNER. Despite its limitations, this protocol laid the foundation for the government to begin an adaptive management process that, years later, led to an update to the protocol [10] and the purchasing of sargassum removal equipment.

In the US Caribbean context (e.g., Puerto Rico and United States Virgin Islands), the development of sargassum management guidance documents took more than a decade for the United States Virgin Islands (USVI). In 2023, the USVI developed a foundational Blueprint aimed to serve as the initial step for the future development of a comprehensive sargassum management plan for the USVI [2]. A year before, in 2022, the Division of Fish and Wildlife of the Department of Planning and Natural Resources of USVI developed the document *Sargassum in the U.S. Virgin Islands: A Management Brief* to guide individuals and entities for acquiring permits for mechanized sargassum removal. All permits require the applicant and removal personnel receive training about handling and removing sargassum that may contain threatened, endangered, and indigenous species of concern. The document indicates that removal of sargassum is only permitted onshore once it has reached land. However, conversations are taking place to consider the removal of sargassum that becomes an immobile mass next to the shoreline (L. Fletcher, Bioimpact Inc., pers. comm.).

At the federal level, USVI and Puerto Rico share the same legal framework, meaning that they not only experience the social and environmental nuisances associated with sargassum influxes but might also experience similar obstacles in the federal permit application and consultation processes. Considering the WCR as a polycentric governance system [32], the US Caribbean has the potential to become one of the dispersed centers where decision-making occurs.

Lessons learned from the WCR suggest that adaptation to sargassum influxes may benefit from recognizing national policy weaknesses and institutional capacity constraints [14]. Therefore, it is not only important to understand flaws and obstacles in the sargassum management framework in Puerto Rico but to provide recommendations that fit the particularities of this US territory and institutional capacity of the DNER and other pertinent entities.

3.6. Recommendations to improve the permitting process in Puerto Rico

The main recommendation received during semi-structured interviews and the workshop (Table 5) was for the local government to develop a territory-wide plan to respond to sargassum influxes. This plan should include the identification of priority coastal areas (e.g., areas where sargassum accumulations are recurrent and where the impacts are high) and an updated version of the Protocol for the Handling of Extreme Accumulations of Sargassum on the Coasts of Puerto Rico [9]. The plan could also serve as one of the requirements for requesting federal assistance through Stafford Act emergency or major disaster declarations. Localized response plans can also be made for priority areas interested in establishing mitigation actions. For example, in an effort to protect Laguna Grande bioluminescent bay, a localized plan was drafted by DNER to mitigate sargassum influx into Las Croabas Bay in Fajardo [6]. This information can be used to facilitate the permit request process by requesting, in advance, permits for certain methodologies and areas where it is known that mitigation actions will be needed. These plans can be drafted considering other plans, policy, and guidance documents being used in the WCR (e.g., [2,11,26,23]), and should be regularly updated given the dynamics of sargassum research data, and sargassum management practices and uses [30].

Along these lines, after the workshop, on January 3, 2023, the Governor of Puerto Rico approved a joint resolution [7] ordering DNER to include a mitigation plan to address the sargassum problem as part of its plans, which was to include concrete solutions to address the problem

Table 5
Recommendations provided by participants of this study.

List of Recommendations
Create a territory-wide plan to respond to sargassum influxes
Develop plans and permit application packages for priority areas where sargassum is a recurrent issue
Conduct workshops and round tables with agencies to further clarify the sargassum legal regime in Puerto Rico
Develop an operational online platform to guide applicants through the sargassum permitting process
Create a website (one-stop-portal) to share sargassum information and permitting information for sargassum mitigation actions
Create a contact list for each permitting agency
Provide the option of pre-application meetings with agencies to clarify doubts about the permitting process
Create a list of best management practices regarding sargassum mitigation actions by agency
Create videos where agencies explain the permitting process
Explore options for expedited permits (e.g., RGP and NP)
Create a list of potential sources of funds to cover expenses regarding the permitting process and sargassum removal activities

