A Foundational Blueprint for the Development of a Comprehensive Pelagic Sargassum Management Plan for the United States Virgin Islands

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Cover photo by Jaughna Nielsen-Bobbit for Bioimpact, Inc. The photo was taken via drone of a sargassum landing in Great Bay off the Ritz-Carlton Club on St. Thomas, U.S. Virgin Islands in June 2021.

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Acronyms

CARICOM	The Caribbean Community
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERMES	Centre for Resource Management and Environmental Studies
CFMC	Caribbean Fishery Management Council
CRFM	Caribbean Regional Fisheries Mechanism
CWA	Clean Water Act
CWLUP	United States Virgin Islands Comprehensive Water and Land Use Plan
CZM	Division of Coastal Zone Management
DFW	United States Virgin Islands Division of Fish and Wildlife
DPNR	United States Virgin Islands Department of Planning and Natural Resources
DPW	United States Virgin Islands Department of Public Works
DRNA	Puerto Rican Departamento de Recursos Naturales y Ambientales
EFH	Essential Fish Habitat
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ESS	Endangered Species Survey
FEMA	Federal Emergency Management Agency
FWCA	Fish and Wildlife Coordination Act
GASB	Great Atlantic *Sargassum* Belt
GVI	Government of the U.S. Virgin Islands
HOA	Homeowner Association
HTA	United States Virgin Islands Hotel and Tourism Association
MMABE	Ministry of Maritime Affairs and Blue Economy
MPRSA	Marine Protection, Research and Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NWP	Nationwide Permit
OSHA	United States Occupational Safety and Health Administration
PPM	Parts Per Million
RGP	Regional General Permit
RGPSM	Regional General Permit for Sargassum Management
RHA	Rivers and Harbors Act
RO	Reverse Osmosis
SARTAC	Teleconnected SARgassum risks across the Atlantic: building capacity for Transformational Adaptation in the Caribbean and West Africa
SECART	Southeast and Caribbean Regional Team
SCTLD	Stony Coral Tissue Loss Disease
SEA	St. Croix Environmental Association
TNC	The Nature Conservancy
UNEP-CEP	United Nations Environment – Caribbean Environment Programme
USACOE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
USVI	United States Virgin Islands

UTV	Utility Terrain Vehicle
UVI	University of the Virgin Islands
VI-EPSCoR	Virgin Islands Established Program to Stimulate Competitive Research
VIPCA	Virgin Islands Professional Charter Association
VITEMA	United States Virgin Islands Territorial Emergency Management Agency
VIWAPA	Unites States Virgin Islands Water and Power Authority
VIWMA	United States Virgin Islands Waste Management Authority
WCR	Wider Caribbean Region

About this Document

The purpose of this document is to serve as a foundational Blueprint from which a comprehensive sargassum management plan can be created for the United States Virgin Islands (USVI). The now annual inundations are far more than "just a nuisance" to the territory, without thoughtful planning and management, sargassum could irreversibly damage the coastal and marine resources and infrastructure upon which the U.S. Virgin Islands' economy, and legacy, is built.

Anecdotal evidence and emerging research indicate that coral and seagrass are being smothered, scoured, and/or poisoned by sargassum's seasonal arrival to the territory. Seaside hotels are losing guests, and, in the age of social media, potential visitors are deterred by the images of sargassum-laden beaches that circulate the Internet. Local fisherfolk and boaters have incurred heavy costs from the degradation of vessels and equipment moored in marinas where trapped rafts of decomposing sargassum acidify calm waters that were once protective. In addition, coastal communities, who have already been financially impacted by sargassum landings, are coming to grips with the health implications of prolonged exposure to sargassum-emitted hydrogen sulfide fumes.

Interviews and surveys with USVI residents reveal a willingness to do "the right thing" when it comes to planning for, and responding to, sargassum inundations; however, community education on what "the right thing" is, is sorely lacking. Mis- and conflicting information is rampant, and clear guidelines from federal and territorial agencies have not always been timely or available.

To inform the next steps in the development of a comprehensive USVI sargassum management, Bioimpact, Inc. was hired to create this foundational Blueprint. This document is organized into different sections and as whole, is a standard operating procedure resource for government staff and public stakeholders with regards to sargassum management.

This document includes:

1. A literature review of sargassum management plans and models from other Caribbean islands, as well as a review of relevant peer-reviewed research on the subject.
2. An overview of the current federal regulations and recommendations with regards to land-based and in-water management of sargassum in the American Caribbean.
3. An overview of the current process for applying and obtaining approval from territorial authorities to conduct land-based sargassum management activities.
4. A list of sargassum "hotspots" throughout the territory based on available literature, resources for sargassum forecasting, existing permits, and community input.
5. The findings of a community survey on sargassum.
6. The findings of key informant interviews with sargassum stakeholders at the local and federal levels.
7. Recommendations regarding the creation of a local sargassum working group.
8. The first draft of a Regional General Permit for sargassum to provide a framework through which actions can be taken to address sargassum inundations from shore and in-water.

In order to create this foundational Blueprint, Bioimpact, Inc.:

- Reviewed the available literature on sargassum influxes in the Wider Caribbean Region with a focus on how sargassum is managed in other jurisdictions/Caribbean nations, cleanup options, and alternative sargassum uses and methods of disposal.
- Interviewed representatives from the federal agencies tasked with regulating activities related to sargassum management in the United States to better understand federal permitting requirements and gather recommendations on what these agencies would like to see moving forward.
- Interviewed representatives from the territorial agencies tasked with regulating activities related to sargassum management in the USVI to better understand the local permitting process and to gather recommendations on how to streamline processes and better protect our natural resources.
- Identified the areas most affected by sargassum influxes in the territory.
- Interviewed community stakeholders from the various sectors impacted by sargassum on St. Croix, St. John, St. Thomas, and Water Island.
- Developed and disseminated an online survey for residents in the territory to ascertain their knowledge of sargassum and document community impacts.
- Created a draft sargassum permit, with input from federal and territorial regulators, to facilitate the permitting process for sargassum management and, thus, regulatory compliance.

This Blueprint presents a way forward for the territory to address the recurring sargassum influxes more systematically while still protecting its natural resources. It is unlikely that these seasonal inundations will go away and will, in fact, become more and more commonplace throughout the territory. We hope that, as time goes on, the "golden tide" can shift from being a problem to becoming a resource that will benefit all Virgin Islanders.

* * *

A note about terms in this document: At the time of writing, sargassum researchers and stakeholders across the Tropical Atlantic were in the process of standardizing preferred terms and language to use when describing sargassum inundations in the Wider Caribbean Region. Terms that liken sargassum to an invasion were being strongly discouraged and the use of the word "sargassum" – with a lower case "s" and not italicized – was deemed acceptable when not referring to specific species of the seaweed. The terms and language in this document reflect the current consensus. See Appendix O for more about the terms.

“Let’s prepare for it and not act like this is the first time [we’ve] seen it… It’s like hurricane season. You know sargassum is going to come.”

– Federal Stakeholder, October 2022

Executive Summary

Sargassum is a floating macroalgae, or seaweed, whose historical distribution has been primarily confined to the Sargasso Sea. As Trinanes et al. recounts in their 2021 article in the *Journal of Operational Oceanography*:

> "Beginning in 2011, massive amounts of pelagic *Sargassum* algae began washing ashore along islands throughout the Caribbean Sea. Studies conducted using remote sensing techniques by satellite showed that the bulk of the *Sargassum* that entered the Caribbean Sea arrived from the tropical Atlantic Ocean, a region previously unknown to host such dense mats of Sargassum" (p. 48).

Researchers now agree that the influxes of sargassum into the Wider Caribbean Region (WCR) comes from a new "consolidation region" now known as the Great Atlantic *Sargassum* Belt (GASB). The Belt extends from West Africa to the Caribbean Sea and into the Gulf of Mexico, and predominantly consists of two species of holopelagic sargassum: *Sargassum natans* and *Sargassum fluitans*. The origin of the GASB is believed to be the result of warmer and over-nutrified waters which fed a sargassum seed population from "small amounts of *Sargassum* [that had] existed in the Central Atlantic in previous years" (Wang et al., 2019, p. 84).

In response to this new phenomenon, most island nations and territories in the Caribbean have some sort of a management plan or strategy on how to address the impacts of pelagic sargassum in their jurisdiction. These plans vary markedly in their contents and detail; and, as some researchers note, do not consider the capacity of the island, or nation, to implement the various strategies. As a result, a number of research institutes and non-governmental organizations (NGOs) have created guidelines to assist Caribbean islands in developing, and tailoring, a sargassum management plan. The two documents of notable mention are:

1. The Centre for Resource Management and Environmental Studies (CERMES) management brief, *Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up,* which presents guidelines for managing sargassum that can be, "adapted to the local situation as well as some local examples and some dos and don'ts based on experiences around the Wider Caribbean Region" (Hinds et al., 2016, p. 2); and
2. The Caribbean Regional Fisheries Mechanism (CRFM) Secretariat, *Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CFRM Member States,* which presents a template for outlining and codifying into law the management of sargassum pursuant to the protocol.

Key recommendations from the CERMES Brief and CFRM Protocol on what to determine and include in a sargassum management plan are:

- Creating a multi-sectoral committee to manage sargassum within a jurisdiction and tasking a lead agency to implement and drive the management plan.
- Selecting which beaches will be cleaned up and on which beaches the sargassum will be allowed to accumulate.

- Agreeing on when mechanized methods of removal will be used versus manual methods – i.e., hand raking.
- Determining whether to collect sargassum in nearshore waters before it is beached.
- Acknowledging that sargassum has an ecological value.
- Exploring opportunities to valorize sargassum as a commercial product.

The importance of communication with stakeholders, the community, and even tourists was repeatedly mentioned in all the documents reviewed. In fact, in their 2019 report, *The Prevention and Clean Up of Sargassum in the Dutch Caribbean*, the Dutch Caribbean Nature Alliance noted that communication and engagement with multiple stakeholders was "key" to managing sargassum while the writers of the 2021 *Draft Barbados Sargassum Adaptive Strategy* intend to convert the strategy into a "dynamic website in which the many appendices are updated often, using new information and learning from monitoring and evaluation" (CERMES, p.iii).

The need to develop a management plan that is "adaptive" – i.e., able to be reviewed, revised, and improved over time, was another core theme across the sargassum strategies reviewed. In their 2019 peer-reviewed article, Cox et al. describe how to do so following a multi-priority framework.

In the U.S. Virgin Islands (USVI), the coastal zone is managed by the two agencies within the Department of Planning and Natural Resources (DPNR) – the Coastal Zone Management Agency (CZM) and the Division of Fish and Wildlife (DFW); often in conjunction with the U.S. Army Corps of Engineers (USACOE). The current territorial and federal policies with regards to sargassum management are as follows:

1. Non-mechanized, manual removal of the seaweed from the shoreline (e.g., hand raking) does **not** require a local or federal permit.
2. The use of any machinery along the shoreline to remove sargassum **does** require prior permission, and approval, from DPNR-CZM in conjunction with DFW, who is CZM's partner in sargassum management efforts.
3. **No federal agency prohibits** the collection or removal of sargassum from the water. Only two federal permitting processes are potentially triggered by collecting and/or removing sargassum in-water. They are a) the USACOE permitting process if a structure, like an aquatic plant boom aka "barrier," is to be installed in territorial waters, all of which are considered navigable waters of the US; or if sargassum-related mechanized work is to be conducted in territorial waters; and b) the Environmental Protection Agency (EPA) permitting process if collected sargassum is to be discharged back into the ocean.

The collection and removal of sargassum on beaches does not, currently, fall under federal jurisdiction unless the collected sargassum is disposed of in the ocean; then this would require an EPA permit.

In 2003, the National Marine Fisheries Services (NMFS) approved a rule designating pelagic sargassum located off the coasts of the Southern Atlantic States to be Essential Fish Habitat and, thus, limited sargassum harvesting and certain types of fishing in this area – i.e., the Sargasso Sea. By its terms, the federal rule applies to a specific area **outside the Caribbean** and was passed before the sargassum inundations became commonplace in the Wider Caribbean Region.

Federal regulation around sargassum management within American waters outside the coasts Sargasso Sea has been absent as federal agencies have yet to grapple with what to do about the piles of

sargassum in Florida, Puerto Rico, and the USVI. Key informant interviews with sargassum stakeholders at the federal level described how pelagic sargassum sits in a "weird gray area," and admitted that some federal agencies "haven't had these conversations with attorneys or management" about whether, who, or how to regulate the "new activities" that sargassum management presents. As one federal stakeholder explained, "NOAA has questions [about] what to do with it… The EPA doesn't know what to do with it. They don't know if it's a waste [and they're] only triggered when someone dumps sargassum back into the ocean."

One recommendation worth noting is the suggestion to obtain an Incidental Take Permit for any in-water sargassum work that is not federally funded. Incidental Take Permits are issued by NMFS under Section 10 of the Endangered Species Act (ESA) and allows for non-federal entities "undertaking otherwise lawful projects that might result in the take [i.e., death] of an endangered or threatened species" to not be prosecuted for an ESA violation. "That's just in case something happens, [like] a turtle gets entangled in a net [during in-water collection], then you're covered," one stakeholder noted. "Especially if [the cleanup] is privately funded."

As the need to engage with the community was a recurring, and important, theme in successful sargassum management Bioimpact, Inc. conducted an online survey of local residents impacted by sargassum on St. Croix, St. John, St. Thomas, and Water Island. A total of 221 residents completed the survey. Key findings are as follows:

- The majority of survey respondents correctly identified sargassum as a seaweed or algae (91%) and acknowledged that the other islands in the Caribbean have pelagic sargassum "like we do in the USVI" (84%).
- The highest percentage of respondents (36%) believed the Sargasso Sea to be the origin of the sargassum that reaches the territory. Only two people correctly identified the GASB as the origin of the influxes.
- Respondents were split with regards to whether sargassum has any potential benefits. Among those who believed that it does, half (57%) believed that sargassum's benefit was to the marine environment followed by agricultural use (36%).
- Nine out of ten respondents reported having been negatively impacted by sargassum. When asked how, the most common response was that sargassum had negatively impacted their recreational activities (79%), followed by their business / industry / job (32%), and property (land) / home / Homeowner Association ([HOA], 28%).
- With regards to self-report adverse health impacts, a little over one quarter (28%) of respondents believed that exposure to sargassum, in water or on land, had ever affected their health. Headache was the most common issue, followed by breathing problems and itchiness and/or rashes.
- The majority of respondents (83%) were either not sure or didn't believe that something was being done to manage, prevent, or monetize the sargassum that arrives in the USVI.
- The majority of respondents (79%) believed that a territory-wide committee on sargassum should be created. When probed on who should be on the committee, respondents overwhelmingly suggested a joint public-private partnership. Representatives from DPNR agencies, the University of the Virgin Islands, marine biologists, the Department of Tourism, hotel/villa operators, and local environmental/conservation groups were frequent suggestions for members of the committee. Representatives from condo boards, the charter/marine industry, fisherfolk, and beachfront businesses were also recommended from the private sector.

Other government agencies mentioned included the Waste Management Authority, the Department of Health, the Department of Agriculture, and the Governor's Office.

Additionally, Bioimpact, Inc. interviewed key informants whose businesses, agencies, industries, or livelihoods directly deal with, or have been directly impacted by, influxes of pelagic sargassum in the territory. Over 100 individuals were contacted to participate. A total of 67 key informants were ultimately interviewed between October and December 2022.

Accounts of the negative impacts that sargassum landings has had on the nearshore environment were relayed by key informants. Accelerated beach erosion and injury to marine life/loss of habitat/degradation of water quality were common themes:

> "We have no beach front now and [sea] water is going to encroach on the pool. Palm tree roots have been exposed. We're seeking assistance from DPNR [due to the] degradation of the beach front."— Homeowner, St. Croix

> "Around 2015, we lost a staghorn coral thicket that had been documented as several acres large over in East End Bay on the East End peninsula. We had incredible pictures that had been shared with NOAA of this beautiful staghorn thicket. When a NOAA rep went out a year or two later it was simply gone. It had been killed by being smothered by sargassum mats." – Civil Society Stakeholder, St. John

The release of toxic levels of ammonia, which are detrimental to corals and present after a large wave of sargassum, was an emerging finding noted by The Nature Conservancy, an NGO with coral restoration projects on St. Croix:

> "When sargassum rots, it creates an anoxic zone and high ammonia levels and, of course, ammonia is one of the most toxic chemicals for corals… As soon as there's a wave [of sargassum], about a week later we get spikes in ammonia that are about four times the lethal limit to corals… For example, a 0.2 [parts per million] concentration would be very stressful [to coral] and for longer periods [of time] would kill the coral. We're [finding ammonia levels at] 5 ppm."

During key informant interviews, many private sector stakeholders spoke openly about the financial burdens that they've incurred as a result of sargassum influxes. Loss of income/revenue, property damage and exorbitant costs of cleanup and disposal were common themes:

> "[Guests] have had to cancel [a charter] because of sargassum. [The] lost revenue component is hard to judge because [we are not sure] how many people have not come to St. Croix because of it. [We] also run fishing charters and sometimes the sargassum is so thick [that] they cannot fish." – Tour Operator, St. Croix

> "[The budget to pay for sargassum cleanup] literally comes from homeowners. I can't charge more. At some point, it will price people out of being able to afford here. This is a huge problem for my portion of the industry." – Villa Operator, St. Thomas

> "Us spending $200,000 a year to remove sargassum is a burden." – Marina Operator, St. Thomas

> "Loss of income was the biggest part… For two months, all three [of our] boats were down. We canceled 170 charters. Not including [that], I probably spent a couple hundred thousand dollars on components. Those diesel engines [cost] up to $60k to $70k a piece. It was a massive blow... We are still recovering financially." – Charter Captain, St. Thomas

> "[When sargassum is bad], the guests start checking out in droves. We had that for about a week and a half." – Hotel Operator, St. Croix

> "We have lost business and have had to compensate guests that have been on property who feel there is either a health concern with regards to smell or who cannot use the beach." – Hotel Operator, St. Thomas

Charter captains and commercial and recreational fisherfolk all spoke about the primarily negative effects of sargassum on fishing while also noting that when rafts are in mahi fishing does improve:

> "We catch less fish. We are spending more time clearing lines, which is more time with the lines out of the water and the lines and lures are catching sargassum in the water so much that the fish won't bite them." – Charter Captain and Recreational Fisher, St. Thomas

> "[Sargassum] almost completely negates trolling. Trolling is very tough when the sargassum is super thick." – Charter Captain, St. Thomas

> "Sometimes sargassum on the bottom will roll into fish pots with the current and those fish pots won't catch any fish and will come up full of sargassum. I can't dive for whelks in areas where sargassum is packed up on the shoreline." – Commercial Fisher, St. Thomas

> "[Sargassum] does provide a lot of shelter for a lot of life. It helps a lot with mahi fishing, we have been able to find a lot of mahi along the [sargassum] lines. Even a month ago we found a weed line on the southside with 60 mahi under it." – Charter Captain, St. Thomas

The impacts that sargassum has had on guests' perception of, and satisfaction with, the territory was noted by all stakeholders involved in the tourism sector:

> "The sad part is that people come to the island, and they have this vision of having a tropical vacation that is beautiful and serene. They book a charter; get to the marina and the first thing that they experience is the stench. It destroys their expectations." – Marina Operator, St. Thomas

> "The beaches are to be enjoyed by our travelers, [our] guests. So, once we take away that element of having clean waters, you're really taking away 90% of what they're coming to the islands for." – Private Sector Stakeholder, St. Thomas

> "[Sargassum has] impacted us dramatically, drastically… Just the sheer volume alone. It has definitely decreased our guest satisfaction with us and with the island, because they [guests] come to be on the beach and they can't… Even for our employees, our employees don't want to clean it up… It smells." – Hotel Operator, St. Thomas

What the future of the sector will be if sargassum continues to be unmanaged was the question that kept many a tourism sector stakeholder up at night:

> "The one thing that scares me about the survival of the islands is not hurricanes, it's sargassum. In five to seven years from now, people are going to say, 'I don't want spend two grand on [a charter] boat because I can't [even] go to certain places.' They're going to spend their money somewhere else [not in the USVI]." – Charter Captain, St. Thomas

> "What is the future going to be? The uncertainty…" – Hotel Operator, St. Croix

> "Guests taking pictures of [the beaches full of sargassum], putting it on the Internet. That doesn't just hurt [our hotel], it hurts all of the VI." – Hotel Operator, St. Croix

While outside this scope of work, the impacts of sargassum on public health was noted by some key informants:

> "Guests have complained about itchiness… Now people do their own research. One guest in particular… [She] did a bunch of research and did claim that it affected her asthma. She demanded full compensation from the cost of staying at the resort to the plane ride [to St. Thomas]." – Hotel Operator, St. Thomas

> "We actually had the EPA out and they took [hydrogen sulfide] readings by the dumpsters… They found [the readings were] above the legal hydrogen sulfide limit… and residents and boaters complain about itchy eyes and headaches." – Civil Society Stakeholder, St. John

With regards to sargassum use and valorization, a number of stakeholders outside the academia and education sector mentioned that sargassum could be used in agriculture, while others noted having heard about issues with heavy metals. The researcher at the Virgin Islands Established Program to Stimulate Competitive Research (VI-EPSCoR) who confirmed that sargassum arriving to the territory had high heavy metal content on par with other areas of the WCR, explained that it's not just about the metals:

> "In 2019, VI-EPSCoR at the Agricultural Experimentation Station was looking at the possible use [of sargassum and other] materials as a mulch, not fertilizers… to primarily prevent weed growth. Because [sargassum would be being used] as an organic mulch, we wanted to understand the chemical composition [of it] compared to hay, wood chips, sand, and other mulch materials. So, we sent off [a sample of sargassum from the VI] for nutrient analysis… [The data revealed] that sargassum did have elevated levels primarily of arsenic. There were others, but they were less eye popping. Sodium [was also found] within the tissue of the sargassum… [Even after rinsing] sargassum still contains salt. [I worry more about] soil salination than heavy metals in terms of [using sargassum] on the soil... One season is not really a big deal. If you have a lot [of sargassum] on hand and if you want to use it once [on the soil] then that's OK. Don't just use it over and over again, that would be really bad, and I was just thinking about salinity… You can't undo [the salination of soil]... There are plants that can take up [the sodium] and you can harvest them. However, it is an extremely difficult remediation process [to remove salt from soil] that would also be a nightmare."

When asked to describe the kinds of support local government agencies could offer stakeholders with regards to sargassum management, information, cleanup, and protection of marinas were the most common themes that emerged. Coordination between agencies, clear policies, and regulatory relief were also mentioned, as were strategies to intercept sargassum mats in-water before they come ashore:

> "People really don't know what to do [as] the end user. We understand that before [sargassum] reaches the bay, [that] it is a habitat for endangered species, but once it gets into the bay it becomes a health issue and an ecology issue... What do we tell people when they are being affected by it? What can we do? What is the government doing? I know people want to know." – Civil Society Stakeholder, St. John

> "Regular cleanup of the sargassum where [the fisherfolk] keep their boats, and prevention of sargassum from breaking down in the bays. [This] is what the fishers want." – Local Government Stakeholder, Territory-wide

> "People need to hear what is working well. We're getting stuck in what's not working and need to think about what is." – Hotel Operator, St. Thomas

> "When snow happens in the north, one of the first things [the municipality does is] clear out the bus stops, so that the buses can move the people. [That's what should happen here with sargassum in marine transportation areas.]" – Private Sector Stakeholder, St. Thomas

> "[I would like to see] a website dedicated to sargassum that has background and information so, if we needed to send that to someone it's coming from a government agency. Kind of one place to go [a repository] for sargassum. What the government is doing, what we can do." – Civil Society Stakeholder, St. John

> "The biggest hinderance [to] any [sargassum] management plan is… [that] there's no central figure that organizes [the response]. That's the reason why there's not a FEMA for sargassum. [During a] recent NOAA meeting, [we] discussed [how] a lot of places were hoping that there would be someone to call when an [sargassum] event happens and there's not. Cleanup is private. Sometimes it's hotels, sometimes it's volunteers." – Academia and Education Stakeholder, St. Thomas

> "There isn't one agency that's owned it, and that's been the problem, that's been the delay." – Hotel Operator, St. Thomas

For the past decade, the WCR has been "subject to unprecedented, massive, episodic influxes of sargassum seaweed... [which have had] significant negative impacts, particularly on coastal communities and livelihoods, public health, tourism, and fisheries" (UNEP-CEP, 2021, p. 4). Like other areas in the region, this new phenomenon took the territory by surprise; however, unlike other Caribbean islands, the USVI has been slow to develop and adopt a sargassum management strategy.

Based on our review of current research, sargassum management strategies and plans from other Caribbean nations; analysis of a community survey on sargassum; and key informant interviews with federal and local stakeholders across multiple sectors, Bioimpact, Inc. has put together the following recommendations:

1. **Develop and formalize a comprehensive sargassum management plan,** ideally that is modeled after the CERMES management brief and CFRM protocol. The plan should be digitalized and widely disseminated to other territorial government agencies, local stakeholders, and the USVI public.
2. **Create a multi-sectoral working group on sargassum for the territory, as well as a Sargassum Task Force at UVI**. The latter would work to inform the former with research and evidence-based recommendations. There is precedent for this – i.e., the Stony Coral Tissue Loss Disease Task Force.
3. **DPNR-CZM and DFW should work with the Antilles Division of the USACOE to review and finalize a Regional General Permit for sargassum in the USVI**.
4. **Develop and disseminate sargassum information on a website** with information for residents and guests. As an example, the Department of Tourism in Belize hosts the nation's sargassum repository on their website.
5. Additionally, **locally appropriate materials should be developed and disseminated for the territory to educate the different sectors on sargassum**. These materials should be brief, easily understandable and, as one key informant said, "meet people where they are." These briefs should serve as a blueprint for future sector-specific briefs in the territory with tailored messages for tour operators, hoteliers, fisherfolk, and community councils, as examples.
6. **The Government of the USVI (GVI) should allocate funds to support sargassum mitigation and management in the territory.** The cost of sargassum clean-up cannot solely fall on the private sector. The GVI must be financially involved in sargassum mitigation and management. Funding could be in the form of grants for small businesses financially impacted by sargassum influxes, cleanup support to homeowner associations located in heavily impacted coastline, or by subsidizing the cost of aquatic booms for entities interested in installing sargassum barriers along the coasts. The GVI could engage federal partners, like the Federal Emergency Management Agency, in sargassum management if it were to be declared a Disaster and/or State of Emergency, and a Presidential disaster declaration was also obtained.
7. **Sargassum and agriculture need to be locked in separate boxes**. Even without the discovery of heavy metals like arsenic, lead, and cadmium, sargassum also contains sodium within its tissue. This means that the use of sargassum as a fertilizer, compost, or mulch is not advisable, as it will result in the salinization and buildup of heavy metals in soil over time. No amount of dewatering or rinsing will remove the salt or heavy metals contained within tissue of sargassum. Prolonged use could also lead to the leaching of salt and heavy metals in the water table.
8. **DPNR should create a Sargassum Coordinator position that would be in charge of overseeing the territory's sargassum strategy**.
9. **Sargassum must be intercepted before it reaches the shore and there is available research for determining at what distance from shore sargassum stops being a productive habitat**.
10. **Marinas should be protected** with aquatic booms and other techniques and divert and/or prevent sargassum from entering these protective bays.
11. **Much like climate change, sargassum should be incorporated into any plans, permits, or policies related to the waters of the territory of the USVI**. This includes the territorial *Comprehensive Water and Land Use Plan* (CWLUP) that is currently seeking community input on critical areas, and items, of focus.
12. **Opportunities to valorize sargassum have to be explored in earnest, as it is the only way to sustainably fund mitigation and clean-up measures in the territory**. No one solution or industry will be able to convert all the sargassum in the territory into "brown gold," and the territory cannot continue to dump sargassum into the islands' overtaxed landfills. Pilot programs will

need to be explored and partnerships made with entrepreneurs and other entities throughout the region to find avenues through which sargassum can be monetized.

13. **Sargassum influxes are not unique to the USVI and, as such, we cannot, and should not, operate in a vacuum**.

In 2018, the Great Atlantic *Sargassum* Belt had already grown into the largest macroalgae bloom in recorded history at 8,850 kilometers (5,500 miles) long. Sargassum is a multinational and multisectoral issue, and a number of NGOs have created working groups to think through solutions. Representation from the USVI has been woefully absent from all. The territory needs to join these groups, attend the conferences (which have almost all been virtual), and contribute to the region's emerging research on the issue. We do have laws and regulatory frameworks which are specific to the United States, but we must not look so inward that we do not see the successes and failures of other island nations; nor that we lag behind the most up-to-date and relevant approach to this challenge. As Puerto Rico is often the focus of federal attention in the American Caribbean, the USVI should also reach out to their local agencies to share in the available sargassum resources.

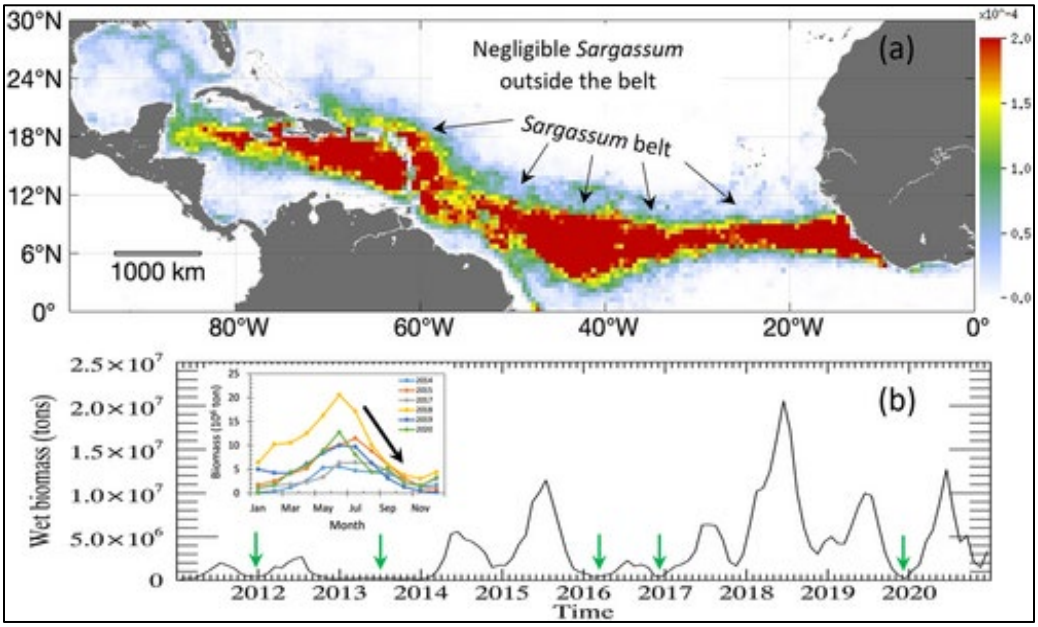
Sargassum in the US Virgin Islands

As Trinanes et al. recounted in their 2021 article in the *Journal of Operational Oceanography*:

> "Pelagic *Sargassum* is a floating macroalgae that was first definitively noted in the reports of Christopher Columbus during his voyages to the Americas… The historical distribution of *Sargassum* has primarily been within the Gulf of Mexico and western North Atlantic, with the centre [sic] of mass in the aptly named Sargasso Sea… Beginning in 2011, massive amounts of pelagic *Sargassum* algae began washing ashore along islands throughout the Caribbean Sea. Studies conducted using remote sensing techniques by satellite showed that the bulk of the *Sargassum* that entered the Caribbean Sea arrived from the tropical Atlantic Ocean, a region previously unknown to host such dense mats of Sargassum" (p. 48).

Researchers now agree that the influxes of sargassum into the Wider Caribbean Region (WCR) come from a new 'consolidation region' named the Great Atlantic *Sargassum* Belt (GASB, Figure 1). This new region extends from West Africa to the Caribbean Sea and into the Gulf of Mexico (Wang et al., 2019), and predominantly consists of two species of holopelagic[1] sargassum: *Sargassum natans* and *Sargassum fluitans*.

Figure 1. The Great Atlantic *Sargassum* Belt[2]
[Source: Putnam and Hu, 2022]



[1] Holopelagic loosely translates to "wholly pelagic" which means spending the entirety of life at sea.
[2] The top image is a model of the GASB derived from satellite observations between 2011 and 2020 during the months of June to November. The bottom image is the monthly mean Sargassum biomass in the GASB. See Appendix B for additional figures.

There are a number of morphotypes of each of these species and "some debate as to whether there may be a third additional distinct species" (UNEP, 2021, p. 8; Appendix C). The origin of the GASB is believed to be the result of warmer and over-nutrified waters[3] which fed a sargassum seed population from "small amounts of *Sargassum* [that had] existed in the Central Atlantic in previous years" (Wang et al., 2019, p. 84).

The mechanism by which sargassum blooms in the GASB are driven and, thus, differ year-to-year, are not well understood; however, according to Wang et al. (2019), three conditions "appear to be associated with massive *Sargassum* blooms:

1. Large seed populations during winter as a result of the previous year's bloom.
2. Higher nutrient supply from the West Africa upwelling in winter months, which can be inferred from higher Chl [chlorophyll] and lower SST [sea surface temperatures] in satellite imagery; and
3. Higher nutrient supply from the Amazon River input but normal or lower SST [sea surface temperatures] during the current year" (p. 88).

"Furthermore," the researchers go on to note, "during November to December, the Sargassum change rates showed negative correlations with SST [sea surface temperatures], suggesting that the former might serve as an indicator for possible blooms in the following year, with a lead time of at least 3-4 months" (Wang et al., 2019, p. 88).

Sargassum is carried by the prevailing winds, currents, and waves and, as such, primarily impact the eastern-, northeastern-, and southeastern-facing beaches and embayments in the USVI. The shape of the coastline and the presence of manmade structures like piers and jetties also have a significant impact on where the sargassum lands and where it accumulates. Tiny airbladders allow S. *natans* and *S. fluitans* to keep afloat for miles, while its "leaves" can extend to create small sails to direct the seaweed's trajectory. Within the territory, localized currents impact the movement of sargassum mats and do no always work in concert with wind, waves, or swells. As a result, sargassum can also be pulled into western-facing shorelines making some landings difficult to predict. Table 1 is a list of sargassum 'hotspots' in the USVI; meaning areas that are routinely and heavily inundated by wracks of sargassum annually. Figure 2 is an illustrative map of the same.

[3] The over-nutrification of ocean waters is believed to the be the result of anthropogenic activities (e.g., fertilization runoff from the Amazon) and climate change-induced upwelling of nutrients from the deep.

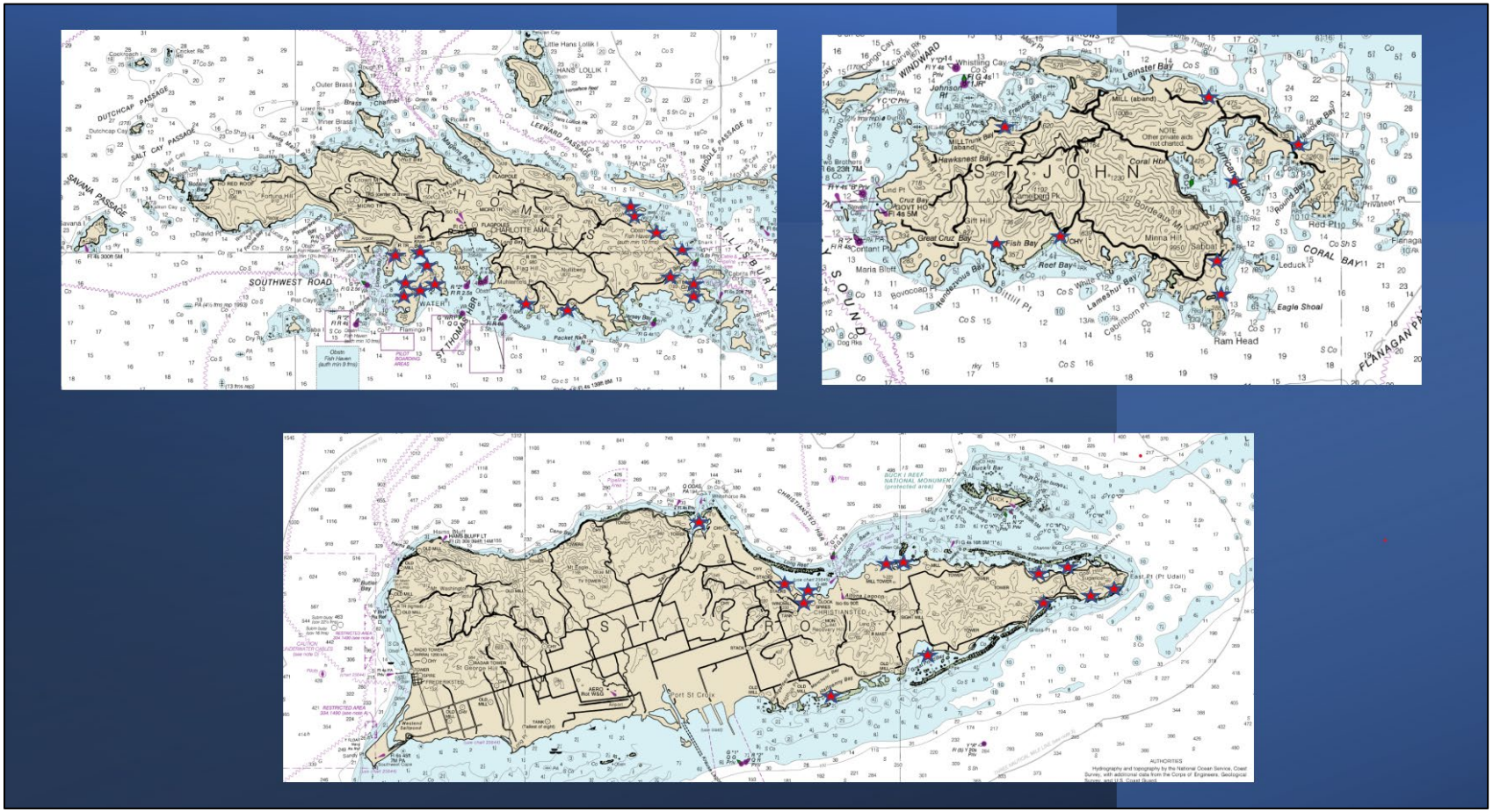
Table 1. Sargassum 'hotspots' in the USVI

St. Croix	Christiansted	Salt River
	Condo Row	Shoys Beach
	Great Pond	Smugglers Cove
	Green Cay	Teague Bay
	Ha'Penny Beach	Turner Hole (Divi Carina Bay)
	Isaac/Jacks Bay	
St. John	Brown Bay	Haulover Beach/Bay
	Coral Bay	Johns Folly
	Drunk Bay	Jumbie Beach
	Fish Bay	Reef Bay
St. Thomas	Abi Beach	Krum Bay
	Bolongo Bay	Lindqvist Beach (Smith Bay Park)
	Coki Beach	Red Hook Bay/Vessup
	Cowpet Bay	Sapphire Beach
	Crown Bay	Water Bay (Margaritaville)
	Great Bay (Ritz-Carlton)	
Water Island	Ferry Dock	Limestone Beach
	Honeymoon Beach	Sprat Bay
	Ruyter Bay	

During in-depth interviews, a number of key informants described exactly how sargassum migrates into some of these hotspots, particularly bays with manmade structures like piers:

> "You have to keep in mind that there is very little tidal flow in Coral Bay, however there is a very noticeable, very strong surface current," a St. Johnian resident and sargassum stakeholder explained. "Let me step back… When I talk about Coral Bay, I mean the large body of water that goes from Penn Point. [When] I talk about Coral Bay Harbor, I mean a much smaller body of water. Throughout all of Coral Bay, the dominant wind direction is from the southeast 80% of time. [The dominant wind force] causes a surface current that would push any object to the northwest. There is also a countervailing current… A return flux just below the surface that compensates and counterbalances that dominant wind force. As these, more or less, dispersed rafts [of sargassum] come in… you can see [that they move] almost precisely in the same direction as the wind. Places like Johnson Bay and Friis Bay and the inner harbor around the mangroves… they get absolutely clogged maybe to 100 feet out."

Figure 2. Map of Sargassum 'hotspots' in the USVI



One local government official on St. Thomas explained what happens when sargassum comes into the island's heavily trafficked marine terminals:

> "Red Hook [is an issue] when [the sargassum] comes in. It does mess with the ferries. [The sargassum] goes into the [ferry's] engine… [At] the waterfront, [the sargassum] comes down by seaplane and Frenchtown area. [It also comes in] down by [the Crown Bay] cruise ship dock, down by the shipyard. It really piles up there and we have no option, [we] have to skim and pick it up from the rocks. [Cleanup] is so tedious and time consuming that we have to outsource it. It's costly for us. We don't have the personnel to do it [ourselves]."

A private sector stakeholder also spoke about what happens when sargassum builds up in Red Hook, both its impact to the harbor and the community around it:

> "By the time you get to the high school [i.e., Ivanna Eudora Kean] you know what kind of day you're going to have. The poor students at the high school, half of time they have to suspend classes in the afternoon b/c [the smell] it's just so toxic. Then you have parents scrambling with what they are going to do with their kids, and [the smell] it just like stays."

While another private stakeholder spoke about how sargassum affects ferry operations in Crown Bay:

> "When [sargassum] is there… it requires the captains to have to maneuver the boat to leave Crown Bay or come into Crown Bay in an abnormal way because you have to compensate for the sargassum in the water. Instead of coming in completely under a controlled forward power we have to go to neutral to slide through an area of sargassum to get to another open spot… So, it requires more skill on the captains' part and even then, you're not quite sure… Sometimes the boat doesn't move, it's just spitting sargassum."

With regards to what happens to the ecology of the area when sargassum does overrun an inlet or bay, a federal stakeholder used a mangrove lagoon as an example:

> "When we get a massive amount of sargassum accumulating in mangrove lagoons… the wind keeps accumulating the amount of biomass within the lagoon until it basically fills the entire water column with sargassum. This creates anoxic conditions [i.e., a lack of oxygen] that kills all the mangrove roots. Birds walking over some of the floating sargassum eat up all the dead macrofauna, and they get to benefit from that; but basically, what happens is that mortality that is cause by the anoxic events affects all essential fish habitats that surrounds these mangrove environments."

Similar sentiments were echoed by private sector stakeholders working in and around Water Bay, one of the areas most affected by sargassum on St. Thomas:

> "This beach is different because it doesn't flush out like [other bays]. Coki Point gets [sargassum] from time to time and then [the sargassum will] disappear, but here... it's stuck. We've had times where no matter how much we clean we can't get rid of [the sargassum]… [Here], sargassum has become a full-time operation."

Literature Review of *Sargassum* Management and Response in the Wider Caribbean Region

As part of developing a foundational Blueprint for a comprehensive sargassum management plan for the USVI, Bioimpact Inc. conducted a desk review of available literature on sargassum in the WCR. The documents reviewed were:

1. Sargassum management plans of other Caribbean nations.
2. Management techniques recommended by regional organizations and other Caribbean governments; and
3. Research regarding potential commercial or other uses of sargassum after it is removed from coastal areas.

The purpose of the review was to identify best practices and lessons learned in the response to, and management of, pelagic sargassum. This section reviews the contents and critiques of some of these models and plans, while highlighting the available resources and studies that should be used to inform and guide the development of a comprehensive sargassum management plan.

Which Caribbean Islands Have a *Sargassum* Management Plan?

According to van der Plank et al. (2022), "most states and territories in the Caribbean have some form of sargassum management strategy in place, but there is a marked difference in detail among them" (p. 293). Specifically, twenty jurisdictions in the WCR have either a management plan, strategy, brief, guidance, or recommendations on how to address the impacts of pelagic sargassum in their jurisdiction as of van der Plank et al.'s 2022 peer-reviewed publication. (See Appendix D for a table of the national policy documents by type and Caribbean nation/island).

In a previous working paper published in 2020 under the Teleconnected SARgassum risks across the Atlantic: building capacity for Transformational Adaptation in the Caribbean and West Africa (SARTRAC) project, van der Plank et al. also identified the recommended "adaptations" – i.e., management actions and activities in response to pelagic sargassum – and responsible parties in each jurisdiction with a sargassum policy. (See Appendix E for a table of national policy documents by country, goal, management actions and responsible agencies.) The adopted management strategies reflected in these tables demonstrate that many countries are utilizing similar management strategies to address sargassum.

Developing a *Sargassum* Management Plan

In 2021, the United Nations Environment-Caribbean Environment Programme (UNEP-CEP) analyzed recent literature related to sargassum impacts, redefined the extent of the sargassum problem and broadened the impact areas to include Brazil and the western coast of Africa. The UNEP-CEP identified regional, organizational sargassum stakeholders – including The Caribbean Community (CARICOM) and international agencies – and recommended further regional management efforts to address sargassum management and commercialization. In stark contrast, van der Plank et al. (2022) noted that, despite attempts at regional information sharing to support the management of sargassum in the region,

capacity limitations in small Caribbean nations limited the effectiveness of regional efforts. Thus, the researchers suggested that any sargassum management plan should consider the capacity of the island/nation – e.g., economics, human capital, etc. – before proposing sargassum management strategies.

The CERMES Guidelines for *Sargassum* Management

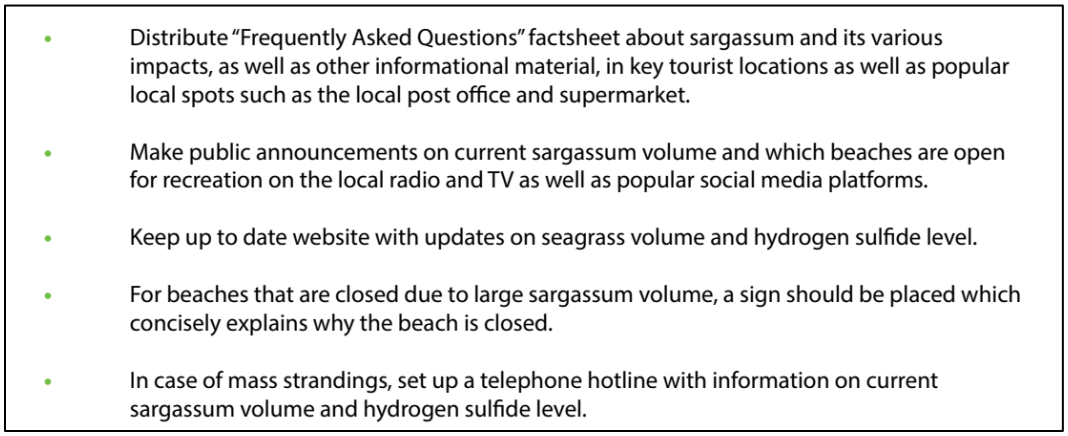
In 2016, researchers from the Centre for Resource Management and Environmental Studies (CERMES) created a management brief titled the *Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up*. The brief presents "guidelines [for managing sargassum] that can be adapted to the local situation as well as some local examples and some dos and don'ts based on experiences around the Wider Caribbean Region" (Hinds et al., 2016, p. 2). Key activities and recommendations are summarized as follows:

1. Develop a communication plan to educate residents and tourists about sargassum.
2. Determine in advance which beaches will be cleaned up and on which beaches the sargassum will be allowed to accumulate.
3. Determine when hand raking will be used and when mechanized tools will be used. The report recommends using hand clearing when amounts are small or moderate and only using mechanized removal when the areas are inundated, due to the risk of beach erosion. When mechanized equipment is used, the report recommends soft tired mechanized beach rakes and using heavy equipment with claws, not buckets. The heavy equipment should only be used to pick up the top layer and then beach rakes should be used to avoid over collecting sand. Equipment should only be operated in the intertidal area on wet sand and during operations monitor for sea turtle nests and other wildlife.
4. Determine whether to collect sargassum in nearshore waters before it is beached. The report recommends this approach where possible but cautions against offshore collection due to potential wildlife impacts. The researchers note that barges with treadmills that can collect 10 tons at a time are used in Guadeloupe; that the Mexican Navy has created a combined boom and suction pumping system; and that, in Barbados, a local company uses horses to pull seaweed traps in the surf.
5. Booms can (re)direct sargassum. The report notes that booms can be deployed to protect beaches or funnel sargassum to a collection point, and that, in shallow waters, reinforced fishing nets and hand collection from boats is also possible. The authors urge that all collection plans should include wildlife monitoring and turtles, eels, and other creatures in the sargassum should be caught and returned to the sea.
6. Whether or not to bury sargassum depends on the beach. Burying collected sargassum in situ is listed as an option on wide beaches; on narrow beaches and sea turtle nesting beaches the authors do not recommend it because the sargassum changes the composition of the sand and may interfere with hatchlings.
7. Sargassum has an ecological value. The researchers emphasize that pelagic sargassum has been recognized as essential fish habitat by the South Atlantic Fisheries Council and that the Sargasso Sea has conservation status. It is also noted that the sargassum impacting the WCR is from a new source region in the equatorial Atlantic. Water temperature and current fluctuation are suggested as reasons for annual variability of quantities of sargassum reaching the Caribbean.

The Prevention and Clean Up of Sargassum in the Dutch Caribbean, prepared by the Dutch Caribbean Nature Alliance in 2019, bases its recommendations for beach management on the CERMES report. It expands on the analysis of types of mechanized equipment used in sargassum management (see Appendix F); describes how Guadeloupe has created a Green Brigade of workers – 90% of whom are paid by the government – who clean the beaches by hand using rakes and wheelbarrows; and includes a section on sargassum worker safety based on the U.S. Occupational Safety and Health Administration (OSHA) regulations for hydrogen sulfide (see Appendix G).

The importance of communication is repeatedly mentioned in the Dutch Caribbean report which indicates that communication and engagement with multiple stakeholders is key to managing sargassum (Figure 3). The report refers to, but does not cite, a 2018 study by CERMES that found tourists are willing to pay up to a $20 surcharge for sargassum clean up, and that tourists are willing to travel 10-15 minutes to non-impacted beaches, indicating that not all beaches need to be cleaned to ameliorate impacts to the tourism sector.

Figure 3. Suggested targeted sargassum communication methods to implement
[Source: Dutch Caribbean Nature Alliance, 2019)



Lastly, the report also outlines tracking systems, both existing and in development, that will predict when and how much sargassum is likely to end up in particular locations. Other academics have developed and described different tracking systems for use in management of sargassum influxes; for example, Trinanes et al. (2021) describes the Sargassum Inundation Report system, Arellano-Verdejo and Lazcano-Hernandez (2020) propose crowdsourcing data for sargassum monitoring in Mexico, and Hernández et al. (2022) describes using high-resolution satellite imagery to assess the impact of sargassum inundation on coastal areas.

The Caribbean Regional Fisheries Mechanism Model Protocol

In 2016, the Caribbean Regional Fisheries Mechanism (CRFM) Secretariat created the *Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts Of CFRM Member States*. The protocol is an adaptation of the 2015 *Protocolo para el Manejo de Acumulacion Extrema de Sargazo en las Costas de Puerto Rico* ("Protocol to Manage the Extreme Accumulations of Sargassum on the Coasts of Puerto Rico"), developed by the Puerto Rican Departamento de Recursos Naturales y Ambientales ("Department of Natural and Environmental Resources" [DRNA]) and is meant to encourage and assist

CFRM member states to develop their own country-specific sargassum management plan. Prepared in the form of a template, the model protocol assumes that each adopting country will adopt national legislation authorizing the management of sargassum pursuant to the protocol. The template provides that the national legislation will both identify a lead agency (and calls for it to be the agency tasked with environmental protection) and provide funding for that agency to implement the legislation.

The protocol further provides that sargassum issues be addressed by a committee comprised of agency representatives from agriculture, tourism, solid waste management, other environmental agencies, the U.S. Virgin Islands Hotel and Tourism Association (HTA), and other environmental entities or organizations, community groups and/or volunteers. The protocol provides that the committee should function to:

1. Explore viable commercial uses of sargassum.
2. Promote public education and awareness about sargassum and its impacts; and
3. Support the efforts of the lead agency in implementing the protocol.

The protocol provides that committee members should enter into inter-agency or public/private agreements with the lead agency to facilitate sargassum management effort.

The template then provides a stepwise process for addressing sargassum accumulation events, beginning with a notification protocol, continuing with a protocol for the assessment of the impacted area by a technical professional, and ending with the development of, and authorization to implement, a workplan to address the accumulation. The protocol provides that technical evaluation – i.e., the assessment of the impacted area by a "technical professional" – should determine the following:

a. Area impacted, be it the zone of the coast affected above high tide or the coastal pelagic zone.
b. A biological sampling of the area to determine water quality, the presence of turtle nests, marine or terrestrial organisms that require rescuing and releasing.
c. Whether to remove, not remove, or relocate the material.
d. Specific places where removal of the material will occur, if applicable.
e. Approximate quantity to be removed, if applicable. This evaluation will determine the method of removal and if the process will be done manually by raking (with minimal impact to the system) or if machinery is necessary. Removal method, if applicable (CRFM, 2016, p. 10).

Timelines are established for each step (e.g., technical evaluations should be finalized within two days of knowledge of the accumulation event), and the protocol suggests that the type of response authorized by the adopted legislation should be tiered to minimize impact to environmental resources and beneficially use sargassum as part of an erosion protection strategy where appropriate. This means that any plan developed to manage the "extreme accumulation of *Sargassum*" (CRFM, 2016, p. 9) should include specific responses based on the amount of pelagic sargassum deposited. For example, the protocol suggests that smaller accumulations are to be handled with hand rakes and potentially leaving the material in place to support dunes and shoreline vegetation, while extreme accumulations, on the other hand, should be dealt with using machinery to remove the material.

In 2019, Cox et al. reviewed four draft national sargassum plans, all of which were prepared using the aforementioned CFRM model protocol.[4] The reviewers found that, even after following the recommendations in the model protocol, none of the four national plans contained enough detail to be actionable. The plans were also not "adaptive" – meaning that the plans were not structured to be "altered" or "improved over time" (Cox, Oxenford, & McConney, 2019, p. 3).

Specifically, the reviewers suggested that all four plans would benefit from revisions to address the following:

- "Simplifying and reducing the amount of 'official reporting' that seems to be required given the limited capacities claimed by stakeholders, unless key specific purposes are assigned to reports.
- Providing more specific guidance on how to do things that are called for in the plan such as 'evaluating a beach' or 'monitoring the sargassum' or 'determining the water quality', and exactly what equipment to use etc. either by appendices or by links to other resources.
- Using tables that specifically identify the issue and then provide the 'solutions' (management actions) which may vary according to the severity of the stranding and the sensitivity of the beach (i.e., turtle nesting site), in the same way that a Fishery Management Plan would be written.
- Giving more detail on exactly which authorities, agencies, or non-governmental organizations (NGOs) need to be contacted to undertake which listed actions, including their contributions to monitoring, learning and adaptation.
- Setting out how the Sargassum Management Committee actually functions through terms of reference and operational procedures with clear information on decision-making processes.
- Ensuring that management actions actually serve the overall goal, listing clear objectives of the plan based on the issues being faced and addressing each of the issues identified and outlined.
- Considering the potentially severe impacts of both sargassum and its clean-up actions on coral and seagrass communities as well as beaches.
- Setting out the budget and other resources that might be needed to implement the stated actions and who will be responsible for providing them" (Cox et al., 2019, pp. 3-4).

Additionally, the reviewers suggest that agencies should use the following steps to prepare or revise plans:

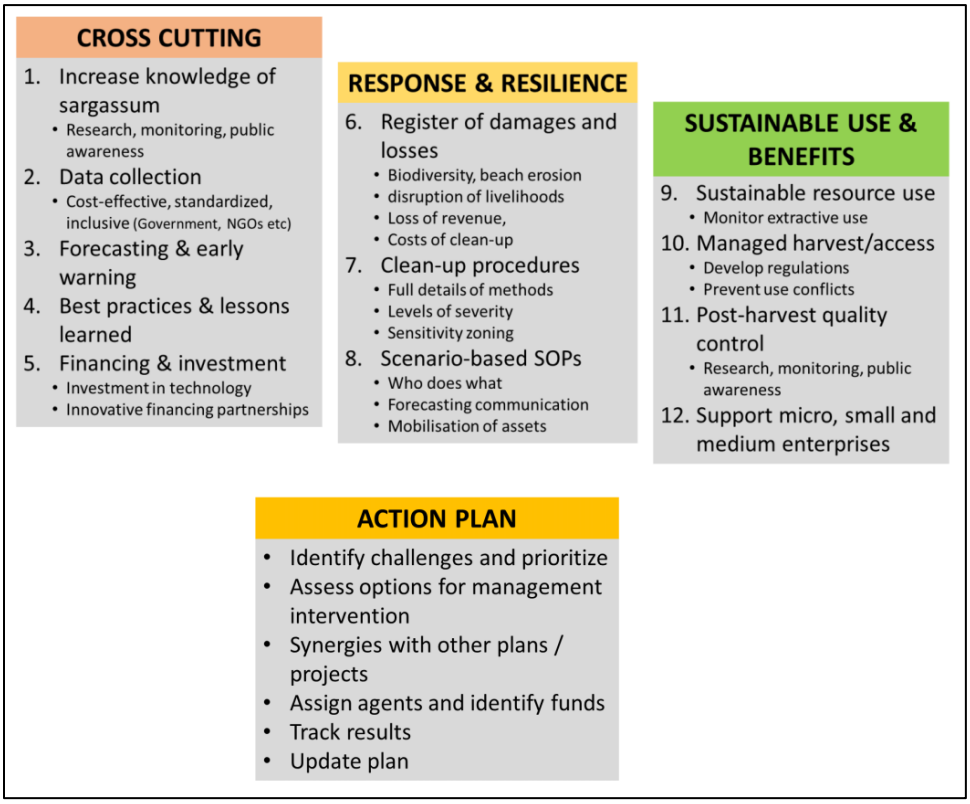
- "Use their experiences and lessons learned.
- Use relevant existing sargassum plans, etc.
- Use good governance principles (e.g., National Inter-sectoral Coordination Mechanisms),
- Use a disaster risk management approach.
- Use an innovation and livelihood approach.
- Use entrepreneurial product development.
- Combine these and other facets in planning; and
- Develop adaptive, multi-level, inter-sectoral plans" (Cox et al., 2019, pp. 6-7).