across the coasts of Puerto Rico, a calendar for its implementation, and the identification of funds for its implementation. It also required DNER to acquire specialized machinery to collect sargassum along the coast. DNER had 90 days from the approval of the joint resolution to provide the legislative bodies with their sargassum mitigation plan. The deadline passed and the DNER did not comply with the mandate. The agency attributes this to the short time to comply with the order and some legal inconsistencies at the federal level [13]. However, by June 2023, the agency updated its sargassum management protocol [10], which addressed the joint resolution mandate by developing strategies to evaluate sargassum arrivals and consider ecological and socio-economic impacts. The new protocol established specific management strategies, like removal or monitoring, depending on the evaluation results. In addition, DNER acquired 6 beach rake tractors and one sargassum removal vessel. The 6 beach rake tractors were located at strategic points throughout the island while the sargassum removal vessel is expected to support sargassum removal efforts at certain locations such as Las Croabas Bay. DNER is still supporting planning efforts that will result in a more comprehensive mitigation plan by including aspects that were not discussed in the revised protocol such as exploration of different sargassum disposal alternatives, chemical analysis of local sargassum, and participatory processes in heavily affected communities.

Some participants recommended conducting additional workshops and roundtables with agencies to further clarify the permitting process for sargassum mitigation actions, including permitting for sargassum disposal on land. They also recommended exploring options for expediting the processing of permit applications, including proposing a RGP and/or NP for sargassum mitigation activities, and reestablishing interagency meetings where applicants can discuss permit requirements and ask questions before submitting a permit. Another recommendation brought by relevant group representatives during the workshop was to create an operational online platform where sargassum information, as well as the sargassum removal and ocean disposal permitting flowchart (Fig. 1) could be made available to permit applicants. Applicants could follow a list of questions that show them what permit(s) they need to apply for, and the process required to request them on this platform. Additional recommendations mentioned by participants are included in Table 5.

4. Conclusions

This article first assessed the jurisdiction of the U.S. federal and Puerto Rico Commonwealth regarding sargassum removal and its disposal in the ocean. Second, it analyzed the interconnection of both jurisdictions in the permitting process, providing general guidance for future sargassum mitigation actions. Third, the existing legal barriers were identified such as lack of information and clarity in the permitting process and the extensive time required for this process and for government policies to adjust to relevant groups' needs. Lastly, recommendations provided by agencies and other social actors were put forward, including the development of a territory-wide response plan and localized plans for priority areas, and the continuation of meetings with agencies to clarify legal aspects of sargassum mitigation actions, including its disposal on land.

The methodology applied here facilitated overcoming some of the deficiencies in coordination and integration within and among governmental agencies, and the findings of this research lay the foundation for more effective planning for the mitigation of sargassum impacts in Puerto Rico. This article has far-reaching implications to improve the governmental, private, and civil response to sargassum influx events, promote the development of alternatives for sargassum reuse and valorization, and safeguard Puerto Rico's coastal ecosystems and communities. The information provided regarding federal jurisdictional issues can be applied to other U.S. jurisdictions affected by sargassum influxes, such as the U.S. Virgin Islands, Florida, and Texas. Clarification of the governance framework of U.S. jurisdictions and Puerto Rico would put resource managers in a better position to contribute to regional coordination and collaboration on sargassum response efforts.

CRediT authorship contribution statement

Mariana C. León-Pérez: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **James C. Gibeaut:** Conceptualization, Funding acquisition, Project administration, Resources, Writing – review & editing. **Richard J. McLaughlin:** Conceptualization, Methodology, Writing – review & editing. **Ricardo J. Colón-Rivera:** Writing – review & editing. **Lisamarie Carrubba:** Writing – review & editing. **René Esteves:** Methodology, Resources.

Data availability

No data was used for the research described in the article.

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