[4] The four national plans that were developed in country and submitted for review were from Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines.

Creating a *Sargassum* Management Plan That is Adaptive

The need to make sargassum management plans adaptive – i.e., able to be reviewed, revised, and improved over time, and approaching sargassum as both a hazard and an opportunity were recurring themes across the literature reviewed. Cox et al. (2019) noted that, "the main elements of an adaptive management plan for sargassum should seek to foster improved resilience to sargassum influxes as well as opportunities for economic benefit" (p. 5). The reviewers cited, with approval, the proposed framework for an adaptable sargassum management plan from Sabir (2018) which, "sets out a suite of 12 priority areas for considering action… arranged across three thematic areas" (Cox et al., 2019, p. 5). The reviewers then highlight the expanded framework Oxenford et al. (2019), that includes sub-activities under each of the 12 priority areas originally proposed by Sabir (2018). This expanded framework (Figure 4) also includes an action plan and is the adaptive model from which, "Stakeholders should be encouraged to revise [or create] existing plans" (Cox et al., 2019, p. 6).

Figure 4. The expanded framework for an adaptable sargassum management plan
[Source: Oxenford et al., 2019]



Case Studies: Dominica and Barbados

Dominica adopted its *Strategic Sargassum Preparedness Plan* in 2019 and is one example of the process used to develop, and contents of, a national sargassum management plan. The Fisheries Division of Dominica commissioned an outside consultant to write the island nation's Preparedness Plan for sargassum. The Plan summarizes how the contractor preparing the report worked with the Fisheries Division to conduct limited stakeholder interviews, reviewed available literature to provide a broad overview of what sargassum is and its potential impacts to Dominica, as well as potential economic uses

of sargassum. The report emphasized that Dominica has had sparse inundations of sargassum when compared to other islands. The plan then sets forth short term strategies and a five-year plan to implement longer term strategies. The short-term strategies include: 1) the Fisheries Department employing day laborers to rake the sargassum up to the dune line, 2) burying the sargassum on the beach, and 3) installing signage providing educational information to tourists. The proposed longer-term strategy provides for: 1) establishing a national level committee as well as three regional subcommittees with responsibility for reporting influxes, 2) collecting data on the quantity and types of sargassum on Dominican beaches and impacts to the regional stakeholders, and 3) implementing additional commercial uses of sargassum as quantities increase. In year three, the committee would have selected management options for larger quantity events that would include using the sargassum as fertilizer and shipping to Barbados for conversion into biofuel. The structure and management effects would be evaluated in year five and the program would be renewed and adjusted as needed. The plan recommends that private sector members of the committee be paid to participate and provides for quarterly meetings of the regional subcommittees and biannual meetings of the national committee.

Another example of national sargassum management plan worth noting, is the two volume *Draft Barbados Sargassum Adaptive Strategy*. The 2021 strategy attempts to place sargassum management in the broader context of climate change adaptation strategies and begins the document with the following note:

> "The strategy should be converted into a dynamic website in which the many appendices are updated often, using new information and learning from monitoring and evaluation. The adaptive strategy (first volume) and action appendices (second volume) cover many aspects of sargassum marine science from open sea to shore, methods for responsible removal and use, financing, plus the roles and coordination of public sector, private sector and civil society actors at all stages and levels. Critical to the strategy are the appendices of site profiles that set out social and ecological characteristics, history of impacts and responses, vulnerabilities, opportunities and whatever other features are relevant to each site. The institutional arrangements for response have these site-level building blocks as their foundation, similar to community-based disaster management, while scaling up to national level to match the requirements of very massive influxes that call for major mobilization. The frequently updated strategy fits within the intersectoral and multi-stakeholder scope of national adaptive management such as climate change adaptation, disaster risk management and blue economy initiatives" (p.iii).

Uses of Collected *Sargassum*

As the disposal and valorization of sargassum are considered key components to any sargassum management plan, the literature was also reviewed to identify recommendations and best practices. Based on available literature, the potential commercial uses for sargassum are plentiful, but most are at the research stage, and few are operating at scale.

The 2016 CERMES report Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up notes:

> "Research and experimentation to date have revealed a number of potential value-added uses of sargassum, such as: fertilizer, plant tonic, compost, mulch and pest control; chemical

> compounds for pharmaceuticals/personal care products/food supplements; biofuel/biogas; chipboard; biosorbent for removal of heavy metals in polluted water; and livestock and fish food" (p. 14).

The report continues with the following caveat:

> "Considerable research and development is still needed to commercialise [sic] the products and to ensure economic viability under an uncertain supply of the raw material. In particular, the use of sargassum for consumptive purposes will require careful biochemical analysis to determine the local levels of possible contaminants, given the strong biosorbent properties of the seaweed which means that it could 'collect' heavy metals and other pollutants depending on where it has travelled" (p. 14).

The Dutch Caribbean Nature Alliance's 2019 sargassum management brief lists possible uses of sargassum based on ongoing valorization projects (p. 18):

- Biostimulant: sargassum contains important plant nutrients such as potassium and phosphates, making it a promising biostimulant. The seaweed has also been found to optimize the nutrient uptake of plants by promoting strong root development. The high salt content of the seaweed is however an issue as it can result in soil salinity if not washed out.[5] Removing this excess salt is not only expensive and time consuming but it may wash out key nutrients. In St. Lucia, Algas Organics has successfully created the Algae Total Plant Tonic, a natural bio-stimulant made from collected sargassum… The product was recently introduced to Barbados.
- Biosorbent for removal of heavy metals in polluted water.
- Take-away containers for food and drinks possibly in combination with cassava starch and banana fiber.[6]
- Charcoal briquettes: sargassum can be ground into a powder and mixed with other carbon sources to produce charcoal briquettes.
- Adobe bricks for construction of houses: in Quitana Roo, Mexico, a house was recently constructed entirely from sargassum. Sargassum bricks are a brown-reddish color, do not smell and cost 50% less than usual adobe bricks.
- Other uses currently being studied: chemical compounds for pharmaceuticals/food supplements, biofuel, and bioplastics.

In 2020, Desrochers et al. published *Sargassum Uses Guide: A Resource for Caribbean Researchers, Entrepreneurs and Policy Makers*. The guide begins by summarizing the chemical composition of the species of *Sargassum spp.* impacting the Caribbean and the research that has been done on heavy metal and other pollutant content in Caribbean sargassum, noting the consistently high inorganic arsenic content across most samples analyzed (see Appendix H). The guide then outlines the global use of brown algae in 14 economic sectors, noting which of these potential uses require further research, identifying any Caribbean-based projects or research by sector, and comparing, based on a rough biomass index, how much sargassum would be required for each particular use. The document also includes case studies of some of the Caribbean-based projects, a directory of entrepreneurs and researchers, as well as a section summarizing challenges for valorization (see Appendix I for an

[5] Emerging research has found that sargassum contains sodium within its tissue. Thus, regardless of how well the sargassum is washed it will still contain salt and salinize the soil.
[6] This project is being conducted in the Dominican Republic.

example). Similarly, the Rosellón-Druker et al. 2022 study summarizes the sargassum-related research, and management, activities conducted in Mexico over the last decade and suggests gaps where further work is needed, particularly with regards to the management of sargassum in non-tourist areas.

In 2021, Robledo et al. offered a similar analysis, including a framework for advancing research and commercialization of sargassum uses. The researchers stress that the:

> "Tourism in the Caribbean is worth $29.2 billion dollars, and it has been estimated that it will cost at least $120 million dollars to clean-up the *Sargassum* inundations in this region (Milledge and Harvey, 2016). Due to the economic cost of removing the stranded seaweed, there is an imperative need to define technical and ecological measures to forecast an event and reduce its proliferation and valorize its biomass" (Robledo et al., 2021, p. 8).

So does Oxenford et al. in their 2021 summary of the challenges to developing commercialized uses for sargassum, where the researchers suggest government and/or public sector involvement in "the domain of applied research and product development" (p. 44), and funding to solve some of the challenges noted in the 2020 Desrochers et al. *Sargassum Uses Guide*.

As an alternative to commercial uses, others have suggested utilizing sargassum as part of a carbon sequestration strategy by sinking collected sargassum in the deep ocean; for example, the Littoral Collection Module-Towline-Sargassum Ocean Sequestration of Carbon barge system described in Gray et al. (2021). Using sargassum to combat beach erosion has been explored; a study on Galveston Island, Texas demonstrated that sargassum deposited on dunes facilitated the growth of dune vegetation when the seaweed was deposited in large amounts. The increase in vegetation was assumed to stabilize the dune line (Williams & Feagin, 2010). The same study determined that leaving the sargassum on the beach did not protect beaches from erosion.

Federal Regulations and Policies on *Sargassum* Management

In 2003, the National Marine Fisheries Services (NMFS) approved a rule designating pelagic sargassum located off the coasts of the Southern Atlantic States to be Essential Fish Habitat (EFH) and, thus, limited sargassum harvesting and certain types of fishing in this area – i.e., the Sargasso Sea. By its terms, the federal rule applies to a specific area outside the Caribbean and was passed before to the sargassum influxes became commonplace in the Wider Caribbean Region.

Federal regulation around sargassum management within American waters outside the coasts of the Southern Atlantic States has been absent as agencies have yet to grapple with what to do about the piles of sargassum in Florida, Puerto Rico, and the USVI. Key informant interviews with sargassum stakeholders at the federal level described how pelagic sargassum sits in a "weird gray area," and admitted that some federal agencies "haven't had these conversations with attorneys or management" about whether, who, or how to regulate the "new activities" that sargassum management presents. As one federal stakeholder explained, "NOAA has questions [about] what to do with it… The EPA doesn't know what to do with it. They don't know if it's a waste [and they're] only triggered when someone dumps sargassum back into the ocean."

In response to mis- and conflicting information around the regulatory environment of sargassum management in the American Caribbean, a virtual workshop was held in Puerto Rico in June 2022. The workshop, titled *Legal Considerations on the Removal of Sargassum from the Coast of Puerto Rico,* was organized by Sea Grant Puerto Rico and the Harte Research Institute for the Gulf of Mexico Studies. Representatives from each of the relevant federal regulatory agencies presented their role with regards to sargassum management, including the legal framework for their jurisdiction and any existing permitting processes (see Appendix J for the complete presentations).

Currently, **no federal regulatory agency prohibits** the collection or removal of sargassum from the water. Only two federal permitting processes are potentially triggered by collecting or removing sargassum from the water. They are:

1. The US Army Corps of Engineers (USACE) permitting process if a structure, like an aquatic plant boom, is to be installed in territorial waters, all of which are considered navigable waters of the US; or if sargassum-related mechanized work is to be conducted in territorial waters.
2. The Environmental Protection Agency (EPA) permitting process if collected sargassum is to be discharged back into the ocean.

"If you're going to go out there with a boat and scoop [sargassum] up with a boat, you don't need our approval for that," remarked one key informant from NMFS. "The only situation in which you involve us is if you are going to deploy some anchors and put out a boom between to collect the sargassum. [That requires] a Section 10 permit from the USACE because [it could be] a navigation hazard. In that case, [NMFS's role is to] advise the Corps. [However] the USACE can view that as a minor activity that requires no coordination [with NMFS]."

The collection and removal of sargassum on beaches, technically, does not fall under federal jurisdiction unless the collected sargassum is disposed of in the ocean; then this would require an EPA permit. Key informant interviews with federal stakeholders did note that this is another "gray area," as some land-based methods of sargassum collection could potentially fall under USACE jurisdiction in the future. For

example, if workers at a marina are collecting sargassum using a net in between slips while standing on a marina bulkhead – i.e., a hard substrate, then that is not under USACE jurisdiction because no "work" in-water is being done. However, if workers at a resort are using machinery on the beach to remove sargassum and this machinery has a "discharge," or if the machinery is moved waterward of high tide line – i.e., within the Corps' jurisdiction, then this activity could, potentially, require a USACE permit. As previously mentioned, these questions have yet to be tackled by federal regulators and the USACE has not (yet) issued any guidelines regarding these kinds of sargassum management activities. Table 2 is a summary of the federal regulatory environment for sargassum management by agency, jurisdiction stature, and regulatory trigger.

One recommendation worth highlighting is the suggestion to obtain an Incidental Take Permit for any in-water sargassum work that is not federally funded. This idea was mentioned in the June 2022 virtual workshop and again during key informant interviews with federal stakeholders. Incidental Take Permits are issued by NMFS under Section 10 of the Endangered Species Act (ESA) and allows for non-federal entities "undertaking otherwise lawful projects that might result in the take [i.e., death] of an endangered or threatened species" to not be prosecuted for an ESA violation. "That's just in case something happens, [like] a turtle gets entangled in a net [during in-water collection], then you're covered," one stakeholder noted. "Especially if [the cleanup] is privately funded."

Table 2. The federal regulatory environment for sargassum management

Regulatory Agency	Jurisdictional Statures for Managing Sargassum	Agency Role with Regards to Sargassum	Regulation Triggered If…	Prohibits Sargassum Collection or Removal	Notes
Environmental Protection Agency (EPA)	Marine Protection, Research and Sanctuaries Act: MPRSA Section 1412 Clean Water Act: CWA Section 404 Rivers and Harbors Act: RHA Section 10	1) To regulate the dumping of material into the ocean that would unreasonably degrade or endanger human health… or the marine environment, ecological systems or economic potentialities. 2) To provide recommendations to the USACOE under CWA Section 404 and/or RHA Section 10.	Sargassum, which is considered a non-dredged "material" under the MPRSA, is being dumped, in any form, back into the ocean.	No.	Collaboration between parties performing the collection and disposal of sargassum is crucial. All EPA-designated ocean dredged material disposal sites must have a site management plan.
National Oceanic and Atmospheric Administration, National Marine Fisheries Services (NOAA-NMFS)	Magnuson-Stevens Fishery Conservation and Management Act: MSA Section 305(b)(2) Endangered Species Act: ESA Section 7(a)(2) and ESA Section 10(a)(1)(B)	To be consulted with, and thus provide recommendations, on any action, or proposed action, that may adversely affect EFH. Recommendations are <u>not</u> prescriptive.	A <u>federal</u> agency is funding, permitting, licensing, or undertaking an action which may adversely affect EFH.	No.	Activities can be delayed if EFH and/or an ESA Section 7 or Section 10 consultation is required.
US Army Corps of Engineers (USACOE)	Clean Water Act: CWA Section 404 Rivers and Harbors Act: RHA Section 10	To regulate any structures, mechanized work, or discharges of dredged/fill material in navigable waters of the US related to the prevention, removal, or management of sargassum in coastal waters.	A structure is installed, mechanized work is conducted, or dredged/fill material is discharged within the navigable waters of the US.	No.	USACOE has no specific procedures in place related to management of sargassum. Applicable USACOE permits are a General Permit or an Individual Permit.
US Fish and Wildlife Services (USFWS)	Endangered Species Act Fish and Wildlife Coordination Act (FWCA) Marine Mammals Protection Act	To provide guidance on how to minimize the impacts of sargassum removal to federally protected species.	A <u>federal</u> agency is funding, permitting, licensing, or undertaking an action which may impact fish or wildlife resources under the FWCA or ESA.	No.	Activities can be delayed if an ESA consultation is required.

The USACE and *Sargassum*

Before a structure is installed in the navigable waters of the US, or mechanized work or discharges of dredged/fill material are conducted in the navigable waters of the US, an Application for Department of the Army Permit must be submitted to, and approved by, the USACE. All the waters in the territory are considered to be "navigable waters of the US." Thus, the installation of sargassum mitigation structures, like aquatic plant booms, or the mechanized collection of sargassum in-water would require an "Individual Permit" or a "General Permit" from the USACOE. As previously stated, the USACE has no specific procedures in place related to the management of *Sargassum* at this time.

As part of obtaining any permit from the USACE, the applicant must show that the proposed project is in compliance with Section 7 of the ESA, Section 10 of the RHA, Section 305 of the MSA, Section 404 of the CWA and Section 106 of the National Historic Preservation Act of 1966 (NHPA). While different federal regulators are in charge of these statutes, the USACE serves as the nexus between the agencies. As such, the USACE will have either "informal" or "formal" consultations with its sister agencies to ensure that the proposed project is, in fact, in compliance with the various statures.

Since the Caribbean Fishery Management Council (CFMC) has identified *Sargassum* as EFH for managed fish species, at minimum an application to the USACE to permit a sargassum management activity in the USVI will need to address how the activity could impact the territory's managed fish species and their habitats. NMFS has also identified and described Sargassum as EFH for managed fish species but only off the coasts of the Southern Atlantic States. Thus, NMFS does not regulate or prohibit sargassum removal in the American Caribbean. Additionally, since the territory is home to a number of pelagic species protected under the ESA, a USACE permit application would need to address the potential impacts to the ESA-listed species that can be found in sargassum. These species include green sea turtles *(Chelonia mydas)*, leatherback sea turtles *(Dermochelys coriacea)*, hawksbill sea turtles *(Eretmochelys imbricata)*, loggerhead sea turtles *(Caretta caretta)*, Nassau groupers *(Epinephelus striatus)*, and scalloped hammerhead sharks *(Sphyrna lewini)*.

At this time, the USACE has a total of fifty-nine different Nationwide Permits (NWPs) and there is no NWP that directly addresses activities related to sargassum collection or removal. These permits were approved in 2021 and will be valid until 2026, after which time they will be modified or reapproved. The two closest USACE NWPs that could be modified to become a sargassum NWP are:

1. Nationwide Permit 20, Response Operations for Oil or Hazardous Substances; and
2. Nationwide Permit 38, Cleanup of Hazardous and Toxic Waste.

Nationwide Permit 20, Response Operations for Oil or Hazardous Substances permits activities conducted in response to a discharge or release of oil or hazardous substances that are subject to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300). This includes containment, cleanup, and mitigation efforts, provided that the activities are done under either:

a. The Spill Control and Countermeasure Plan required by 40 CFR Part 112.3.
b. The direction or oversight of the federal on-scene coordinator designated by 40 CFR part 300; or
c. Any approved existing state, regional or local contingency plan provided that the Regional Response Team (if one exists in the area) concurs with the proposed response efforts.

This NWP also authorizes the use of temporary structures and fills in waters of the U.S. for spill response training exercises under Section 10 of the RHA and Section 404 of the CWA.

Nationwide Permit 38, Cleanup of Hazardous and Toxic Waste, permits specific activities required to affect the containment, stabilization, or removal of hazardous or toxic waste materials that are performed, ordered, or sponsored by a government agency with established legal or regulatory authority. Court ordered remedial action plans or related settlements are also authorized by NWP 38. This NWP does not authorize the establishment of new disposal sites, or the expansion of existing sites used for the disposal of hazardous or toxic waste.

Under this NWP, the permittee must submit a pre-construction notification to the District Engineer prior to commencing the activity. Worth noting, activities undertaken entirely on a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the CWA or Section 10 of the RHA.

Neither of these NWPs are a perfect match to permit sargassum management activities, nor do either of these permits directly address sargassum which is a naturally occurring substance and does not always become a hazardous substance.

The EPA and *Sargassum*

Under the Marine Protection, Research and Sanctuaries Act (MPRSA, also referred to as the 'Ocean Dumping Act'), "the dumping of material into the ocean that would unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities is prohibited under the MPRSA" (Guerrero Perez, 2022). Under the act, sargassum is considered a "non-dredged 'material'" and the dumping of either fresh or manipulated sargassum into the ocean is, thus, an act regulated under MPRSA and is, thus, unlawful unless permitted by the EPA.

If an individual or entity in the USVI were ever to put sargassum back into the ocean, they would need an EPA permit to do so under Section 1412 of the MPRSA. A MPRSA permit would consider the following, which means that any application for a MPRSA permit would need to consider and/or address the following items:

- The type of material to be dumped.
- The amount that may be transported for ocean dumping.
- The location of the dumpsite.
- The length of time the permit is valid; and
- The need for any special provisions for dumping site surveillance.

As part of the permit application process for the ocean dumping of material, like sargassum, a notice of an opportunity for a public hearing must be issued to the public and public hearing held to discuss the application and, potential, long-term effects.

If seeking an "Individual Permit" for ocean dumping proves too costly for one entity, there is the option for local and municipal (i.e., territorial) governments to jointly petition with a private entity for the issuance of a "General Permit" under Section §1414(c) of MPRSA. If meaningful cooperation among

territorial governments – e.g., Puerto Rico and the USVI – and private entities is achieved, a "General Permit" for the dumping of sargassum could be sought. The benefit of seeking a joint "General Permit" would be its applicability to all sargassum dumping within a region.

> "Rather than seeking one permit, multiple entities could make a showing that the necessity for the ocean dumping of *Sargassum* outweighs its environmental impact. Such a permit would also operate on a needs basis as *Sargassum* flow fluxes over the years" (Guerrero Perez, 2022).

Appendix J has more on the EPA permitting process for ocean dumping.

Federal Funding for *Sargassum* Management

The potential to receive funding for sargassum management was discussed during every key informant interview with federal stakeholders. Since regulations around pelagic sargassum in the waters of the American Caribbean are lacking, identifying a funding stream to support sargassum management activities is not, currently, clearcut.

The issue of whether sargassum could be included under the NOAA Marine Debris Program was repeatedly raised by federal and territorial stakeholders; however, even with all the refuse it accumulates and carries to shore, pelagic sargassum does not currently fall under the rigidly specific definition of "marine debris." The inclusion of any sargassum management work, and funding, under the NOAA Marine Debris Program would require an Act of the United States Congress. "That does not mean that, some months from now, things could not be different," one federal stakeholder noted. "We're still bringing attention to the [sargassum issue] as an emerging problem that is getting bigger and bigger. Congress has to say, Marine Debris [Program], you can get involved in [sargassum management] … A policy change would require an Act of Congress and may take some years."

"[What we need is] research that demonstrates that sargassum is a really big debris problem…" one federal stakeholder recommended. "Documentation… Citizen science… If there are studies that point out that [sargassum] might or is a contributor to marine debris problem [that could] definitely [help to advocate] for a policy change. Right now, I don't think that [sargassum] is even a priority for the [NOAA Marine Debris] Program."

The table below summarizes some of the potential federal funding streams currently available for sargassum management recommended during key informant interviews with federal stakeholders.

Table 3. Potential federal funding streams for sargassum management suggested during key informant interviews with federal stakeholders[7]

Program	Agency	Rationale/Notes
Coral Reef Conservation Program	NOAA	Sargassum is negatively impacting corals and coral habitats.
Fishery Disaster Assistance	NOAA	After Hurricanes Irma and Maria, Puerto Rico included sargassum cleanup under their Fisheries Disaster Funding proposal.
Coastal Zone Program, NOAA Regional Collaboration Network	NOAA	Programs and projects that mitigate the impacts of sargassum fall under the priorities identified by the NOAA Southeast and Caribbean Regional Team (SECART) in their FY23-25 Plan and are consistent with NOAA Goals and Regional Collaboration priorities.
Pollution Prevention Grant: Environmental Justice in Communities Pollution Prevention Grant: Environmental Justice Through Safer and More Sustainable Products	EPA	Grants range from $100,000 to $800,000 and eligible applicants include states, state entities such as universities, and U.S. territories and possessions. The program aims to help businesses adopt pollution prevention practices to advance environmental justice and could, potentially, be used to purchase hydrogen sulfide monitors or fund other sargassum management activities related to hydrogen sulfide emissions.

[7] The EPA Pollution Prevention Grants became available after key informant interviews had been conducted.

Territorial Regulations and Policies on *Sargassum* Management

In the USVI, the Coastal Zone Management Agency (CZM) under the Department of Planning and Natural Resources (DPNR) is responsible for authorizing and permitting "sargassum inundation [mitigation]"— i.e., sargassum management activities in the territory. To date, the sargassum management actions undertaken by private and public entities in the territory, and overseen by DPNR-CZM, have almost exclusively been land-based activities. There is no official, territorial policy regarding the collection of sargassum in-water, either within DPNR or in the US Virgin Islands Code of Law; nor is there an official, territorial policy regarding the disposal of sargassum, either within DPNR, the US Virgin Islands Waste Management Authority (VIWMA), or in the USVI Code of Law.

The following sections outline the current policies and practices with regards to sargassum management in the USVI.

Land-Based *Sargassum* Management

Non-mechanized, manual methods to remove sargassum from shore do **not** require prior permission from DPNR-CZM nor the Division of Fish and Wildlife (DFW), who is CZM's partner in sargassum management efforts. An example of a non-mechanized manual method is using a rake to gather the sargassum that has landed on the beach.

"In some respects, we've adopted the regional sargassum guidance," said a territorial regulator during a key informant interview. "Small [sargassum] weed lines [we should] leave in place. [It's a] natural part of the system… A [sea]weed line is the normal process within our region. The beaches do not need to be free and clear of everything. Daily raking just so your guests don't have a [seaweed line is not necessary]."

Mechanized methods to remove sargassum from shore **do** require prior permission, and approval, from DPNR-CZM in conjunction with DFW. When sargassum "becomes an odor nuisance, or when the rate at which you're trying to remove it manually [becomes] overwhelming, and the problem is persisting then [an entity] can apply to utilize manual means," a territorial regulator explained. There is no application form to obtain permission. The current process is described as follows:

1. Write a letter to DPNR-CZM. An individual or entity that has a large sargassum influx, unmanageable by non-mechanized, manual methods must make a written request to DPNR-CZM (i.e., by letter) outlining the issue, location, removal methodology, and method of disposal.
2. Await a site visit. That request is reviewed by DPNR-CZM, and a site visit is scheduled to evaluate the request. The individual/entity requesting the use of mechanical removal and/or the contractor directly involved in the methodology should be present for the site visit.
3. Receive (short-term) approval. Once the site visit has been completed, and removal and disposal methodologies deemed appropriate by both DPNR-CZM and DFW, then a letter is written and sent to the individual/entity outlining length of permission and any special conditions that are particular to the request. As part of the approval, applicants are required to review and sign the DFW's *Management Brief for Onshore Removal Permits* (see Appendix K) and DPNR-CZM will mandate that responsible parties are trained in, or instructed on, the proper technique(s) for removing sargassum prior to any removal taking place. The DFW Brief provides an overview of sargassum – i.e., its impact on fisheries, tourism, the environment, and human health; as well as

best practices for sargassum removal and considerations for worker safety. This resource, in conjunction with the DPNR-CZM training, are focused on mitigating damage to natural resources and avoiding injury or harm to marine creatures.

The approval process should take an average of one to two weeks as, one territorial regulator noted:

> "We understand the immediacy and urgency with which some of these requests are made. If it's a new location, [or a new entity] that we haven't worked with before, [the application process] may take a little longer. In seven to 14 working days, we have a response out. [We] try not to delay… We know the urgency."

DPNR-CZM has not set clear guidelines as to whether an individual/entity has to wait until sargassum landings begin to apply for permission to remove the seaweed, or whether they can request approval prior to the start of sargassum season.

When approval is granted, it is not as a "blanket permit" but as a short-term authorization for one sargassum season. As one territorial regulator explained:

> "[The short term permit is] best for control, in terms of what is happening in these sensitive areas. Not just sensitive to the flora and fauna, but for coastal protection in these areas… For example, the operators of the bobcat may change and, thus, [new] operators need to be retrained. [We] don't want to rely on the overall contractor to ensure [the approved sargassum removal] methodologies are being followed… In this community we have seasonal work and transitional work. The same people are not there all the time."

A territorial regulator added:

> "What we're finding now is usually there is a seasonal influx [of sargassum] from early spring to early late September depending on the severity of storm activity… March, April to the end of October is the most active [sargassum] times. After which, [an applicant] has to request again [for a sargassum removal permit], because we're looking at specific methodologies and equipment, and if things have changed."

With regards to "CZM-approved methodologies" for mechanized means of sargassum removal, "the less heavy machinery, the less heavy equipment that is utilized in removal activities, the more appropriate we think for the resources," said a territorial regulator.

According to a territorial regulator, allowable mechanized means and methodologies to remove sargassum include:

> "Small tractors, small skidsteers with wide rubber wheels… Large equipment with large wheels spread the scope of the impact [i.e., spread out the compacting of sand]. [We are] looking for between 18 and 24 wheel size… [We] haven't really set a depression distance but [we] want less depression, less cutting into the substrate.
>
> "Defined routes… If you drive onto the beach one way, continue to utilize that area. Having specific collection points, rather than having collection points all along the entire section of an area. Try to utilize best practices to minimize impact on beach resources."

In-Water *Sargassum* Management

As previously mentioned, the sargassum management actions undertaken in the territory and approved by DPNR to date, have almost exclusively been land-based activities. A handful of entities, primarily private, have applied for, and received permission to use, in-water sargassum management methodologies – i.e., the installation of aquatic plant booms, to keep sargassum from beaching and/or to divert sargassum to designated areas of clean-up.

This approach of containment and/or diversion, is being used throughout the WCR and is included in the Dutch Caribbean Nature Alliance's 2019 document, *The Prevention and Clean Up of Sargassum in the Dutch Caribbean*:

> "According to Hinds et al. (2016), one strategy to minimize the amount of seaweed reaching shore and accumulating in the shallows is 'to divert sargassum away from sensitive areas or to funnel the weed into a nearshore collection area through the use of containment booms.' The containment booms used to help deviate seaweed are temporary floating barriers such as the ones used to contain oil spills… Hinds et al. (2016), recommend that a set of small booms 'be linked together to maximize flexibility, allow for ease of deployment and maintenance, as well as the transport to new locations as required.' The booms must be placed in such a way that boats can access the open sea. They also must be anchored, either temporarily with small anchors or permanently with small helix moorings and must be marked with buoys for safety.
>
> "It is important that a clear plan of where the sargassum will be directed to and how it will be collected is set up before the deployment of booms. Visual monitoring of the collected sargassum must be maintained in order to free any live trapped creatures (Hinds et al, 2016).
>
> "Because containment booms can be very expensive, and because they can break under the weight of sargassum and have negative impacts on marine wildlife, some communities have used fishing nets instead to deflect sargassum. Other issues with the use of booms include maintenance cost, stability during storms and habitat damage if they break free. The results of using booms to prevent sargassum reaching shores have been mixed. It is vital that communities who decide to install booms consider coastal dynamics. As sargassum moves in longshore drift, the use of booms can result in the full load of sargassum deflected onto communities further along the coast who cannot afford to install a boom" (p. 11).

The permitting process for conducting in-water sargassum management follows the same DPNR-CZM and DFW review and approval process for land-based sargassum management, and a federal review and approval process under the USACE (See Section, *Federal Regulations and Policies on Sargassum Management* for more details).

Sargassum Monitoring

DPNR-CZM has been attempting to monitor sargassum in the territory via their citizen science portal, MyCoast Virgin Islands. Information submitted by the public is collected and analyzed to create reports that help stakeholders like government agencies, business owners, and residents understand the territory's changing coastal environment and make informed decisions. Of the 74 reports submitted by the public to-date, only two reports have been sargassum related (Appendix Q). This portal has the

potential to fill crucial gaps in local data on how, and where, sargassum is impacting communities around the U.S. Virgin Islands.

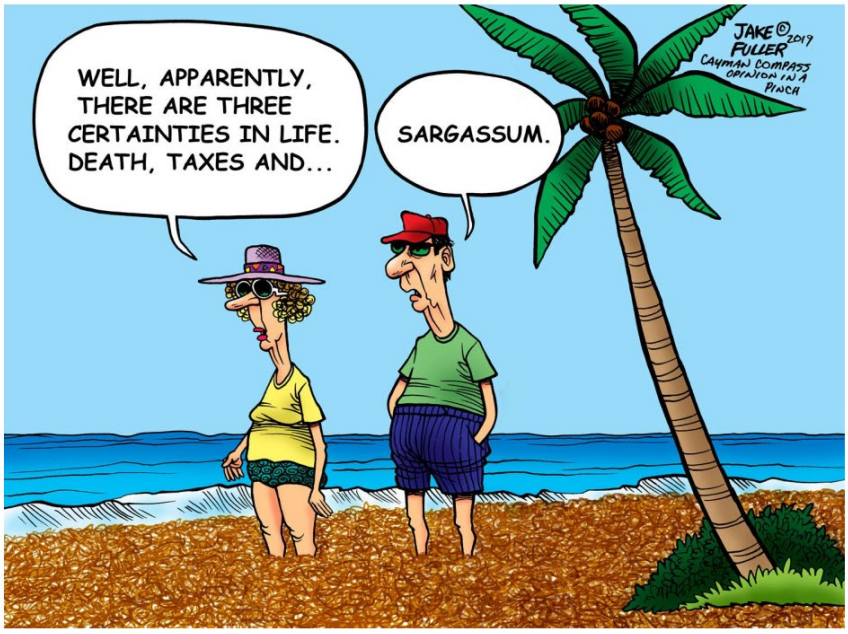


Figure 1. Illustration by Fuller, J. (2019). Sargassum certainty.

Community Input on *Sargassum*

The need to engage with the community was a recurring, and important, theme across all the sargassum management plans and strategies reviewed. To help inform the development of this Blueprint and future activities with sargassum stakeholders across the territory, Bioimpact Inc.:

1. Designed and disseminated an online survey for USVI residents to ascertain their knowledge of sargassum and document community impacts.
2. Interviewed community stakeholders from the various sectors impacted by sargassum on St. Croix, St. John, St. Thomas, and Water Island.

This section summarizes the findings of the community survey and key informant interviews.

Community Survey

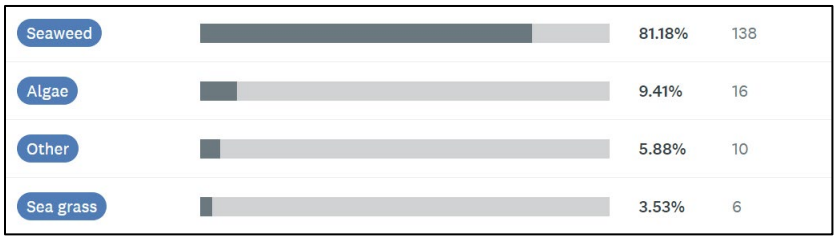
In 2022, a community survey was conducted to determine Virgin Islanders' knowledge of sargassum, understand their perceptions around how sargassum is being managed in the territory, and to gather recommendations for a territory-wide, public-private task sargassum force. The survey also collected data on self-reported adverse health effects related to sargassum exposure, sargassum "hotspots," and valorization opportunities (see Appendix L for the survey questionnaire).

The survey was designed in SurveyMonkey and distributed widely online via local Facebook groups, other social media platforms, and direct emails. The survey was also shared with members of the Water Island Civic Association, the Virgin Islands Conservation Society, and the St. Croix Environmental Association. The survey was anonymous; no identifying information was collected about survey respondents unless a respondent opted to be contacted for future sargassum-related follow up.
The link to complete the survey was live for eight weeks, beginning on October 3, 2022, and ending on November 29, 2022. A total of 221 residents completed the survey. The majority of individuals completing the survey resided on St. Thomas (43%), St. Croix (26%), or St. John (22%).

Community Knowledge of *Sargassum*

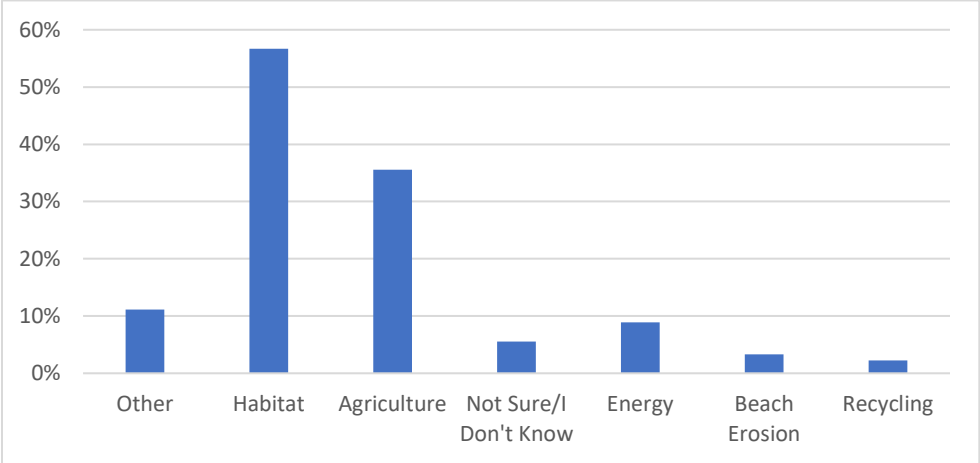
The majority of survey respondents correctly identified sargassum as a seaweed or algae (91%, Graph 1), and acknowledged that the other islands in the Caribbean have pelagic sargassum "like we do in the USVI" (84%). The highest percentage of respondents (36%) believed the Sargasso Sea to be the origin of the sargassum that reaches the territory. Only two people correctly identified the Great Atlantic *Sargassum* Belt as the origin.

Graph 1. What is Sargassum (sargasso)?[8]



Respondents were split with regards to whether sargassum has any potential benefits; a little over half (53%) believed that sargassum does, or could, have a benefit while 47% of respondents were either "not sure or said it had no benefits. Of the respondents who believed that sargassum has benefit, more than half (57%) believed that the benefit was to the marine environment – i.e., that sargassum, in the open ocean, provides habitat to a variety of sea life. Agriculture was the next reported benefit (36%), followed by other (11%) and energy (9%, Graph 2). Other benefits included trapping plastic, creating jobs, and for use in cosmetics and as a paper alternative. Sargassum as a way to combat beach erosion was mentioned by a handful of respondents; specifically, as an "aid in creating sand dunes which helps in restoring eroded beaches."

Graph 2. If yes, you believe that sargassum has benefits, what benefits does sargassum have?

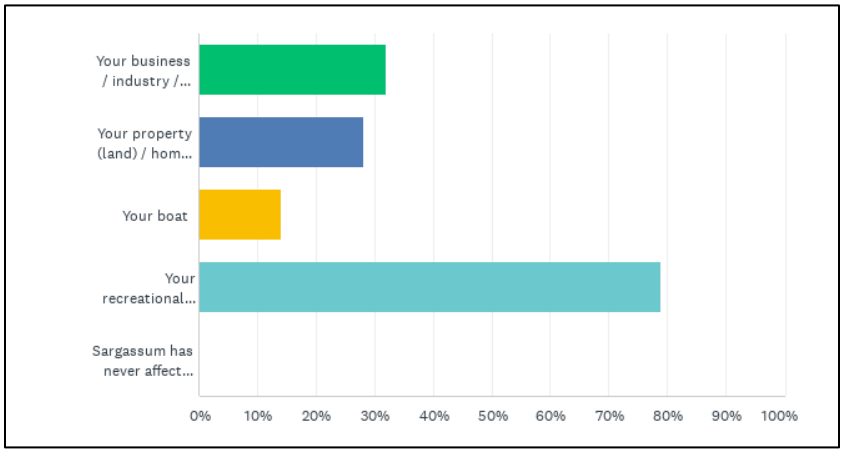


Perceived Impacts to Individuals and the Community

Nine out of ten respondents (91%) reported having been (negatively) impacted by sargassum. When asked how sargassum had (negatively) impacted them, the most common response was that sargassum had impacted their recreational activities (79%), followed by their business / industry / job (32%), and property (land) / home / HOA (28%, Graph 3).

[8] Responses classified as "Other" included: "A plant that grows in the water," "An invasive species," and "A nuisance that impacts tourism and level of happiness with the beach area."

Graph 3. If yes, you have been impacted by sargassum, what did sargassum impact?[9]



With regards to self-report adverse health impacts, a little over one quarter (28%) of respondents believed that exposure to sargassum, in water or on land, had ever affected their health:

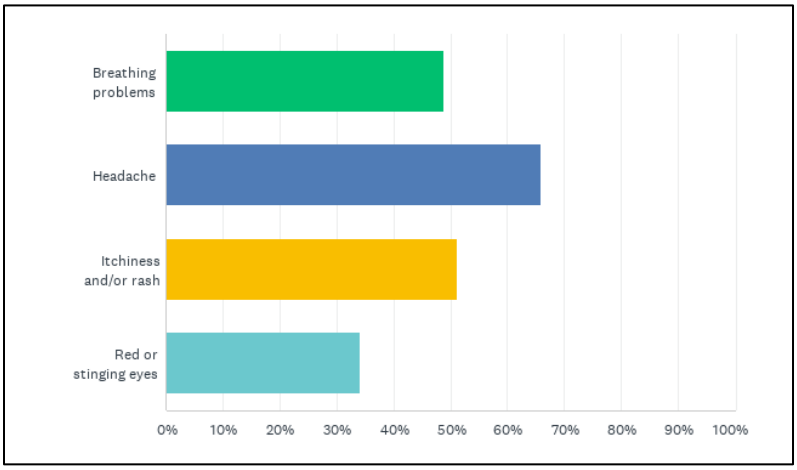
> It causes health issues. My mom is on oxygen and her breathing was affected. Our bathtub stayed covered with sargassum that was in the air. A renter saw it and demanded a full refund. I have been unable to rent my property since August. 2022.

> It would be nice not to be sick for months at a time. I have a breathing trouble all day and all night and have a headache 24/7 when the Sargassum is in the bays. Itchy eyes don't feel good, but doesn't effect me as bad as breathing, headache and stomach issues.

Of those reporting adverse health effects, headache was the most common issue, followed by breathing problems and itchiness and/or rashes (Graph 4).

[9] Respondents could choose multiple answers.

Graph 4. If yes, you believe that exposure to sargassum has affected your health, did you experience (choose all that apply):



Beliefs About *Sargassum* Management in the Territory

When asked whether they believed that something was being done to manage, prevent, or monetize the sargassum that arrives in the USVI, the majority of respondents (83%) said "No" or "I don't know / Not sure." Less than one in five respondents said "Yes," they believed something was being done to manage sargassum in the territory. Of those who believed that something was being done, sargassum collection and disposal from the beaches/shoreline was the main activity mentioned.

The complexity of managing sargassum was not lost on a handful of survey respondents who made a note about the difficulties of finding a solution:

> Any policies or plans will require complex decisions that take into consideration social, economical, ecological, and cultural values. Leaving the Sargassum could have adverse economic effects, but removing it could have adverse environmental effects.

> I appreciate the complexities of it all wish everyone well, hope they can be creative, and open to new and interesting ideas as well as each other.

A few survey respondents even expressed gratitude for the efforts in trying to manage sargassum:

> I applaud any efforts to solve this problem!

> Glad to see information being collected and assessed to create plan for management

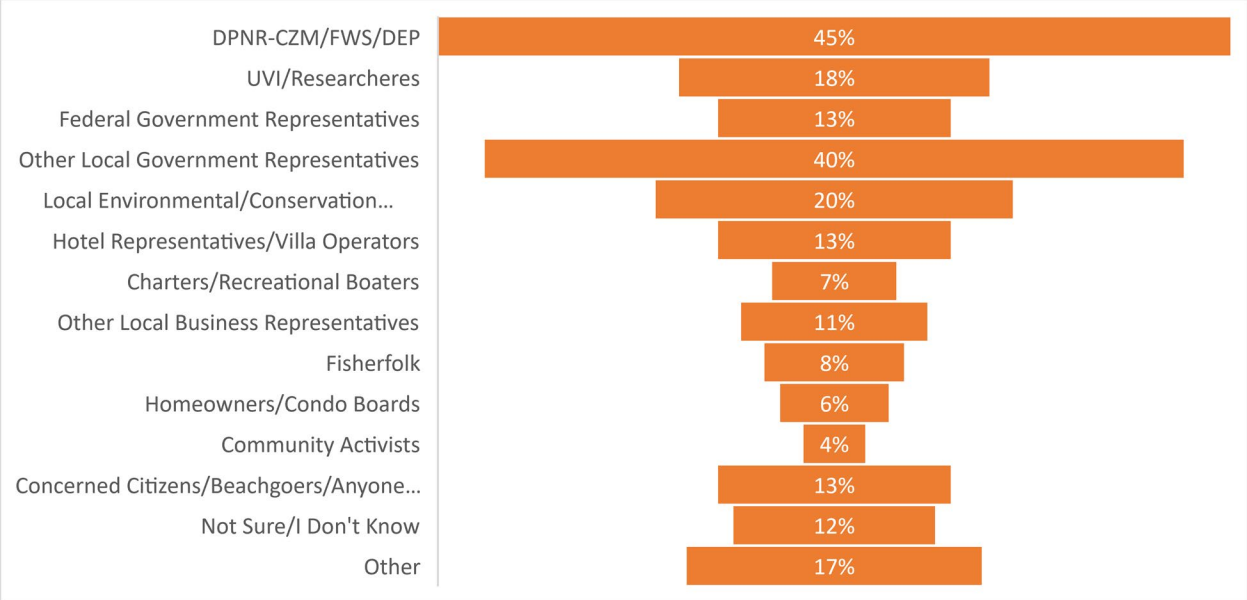
> Thank you for recognizing this problem and, hopefully, effectively addressing it.

With regards to the creation of a territory-wide committee on sargassum, the majority of respondents (79%) believed that one should be created:

> A committee is absolutely necessary to focalize sargassum mgmt in the Territory. It's too cross disciplinary to be spearheaded by a specific agency. We need increased awareness for the destruction of beaches and possibility of erosion for on beach removal. We. Need to look towards in water collection that is nearshore, we need to further the science as to the effects of such clean up on marine species

When probed on who should be on the committee, respondents overwhelmingly suggested a joint public-private partnership. Representatives from DPNR agencies, the University of the Virgin Islands (UVI), marine biologists, the Department of Tourism, hotel/villa operators, and local environmental/conservation groups were frequent suggestions for members of the committee (Graph 5). Representatives from condo boards, the charter/marine industry, fisherfolk, and beachfront businesses were also recommended from the private sector. Other government agencies mentioned included VIMWA, the Department of Health, the Department of Agriculture, and the Governor's Office.

Graph 5. If yes, which agencies, businesses, groups, and/or individuals would you recommend be on the committee?[10]



[10] This question was a subset of, "Do you think that a territory-wide committee on sargassum should be created?" A total of 113 respondents answered the question and respondents could suggest as many entities/groups as they wanted. Federal government representatives included FEMA, EPA, U.S. Coast Guard, National Park Service, and the National Guard. Local government representatives included VIWAPA; VIWMA; Departments of Public Works, Agriculture, Tourism, and Health; and the Governor's/Lieutenant Governor's Office. Local environmental/conservation groups included St. Croix Environmental Association, St. Thomas Environmental Association, The Nature Conservancy, VI Conservation Society, East End Marine Park, and Friends of VI National Park. Other local business representatives included the Chamber of Commerce, restaurant/bar owners, oceanfront businesses, and Bioimpact, Inc.

At the end of the survey, respondents were asked if they would like to be contacted for future interviews on the impacts of sargassum in the territory. More than a third of respondents (39%) answered “Yes” and provided information on how they could be contacted in the future.

Key Informant Interviews

Between October and December 2022, Bioimpact, Inc. conducted in-depth interviews with key informants whose businesses, agencies, industries, or livelihoods directly deal with, or have been directly impacted by, influxes of pelagic sargassum in the territory. The purpose of these interviews was to better understand how representatives from different sectors are currently responding to sargassum inundations, to document their experiences, and to gather recommendations and desired support from local government agencies and other stakeholders. Over 100 individuals were contacted to participate. A total of 67 key informants were ultimately interviewed from the following sectors (Appendix M has a list of the stakeholders interviewed):

- Territorial and federal government agencies
- Academia and education – e.g., adjunct professors at UVI and high school teachers
- Civil society – e.g., yacht clubs, non-profit conservation groups, and community councils
- Hotel, villa, and marina operators
- Commercial and recreational fisherfolk
- Homeowners and homeowners’ associations
- Inter-island transportation operators
- Tour operators – e.g., dive shops and sail charters
- Other private sector businesses – e.g., landscapers and beach maintenance companies

Each stakeholder was asked seven core questions during their interview, in addition to sector-specific questions like impacts of sargassum on guests for hotel and villa operators, and perceived impacts to catch for fisherfolk:

1. When, and in what capacity, did sargassum first come on your radar?
2. How has sargassum impacted your business / agency / home / community?
3. Has any of your staff / colleagues / community reported that sargassum has negatively impacted their health? If so, please explain what was reported.
4. If you could summarize your biggest concern with regards to sargassum, what would it be?
5. Do you have any best practices or recommendations for others dealing with sargassum in the territory?
6. What kind of support would you like to see from the local government to assist in managing sargassum?
7. If a territory-wide committee on sargassum were created, who would you like to see included on the committee?

Environmental Impacts

Accounts of the negative impacts that sargassum landings has had on the nearshore environment were relayed by key informants. Accelerated beach erosion and injury to marine life/loss of habitat/degradation of water quality were common themes.

Erosion:

> "We have no beach front now and [sea] water is going to encroach on the pool. Palm tree roots have been exposed. We're seeking assistance from DPNR [due to the] degradation of the beach front."— Homeowner, St. Croix

> "The erosion, it's tricky... [When] the currents are moving, [the sand] will come back ashore, but when that happens, and you have seaweed coming in the same time, [the sargassum] blocks the waves from the bringing the sand back into the beach so the sand settles in the bay, and you have an eroded beach with the seaweed coming right to the eroded level." – Private Sector Stakeholder, St. Thomas

Injury to animals / Loss of habitat / Degradation of water quality:

> "There have been times when the bay has been so covered with seaweed that when it starts to decompose the water turns into a toxic soup. It's like getting a bowl of kallaloo but it's all just seaweed, and everything in the bay is dead. Big fish, little fish, fry, octopus, squid, iguana, cat, seagull; everything [is] dead, and they're on the seaweed." – Private Sector Stakeholder, St. Thomas

> "Around 2015, we lost a staghorn coral thicket that had been documented as several acres large over in East End Bay on the East End peninsula. We had incredible pictures that had been shared with NOAA of this beautiful staghorn thicket. When a NOAA rep went out a year or two later it was simply gone. It had been killed by being smothered by sargassum mats." – Civil Society Stakeholder, St. John

> "Trust me, we don't like pulling out [the sargassum] and seeing live critters in there. But we also know if we don't pull it out, it sits, it dies, and other things happen to the ocean and then the fish die… that's when we start seeing the fish dying." – Hotel Operator, St. Croix

> "Last year when [the sargassum] got real thick, I noticed all the marine life in Red Hook [had] left the harbor. The [few] fish that didn't get out would float up, dead. We would see the tarpon taking gulps of air out of the water. We found a lot of dead lobster. Fisherman [were] storing lobster by their boats at night and the lobster would die." – Charter Captain, St. Thomas

> "I've seen dead cats, dogs, iguanas when [the sargassum] was really bad… Sometimes the cats and [other] animals would go out to eat fishes and they would drown… [I've seen dead] birds. [I have not seen dead] turtles. Dead fish, yes." – Private Sector Stakeholder, St. Thomas

> "[Sometimes] the marina is three-quarters full [of sargassum]. And, when [the marina] is that full, we can't get the sargassum out before it sinks so there is a lot of decomposed sargassum at the bottom [of the bay]. It makes the water murkier and that can't be good for the fish." – Marina Operator, St. Thomas

> "We had to repair one of our slips, one of our piles… Generally, they're about three feet below the bottom. [The sunken sargassum changed the depth of the marina so much] that we were

more than six feet deep to get to the base of [the pole]… We had to go through [three feet] of [sargassum] muck." – Marina Operator, St. Thomas

The release of toxic levels of ammonia, which are detrimental to corals and present after a large wave of sargassum, was an emerging finding noted by The Nature Conservancy (TNC), an NGO with coral restoration projects on St. Croix:

> "We started a daily testing [routine] on our [sea]water coming into [our coral propagation tanks]… and I noticed massive spikes in ammonia concentration related to sargassum. When sargassum rots, it creates an anoxic zone and it creates high ammonia levels and, of course, ammonia is one of the most toxic chemicals for corals… As soon as there's a wave [of sargassum], about a week later we get spikes in ammonia that are about four times the lethal limit to corals… It's really, really high concentrations [of ammonia] for the corals. For example, a 0.2 [parts per million] concentration would be very stressful [to coral] and for longer periods [of time] would kill the coral. We're [finding ammonia levels at] 5 ppm; so, we're having to take a lot of precautions… buffer our [sea]water… treat it heavily… run it through a bunch of biofilters and try and remove all the ammonia [to] get [the sweater] to a point where it doesn't the kill the corals." – Civil Society Stakeholder, St. Croix

The representative from TNC went on to describe just how widespread, and long lasting, these ammonia waves are by relaying how difficult it was to find seawater that had low enough levels of ammonia for their coral propagation tanks after the 2022 State of Emergency in the Territory related to sargassum clogging the U.S. Virgin Islands Water and Power Authority (VIWAPA) reverse osmosis (RO) seawater intake line on St. Croix:

> "[St. Croix] got one really big wave that took out the WAPA desal[ination] plant… When that wave hit, it was really bad for us… During that time I was kind of desperate to try and [get sea]water [that had low levels of ammonia]… I was just trying to get [sea]water. [I was] driving a truck and a barrel [around the island] and everywhere that we tested was pretty bad. I sent a couple of our technicians, literally island wide, to four or five beaches on the east end, west side… [They went to] Altona Lagoon, Frederiksted Pier, towards Sandy Point, Ham's Bluff, Cane Bay… [The seawater] was less concentrated in Frederiksted but [the ammonia level was still] 0.2 ppm which would be stressful and toxic to corals… It seems like an island wide issue when there's a large wave of sargassum." – Civil Society Stakeholder, St. Croix

TNC was able to obtain some seawater for their propagation tanks a mile offshore St. Croix but, as the key informant noted, "you can't run a[n RO] pipe a mile offshore."

In addition to ammonia:

> "There's also a lot of anecdotal evidence between other VI coral propagation communities, like UVI… and in Saba, and in Mexico. They are all saying, anecdotally, that when the sargassum comes in, so does a lot of other diseases… For example, the main one that seems to be correlated is different types of ciliates or ciliated protozoans. There's a genus called *Halofolliculina [spp.]* and it makes a little home on the coral and irritates the coral. I've seen it a lot in the wild and other people have said that it seems to be correlated heavily with the sargassum." – Civil Society Stakeholder, St. Croix

A handful of key informants noted that sargassum can have a positive effect, mainly in the form of serving as shelter for pelagic fish species and a food source for seabirds:

> "There is more life around [the sargassum] for sure... There are so many more Almaco jacks offshore now and it seems to coincide with when the sargassum influxes started coming. It is an untapped fishery. – Recreational Fisherfolk, St. Thomas

Financial Impacts

During key informant interviews, many private sector stakeholders spoke openly about the financial burdens that they've incurred as a result of sargassum influxes. Loss of income/revenue, property damage and exorbitant costs of cleanup and disposal were common themes.

Loss of income / revenue:

> "Yes, we have lost business and have had to compensate guests that have been on property who feel there is either a health concern with regards to smell or who cannot use the beach." – Hotel Operator, St. Thomas

> "Homeowners have reported that they've lost income. We had to move [rental guests] because [they] thought that some of the units were filthy. The Property Manager checked [the units]. The cleaners had cleaned the day before and within 24 hours there was scum everywhere [from the sargassum]." – Homeowner, St. Croix

> "[When sargassum is bad], the guests start checking out in droves. We had that for about a week and a half." – Hotel Operator, St. Croix

> "Yes [I have lost revenue]. There were days I would lose money on charters because the sargassum was so thick I could not push my boat out of the slip to run the charter." – Charter Captain, St. Thomas

> "Some unit owners don't bother renting during sargassum season to avoid the complaints." – Villa Operator, St. Croix

> "One of the charter fishing boats, they had two or three boats, and they left the marina in September 2021 and have not been back [because they] could no longer operate [as a result of the sargassum]. [Another tour operator] has posted numerous times on his Facebook page that he's not able to operate because of sargassum." – Marina Operator, St. Thomas

Exorbitant costs of cleanup:

> "[The budget to pay for sargassum cleanup] literally comes from homeowners. I can't charge more. At some point, it will price people out of being able to afford here. This is a huge problem for my portion of the industry." – Villa Operator, St. Thomas

> "[Cleanup] is so tedious and time consuming that we have to outsource it. It's costly for us. We don't have the amount of personal to do it [ourselves]." – Local Government Stakeholder, St. Thomas-St. John

> "[Sargassum cleanup] is a huge expense…" – Homeowner, St. Thomas

> "To continue putting this burden on the property owner isn't an acceptable solution. Us spending $200,000 a year to remove sargassum is a burden… It's a waste of money. We're taking something and filling up our dumps." – Marina Operator, St. Thomas

Even the private sector business owners, involved is sargassum removal and disposal talked about the high costs associated with cleanup:

> "[Sargassum cleanup] is not a money-making thing. People think you're making money [off cleaning the beach]. You make money, but there's a short lifespan to these things. We're doing it every day, but we can't charge the resort like that. Nobody wants to do it. No one goes, today I want to clean seaweed." – Private Sector Stakeholder, St. Thomas

> "I bought new John Deere track loader, a skidsteer. I got it in 2020. If you look at it now, you would think [that] I've had it for 10 years because all the parts [have] rust[ed]. The electrical system gets messed up. The fuses, the computer gets corroded inside so it doesn't fire the signals to the different components. The hydraulics gets messed up. The undercarriage gets messed up… Once you start using [the machinery] on salty, sandy conditions you know that's the end of the machine." – Private Sector Stakeholder, St. Thomas

Research and environmental institutions, who operate on defined scopes of work and finite grants, have also incurred costs as a result of sargassum influxes into the territory:

> "[Sargassum] places a pretty strong financial strain on us because it's a problem that we didn't know we would have to deal with. [My organization] has all their ducks in a row. Everything is lined up. Every cent is accounted for a certain project… and then [sargassum]… It wasn't a hurricane. It wasn't on anyone's radar as being a problem. [Sargassum] came in and is necessitating a redesign of our facility… [A new] filtration system [will cost us] $10-$15,000. Plus, the cistern [we will need to store seawater for our coral propagation tanks]… We just got a quote of $74,000 and that's just right off the top of my head. [These are] expenses that will have to come out of somewhere, that we don't have money allotted towards… In addition, to the fact that our [coral] production has suffered majorly [as a result of sargassum]." – Civil Society Stakeholder, St. Croix

Hydrogen sulfide-related damage to charter vessels and fishing vessels in marinas was such an issue that even other private sector stakeholders talked about the damage:

> "[Guests] have had to cancel because of sargassum. [The] lost revenue component is hard to judge because [we are not sure] how many people have not come to St. Croix because of it. [We] also run fishing charters and sometimes the sargassum is so thick [that] they cannot fish." – Tour Operator, St. Croix

> "Loss of income was the biggest part… For two months, all three [of our] boats were down. We canceled 170 charters. Not including [that], I probably spent a couple hundred thousand dollars on components. Those diesel engines [cost] up to $60k to $70k a piece. It was a massive blow... We are still recovering financially. [We are] still trying to get engines put together. We can't buy new engines anymore; everything has gotten so expensive." – Charter Captain, St. Thomas

There were other forms of property damage noted as well:

> "All our jewelry does turn black; we all wear the [Cruzan] hooks. [The hotel's] air conditioners struggle. The AC components, remember everything metal, the sargasso turns everything black. It's like eating the metal. All of our door entry locks, they're being pitted and eaten away. Again, that's part of the cost thing, cause we're going to have to replace all of them... It eats all of that… I think people don't really realize it, it kind of sneaks up on them." – Hotel Operator, St. Croix

> "[At our office we] had to replace: two ice machines, a refrigerator, the AC twice, all of metal desks… Pennies in the office are dark black. The internet system was constantly breaking because all the wires corroded. We didn't have phones because of the hydrogen sulfide. [I] had to have the entire building rewired twice. [We had a] Spenceley's printer. They had to take it away to replace the motherboard." – Local Government Stakeholder, St. Thomas

Hotel operators declined to share their property's expenditures on sargassum management, but one representative gave some insight into costs:

> "I'd prefer not to answer that question, but I will tell you that [the hotel has spent] well over $20,000 or $30,000. We have huge capital invested in this. [We have] manpower [invested in this]. We have to maintain all this equipment… Not to mention how much business we've lost [as a result of sargassum on our beach], so we can't really answer it. It's hard to measure." – Hotel Operator, St. Croix

HOAs were more forthcoming with costs:

> "Cleaning of the beach from last July to now has cost [us] $19,217." – HOA, St. Thomas

> "The loss of revenue at [our] Condos [to be] $35,000 [last year]." – HOA, St. Croix

The need to quantify the financial costs of sargassum as a means to advocate for more resources, was not lost on Academia and Education Stakeholders:

> "[We need to be able to say] X amount of tourism dollars. This is how much this [sargassum] costs. This is why we need better management plans. We are relegated to say these are all the questions that we have and why we cannot come up with recommendations." – Academia and Education Stakeholder, St. Thomas

> "Someone is going to have to spend a lot of money, and someone is going to have to say that we need to spend this money because it will cost XYZ later." – Academia and Education Stakeholder, St. Thomas

Impacts to Fishing

Charter captains and commercial and recreational fisherfolk all spoke about the negative effects of sargassum on fishing, primarily on trolling and catching bait:

> "When the sargassum is bad… it [also] impacts where we can catch live bait. In the back of Red Hook, we couldn't even catch bait some [of the] times this year." – Charter Captain, St. Thomas

> "We catch less fish. We are spending more time clearing lines, which is more time with the lines out of the water and the lines and lures are catching sargassum in the water so much that the fish won't bite them." – Charter Captain and Recreational Fisher, St. Thomas

> "[Sargassum] almost completely negates trolling. Trolling is very tough when the sargassum is super thick." – Charter Captain, St. Thomas

> "When [the sargassum] is all strung out and it screws up everyone." – Tour Operator, St. Croix

> "Sometimes sargassum on the bottom will roll into fish pots with the current and those fish pots won't catch any fish and will come up full of sargassum. I can't dive for whelks in areas where sargassum is packed up on the shoreline." – Commercial Fisher, St. Thomas

They did also note some positives for fishing when sargassum is in the area:

> "[Sargassum] does provide a lot of shelter for a lot of life. It helps a lot with mahi fishing, we have been able to find a lot of mahi along the [sargassum] lines. Even a month ago we found a weed line on the southside with 60 mahi under it." – Charter Captain, St. Thomas

> "Don't swim or fish in it. Unless you are fishing for mahi." – Commercial Fisher, St. Thomas

> "When the current and winds bring [the sargassum] together it can be an incubator and often times find mahi underneath." – Tour Operator, St. Croix

Impacts to Tourism

The impacts that sargassum has had on guests' perception of, and satisfaction with, the territory was noted by all stakeholders involved in the tourism sector:

> "The sad part is that people come to the island, and they have this vision of having a tropical vacation that is beautiful and serene. They book a charter; get to the marina and the first thing that they experience is the stench. It destroys their expectations." – Marina Operator, St. Thomas

> "[Feedback from guests are that the sargassum] is unsightly... It looks terrible, I can't swim. I came here for a beautiful beach, to sit on the beach but I can't sit on the beach, I don't want to look at a bunch of sargasso or your machine going up and down." – Hotel Operator, St. Croix

> "The beaches are to be enjoyed by our travelers, [our] guests. So, once we take away that element of having clean waters, you're really taking away 90% of what they're coming to the islands for." – Private Sector Stakeholder, St. Thomas

> "Complaints from 100% of guests who all left the next day. They moved mostly to hotels." – Villa Operator, St. Croix

> "[Sargassum has] impacted us dramatically, drastically… Just the sheer volume alone. It has definitely decreased our guest satisfaction with us and with the island, because they [guests] come to be on the beach and they can't… Even for our employees, our employees don't want to clean it up… It smells." – Hotel Operator, St. Thomas

> "[We receive a lot of] complaints. You cannot swim. Then when you're by the pool, you smell it. You hear the guys trying to clean it up. The privacy is kind of gone. [Sargassum brings in] lots of trash." – HOA, St. Croix

> "Sometimes [the sargassum wrack] doesn't land on the shore. Sometimes it just sits in the bay, floats around, eventually sinks, and literally turns the bay acidic. It's not healthy to swim in… The water is discolored. The whole bay looks dirty [and] bad. I expect that [this is] damaging to the coral and not great for the fish… One of the things that attract people to [our property] is the snorkeling, so having a healthy coral reef is important not just for the environment but for our livelihood." – Marina Operator, St. Thomas

> "In general, [guests will] say it smells, [that] they cannot get in the water, [that] it's made people itchy because it does have a lot of bugs in it… People complain about bug bites [from the bugs attracted to the sargassum], that it's ugly." – Hotel Operator, St. Thomas

What the future of the sector will be if sargassum continues to be unmanaged was the question that kept many a tourism sector stakeholder up at night:

> "The one thing that scares me about the survival of the islands is not hurricanes, it's sargassum. In five to seven years from now, people are going to say, 'I don't want spend two grand on [a charter] boat because I can't [even] go to certain places.' They're going to spend their money somewhere else [not in the USVI]." – Charter Captain, St. Thomas

> "What is the future going to be? The uncertainty…" – Hotel Operator, St. Croix

> "Guests taking pictures of [the beaches full of sargassum], putting it on the Internet. That doesn't just hurt [our hotel], it hurts all of the VI." – Hotel Operator, St. Croix

Sargassum and Public Health

The effects of hydrogen sulfide emitted from on human health was also discussed during key information interviews:

"[The] sulfuric acid [emitted from the decaying sargassum] burns your skin, it burns your lungs. I have scars on my arms from cleaning… Breathing, you have to wear respirators because [the hydrogen sulfide] will affect your sinuses, your lungs." – Private Sector Stakeholder, St. Thomas

"Guests have complained about itchiness… Now people do their own research. One guest in particular… [She] did a bunch of research and did claim that it affected her asthma. She demanded full compensation from the cost of staying at the resort to the plane ride [to St. Thomas]." – Hotel Operator, St. Thomas

"We actually had the EPA out and they took [hydrogen sulfide] readings by the dumpsters… They found [the readings were] above the legal hydrogen sulfide limit… and residents and boaters complain about itchy eyes and headaches." – Civil Society Stakeholder, St. John

"[The hotel] had to stop making seaweed because the [RO] line was clogged. You can smell [the hydrogen sulfide] in the [treated] water and you're not supposed to." – Private Sector Stakeholder, St. Thomas

"There's a whole group of people who live in what is called Spring Garden, right on the shoreline… It is the residential area that is primarily impacted [by sargassum in Coral Bay]. They are the people where the health impact is 24 hours a day... Irritated eyes, trouble sleeping because of the respiratory [problems], headaches. I would check in with the doctors at Myrah Keating Clinic because I can't imagine that there haven't been people who have showed up with issues." – Civil Society Stakeholder, St. John

Valorization and Use Opportunities

How to use and valorize sargassum was a question that almost every key informant raised, prompted or unpromoted, with the understanding that landfill disposal is not ideal. A number of stakeholders outside the academia and education sector mentioned that sargassum could be used in agriculture, while others noted having heard about issues with heavy metals. "[I would like to hear people] stop talking about [sargassum] in relation to agriculture…" one local government stakeholder said, "[It] doesn't matter how many times you rinse it; it still has heavy metals."

The researcher at the Virgin Islands Established Program to Stimulate Competitive Research (VI-EPSCoR) who confirmed that sargassum arriving to the territory had high heavy metal content on par with other areas of the WCR, explained that it's not just about the metals:

"In 2019, VI-EPSCoR at the Agricultural Experimentation Station was looking at the possible use [of sargassum and other] materials as a mulch, not fertilizers… to primarily prevent weed growth. Because [sargassum would be being used] as an organic mulch, we wanted to understand the chemical composition [of it] compared to hay, wood chips, sand, and other mulch materials. So, we sent off [a sample of sargassum from the VI] for nutrient analysis… [The data revealed] that sargassum did have elevated levels primarily of arsenic. There were others, but they were less eye popping. Sodium [was also found] within the tissue of the sargassum… [Even after rinsing] sargassum still contains salt. [I worry more about] soil salination than heavy metals in terms of [using sargassum] on the soil... One season is not really a big deal. If you have a lot [of sargassum] on hand and if you want to use it once [on the soil] then that's OK. Don't

> just use it over and over again, that would be really bad, and I was just thinking about salinity… You can't undo [the salination of soil]... There are plants that can take up [the sodium] and you can harvest them. However, it is an extremely difficult remediation process [to remove salt from soil] that would also be a nightmare."

Using sargassum for beach restoration was noted stakeholders on St. Thomas:

> "Sometimes burying it works because you can dig a big hole and put [the sargassum] in there and it'll decompose. Then just spread the sand that you [collected with the sargassum] back onto the beach. No one smells it and no one sees it. It disappears… Once [the sargassum is] like three feet under the sand, you really don't notice it being there anymore." – Private Sector Stakeholder, St. Thomas

> "The color of [the sand] changes because the seaweed has started to decompose. So, what we do is scrap the clean sand, put the seaweed sand down, and [then] cover it with clean sand, and that has worked well." – Private Sector Stakeholder, St. Thomas

The challenges of finding, or creating, an industry for sargassum was not lost on almost all stakeholder:

> "There's no [major] industry for sargassum's use... One of the problems we have is that it's not a localized problem. It's not a problem that you can sell to someone. There's no pipeline [and] no need to establish [a pipeline] to get rid of the problem. It's not like we're growing a crop that only grows in the islands that someone else needs." – Academia and Education Stakeholder, St. Thomas

> "The [sargassum] industry is in its infancy. Shoes, bricks, none of these industries have a self-sustaining commercial value right now. All of them are experimental." – Academia and Education Stakeholder, St. Thomas

However, as one civil society stakeholder on St. John noted, "[Sargassum] is a gift of God's nature and we should use it."

> "It would be good if we had an alternative of how we can use the seaweed convert to energy or some kind of fertilizer… Offer a new market [for the territory]." – Private Sector Stakeholder St. Thomas

> "This island needs something other than oil. Is there really an effective use of this [sargassum]? Should we try and build an industry around it? Should we take one of these old buildings and start using this stuff? We have a university; can this not be part of the university curriculum to try and rectify this?" – HOA, St. Croix

Desired Support from Local Government Agencies

When asked to describe the kinds of support local government agencies could offer stakeholders with regards to sargassum management, information, cleanup, and protection of marinas were the most common themes that emerged. Coordination between agencies, clear policies, and regulatory relief were also mentioned, as were strategies to intercept sargassum mats in-water before they come ashore.

Information:

> "People really don't know what to do [as] the end user. We understand that before [sargassum] reaches the bay, [that] it is a habitat for endangered species, but once it gets into the bay it becomes a health issue and an ecology issue... What do we tell people when they are being affected by it? What can we do? What is the government doing? I know people want to know." – Civil Society Stakeholder, St. John

> "Just [to] better understand what can be done, in an environmentally responsible manner… So, I think [CZM could support by] either having the research, or doing the research, or supporting the research because it's not just a Virgin Islands' issue… Gathering some of that information together [on what other island nations are doing] in short fact sheets that are great for the public but also for us that talk to other [is key]." – Non-Profit Stakeholder, St. Croix

> "People need to hear what is working well. We're getting stuck in what's not working and need to think about what is." – Hotel Operator, St. Thomas

> "If CZM came and said something was wrong [with how we were removing the sargassum] that would be horrible for us. [We would like] CZM [to] flat out approve this type of equipment or disapprove it. [If] they could figure out what tools work... and approve them, so they could say to people, here is a solution, here are the tools that we pre-approve and work to do the job." – Homeowner, St. Thomas

> "We would like to know who to report to and we would like to know, what are the solutions?" – Private Sector Stakeholder, St. Croix

> "[I would like to see] a website dedicated to sargassum that has background and information so, if we needed to send that to someone it's coming from a government agency. Kind of one place to go [a repository] for sargassum. What the government is doing, what we can do." – Civil Society Stakeholder, St. John

Cleanup:

> "Some kind of machinery to keep it off the beach, or some netting so we can catch [the sargassum] out father by the buoys, or some kind of machinery and that could help us pick it up and not pick up the sand. Sometimes when we pick up [the sargassum] we can lose a lot of sand." – Civil Society Stakeholder, St. Thomas

> "Regular cleanup of the sargassum where [the fisherfolk] keep their boats, and prevention of sargassum from breaking down in the bays. [This] is what the fishers want." – Local Government Stakeholder, Territory-wide

> "A [coordinated] schedule; a shared schedule for [managing] and clean up." – Homeowner, St. Croix

> "Maybe the government, as a whole, could find some way to help fund the cleaning of the seaweed so that it's not just the businesses paying for it. [The private sector] is paying for it, on

a beach that's supposed to be public, but the government, they're not putting anything [in]to [the cleanup costs]. At the same time, [the government will] tell the hotel that they don't own the beach. It's not unfair because the resort benefits from the beach, but [the government] needs to find a way to alleviate some of the costs to businesses that pay for [sargassum cleanup]." – Private Sector Stakeholder, St. Thomas

"Cash. [Sargassum] cleanup is expensive." – Civil Society Stakeholder, St. Thomas

Protection of the marinas:

"Try to keep it out of the marinas and bays where there are baitfish. To help prevent it bogging up and killing more stuff. Vessel owners in sapphire have definitely suffered financial strains because it starts eating [their vessels]." – Fisherfolk, St. Thomas

"When snow happens in the north, one of the first things [the municipality does is] clear out the bus stops, so that the buses can move the people. [That's what should happen here with sargassum in marine transportation areas.]" – Private Sector Stakeholder, St. Thomas

"[Local authorities] were fussing about blocking the sargassum [at the marina] and diverting it onto the beach. All the value is in the marina." – Charter Captain, St. Thomas

"Number one, let's get [the sargassum] out of the water. Hire someone who is going to rescue the baby turtles and whatever else is trapped in it… If you get [the sargassum] out [of the water] while it's alive, then the raft is not getting mixed in with the sand… It's not getting mixed in with the coral or the vessels." – Marina Operator, St. Thomas

In-water collection/mitigation:

"It's pretty clear that there does need to be some offshore mitigation [measures] in place. It's just generally unacceptable, for such a multitude of reasons, to let this stuff get ashore and let it get into the coastal system. It's environmental. It's tourism. It's how it affects the power and desal[ination] plant. [Sargassum] just has so many affects that the decision will be made that something has to be done." – Academia and Education Stakeholder, St. Thomas

"People are now seeing that barriers have made a difference. They had no idea how bad it could've been by not having those barriers." – Hotel Operator, St. Thomas

"It's unconscionable to allow sargassum to keep reaching the shore." – Private Sector Stakeholder, St. Thomas

"I would like to see a standardized deployable [temporary] boom that people could use. Sea turtle nesting beaches may need to be boomed. Sea turtles can swim around booms, but they cannot get around it if inundated with sargassum." – Local Government Stakeholder, St. Croix

"The whole idea was we are going to want to ultimately intercept this stuff before it has an impact on the coast itself. So, the earlier we can do that…" – Academia and Education Stakeholder, St. Thomas

Coordination:

> "The biggest hinderance [to] any [sargassum] management plan is… [that] there's no central figure that organizes [the response]. That's the reason why there's not a FEMA for sargassum. [During a] recent NOAA meeting, [we] discussed [how] a lot of places were hoping that there would be someone to call when an [sargassum] event happens and there's not. Cleanup is private. Sometimes it's hotels, sometimes it's volunteers." – Academia and Education Stakeholder, St. Thomas

> "There isn't one agency that's owned it, and that's been the problem, that's been the delay." – Hotel Operator, St. Thomas

> "I have two dreams. I would like to see an international effort. To see the USVI work in collaboration with other [affected nations] to control [sargassum] closer to the source… I realize that's a huge idealistic goal." – Marina Operator, St. Thomas

Regulatory relief:

> "The government [of the USVI] can help us [by] giving us an annual permit [for sargassum management]. [The government] can revoke [the permit] if we screw up but, trust us, we don't want to [screw up]. [We don't want to] stare at that boom. Our vessels don't want to navigate around [the boom]. So, when we don't need it, we will pull it out [of the water], and, when we need it… I want to be able to put it in." – Marina Operator, St. Thomas

> "I would like us to have standing permission to use the [sargassum management] process that we [already] have [in place], without having to email [DPNR and] hope [they] see [the email] on time… If the government is not going to pay for [sargassum clean up], please don't handcuff us from doing what we need to do." – Private Sector Stakeholder, St. Thomas

Territorial Committee on *Sargassum*

Similar to community survey respondents, the sargassum stakeholders interviewed were keen to see a multi-sectoral committee on sargassum established and were divided on whether the lead agency should be the government or private sector:

> "You need a central committee before any [sargassum management] plan can be implemented. You need the people involved in every aspect of this from cradle to grave to realize that they are all related somehow to this problem… You need Public Works, Waste Management, DPNR, Fish and Wildlife, Tourism, [the] Hotel Association. You need volunteer groups. You need the Department of Health. [You need to] make a central committee and [designate] that the committee decides who are we going to call when we have an event, and what are the actions that we need to take… And you need the government to commit to investing money. Unfortunately, this is a problem that is going to need money thrown at it." – Academia and Education Stakeholder, St. Thomas

> "Environmental consultants should be in the working group. They're the ones seeing it from multiple sites." – Federal Stakeholder

> "Someone with decision making power should chair. VITEMA is able to act fast… [VITEMA] should be involved if we get air quality monitors. Then they need to send out a text message on that system." – Local Government Stakeholder, Territory-wide

The need to include the "right" people, and not just any people, was echoed over and over, regardless of whether the stakeholder believed that the private sector or a government agency should lead the way:

> "My best advice is to make a central committee with the 'right people' sitting at the table. Not just the right agency but the right people; people who understand this problem." – Academia and Education Stakeholder, St. Thomas

The number of people on the committee was also discussed, with some stakeholders emphasizing that size matters:

> "The group can't be so big so that nothing get done, but also has to be based in reality… Regular coordination is needed; things are changing regularly." – Federal Stakeholder

A stakeholder from the Academia and Education Sector noted that UVI could play a bigger role in sargassum management:

> "[There is] no [sargassum] task force at UVI. It's something that we could do. It would be useful if we were prompted to do that…"

Recommendations

Lastly, key informants offered a number of recommendations and key issues to consider as the territory moves forward with developing a systematic approach to sargassum management.

Incorporating sargassum in other coastal management activities:

> "One of the things that needs to be taken into account with existing and new marine structures in bays [of the USVI] that are affected by sargassum is [how sargassum will be mitigated and removed]. It is unclear [whether] lead [federal] agencies are actively taking sargassum impact into consideration when reviewing marine infrastructure… regarding the impacts of the development [on the going sargassum problem]." – Civil Society Stakeholder, St. John

> "From our perspective of habitat conservation and species protection, the big alert would be in the months that the turtles are nesting. Once they nest, usually about 30-60 days later the eggs will start hatching. The [VI] government and local stakeholders for those shorelines that have nesting areas… they should have a protocol to patrol those beaches so that any sargasso that is accumulating can be removed to help with the survival of the juvenile [turtle] species." – Federal Stakeholder

Setting up monitoring systems for hydrogen sulfide emissions:

> "[We suggest] purchasing air quality monitors and doing routine monitoring [for hydrogen sulfide] in public access points. [Hotels could] do daily monitoring so that guests know that they are safe. This was discussed in 2021. It was suggested to DOH during a meeting. DEP is supposed to have Honeywell as a vendor, but they have not been able to get the EPA meters." – Local Government Stakeholder, Territory-wide

> "I would like to see an air quality monitoring system. We should have weekly [monitoring of] air quality during sargassum events. This could be under DEP or DOH." – Local Government Stakeholder, St. Thomas

The need to have, and use, sargassum forecasting tools:

> "VITEMA and the emergency people have sargassum trackers. I didn't even know that [these] existed before [the State of Emergency Declaration on St. Croix]. They have systems where they can track the movements of sargassum and be able to predict more or less when you would see the seaweed come in." – Local Government Stakeholder, Territory-wide

The desire for locally appropriate informational sargassum materials:

> "[There needs to be] fact sheets that tells people what sargassum is, how to clean it, something simple. You don't want people to have to sit down and read. Something bulleted. [The materials will] need a lot of buy in, and [they will] need to talk to the people where they are [i.e., be locally appropriate]. – Academia and Education Stakeholder, St. Thomas

Practices to discontinue:

> "Waiting until [sargassum] gets to the shore before you can [remove] it. [Not dealing with it in the water] is allowing the sargassum to build up and decompose, [emit] more hydrogen sulfide gas, [and] you are tearing up the beach when you try to remove it [from the shoreline]." – Charter Captain, St. Thomas

> "We don't want anyone to go out of business because of sargassum… but a bulldozer out on the beach is a big problem or could be a big problem. If there is wildlife actively using the beach or potentially using the beach, that kind of activity could potentially cause a lot of damage." – Civil Society, St. Croix

> "Places like [one seaside hotel] that use a lot of fertilizer for their maintenance for their grounds, you'll find that seaweed once it gets in that bay there is rapid growth." – Private Sector Stakeholder, St. Thomas

Disposal:

> "A practical [sargassum] disposal plan [for the territory] needs to be developed. Nothing too complicated. [The plan] has to be practical." – Federal Stakeholder

> "There [needs to be] a hierarchy; if you can't do this, then do this. If [you] can't do digestion, then putting [the sargassum] on the ground in a spot I get, definitely." – Academia and Education Stakeholder, St. Croix

The need to act:

> "If you don't do anything, then the nearshore resources can suffer. Not just the hotels, which is a huge in and of itself because the economy suffers. Aquatic resources, there are so many in the near shore area. Seagrass and corals, seeing dead fish sitting in the masses." – Federal Stakeholder

> "You want to get out there and show that you're actually putting in effort [to do something about the sargassum]. If [guests] they see you out there cleaning it, taking measures to take care of it, they feel a lot more at ease with the money they're spending to stay there." – Private Sector Stakeholder, St. Thomas

> "[Sargassum] is a problem that is going to need money thrown at it." – Academia and Education Stakeholder, St. Thomas

> "As a new person in the area… I used to live in Florida on the west side so didn't see a ton of [sargassum]. As a Crucian, I see how it's changed the environment from the air that you breathe to what you see. [Sargassum] is definitely a present and a real issue." – Federal Stakeholder

Draft Regional General Permit for *Sargassum* Management

As an additional piece of this scope of work, Bioimpact, Inc. was requested to put together the first draft of a permit for individuals or entities wishing to engage in land- or water-based sargassum management activities in the USVI. Currently, there is no territorial permit for sargassum management activities, nor is there a federal permit for sargassum management activities. One of two federal permitting processes could be triggered by collecting or removing sargassum from land or water, with the USACOE serving as the nexus agency for both processes (See Section, *Federal Regulations and Policies on Sargassum Management* for more). Thus, a sargassum permit, and its accompanying application process, would need to demonstrate compliance with territorial and federal regulations. As one federal stakeholder noted:

> "If the permit is written well [then] it's clear that [Section] 401 is done; that the suite of conditions for water quality have been met. [The permit needs to be developed] in a way that is meaningful and clear and user friendly... There will be a lot of trial and error. Even when [we] make a general permit, it is still something we will need to go back to. [The territorial sargassum permit] needs to be something that can be revised easily. Maybe there's a landfill issue or something else that needs to be stopped. Maybe [we] send it [sargassum] downstream and someone else sues us… We don't know. Once done, a general permit would increase compliance with regulatory programs in the long term."

Bioimpact, Inc. suggests the following for the territory:

1. Develop a Regional General Permit (RGP) for sargassum to provide a framework through which actions can be taken to address sargassum inundations. Under the USACOE, an RGP is issued for a specific geographic area which, in this case, would be the U.S. Virgin Islands. Bioimpact, Inc. suggests that this RGP not fall solely under the purview of the USACOE but be a joint DPNR-CZM/USACOE Antilles District permit.
2. The RGP would need to cover not only physical structures related to sargassum management, but also operational activities. Permits are often tied to a specific property but, in this case, the sargassum RGP must also cover operations which could occur completely offshore or nearshore to multiple properties.
3. The sargassum RGP would have specific terms and conditions, all of which must be met for project-specific actions to be approved and permitted. As one of these terms, anyone applying for a sargassum RGP should provide details, or a framework, on how they plan to minimize the environmental impact of the potential activities and/or actions being requested.

As the permit will need to be adaptable, the sargassum RGP will not be one-size-fits-all. The permit must address different benthic habitats, methods of sargassum collection, and means of disposal. The conditions on the sargassum RGP would need to be structured to:

- Ensure that natural resources are not damaged.
- Impacts are mitigated.
- Actions or activities are monitored to ensure compliance with the RGP can be verified and assessed; and

- Gather long-term data so that the permitting program, and even specific activities, can be evaluated and modified as more experience and knowledge are gained.

Who should be able to apply for a sargassum RGP?
Those seeking coverage could include property owners, lease holders, government agencies, NGOs, researchers, non-profits and community councils, businesses, and even individuals.

Is there an application fee?
Yes, there should be a fee structure to obtain a sargassum RGP. The funds collected should be used to protect public shoreline areas and/or areas where no entity is present to actively protect the shoreline. However, the fee should not be so high as to be prohibitive and should be tiered based on the type of entity applying. For example, the application fee for a beachside hotel could be $500 while the fee for a public beach without a private structure, or a community council applicant, could be $100. Fees could also be tiered based on the size of the shoreline and/or its status as a sargassum "hotspot".

The following page has a first draft of a General Regional Permit for Sargassum Management in the USVI with details on how to complete each section. The form was developed by Bioimpact, Inc. and, thus, will require review from the relevant territorial and federal agencies.

Bioimpact, Inc. also recommends that a template approval letter be developed for the permit. This would be the last step.

U.S. Army Corps of Engineers, Antilles Division and the U.S. Virgin Islands Department of Planning and Natural Resources, Coastal Zone Management Agency and Division of Fish and Wildlife

Application for a Regional General Permit for Sargassum Management (RGPSM) in the U.S. Virgin Islands

This form integrates requirements of the U.S. Army Corps of Engineers (Corps) Regional Permit Program within the Antilles Division, and the requirements of the U.S. Virgin Islands (USVI) Department of Planning and Natural Resources (DPNR), Coastal Zone Management Agency (CZM) and Division of Fish and Wildlife (DFW). Boxes 1-7 must be completed by the Applicant. If additional space is needed, provide the additional information in a separate attachment. Please refer to the *Instructions for the Application for a Regional General Permit for Sargassum Management in the U.S. Virgin Islands* (Instructions) for how to complete the RGPSM.

0a. To be filled by the Corps		
Application Number:	Date Received:	Date Complete:
0b. To be filled by CZM		
Application Number:	Date Received:	Date Complete:
1. Applicant and Address		
Name (First, Last): Company or Organization: Email Address: Address, City, State/Territory, Zip Code: Phone (Work), Phone (Mobile):		
2. Name and Location of the Proposed Sargassum Activity		
a. Activity Name or Title:	b. Island, USVI:	
c. Coordinates: Latitude – Latitude –	Longitude – Longitude –	
d. Additional Details/Description of Location/Size:		
3. Type of Benthic Habitat Present		
a. Complete description of Benthic Habitat Present, including methods used for determining the Benthic Habitat Present:		

b. Does the proposed activity impact hard bottom substrate? Yes / No
c. Does the proposed activity impact seagrass? Yes / No
d. Does the proposed activity impact corals listed under the Endangered Species Act? Yes / No
4. Sea Turtle Nesting Beach
Is there a sea turtle nesting beach present within the Location of the Proposed Activity? Yes / No
5. Description of the Proposed Sargassum Activity
Complete description of Proposed Sargassum Activity:
6. Sargassum Disposal or Use Plan
a. Complete description of the Proposed Sargassum Disposal or Sargassum Use Plan:
b. Has the Applicant contacted VIWMA regarding the proposed activities and scheduling, if landfill disposal is proposed? Yes / No
7. Maintenance, Monitoring, and Documentation Plan
a. Complete description of how the Proposed Activities will be monitored, including how in-water equipment will be checked and maintained, how natural resources will be protected, and who will be responsible for reporting to, or liaising with, the local government authorities:
b. The Applicant acknowledges that they will be responsible for attending or conducting the following activities, at minimum, as a condition for obtaining a RGPSM: 1. Attend a Division of Fish and Wildlife training on sargassum. 2. Keep and maintain monitoring logs for all the Proposed Sargassum Activities onsite for review by DPNR inspectors. 3. Submit monthly summary reports to DPNR-CZM/DFW.

Applicant Name (Print):
Applicant Signature:
Date:

Instructions for the Application for a Regional General Permit for Sargassum Management in the U.S. Virgin Islands

This document outlines how to complete the Application for a Regional Application for a Regional General Permit for Sargassum Management (RGPSM) in the U.S. Virgin Islands. If you need additional assistance or have questions regarding completion of the RGPSM application, please contact the USVI Department of Planning and Natural Resources (DPNR), Coastal Zone Management (CZM) Agency Office.

Please submit the RGPSM application to your local DPNR-CZM Office. Contact information, including website, mailing and email addresses, and telephone numbers are found at the beginning on page XX of these Instructions.

Box 0a: This box is to be completed by the U.S. Army Corps of Engineers (Corps). Skip to Box 1.

Box 0b: This box is to be completed by the USVI Coastal Zone Management (CZM). Skip to Box 1.

Box 1: Box 1 must be completed by the Applicant. Provide the contact information of the Applicant. The name of a contact person must be included even if the Applicant is an entity like a government agency or non-profit.

Box 2: Box 2 must be completed by the Applicant to provide the name and location of the proposed sargassum activity.

Box 2(a). Provide the name of the proposed sargassum activity. For example: Great Bay Sargassum Diversion Aquatic Booms, The Ritz-Carlton Club, St. Thomas.

Box 2(b). Provide the name of the Island in the Territory where the proposed activity is located. If located offshore, provide the name of the Island closest to the proposed activity.

Box 2(c). Provide the GPS coordinates for the proposed sargassum activity in latitude and longitude. This can range from a specific beach, beaches associated with a parcel of land, or can be a defined area. The coordinates should be provided using NAD 83,[11] and in either decimal degrees or degree-minutes-seconds. The coordinates should be sufficient for the Corps or DPNR-CZM to determine the location of the proposed activity. This is critical so that known habitats, species, and other the natural resources that occur within the proposed activity area can be addressed.

Box 2(d). Provide additional details regarding the proposed sargassum activity area. For example, the size of the area, where the activity GPS coordinates were taken, whether the area includes both land and sea, a public beach, etc.

Box 3: It is critical to identify the underwater habitats which may be affected by the proposed activities. Box 3 must be completed by the Applicant to describe the type of benthic (i.e., underwater) habitat within the proposed sargassum activity area.

[11] NAD38 stands for the North American Datum 1983 and is the most current datum in North America. It provides latitude and longitude and some height information. Geodetic datums like NAD 38 form the basis of coordinates of all horizontal positions for Canada and the United States.

Box 3(a). The Applicant should conduct, or have conducted, a preliminary underwater assessment to identify where seagrass or corals are present within the proposed activity area. Include the findings of the preliminary underwater assessment in a separate attachment. Areas should also be delineated as sand or hard substrate. Hard substrates should be avoided, if at all possible, when proposing to install aquatic booms and other structures. If hard substrates are found to be impacted within the area of the proposed activities, an endangered species survey (ESS) will be required.

Box 3(b). If the proposed activity would impact hard bottom substrate, check the "Yes" box. If hard substrates are found to be impacted within the area of the proposed activities, an ESS will be required. Include the ESS in a separate attachment.

Box 3(c). If the proposed activity would impact seagrass, check the "Yes" box. If seagrass is found to be impacted within the area of the proposed activities, an ESS will be required. Include the ESS in a separate attachment.

Box 3(d). If the proposed activity would impact corals listed under the Endangered Species Act (ESA), check the "Yes" box. If an ESA-listed coral species is found to be impacted within the area of the proposed activities, an ESS will be required. Include the ESS in a separate attachment.

Box 4: Box 4 must be completed by the Applicant. If the proposed activity would impact a sea turtle nesting area, check the "Yes" box. The preliminary assessment should include information regarding the sea turtle nesting area present within the area of the proposed activity. Please contact the Division of Fish and Wildlife for information regarding the site, if unsure.

Box 5: Box 5 must be completed by the Applicant to describe the Proposed Sargassum Activity in detail. Proposed activities could be:

- The installation of aquatic booms to divert away from the shoreline or towards one shoreline location for collection and removal.
- Land-based collection, removal, and disposal of sargassum via mechanized methods; or
- Offshore collection of sargassum for commercial use or disposal.

Conditions are attached to each Proposed Sargassum Activity. See page XX of these Instructions for the list of conditions.

Box 6: Box 6 must be completed by the Applicant to describe how any collected sargassum will be disposed of and/or used. Researchers have found that sargassum is known to contain sodium and heavy metals within its tissues and, as a result, the use of sargassum as fertilizer, compost, or mulch is not advisable as that it will result in the salinization and buildup of heavy metals in soil overtime. No amount of dewatering or rinsing will remove the salt or heavy metals contained within Sargassum tissue. Sargassum can be used for building products and the manufacturing of non-consumable goods.

If landfill disposal is proposed, the Applicant be sure to obtain the proper permits from the US Virgin Islands Waste Management Authority (VIWMA) and check with VIWMA as to the ability to receive and time when it can be disposed.

Box 7: Box 7 must be completed by the Applicant to describe how the Proposed Activities will be monitored and documented, and equipment maintained.

Box 7(a). This should include how the amount of sargassum collected and/or removed will be measured, how natural resources within the project area will be continually assessed to ensure their protection, and who will be responsible for reporting to, or liaising with, the local government authorities. When applicable, the Applicant should also describe how in-water equipment will be checked and maintained so that, for example, sargassum does not buildup behind, or collapse, an in-water barrier.

Box 7(b). As a condition to obtaining a RGPSM, the Applicant will be required to attend a DFW sargassum training, keep and maintain monitoring logs for all the Proposed Sargassum Activities onsite, and submit monthly summary reports to DPNR-CZM/DFW. If the Applicant is an entity, any entity staff involved in the Proposed Sargassum Activities will be required to the attend the DFW sargassum training. The format of, and information required for, the monthly summary reports will be determined by DPNR-CZM/DFW and shared with the Applicant prior to permit approval.

Conditions for the Proposed Sargassum Activities and Conditions for a Regional General Permit for Sargassum Management in the U.S. Virgin Islands

Proposed Sargassum Activity: Sargassum Barrier (Installation of Aquatic Booms)
Sargassum barriers, or aquatic booms, are floating barriers with a submerged curtain that intercept the movement of floating sargassum in water. Barriers can be used to corral sargassum for in-water collection or to direct the sargassum to one location along the shoreline for collection (referred to as "diversion").

Conditions:
The following conditions must be met to obtain a RGPSM for this activity:

1. Barrier installation must have minimal impact on the benthic (underwater) habitat. The benthic environment into which barriers are to be installed, must be surveyed prior to installation to identify habitat type and substrate.

   Sand:
   a. Placement in areas of sand substrate is preferred.
   b. Screw anchors should be used to install barriers and marker buoys into a sand substrate.
   c. Floating lines and floating tackle must be used to attach the barriers and marker buoys to the screw anchors to prevent lines from dragging on seafloor.
   d. Clips, or another releasable component, must be used to secure barriers or marker buoys to floating lines so that the barriers can be removed prior to a storm event.

   Hardbottom:
   a. If possible, barriers should be placed in areas of open sand, placement over hardbottom is only permittable if there is no alternative layout which would avoid hardbottom.
   b. Corals must be avoided.
   c. Rock pins are preferred but block anchors of sufficient size and weight can be used. Block anchors must be heavy and stable enough so that they do not drag along the sea bottom.
   d. Floating lines and tackle must be used. Lines must not impact soft corals, hard corals, or sponges.
   e. Clips, or another releasable component, must be used to secure barriers or marker buoys to floating lines so that the barriers can be removed prior to a storm event.

2. Barriers must be suitable for site wave exposure – i.e., the Barriers must be anchored to withstand wave conditions at the site.

3. Barriers may not direct sargassum downstream onto a neighboring property.

4. Sargassum cannot be allowed to build up behind barriers and sink or collapse the barrier. Sargassum must be collected at a rate to prevent this from happening.

5. Barriers must be monitored and maintained. If barriers become damaged, they must be removed from the water.

6. All individuals involved in sargassum collection must attend a DFW sargassum training. Attendance at the training session must be documented and kept onsite by the Applicant.

7. All individuals involved in sargassum collection must understand that sea turtles, and other sea life, can become trapped in sargassum and what to do when this occurs. Small invertebrates and fish can be returned to the sea if encountered.

   If a sea turtle is found distressed, injured, or dead:
   a. Contact DFW immediately.
   b. If immediate action is required to save the turtle and no one at DFW can be reached, contact DPNR-CZM or the Division of Environmental Enforcement (DEE) and have one of their staff talk the person through rescue. If no one can be reached at any of these places, take reasonable action and document so that local authorities can be later informed.
   c. If a dead sea turtle or hatchling is encountered, immediately contact DFW. If the animal is <u>not</u> subject to being washed out to sea, take no action. If the animal may wash out to sea, it may be secured until DFW's arrival.

8. Barriers must be removed prior to inclement weather and/or seas, or a storm event.

9. A report documenting the installation of the barriers, showing photographs of all anchors must be provided to DPNR-CZM within 7 calendar days of installation.

10. DPNR-CZM must be notified to confirm when barriers have been removed prior to inclement weather or a storm event.

11. DPNR-CZM must be notified 48 hours prior to the redeployment of barriers.

Proposed Sargassum Activity: Shored-based Collection of Sargassum via Mechanized Methods
The removal of sargassum via non-mechanized methods, for example by hand raking, does not require a permit from DPNR-CZM. The use of a Utility Task Vehicle (UTV) along the shoreline requires a permit from DPNR-CZM.

Conditions:
The following conditions must be met to obtain a RGPSM for this activity:

1. All onshore removal of sargassum must follow the Division of Fish and Wildlife's (DFW) Sargassum guidance.

2. Heavy machinery should not be utilized on beaches. Heavy machinery is considered anything larger than a skidsteer.

3. UTVs should not operate in areas of known sea turtle nesting. As nests will occur up shore from the areas of shoreline sargassum accumulation, UTVs should avoid driving in the upper (landward) areas of the beach.

4. Routes for driving machines on the beach must be defined, shared with DPNR-CZM, and adhered to by operators.

5. All individuals involved in sargassum collection must attend a DFW sargassum training. Attendance at the training session must be documented and kept onsite by the Applicant.

6. All individuals involved in sargassum collection must understand that sea turtles, and other sea life, can become trapped in sargassum and what to do when this occurs. Small invertebrates and fish can be returned to the sea if encountered.

   If a sea turtle is found distressed, injured, or dead:
   d. Contact DFW immediately.
   e. If immediate action is required to save the turtle and no one at DFW can be reached, contact DPNR-CZM or the Division of Environmental Enforcement (DEE) and have one of their staff talk the person through rescue. If no one can be reached at any of these places, take reasonable action and document so that local authorities can be later informed.
   f. If a dead sea turtle or hatchling is encountered, immediately contact DFW. If the animal is <u>not</u> subject to being washed out to sea, take no action. If the animal may wash out to sea, it may be secured until DFW's arrival.

7. Daily reporting sheets will be maintained by the Applicant noting sargassum volumes removed, method of collection, any organisms noted within the washed up or accumulated sargassum, and method of disposal.

8. Stored or piled sargassum, that has the potential to impact marine resources, neighboring properties, or people through odors, cannot be left on shoreline or other areas of the property for extended periods of time.

9. Sargassum should not be left to decompose and "dewatered" back into the marine environment. This may result in the degradation of the surrounding environment as a result of elevated levels of nutrients.

Proposed Sargassum Activity: Offshore Collection of Sargassum
Offshore collection of sargassum can be conducted with cages, nets, or conveyor belt systems. The sargassum collected can be stored on the vessel or accompanying barge.

Conditions:
The following conditions must be met to obtain a RGPSM for this activity:

1. All individuals involved in collecting the sargassum ("Collectors") must attend a DFW sargassum training. Part of this training will include what to look for, and what to do if an ESA-listed species

is encountered in the sargassum. An independent Biological Monitor can be brought abroad to monitor collected sargassum for ESA-listed species.

2. The collected sargassum must be monitored as it is brought in from the water to look for endangered species, especially juvenile and adult sea turtles. Juvenile sea turtles are known to hide in floating sargassum nets.

3. The Applicant/Collectors is/are not authorized to “take” any endangered species, which means the Applicant is not allowed to kill an endangered species during operations, be it intentional or unintentional.

4. If a “take” occurs, all activities will have to stop and be evaluated to determine the reason the “take” occurred and ways to prevent future “takes” of species.

5. The Applicant/Collectors must provide methods by which they will minimize the collection of marine life in sargassum. Methods can include rinsing or shaking of the collected sargassum to dislodge species before removal from the water.

6. Daily reporting sheets will be maintained by the Applicant noting sargassum volumes removed, method of collection, any organisms noted within the washed up or accumulated sargassum, and method of disposal.

7. The Applicant/Collectors cannot release sargassum in any area that has the potential to impact other shoreline properties. If sargassum is collected and released – i.e., pushed or pulled in the water with nets or booms to another location and released – it must be released in an area where the currents will carry the sargassum offshore.

8. The Applicant/Collectors cannot dump sargassum back into the ocean without prior approval and permit from the EPA.

Key Findings and Recommendations

For the past decade, the WCR has been "subject to unprecedented, massive, episodic influxes of sargassum seaweed... [which have had] significant negative impacts, particularly on coastal communities and livelihoods, public health, tourism, and fisheries" (UNEP-CEP, 2021, p. 4). Like other areas in the region, this new phenomenon took the territory by surprise; however, unlike other Caribbean islands, the USVI has been slow to develop and adopt a sargassum management strategy.

Based on our review of current research, sargassum management strategies and plans from other Caribbean nations; analysis of a community survey on sargassum; and key informant interviews with federal and local stakeholders across multiple sectors, Bioimpact, Inc. has put together the following key findings and recommendations.

Key Findings

1. While sargassum is a floating macroalgae, or seaweed, whose historical distribution has been primarily confined to the Sargasso Sea, researchers now agree that the influxes of sargassum into the WCR come from a new 'consolidation region' now known as the Great Atlantic *Sargassum* Belt. The Belt extends from West Africa to the Caribbean Sea and into the Gulf of Mexico, and predominantly consists of two species of holopelagic sargassum: *Sargassum natans* and *Sargassum fluitans*. The origin of the GASB is believed to be the result of warmer and over-nutrified waters which fed a sargassum seed population from "small amounts of *Sargassum* [that had] existed in the Central Atlantic in previous years" (Wang et al., 2019, p. 84).

2. To date, most island nations and territories in the Caribbean have some sort of a management plan or strategy on how to address the impacts of pelagic sargassum in their jurisdiction; including Puerto Rico, whose early creation of a management plan served as the basis for CFRM's *Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CFRM Member States*. Sargassum management plans across the WCR vary markedly in their contents and detail; and, as some researchers note, do not consider the capacity of the island, or nation, to implement the various strategies. As a result, a number of research institutes and NGOs have created guidelines to assist Caribbean islands in developing, and tailoring, a sargassum management plan. The two documents of notable mention are CERMES's *Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up* and CFRM's *Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CFRM Member States.*

3. In the USVI, DPNR-CZM and DFW manage the coastal zone, often in conjunction with the USACOE. The current territorial and federal policies with regards to sargassum management are a) non-mechanized, manual removal of the seaweed from the shoreline (e.g., hand raking) does **not** require a local or federal permit; b) the use of any machinery along the shoreline to remove sargassum **does** require prior permission, and approval, from DPNR-CZM in conjunction with DFW, who is CZM's partner in sargassum management efforts; and c) **no federal agency prohibits** the collection or removal of sargassum from the water. Only two federal permitting processes are potentially triggered by collecting and/or removing sargassum in-water. They are

the USACOE permitting process if a structure, like an aquatic plant boom aka "barrier," is to be installed in territorial waters, all of which are considered navigable waters of the US; or if sargassum-related mechanized work is to be conducted in territorial waters; and the EPA permitting process if collected sargassum is to be discharged back into the ocean. In 2003, NMFS approved a rule designating pelagic sargassum located off the coasts of the Southern Atlantic States to be EFH. By its terms, the federal rule applies to a specific area **outside the Caribbean** and was passed before the sargassum inundations became commonplace in the WCR.

4. The need to develop a multi-sectoral task force, or working group, specifically for sargassum, is reiterated throughout the literature and was among the desired support from local government mentioned by key informants. One of the biggest challenges in the USVI is going to be getting stakeholders to dedicate time to the working group and finding not just any people but the "right" people to represent each sector. Hotels, villa operators, and well-funded organizations will be more likely to send representatives to attend the working compared to small tour operators, fisherfolk, or local homeowners. This does not mean that the latter groups are any less impacted by sargassum inundations. Other means of engagement – like virtual meetings or updates disseminated via a local listserv – should be created for them to participate. Representatives from government agencies more indirectly by sargassum, like the Department of Health, Waste Management, or Public Works, will also need to be engaged. The other big challenge will be funding. As one stakeholder flatly said, "[Sargassum] is a problem that is going to need money thrown at it."

5. Key informant interviews with sargassum stakeholders across the territory indicate a willingness to "do the right thing" when it comes to sargassum but being unsure about what the "right thing" is. As the financial burden of sargassum continues to take a heavy toll on the territory's private sector, this sense of shared "goodwill" will not last forever.

6. Mis- and conflicting information about to sargassum was widespread across different sectors and even between levels, or departments, within the same sector. This ranged from knowledge of where sargassum in the territory originates to information related to federal rules and regulations around in-water sargassum management and collection.

7. While this scope of work did not include an exploration of sargassum and public health, repeated and prolonged exposure to hydrogen sulfide from decomposing sargassum was a major concern among key informants and community survey participants. OSHA has limits for hydrogen sulfide exposure, and emerging research in the region seems to indicate that large rafts of beached sargassum can exceed the allowable ceiling that OSHA has set. Other countries in the region, like the Dutch Caribbean, are using the hydrogen sulfide regulations established by OSHA to monitor and protect their community's health. As the concept of environmental justice – i.e., the inequitable distribution of environmental harms – becomes engrained in federal policy, the health impacts to the territory's Black and Brown coastal communities should be included in future sargassum discussions and policies.

Key Recommendations

1. **It is imperative that the territory develop and formalize a comprehensive sargassum management plan**. This plan should be fashioned after existing guidelines – i.e., CERMES's *Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up*, the *Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CFRM Member States* and Oxenford et al.'s *Expanded Framework for an Adaptable Sargassum Management Plan*. Some of the items to include in the plan are a) selecting which beaches will be cleaned up and on which beaches the sargassum will be allowed to accumulate; b) delineating when mechanized methods of removal will be allowed with a list of beach-approved equipment/machines; c) determining whether to collect sargassum in nearshore waters before it is beached; and d) encouraging the exploration of opportunities to valorize sargassum as a commercial product. The plan should be digitalized and widely disseminated with other territorial government agencies, local stakeholders, and the USVI public.

2. **A multi-sectoral working group on sargassum must be created for the territory. Additionally, a *Sargassum* Task Force at UVI should also be created**. The latter would work to inform the former with research and evidence-based recommendations. There is precedent for this. The Stony Coral Tissue Loss Disease (SCTLD) Task Force can serve as model for the structure of the Sargassum Task Force. Appendix P has the proposed structure for a USVI working group on sargassum.

3. **DPNR-CZM and DFW should work with the Antilles Division of the USACOE to review and finalize a RGP for sargassum in the USVI**. The agencies should also put policies and procedures in place to review and revise the permit as we learn more about sargassum management. As one federal stakeholder noted, "if [sargassum management is] done correctly, it can have minimal impacts. If putting in structures… thoughtfully, they can have minimal impact to resources around them. There will be a lot of trial and error. Even when [the Corps] makes a general permit, it is still something we will need to go back to. [The sargassum permit] needs to be something that can be revised easily."

4. **A website should be created to disseminate sargassum information to the territory** with information for residents and guests and **citizen science initiatives to monitor and manage sargassum should be encouraged and widely disseminated to the public**. The need to engage and share information with multiple sectors and the community was repeatedly mentioned as a key component to any (comprehensive) sargassum management strategy. Key informants and community survey participants echoed these sentiments. When asked to describe the kinds of support local government agencies could offer stakeholders with regards to sargassum management information, cleanup assistance, and marina protection were the three most common themes that emerged. As an example, the Department of Tourism in Belize hosts the nation's sargassum repository on their website. As one key informant noted, "[we need] a website dedicated to sargassum so if we [as a community council] needed to send that to someone it's coming from a government agency."

5. Additionally, **locally appropriate materials should be developed and disseminated for the territory to educate the different sectors on sargassum**. These materials should be brief, easily understandable and, as one key informant said, "meet people where they are." A few years ago,

DFW did develop a two-page brief on sargassum, however this brief was not well disseminated and some of its information is now out of date. The UNEP-CEP has developed a series of sargassum briefs for policy makers, civil society, and other sectors from their seminal 2021 Sargassum White Paper. These materials should serve as a blueprint for future sector-specific briefs in the territory with tailored messages for tour operators, hoteliers, fisherfolk, and community councils, as examples.

6. **The cost of sargassum clean-up cannot solely fall on the private sector. The GVI should allocate funds to support sargassum mitigation and management in the territory.** Funding could be in the form of grants for small businesses financially impacted by sargassum influxes, cleanup support to homeowner associations located in heavily impacted coastline, or by subsidizing the cost of aquatic booms for entities interested in installing sargassum barriers along the coasts. The GVI could engage federal partners, like FEMA, in sargassum management if it were to be declared a Disaster and/or State of Emergency, and a Presidential disaster declaration was also obtained.

7. **Sargassum and agriculture need to be locked in separate boxes (for now)**. Even without the discovery of heavy metals like arsenic, lead, and cadmium, sargassum also contains sodium within its tissue. This means that the use of unprocessed sargassum as a fertilizer, compost, or mulch is not advisable, as it will result in the salinization and buildup of heavy metals in soil over time. No amount of dewatering or rinsing will remove the salt or heavy metals contained within tissue of sargassum. Prolonged use could also lead to the leaching of salt and heavy metals in the water table.

8. **DPNR should create a Sargassum Coordinator position that would be in charge of overseeing the territory's sargassum strategy**.

9. **Sargassum must be intercepted before it reaches the shore and there is available research for determining at what distance from shore sargassum stops being a productive habitat**. J.R. Rooker has a number of peer-reviewed publications on the declining biological activity of sargassum as it approaches shore. As on DFW Chief noted, "[the] general rule is, if [sargassum is] inside an embayment, [then it does] not [have] much biological capacity."

10. **Marinas should be protected** with aquatic booms and other techniques and divert and/or prevent sargassum from entering these protective bays.

11. **Much like climate change, sargassum should be incorporated into any plans, permits, or policies related to the waters of the territory of the USVI**. This includes the territorial *Comprehensive Water and Land Use Plan* (CWLUP) that is currently seeking community input on critical areas, and items, of focus.

12. **The territory needs a general permit for sargassum management** that covers both federal and territorial regulations.

13. **We cannot keep dumping sargassum into our landfills**. Opportunities to valorize sargassum have to be explored in earnest, as it is the only way to sustainably fund mitigation and clean-up measures in the territory. Different options should be explored and piloted simultaneously. As

one federal stakeholder put it, “there is not going to be one perfect solution. There are going to be losses. We will need to decide which losses are we comfortable with…”

14. **Sargassum influxes are not unique to the USVI and, as such, we cannot, and should not, operate in a vacuum**. Four years ago, the Great Atlantic *Sargassum* Belt had already grown into the largest macroalgae bloom in recorded history at 8,850 kilometers (5,500 miles) long. Sargassum is a multinational and multisectoral issue, and a number of NGOs have created working groups to think through solutions. Representation from the USVI has been woefully absent from all. The territory needs to join these groups, attend the conferences (which have almost all been virtual), and contribute to the region’s emerging research on the issue. We do have laws and regulatory frameworks which are specific to the United States, but we must not look so inward that we do not see the successes and failures of other island nations; nor that we lag behind the most up-to-date and relevant approach to this challenge. As Puerto Rico is often the focus of federal attention in the American Caribbean, the USVI should also reach out to their local agencies to share in the available sargassum resources.

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Appendices

Appendix A. Scope of Work to Develop a Blueprint for USVI Sargassum Management Plan

The Department of Planning and Natural Resources (DPNR) Division of Coastal Zone Management (CZM) is seeking a contractor to develop a *Blueprint for USVI Sargassum Management Plan* for the Territory.

Background: The US Virgin Islands has experienced increasing quantities of sargassum in our coastal areas since before 2017 which is negatively affecting coastal businesses including hotels, restaurants, and marine based businesses such as fishers and charter vessels. Sargassum seaweed floating from offshore into nearshore areas and onto the shorelines crosses multiple government agencies and stakeholder interests, including DPNR's divisions of Coastal Zone Management (CZM), Fish and Wildlife (DFW), and Environmental Protection (DEP); other local agencies like Waste Management Authority (WMA) and Public Works (DPW); as well as groups including but not limited to the Hotel and Tourism Association, Professional Charter Association, and Fisheries Councils and Associations.

Goal: To clarify and summarize the roles, responsibilities, and impacts of sargassum response and management to each of these stakeholder agencies and groups listed above, as a foundational document that will directly inform next steps in the development of a comprehensive plan for the management of sargassum that will protect natural resources while also guiding management responses to the negative impacts of these nuisance events.

Scope of work: DPNR seeks the services of a contractor to produce a foundational summary document plan through activities such as *key informant interviews, focus groups, VI policy and procedural review, Caribbean review for relatable resources and processes, and recommendations.* The contractor will produce a USVI Blueprint for Sargassum Management Plan which will include clarity and summary of responsible agencies, best practices and requirements for coastal stakeholders seeking to respond to Sargassum influxes, and recommendations for the territory's government and private sector. The contractor will work with DPNR staff and partner agencies to report on how Sargassum influxes moving from offshore to onshore impacts the different roles and responsibilities of GVI agencies.

The contractor will have monthly meetings with DPNR-CZM for project status updates and submit all project-related meeting agendas and minutes to DPNR-CZM project manager. It is expected that the contractor's communication (email, phone, meetings) with project stakeholders will be frequent and consistent. Three (3) rounds of drafts and revisions are expected to produce the final version.

Deliverables:

(1) The contractor will produce a *USVI Blueprint for Sargassum Management Plan* that includes but is not limited to:

- Summary of how Sargassum mats move from offshore into the coastal zone and onto the shoreline;

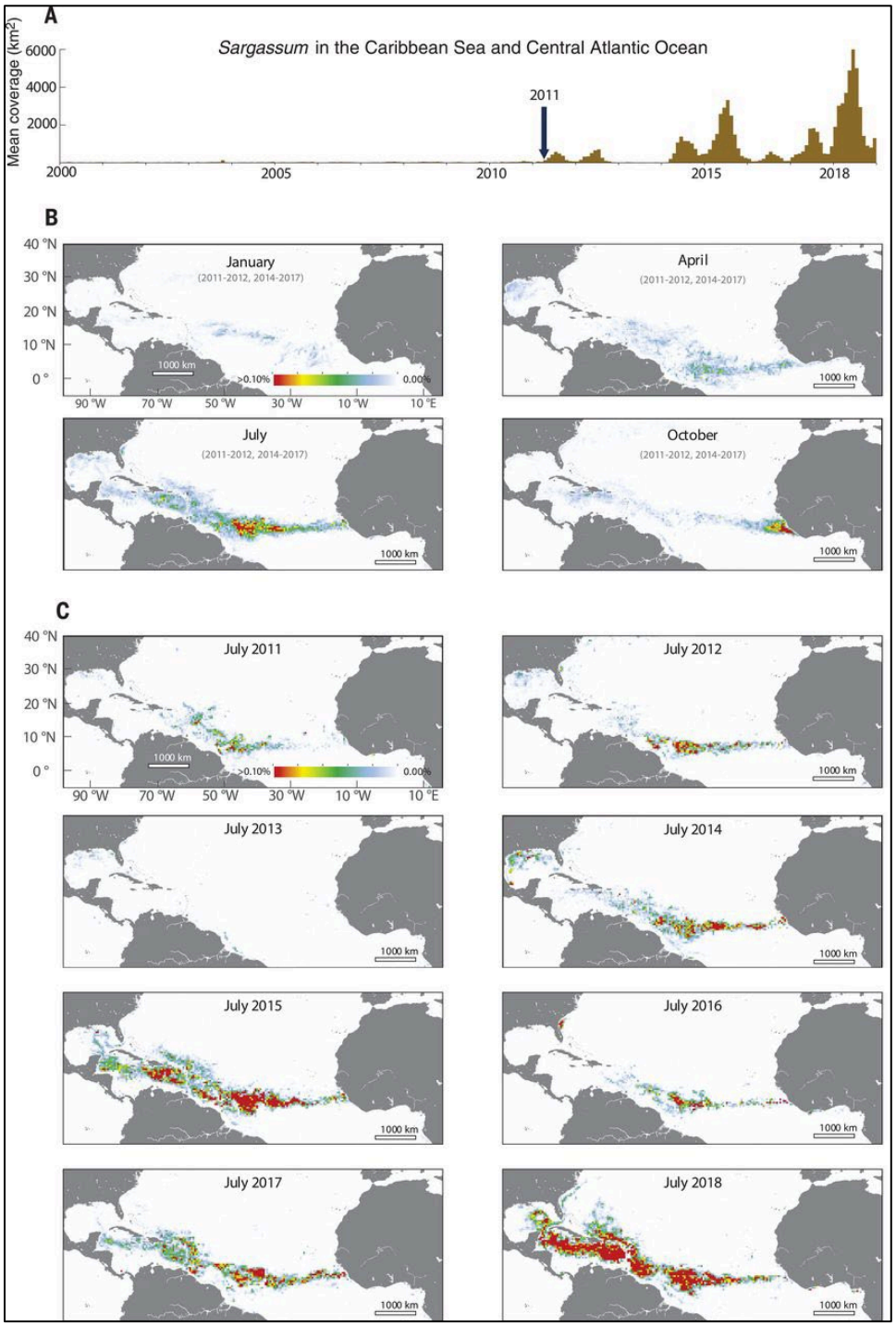
- Mapping of sargassum hot-spots;
- List of agencies and their specific responsibilities and policies that come into play as Sargassum moves from the marine to coastal and shoreline habitats;
- List of stakeholder interest groups that Sargassum impacts and a summary of how/when/where each group is impacted by the mat influxes;
- List/chart of how stakeholders can/must navigate different policies and permits required for Sargassum response;
- Case studies from other Caribbean islands regarding best practices and lessons learned in Sargassum response and management;
- Recommendations for creating a local working group and producing standard operating procedures resources for government staff and public stakeholders re sargassum management

Budget: Budget must include all costs and fees related to development of the document including travel, supplies, and personnel costs.

Contractor Requirements: Contractor must be registered to work in the VI and fulfill all requirements set forth by the Department of Property and Procurement in order to receive payment.

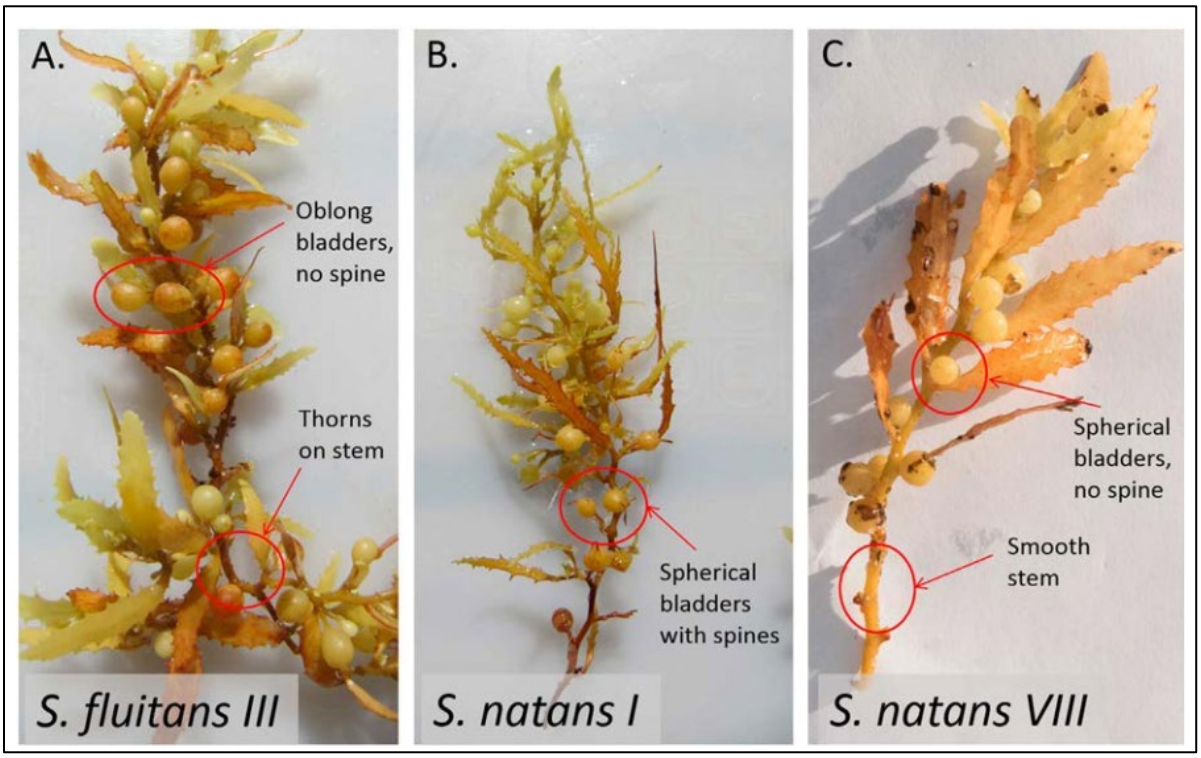
Appendix B. Mean Sargassum Densities from 2011 to 2018

[Source: Wang et al., 2019]



Appendix C. Morphology of the *Sargassum* Species Found in the GASB

[Source: Govindarajan et al., 2019]



Appendix D. List of National Policy Documents Addressing Pelagic Sargassum Influxes by Type and Caribbean Nation or Island[12]

No.	State	Impact levels*	Document type	Report title	Year
1	Anguilla (UK)	VH	Management plan	Draft Sargassum management plan	2015
2	Antigua and Barbuda	VH	Invite for tender	Request for Expression of Interest for the Supply of Equipment and Machinery for Aquatic *Sargassum* seaweed removal in Antigua and Barbuda	2018
3	Aruba (NL)	M	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
4	Bahamas	L	None found	N/A	N/A
5	Barbados	VH	Management brief	Barbados Sargassum Management Plan	2019
6			Management strategy	Barbados Sargassum Adaptive Management Strategy	2021
7	Belize	VH	None found	N/A	N/A
8	Bermuda (UK)	NA	Biodiversity conservation strategy	The protection and management of the Sargasso Sea: The golden floating rainforest of the Atlantic Ocean.	2011
9	Bonaire (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2018
10			Presentation	Sargassum Bonaire	2018
11	British Virgin Islands	VH	Statements to parliament	Statement by Deputy Premier and Minister for Natural Resources and Labor Dr. The Honorable Kedrick D Pickering "Sargassum Seaweed Phenomenon"	2015
12	Cayman Islands (UK)	H	Removal guidelines	Guidelines on Removing Sargassum from Beaches	2015
13	Cuba	L	None found	N/A	N/A
14	Curaçao (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
15	Dominica	H	Strategic preparedness plan	Strategic Sargassum Preparedness Plan	2019
16	Dominican Republic	VH	Technical uses guide	Informe sobre el estado de la técnica: tecnologías sobre la recolección del sargazo	2018
17	Grenada	M	Model protocol	Protocol for the Management of the Extreme Accumulations of Sargassum on the Coast of Grenada	2017
18			Management strategy	Grenada Sargassum Adaptive Management Strategy	2021
19	Guadeloupe (Fr)	VH	Training document	Creation of green brigades for collecting sargassum in Guadeloupe	2015
20			Report and recommendations (Fr)	Le phénomène d'échouage des sargasses dans les Antilles et en Guyane	2016
21	Guyana	L	None found	N/A (supposed to be modifying CRFM protocol)	N/A
22	Guyane (French Guiana)	NA	Report and recommendations (Fr)	Le phénomène d'échouage des sargasses dans les Antilles et en Guyane	2016
23	Haiti	L	None found	N/A (Coastal Sanitation Protection of the Great South Coast)	N/A
24	Jamaica	VH	Strategic preparedness plan	National Response Strategy: The Sargassum Threat	2015
25	Martinique (Fr)	H	Report and recommendations (Fr)	Le phénomène d'échouage des sargasses dans les Antilles et en Guyane	2016
26	Montserrat (UK)	H	None found	N/A	N/A
27	Puerto Rico	H	None found	N/A (Protocol for the management of extreme accumulation of Sargassum on the coasts of Puerto Rico)	2015
28	Saba (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
29	St Eustatius (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019

[12] Source van der Plank et al. (2022). To note, Puerto Rico has a *Sargassum* management protocol.

No.	State	Impact levels*	Document type	Report title	Year
30	St Kitts and Nevis	VH	Management brief	Plan for the Management of the Accumulations of Sargassum on the Coastal and Marine Ecosystem of St. Kitts and Nevis	2017
31			Management brief	St. Kitts and Nevis Sargassum Adaptive Management Strategy	2021
32	St Lucia	VH	Management brief	Saint Lucia National Strategy for the Management of Sargassum Influxes on Beaches, Bays and Small Harbors	2017
33			Management strategy	Saint Lucia Sargassum Adaptive Management Strategy	2021
34	St Maarten (NL)	VH	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
35	St Martin (Fr)	NA	Green Brigade and government statements	N/A	N/A
36	St Vincent and the Grenadines	VH	Management brief	Management of Extreme Accumulations of Sargassum on the Coasts of St. Vincent and the Grenadines	2018
37			Management Strategy	St. Vincent and the Grenadines Sargassum Adaptive Management Strategy	2021
38	Suriname	VH	None found	N/A	N/A
39	Trinidad and Tobago	H	Management brief	National Sargassum Response Plan [Trinidad]	2016
40				Tobago Sargassum Emergency Response Plan [Tobago]	2016
41	Turks and Caicos	VH	None found	N/A (draft in progress)	N/A
42	US Virgin Islands	H	None found	N/A	N/A

*According to UNEP white paper (UNEP-CEP 2018): VH Very High; H High; M Medium; L Low; NA not included in UNEP paper.

This table includes all identified policies/strategies, but only those in English were analyzed in depth. See supplementary material for reference list of all policy briefs. Fr: France, collectivity, NL: Netherlands, country or public body, UK: United Kingdom, overseas territory.

Note: All reports were found through online search, except: (i) Jamaica (2015) which was received directly from National Environment and Planning Agency, Jamaica, and (ii) Barbados, Grenada, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Trinidad and Tobago which were all received from country contacts.

Appendix E. List of National Policy Documents Addressing Pelagic Sargassum Influxes by Country, Goal, Management Actions and Responsible Agencies[13]

Country	Goal of policy document	Recommended adaptations	Adaptation responsibility (stakeholders)
Antigua and Barbuda	To develop a sustainable approach to *Sargassum* seaweed management and seek viable alternatives for the use of *Sargassum* in Antigua and Barbuda.	Clean-up (removal of *Sargassum* at sea; reduction of *Sargassum* arriving on the beach), reuse (economic and beneficial uses for *Sargassum*)	Department of the Environment Ministry of Health, Wellness and the Environment Contractors
Cayman Islands (UK)	*No explicit aim* Guide to good practice on removal of *Sargassum* from beaches	Clean-up (by rake at low-tide; for mechanised clean-up consultation with DOE is required), do nothing (preferred option), reuse (as fertiliser is possible)	*Not explicitly listed* Department of Environment
Dominica	To address the negative impacts of the *Sargassum* influx while taking advantage of the various positive opportunities it presents	Clean-up (rake and bury), governance (action committee, five-year review), partnership, public engagement (beach signage), research (data collection), reuse (fertilizer or export)	Fisheries Division Ministry of Tourism Ministry of Planning and Economic Development UEWI Ministry of Agriculture Ministry of Environment, Climate Resilience, Disaster Management and Urban Renewal Tourism (private) Karlingo Territory Agriculture (private)
Dutch Caribbean (Aruba, Bonaire, Curaçao, Saba, St Eustatius, St Maarten)	*No explicit aim* Highlight the urgency of the *Sargassum* problem, assist stakeholders, present range of solutions, short and long-term mitigation strategies, promote stakeholder engagement.	Clean-up (best practice, disposal, onshore, near-shore, at sea not recommended, manual and mechanised), early warning system (regional systems), forecasting, governance (national coordinating body), partnership (local partnerships, community engagement, communication channels, national and regional), prevention (containment booms), public engagement and stakeholder participation	*Not explicitly listed*
Grenada	*No explicit aim*	Avoidance (avoid contact with equipment and people), Governance (establishment of management structure), public engagement (public education and awareness initiatives for the public), partnership (and collaboration), reuse (commercialisation, organic compost, commercial products, feed),	Fisheries Division Agronomy Division National Solid Waste Management Authority Environmental Division Affected municipalities Grenada Hotel and Tourism Association

[13] Source: van der Plank et al. (2020).

Country	Goal of policy document	Recommended adaptations	Adaptation responsibility (stakeholders)
French Caribbean (Guadeloupe, Guyana, Martinique, St Martin)	To make operational recommendations to organize the collection process, storage, treatment and valuation of *Sargassum* algae from a management perspective on the long term	Clean-up and disposal (manual, mechanical, onshore, nearshore, treatment – within three days), forecasting, governance (integrate *Sargassum* into existing risk management plans at multiple authority levels), monitoring, research, reuse (agriculture)	Agence de l'environnement et de la maîtrise de l'énergie (ADEME) Agence Nationale de Sécurité Sanitaire de l'alimentation, de l'environnement et du travail (ANSES) Agence régionale de santé (ARS) Centre d'étude et de valorisation des algues (CEVA) Chambre consulaire interprofessionnelle des îles de Guadeloupe (CCIIG) Chambre consulaire interprofessionnelle de Saint-Martin (CCISM)
Jamaica	To define measures to respond to the abnormal accumulation of *Sargassum* on the Island's shoreline through national public sensitization, community mobilization and clean-up activities.	Clean-up (shoreline), communication (media and information dissemination), governance (clear designation of responsibilities), monitoring (resource assessments, surveys, data collection centre), partnership (national committee), public engagement (information exchange with fishing and other interest groups, communities), research	National Environment and Planning Agency National Solid Waste Management Authority Fisheries Division Ministry of Local Government and Local Community Development/Local Parish Councils Office of Disaster Preparedness and Emergency Management Ministry of Tourism and Entertainment UWI Scientific Research Council Rural Agricultural Development Authority
St Kitts and Nevis	To ensure the protection and conservation of coastal resources, and the sustainability of marine resources	Clean-up (guidelines, onshore), governance (structure to regulate fishing activities around *Sargassum*, sustainable marine resource management), monitoring, partnership (committee), public engagement (educate and sensitize the public), research (distribution, production and ecology), reuse (fertilizer and fish feed)	Department of Environment Department of Marine Resources Department of Fisheries Department of Physical Planning, Natural Resources and Environment Ministry of Tourism St Kitts Ministry of Tourism Nevis Hotel and Tourism Association St Kitts Tourism Authority

Country	Goal of policy document	Recommended adaptations	Adaptation responsibility (stakeholders)
St Lucia	To address the *Sargassum* influx on St Lucia's beaches and within the bays and harbours	Clean-up (onshore and offshore), communication, , economic opportunities and community employment generation, forecasting, partnership (regional protocol), public engagement (education and awareness, participation), research, reuse (development and innovation for reuse, beach building and nourishment, organic fertilizer, peat moss, agricultural uses, pharmaceuticals and chemicals, food, medicine)	Department of Fisheries Fishers and residents of coastal communities Tourism Officials Hotel Owners
St Vincent and the Grenadines	*No explicit aim* Disseminate information on the *Sargassum* influx and to promote the adaptation of best management practices in dealing with the issue	Clean-up (onshore and offshore, work plan, best management practices advice), governance (national task force), monitoring and reporting of events (and evaluation), preparedness (identification of sites prone to accumulation before events), public engagement (public education and awareness)	Ministry of Agriculture Rural Transformation, Forestry and Fisheries and Industry Ministry of Transport, Works, Urban Development and Local Government National Parks Rivers and Beaches Authority Ministry of Health, Wellness and the Environment Ministry of Housing
Trinidad and Tobago	*No explicit aim* Key goals: public awareness, efficient knowledge exchange, collaboration among the various agencies and sectors and research and development of *Sargassum* products	Clean-up (coordinate clean-up and disposal/reuse, onshore), communication (communication strategy), early warning system (remote sensing, ground truthing, oceanographic modelling), emergency response teams, monitoring, partnership (national coordination), research	Regional Corporations Tobago House of Assembly Tourism Development Company Ministry of Local Government and Rural Development Ministry of Planning and Development Ministry of Finance Ministry of Community Development Institute of Marine Affairs Fisheries Division, Ministry of Agriculture, Lands and Fisheries Office of Disaster Preparedness and Management Civil Society Organisation Hotel Association
Dutch Caribbean and French Caribbean are both grouped here because no independent brief or recommendations were identified (Ministère des Outre-Mer, Ministère de l'Environnement, de l'Énergie et de la Mer, and Ministère de l'Agriculture, de L'Agroalimentaire et de le Forêt 2016; Dutch Caribbean Nature Alliance 2019) Countries with a policy, but that have not been viewed by the research team: Belize, Dominican Republic, Haiti, Puerto Rico, Trinidad and Tobago, US Virgin Islands Countries not known to have policies: Anguilla, Bahamas, Barbados, Bermuda, British Virgin Islands, Guyana, Montserrat (UK), Suriname, Turks and Caicos			

Appendix F. Advantages and Disadvantages of Different Mechanized Beach Collection Techniques in the Dutch Caribbean[14]

	Main Advantages	Main Disadvantages
Public Works Machinery (e.g. tractor, digger, excavator)	• Available • High efficiency • Effective for massive strandings	• Sand catch and packing. • Damage to the coastline. Can cause much erosion, destroy dunes and destroy turtle and bird nests. • Must plan rigorous maintenance.
Beach Grooming Equipment	• Low sand intake	• Low capacity • In case of mass strandings, the experience from several places, notably Galveston (US), has been to use the equipment in a phased manner: large machinery with scoops/claws is first used to pickup sargassum without touching sand; when there is a manageable amount of sargas sum left on the beach, the beach grooming equipment is then used. • Several passages necessary
Self-propelled collection machine (Sargassum cleanup harvester vehicle prototype AXINOR) Rehabilitated agricultural vehicle with combs mounted on a treadmill and located at the front of the vehicle. Harvested algae then transported via conveyors to the storage bin equipped the vehicle.	• Low environmental impact as selective collection tool, low sand intake. • Able to unload alone in the bucket • Able to work in shal low water • Easy movement on the beach via the use of low pressure tires and high volume	• Size of gear restricts its use to accessible and stable beaches • Must adapt driving according to each stranding, otherwise jamming risk • Undifferentiated collection of algae and waste (plastics ...) • Risk of crushing turtle nests in traffic case on the beach top

[14] Source: Dutch Caribbean Nature Alliance, 2019.

Appendix G. Sargassum Worker Safety Considerations based on OSHA Regulations[15]

Safety of Workers

The release of hydrogen sulfide (H2S) by decomposing sargassum and its potential health impacts on workers and/or volunteers that clean up the impacted zones must absolutely be monitored and managed. Not only should collection take place as quickly as possible after each stranding (preferably within 48 hours), but workers should be equipped with hydrogen sulfide portable meters to ensure that H2S levels stay within healthy limits.

The minimal detectable concentration of H2S is 0.05pm and this level can be used as a warning signal. Workers collecting rotting algae should always be equipped with masks. These masks must be worn when H2S levels reach 5 ppm. When levels reach 10 ppm, the impacted area must be evacuated. Workers who operate heavy machinery must also have hydrogen sulfide detectors within the vehicle's cabin. Other recommendations to ensure the safety of workers include personal protective equipment and training in safe practices. If communities cannot afford or obtain hydrogen sulfide portable meters, the smell released by decomposing sargassum can be used as an indicator of harmful effects. According to the US Occupational Safety and Health Administration, the rotten egg smell becomes first noticeable at a concentration of 1.5ppm. The odor becomes much more noticeable at a concentration of 3-5ppm, and above 30ppm, "*the odor is described as sweet or sickeningly sweet*" (OSHA, retrieved from https://www.osha.gov/SLTC/hydrogensulfide/hazards.html).

[15] Source: Dutch Caribbean Nature Alliance, 2019.

Appendix H. Summary of Compositional Analyses of Heavy Metals in Pelagic Sargassum[16]

[Note: Units are parts per million (ppm) dry weight of sargassum unless otherwise indicated.]

Location* (sampling year)	Sample** type (# samples)	Heavy metals***						
		Total As (ppm)	Org. As (ppm)	Inorg. As (ppm)	Cd (ppm)	Hg (ppm)	Pb (ppm)	Cr (ppm)
Mexican Caribbean (2018-2019)	Mixed nearshore & offshore (63)	24-172 (median 80)	-	-	<2	-	<2-3	<8
British Virgin Islands (2016)	Mixed from beach (N/A)	45	17.3	27.7	0.169	<0.005	0.32	-
Martinique, Guadeloupe (2015-2016)	Mixed fresh & dry onshore (11)	11.50-100.8 (average 68.26)	-	-	<0.2-1.02	<0.1	<5.3-1.2	5.2-10.6
Turks & Caicos (2019)	Mixed nearshore (1)	123.69	-	-	0.13	0.01	0.26	<0.3
Dominican Republic (2015)	Mixed (12)	14-42	-	-	0.1-0.3		1-2	2-56
Atlantic, east Gulf of Mexico, Florida Straits & Key West (1974)	*S. fluitans* mixed offshore (4)	4.2-19.5 (wet weight)	-	1.9-19.5 (wet weight)	-	<0.01-0.07	-	-
Ghana (2015)	Mixed offshore & onshore (24)	13-53.5	-	-	78-119	1-2	86-335	-

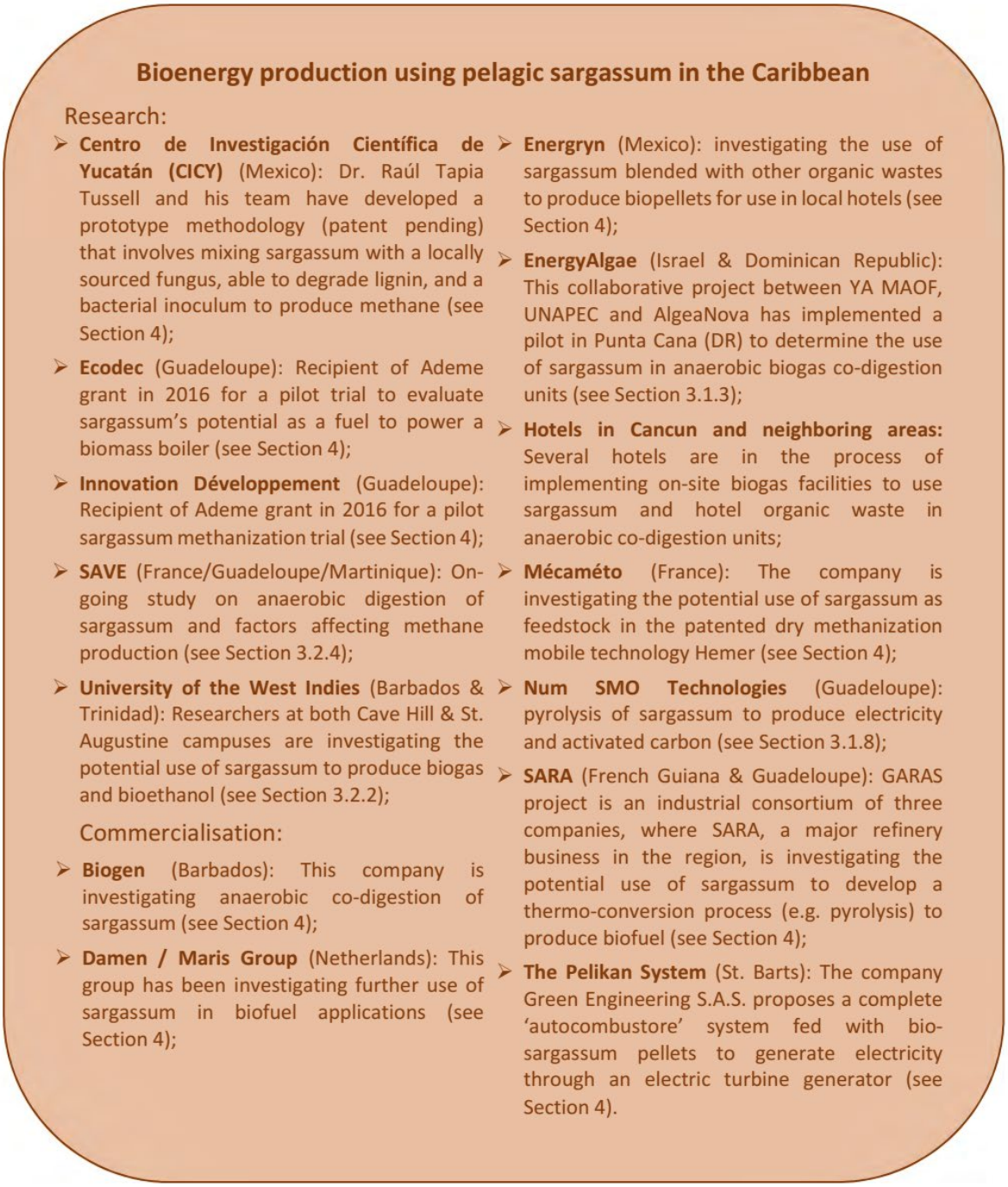
*Reference for each location: Mexican Caribbean: Rodríguez-Martínez *et al.* (2020); British Virgin Islands: Ocean Harvest Technology (2016); Martinique & Guadeloupe: IT2 & ADEME (2015) and Tirolien (2019); Turks & Caicos: Milledge *et al.* (2020); Dominican Republic: Fernández *et al.* (2017); Atlantic, eastern Gulf of Mexico: Johnson and Braman (1975); Ghana: Addico and deGraft-Johnson (2016).

**Sample type: Mixed: refers to mixed *Sargassum natans* and *S. fluitans*.

***Heavy metals: Total arsenic (Total As), organic arsenic (Org. As), inorganic arsenic (Inorg. As), cadmium (Cd), mercury (Hg), lead (Pb), chromium (Cr).

[16] Source: Desrochers et al., 2020.

Appendix I. Sample Directory from Sargassum Uses Guide: Entrepreneurs and Researchers in the WCR Exploring Sargassum as Bioenergy[17]



Bioenergy production using pelagic sargassum in the Caribbean

Research:

- **Centro de Investigación Científica de Yucatán (CICY)** (Mexico): Dr. Raúl Tapia Tussell and his team have developed a prototype methodology (patent pending) that involves mixing sargassum with a locally sourced fungus, able to degrade lignin, and a bacterial inoculum to produce methane (see Section 4);
- **Ecodec** (Guadeloupe): Recipient of Ademe grant in 2016 for a pilot trial to evaluate sargassum's potential as a fuel to power a biomass boiler (see Section 4);
- **Innovation Développement** (Guadeloupe): Recipient of Ademe grant in 2016 for a pilot sargassum methanization trial (see Section 4);
- **SAVE** (France/Guadeloupe/Martinique): On-going study on anaerobic digestion of sargassum and factors affecting methane production (see Section 3.2.4);
- **University of the West Indies** (Barbados & Trinidad): Researchers at both Cave Hill & St. Augustine campuses are investigating the potential use of sargassum to produce biogas and bioethanol (see Section 3.2.2);

Commercialisation:

- **Biogen** (Barbados): This company is investigating anaerobic co-digestion of sargassum (see Section 4);
- **Damen / Maris Group** (Netherlands): This group has been investigating further use of sargassum in biofuel applications (see Section 4);
- **Energryn** (Mexico): investigating the use of sargassum blended with other organic wastes to produce biopellets for use in local hotels (see Section 4);
- **EnergyAlgae** (Israel & Dominican Republic): This collaborative project between YA MAOF, UNAPEC and AlgeaNova has implemented a pilot in Punta Cana (DR) to determine the use of sargassum in anaerobic biogas co-digestion units (see Section 3.1.3);
- **Hotels in Cancun and neighboring areas:** Several hotels are in the process of implementing on-site biogas facilities to use sargassum and hotel organic waste in anaerobic co-digestion units;
- **Mécaméto** (France): The company is investigating the potential use of sargassum as feedstock in the patented dry methanization mobile technology Hemer (see Section 4);
- **Num SMO Technologies** (Guadeloupe): pyrolysis of sargassum to produce electricity and activated carbon (see Section 3.1.8);
- **SARA** (French Guiana & Guadeloupe): GARAS project is an industrial consortium of three companies, where SARA, a major refinery business in the region, is investigating the potential use of sargassum to develop a thermo-conversion process (e.g. pyrolysis) to produce biofuel (see Section 4);
- **The Pelikan System** (St. Barts): The company Green Engineering S.A.S. proposes a complete 'autocombustore' system fed with bio-sargassum pellets to generate electricity through an electric turbine generator (see Section 4).

[17] Source: Dutch Caribbean Nature Alliance, 2019.

Appendix J. Presentations from the Virtual Workshop: Legal Considerations on the Removal of Sargassum from the Coast of Puerto Rico, June 2022

VIRTUAL WORKSHOP: LEGAL CONSIDERATIONS ON THE REMOVAL OF SARGASSUM FROM THE COASTS OF PUERTO RICO

Agency: U.S. Environmental Protection Agency

Name: Carmen R. Guerrero Pérez

Position: Director, Caribbean Environmental Protection Division

Sea Grant Puerto Rico

Texas A&M University Corpus Christi | HARTE Research Institute for Gulf of Mexico Studies

June 21, 2022

What is the role of your agency in managing Sargassum?

- The dumping of material into the ocean that would unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities is prohibited under the MPRSA.
- Sargassum is considered a **non-dredged "material" under the MPRSA.** The ocean dumping of both fresh and manipulated Sargassum is an act regulated under the MPRSA. Therefore, its ocean dumping is unlawful unless permitted. EPA is the permitting agency under Section 1412 of the MPRSA.
- Potential role as a resource agency to the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act if any permits for fill or the construction of structures within Waters of the United States are needed to perform the work.

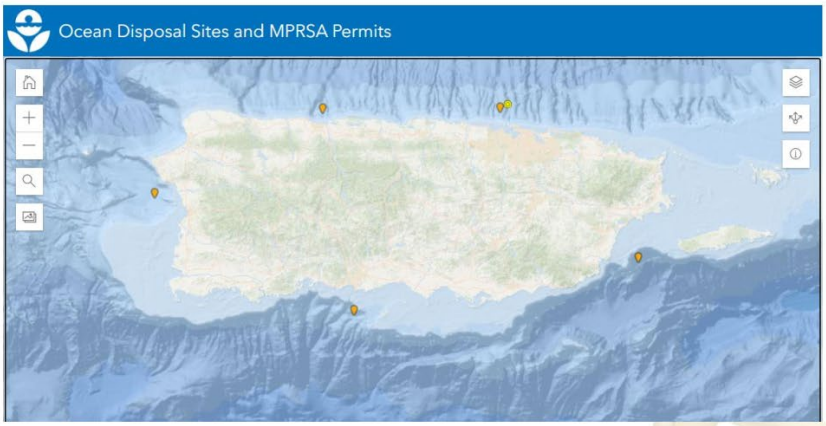
Legal Framework

- Marine Protection, Research and Sanctuaries Act (MPRSA): 33 U.S. Code, Section 1412 - Dumping Permit Program
- Clean Water Act, Section 404
- Rivers and Harbors Act, Section 10

What are the existing regulatory or permitting processes in your agency regarding the management of Sargassum?

- Being a non-dredged material, sargassum is regulated for permitting under §1412 of the MPRSA. It is likely that the ocean dumping of sargassum would have very little environmental impact, as its presence in deep ocean waters is a natural occurrence and is vital to the ecosystem. This is in stark contrast to its presence in shallow beach waters, where sargassum overabundance can hurt the surrounding wildlife, coastal ecosystems, economy, health, and safety. For these reasons, it may be beneficial for entities to seek permitting for the ocean dumping of sargassum.
- The MPRSA permits will consider:
  - The type of material that may be dumped;
  - The amount that may be transported for ocean dumping;
  - The location of the dumpsite;
  - The length of time the permit is valid; and
  - The need for any special provisions for dumping site surveillance.
- The ocean dumping of material may be permitted **after notice and opportunity for public hearing.**
- If seeking **Individual Permits** proves too costly for one entity, both local and municipal governments and private entities may jointly petition for the issuance of a **General Permit** under §1414(c) of the MPRSA. "The Administrator… may issue general permits for the… dumping… of specified materials or classes of materials for which he may issue permits, which he determines will have a minimal adverse environmental impact." If meaningful cooperation among Caribbean governments and private entities is achieved, a **General Permit** for the dumping of sargassum could be sought. The benefit of seeking a General Permit would be its applicability to all Sargassum dumping within a region. Rather than seeking one permit, multiple entities could make a showing that the necessity for the ocean dumping of Sargassum outweighs its environmental impact. Such a permit would also operate on a needs basis as Sargassum flow fluxes over the years.

What are the existing regulatory or permitting processes in your agency regarding the management of Sargassum?

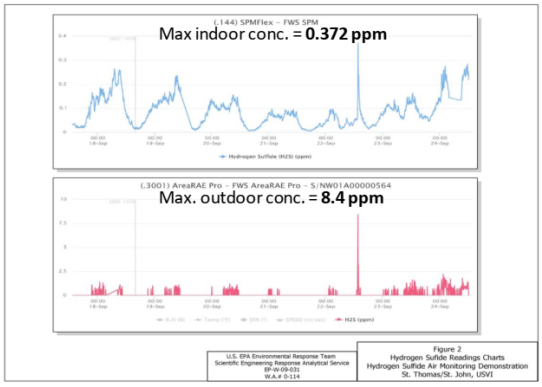


- All currently designated ocean sites in EPA Region 2 are for the disposal of dredged material permitted or authorized under the MPRSA.
- In rare instances, EPA Regional Offices (Ocean Dumping Management Program, Water Division) may issue an emergency, research or special ocean dumping permit to an individual or entity.

Do you foresee any problems or obstacles regarding these processes in the future?

- Collaboration between parties performing the collection and disposal of sargassum is crucial (*Sargassum Working Group*).
- All EPA-designated ocean dredged material disposal sites must have a site management plan including, among other things, the monitoring and management of the site. Disposal site selection and methodology is crucial to avoid potential impacts.
- Coordination between agencies is needed to develop a consistent approach that will provide information to potentially impacted groups/stakeholders.
- Invite US Economic Development Administration (EDA) – Bluetide Puerto Rico Initiative / Bluetide Caribbean Summit

Air Quality Impacts of Decaying Sargassum (Hydrogen Sulfide)



- For the most part, H_2S at lower concentrations are more of a nuisance, where the odor is the biggest complaint.
- As concentrations get higher, around 2-5 ppm, tearing of the eyes, nausea and headaches could develop with prolonged exposure, typically reported as 20-30 minutes. **These effects are generally temporary and will resolve without any long-term impacts after leaving the area. However, at that concentration 2-5 ppm, there could airway problems for people with compromised respiratory systems or people with asthma.**
- **Need of risk communication plan** for hydrogen sulfide produced by decaying *Sargassum*.

From the Department of Labor:

Concentration (ppm)	Symptoms/Effects
0.00011-0.00033	Typical background concentrations
0.01-1.5	Odor threshold (when rotten egg smell is first noticeable to some). Odor becomes more offensive at 3-5 ppm. Above 30 ppm, odor described as sweet or sickeningly sweet.
2 -5	Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep. Airway problems (bronchial constriction) in some asthma patients.
20	Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness.
50-100	Slight conjunctivitis ("gas eye") and respiratory tract irritation after 1 hour. May cause digestive upset and loss of appetite.
100	Coughing, eye irritation, loss of smell after 2-15 minutes (olfactory fatigue). Altered breathing, drowsiness after 15-30 minutes. Throat irritation after 1 hour. Gradual increase in severity of symptoms over several hours. Death may occur after 48 hours.
100-150	Loss of smell (olfactory fatigue or paralysis).
200-300	Marked conjunctivitis and respiratory tract irritation after 1 hour. Pulmonary edema may occur from prolonged exposure.
500-700	Staggering, collapse in 5 minutes. Serious damage to the eyes in 30 minutes. Death after 30-60 minutes.
700-1000	Rapid unconsciousness, "knockdown" or immediate collapse within 1 to 2 breaths, breathing stops, death within minutes.
1000-2000	Nearly instant death

VIRTUAL WORKSHOP: LEGAL CONSIDERATIONS ON THE REMOVAL OF SARGASSUM FROM THE COASTS OF PUERTO RICO

Agency: NOAA-NMFS

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Protected Resources Division (PRD)
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June 21, 2022

What is the role of your agency in managing *Sargassum*?

- Caribbean Fishery Management Council and NMFS identified and described *Sargassum* as essential fish habitat (EFH) for managed fish species.
- EFH means those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.
- NMFS does **NOT** prohibit *Sargassum* removal in the U.S. Caribbean.

Legal Framework

- Magnuson-Stevens Fishery Conservation and Management Act (PL-94-265, April 13, 1976) EFH was introduced in the 1996 amendments
- [16 U.S.C. §§ 1801 et seq.)]

Habitat Conservation Division | Protected Resources Division

What are the existing regulatory or permitting processes in your agency regarding the management of *Sargassum*?

- Only triggers a requirement to **CONSULT** if a federal agency is funding, permitting, licensing, or undertaking an action which may adversely affect EFH [16 U.S.C. Sec 305(b)(2)].
- NMFS is required to provide recommendations, which are not prescriptive, to avoid, reduce or compensate impacts to EFH.
- Federal agency must respond, in writing, to NMFS informing how EFH conservation recommendations are being implemented or justify why they are not.

Habitat Conservation Division | Protected Resources Division

What is the role of your agency in managing *Sargassum*?

NMFS does ***NOT*** prohibit *Sargassum* removal.

- Possible PRD concerns regarding *Sargassum* removal:
  - ➢ Potential impact to ESA-listed species that use or can be found in *Sargassum*.
    - Sea turtles (green, leather, logger, Kemp's ridley and hawksbill)
    - ESA-listed fish (Nassau grouper, scalloped hammerhead shark)
  - ➢ In-water work

Legal Framework

- **Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.).**
  - ➢ **Section 7(a)(2):** Each federal agency is required to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. Section 7(a)(2) requires federal agencies to consult with the appropriate Secretary in carrying out these responsibilities.
  - ➢ **Section 10(a)(1)(B):** Incidental Take Permit. *This permit does not apply to federal activities.*

Habitat Conservation Division | Protected Resources Division

What are the existing regulatory or permitting processes in your agency regarding the management of *Sargassum*?

If applicable,

- Section 7 consultation (federal actions)
  - ➢ Informal consultation

    May Affect, Not Likely to Adversely Affect: All effects are *beneficial*, *insignificant*, or *extremely unlikely to occur*.

  - ➢ Formal consultation

    May Affect, Likely to Adversely Affect: ESA-listed species or critical habitats are likely to be exposed to the action or its environmental consequences and are likely to experience negative responses to the exposure.
- Section 10 permit (non-federal actions)
  - ➢ Required for any "take" of an endangered or threatened species incidental to, and not the purpose of, an otherwise lawful activity.
    - Threatened species with 4(d) rules: Kemp's ridley, green and loggerhead sea turtles (NW Atlantic Ocean DPS), Elkhorn and Staghorn coral.
    - Endangered species: Leatherback and hawksbill sea turtles.

Habitat Conservation Division | Protected Resources Division

Do you foresee any problems or obstacles regarding these processes in the future?

- Removal actions can be delayed if EFH and/or Section 7, 10 **CONSULTATION** is required.

Additional Information

- For more information regarding Essential Fish Habitat consultation, go to:

https://www.fisheries.noaa.gov/national/habitat-conservation/consultations-essential-fish-habitat#:~:text=A%20consultation%20is%20required%20if,will%20%E2%80%9Cadversely%E2%80%9D%20affect%20EFH

- For more information regarding Section 7 consultations, go to:

https://www.fisheries.noaa.gov/southeast/endangered-species-conservation/esa-section-7-interagency-consultation-southeast-united-states

- For more information on Section 10 permits, go to:

https://www.fisheries.noaa.gov/permit/permits-incidental-taking-endangered-and-threatened-species

VIRTUAL WORKSHOP: LEGAL CONSIDERATIONS ON THE REMOVAL OF SARGASSUM FROM THE COASTS OF PUERTO RICO

Agency: U.S. Army Corps of Engineers

Deborah J. Cedeño-Maldonado
Project Manager
Jacksonville District - Antilles Permits Section
June 21, 2022

Working Today to Build a Better Tomorrow

US Army Corps of Engineers ®

WHAT IS THE ROLE OF YOUR AGENCY IN MANAGING SARGASSUM?

Regulate structures, mechanized work, or discharges of dredged/fill material in navigable waters of the United States necessary to prevent, remove, or otherwise manage the accumulation of Sargassum in coastal waters of Puerto Rico and the U.S. Virgin Islands.

Legal Framework

Section 10, Rivers and Harbors Act of 1899
- Structures or work in, over or under navigable waters of the United States

Section 404, Clean Water Act of 1977
- Discharge of dredged or fill material in waters of the United States, including wetlands

Working Today to Build a Better Tomorrow

WHAT ARE THE EXISTING REGULATORY OR PERMITTING PROCESSES IN YOUR AGENCY REGARDING THE MANAGEMENT OF SARGASSUM?

No specific procedures in place related to management of Sargassum.

Submittal of Department of the Army permit application required for evaluation and authorization of proposed activities in navigable waters of the U.S. to manage Sargassum.

- Applicable type of permit (General Permit or Individual Permit)
- Application review process
  - Compliance with: 404(b)(1) Guidelines, NEPA, Section 7 of the Endangered Species Act (ESA), Magnuson-Stevens Act & Section 106 of National Historic Preservation Act (NHPA)
  - State & Territorial Certifications: Costal Zone Management (CZM) Consistency Certification and/or Water Quality Certification (WQC)
- Final decision (issuance of permit or denial)

DO YOU FORESEE ANY PROBLEMS OR OBSTACLES WITH THESE PROCESSES IN THE FUTURE?

Potential Problems or Obstacles:

Unauthorized activities in waters of the U.S. for management of Sargassum.
- May affect future Department of the Army permit requests
- May be subject to enforcement action

Submittal of permit applications for activities proposed as an “emergency” or as to be conducted immediately or in a short amount of time.
- Consultations under Section 7 of the ESA, Magnuson-Stevens Act, and Section 106 of the NHPA take time to complete.
- Precludes timely issuance of permits

VIRTUAL WORKSHOP: LEGAL CONSIDERATIONS ON THE REMOVAL OF SARGASSUM FROM THE COASTS OF PUERTO RICO

Agency: U.S. Fish and Wildlife Service

Name: Felix Lopez

Position: Ecologist

Sea Grant Puerto Rico

TEXAS A&M UNIVERSITY CORPUS CHRISTI | HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES

June 21, 2022

What is the role of your agency in managing Sargassum?

- While the Service does not "manage" Sargassum we do provide guidance on how to minimize the impacts of Sargassum removal to federally protected species.
- The concern is that large mats of coastal Sargassum can impede nesting sea turtles from reaching nesting beaches or hatchlings leaving the beach.

Legal Framework

- Endangered Species Act
- Fish and Wildlife Coordination Act
- Marine Mammals Protection Act

Baby turtles rescued from seaweed grasp

What are the existing regulatory or permitting processes in your agency regarding the management of Sargassum?

- The FWS does not issue permits, rather we are "consulted" by other federal agencies on possible impacts to fish and wildlife resources under the Fish and Wildlife Coordination Act (FWCA), and possible impacts to federally listed endangered species under the Endangered Species Act (ESA). Both legislations require federal action agencies to consult with the Service prior to issuing any permits, grants or other actions.
- For the FWCA the Service can recommend avoidance and mitigation for impacts. For the ESA the federal action agency makes a determination of impacts to threatened or endangered species. The Service can concur with that determination or issue a Biological Opinion if take is anticipated.

Do you foresee any problems or obstacles regarding these processes in the future?

The main concern is obtaining information about the technology to be used to control, gather or holdback sargassum from the shoreline. A better understanding of what technology options are available, where they have been used before and how successful were they, can help agencies evaluate the impacts to their resources and provide better comments and recommendations to the applicants.

Appendix K. The USVI DFW Sargassum Management Brief for Onshore Removal Permits

GOVERNMENT OF THE UNITED STATES VIRGIN ISLANDS

DEPARTMENT OF PLANNING AND NATURAL RESOURCES

4611 Tutu Park Mall
Suite 300, 2nd Floor
St. Thomas, VI 00802
(340) 774-3320

45 Mars Hill, Frederiksted
St. Croix, VI 00840
(340) 773-1082
dpnr.vi.gov

2022

TO: Permittee

FROM: Division of Fish and Wildlife, Department of Planning and Natural Resources

RE: Sargassum Management Brief for Onshore Removal Permits - MEMO

As the issue of sargassum inundations continues to affect the Territory's natural resources, tourism industry, fishery, and the community at large, The Department of Planning and Natural Resources (DPNR) began accepting and issuing permits to allow for mechanized removal of the seaweed from specified shorelines. At present, the Division of Coastal Zone Management (CZM) has issued (3) permits for sargassum removal operations in St. Thomas. While the scope and conditions of each permit have been tailored to site-specific needs and goals, all permits require the applicant and removal personnel to receive training from the Division of Fish and Wildlife (DFW). The purpose of this training is to familiarize those who will be handling and removing the sargassum with any threatened, endangered, and indigenous species of concern that may be residing, breeding, foraging in, or otherwise using the seaweed. In this way, DPNR can assure sargassum removal in the Territory is responsible, ecologically sound, and consistent with Virgin Islands Code.

To meet this identified training requirement, DFW has developed the attached guidance document entitled *Sargassum in the U.S. Virgin Islands: A Management Brief*. It is required that those seeking sargassum removal permits must review this document in full with a DFW representative. If satisfactory, the two parties may sign the endorsement page providing proof of training which can then be submitted to CZM for final permit approval.

It is the hope of DFW that this management brief may remain a living document, to be continuously adjusted to the ever-changing nature of this issue. We plan to continue our review of the best available science regarding sargassum and its implications for the local community and natural resources of the Virgin Islands. In the coming months, we will be developing an index of observed species using sargassum in the Territory and updating the management brief document accordingly. It is important to add that this brief is multi-objective and can be used by various stakeholders seeking general guidelines for managing nuisance sargassum in the Territory. Please share widely.

For questions, comments, or concerns kindly contact the Division of Fish and Wildlife at 340-773-1082.

Sargassum in the U.S. Virgin Islands: A Management Brief

The Department of Planning and Natural Resources (DPNR) Division of Fish and Wildlife (DFW) recognizes that *Sargassum spp.* is a free-floating pelagic seaweed occurring historically in the Sargasso Sea and naturally reaching the shorelines of the U.S. Virgin Islands (USVI) by way of currents and tides. The Division also recognizes that the unprecedented blooming of sargassum since 2011 has resulted in mass inundations of beaches and bays in the Territory with negative impacts on the USVI community, environment, fishery, and tourism industry. In understanding the importance of sargassum as essential habitat for a variety of fish and wildlife while considering the negative impacts of sargassum influxes in the USVI, DFW has created the attached brief to guide sustainable management of sargassum in the Territory by meeting the following objectives:

- To provide ecologically sound solutions for the collection, removal, and disposal of sargassum in the U.S. Virgin Islands;
- To train permit seekers and recipients in sargassum best practices in order to meet permit compliance;
- To present all stakeholders with site-specific guidance and relevant resources for the present and future management of sargassum in the Territory.

Sargassum reaching the shores of Sapphire Beach, St. Thomas.

I certify that I have read and understood this document. I certify that I will only work within the scope of my sargassum removal permit. I certify that I will practice the wildlife guidelines outlined in this document to protect the threatened, endangered, and indigenous species of the U.S. Virgin Islands.

Provided To: _____ Date:_____
Applicant

Provided By: _____ Date: _____
DFW Representative

Sargassum as an Ecosystem

Sargassum is historically found in the Sargasso Sea, a large floating aggregation of the brown seaweed contained by four ocean currents in the North Atlantic. Floating mats of sargassum form biodiversity hotspots by providing food and shelter to over 250 species of fish and wildlife. Some of these species such as the sargassum fish, *Histrio histrio*, are found only in sargassum (Figure 1.0). Sargassum serves as juvenile fish habitat for commercially important pelagic species such as tuna, wahoo, and mahi-mahi. Seabirds such as terns and boobies forage for food in the floating seaweed since it houses an array of invertebrates. Additionally, endangered sea turtle hatchlings such as leatherbacks and hawksbills depend on floating sargassum as a rest stop during their long journey to adulthood.

As sargassum dies it sinks to the ocean floor where it contributes to nutrient cycling and carbon storage. On land, beached sargassum stabilizes sand and prevents erosion while providing nutrients for coastal plant growth and foraging grounds for shorebirds. In natural amounts, oceanic and coastal sargassum creates rich ecosystems for a diversity of life as well as provides ecosystem services such as carbon sequestration and erosion control. Therefore, sustainable management of nuisance sargassum must consider its high social and ecological value.

Sargassum as a Nuisance

Beginning in 2011, unprecedented quantities of sargassum began smothering the shores of the U.S. Virgin Islands. Using satellite imagery and modeling, scientists have traced back this new influx of sargassum to the North Equatorial Recirculation Region (NERR) not the historical Sargasso Sea which is just northeast of the Bermuda Triangle (Figure 2.0). This novel sargassum source has been termed the Great Atlantic Sargassum Belt or GASB and is most likely seeded by the Sargasso Sea but fueled by localized resources (Wang et al., 2019). Rising sea surface temperatures driven by global climate change combined with increased nutrient runoff driven by upland uses such as agriculture are providing optimal growing conditions for the GASB. The GASB continues to grow from these resources as it moves nearshore, eventually reaching Caribbean bays and beaches in massive quantities (Figure 2.0). In the U.S. Virgin Islands, large sargassum landings typically begin in April and continue through September, resulting in damages to a variety of local sectors.

Sargassum impacts on USVI fisheries

Sargassum in the water can limit boat access to fish landing sites and may disrupt the boat's cooling system and cause significant engine damage if caught in a motor. Maneuverability can also become difficult as it may cause loss of steerage and speed due to soiled propellers and rudders. Sargassum can damage gear and inhibit trolling and nets, directly impacting fishers who rely on these practices. Finally, sargassum creates anoxic conditions (low oxygen) in shallow bays as it decomposes which may result in large fish kills and significantly decrease bait fish populations.

Sargassum impacts on USVI tourism

There has been increasing concern with the abundance of sargassum on beaches and how it impacts USVI tourism. With a displeasing smell and unsightly appearance, large influxes of sargassum are unpleasant to be around. Sargassum can also be a hazard in the water, restricting swimming and snorkeling zones. The cost of removal is also a factor as it can become expensive to clean up and if heavy machinery is used and it can alter/jeopardize the beach ecosystem. However, choosing to ignore the issue of the sargassum accumulating on the beach can lead to a loss in revenue due to lower bookings and poor reviews.

Sargassum impacts on the USVI environment

In its natural state, sargassum can be an important ecosystem for many organisms. However, massive sargassum inundations may have adverse effects on the environment. Decaying sargassum consumes significant oxygen, creating anoxic conditions in shallow waters. These conditions are toxic to many marine organisms including fish and turtles. Anoxic conditions paired with physical blocking of sunlight by sargassum can cause seagrass, coral reefs, and mangrove roots to suffocate. This may lead to erosion and alteration of the structure of these coastal zones. Further, some organisms may become disoriented and trapped in the sargassum when trying to navigate through dense mats. Once on the shore, the decaying sargassum may contain high levels of heavy metals which can seep into the sand and soil.

Sargassum impacts on human health

Decaying sargassum releases hydrogen sulfide, which even low concentrations can have adverse effects on human health. The negative effects include headaches, dizziness, irritation of the eyes, and even irritation of the respiratory system. The fumes especially impact people with existing respiratory problems, such as asthma.

Permitting

DPNR is authorized to issue permits on a case-by-case basis for the removal and management of nuisance sargassum in the Territory. Permits are required given that sargassum is recognized as an indigenous species to the U.S. Virgin Islands (Endangered and Indigenous Species Act of 1990, 12 V.I.C. § 101) as well as essential fish habitat by the National Oceanic and Atmospheric Administration (NOAA) (South Atlantic Sargassum Fishery Management Plan). Further, large-scale removal practices can be very damaging to the coastal zone. Removal of sargassum is only permitted onshore once the seaweed has reached land. In-water collection and removal of sargassum is prohibited at this time. Those seeking a sargassum removal permit must present their scope of work to the Division of Coastal Zone Management (CZM) who, in consultation with DFW, will determine if the proposal is consistent with the VI Coastal Zone Management Act (12 V.I.C. § 21). Additional conditions may be required before permit authorization, including signed proof of review of this management brief and associated training.

Note: Manual removal of sargassum by hand or by hand raking does not require permitting at present. Workers should be aware, however, of protected species and/or species of concern that may be residing in the sargassum, as well as human health risks when handling the seaweed. For additional information on listed species and health hazards, continue to *Sargassum Removal Best Practices*.

Sargassum Removal Best Practices

To Remove or Not to Remove

The most ideal action when it comes to sargassum is no action at all. By letting nature run its course the sargassum will eventually degrade and get washed away or buried by the continued wave action and sand deposition. In the process, it will also serve to stabilize the beach and cycle nutrients back into the environment. However, this option may only be feasible for small quantities of sargassum or hard-to-access beaches that are not critical for public use or recreation. While small quantities are best left alone, larger inundations may benefit from low-impact manual removal or in extreme cases, from large-scale mechanical removal. It is imperative to prioritize beaches based on the need for sargassum removal. Often it is not necessary or desirable to remove sargassum from the

entirety of a beach and instead only clean up the worst of it, leaving small amounts in their natural state. See below for a visualization of beaches in need and not in need of sargassum removal (Figure 3.0)

Threatened and Endangered Species

Before any removal of sargassum onshore, the area must be surveyed for signs of wildlife. Native species are locally protected under 12 VIC Chapter 2: Endangered and Indigenous Species Act of 1990, and listed species under the Endangered Species Act are Federally protected. Endangered sea turtle nests and hatchlings are of particular concern in sargassum mats both in the water and onshore. Surveyors should look for signs of nests, such as swept sand mounds, eggs, and female turtles that may be laying (Figure 4.0). Additionally, native and protected shorebirds might be found foraging in the sargassum. Although unlikely to directly nest in sargassum, surveyors must be wary of bird nests, eggs, hatchlings, and even trapped or injured animals (Figure 4.0). If during the initial wildlife survey any signs of listed species or injured species are observed, mark the area if possible and contact the Division of Fish and Wildlife immediately. Touching or handling of any protected species, their young, or their eggs is prohibited and subject to penalty.

Worker Safety

Workers performing low-impact manual removal are advised to wear closed-toed shoes, gloves, and sun protection when removing and handling sargassum. Eye protection and face masks are also advised to mitigate the smell of hydrogen sulfide if present. Note: Strong hydrogen sulfide fumes are toxic to humans and may irritate eyes, noses, and throats. If the smell is strong and/or has negative impacts on human health, it is best to cease removal operations as a safety precaution and proceed with clean-up when the smell has subsided.

Manual Removal

Manual removal is always preferred as it substantially lessens beach erosion and disturbance to wildlife. Manual removal can be conducted in many forms onshore. Gathering sargassum by hand or rake is best for small amounts while larger amounts may be removed by multi-person operated entrapments. Wheelbarrows are also convenient for transporting sargassum from the beach to a larger collection container. **Manual removal does NOT require a DPNR-issued permit however use of a utility task vehicle (UTV) on the beach to assist in manual removal does require a permit.**

Mechanical Removal

If the amount of sargassum is overwhelming, mechanical removal by machine or assisted removal by a UTV may be used after the appropriate DPNR permit is obtained. Machines with claws or rakes are best and tires must be large and soft to minimize the impact (Figure Equipment is best operated on compacted sand in the tidal zone. Machine use should always be supervised with continued surveying for wildlife. Machinery should never go over sand dunes or vegetation.

Containment Booms

Offshore or nearshore containment booms may be a feasible option for holding off small amounts of sargassum from reaching the shore or for channeling sargassum to a designated shoreline area for collection and removal (Figure 6.0). However, any permanent boom installations involving

alterations to the ocean floor will require additional permitting through the Army Corps of Engineers (Rivers and Harbors Act of 1899, 33 U.S.C. § 403; Clean Water Act, 33 U.S.C. § 404).

Disposal

Disposal of sargassum should never be on sand dunes or vegetation. Sargassum should be disposed of in designated and permitted locations if on-site, or in the Bovoni Landfill on St. Thomas or the Anguilla Landfill of St. Croix. If disposing of sargassum near the collection site, consider an area that receives high levels of sunlight for quick-drying and expedited decomposition which in turn decreases the smell. Note: Sargassum disposal at public landfills may be limited to certain days, it is your responsibility to understand which days sargassum will be accepted at your local landfill.

In-water Manipulation

Intercepting and re-directing offshore or nearshore sargassum may be the best way to deal with the sargassum issue. Two main methods exist. First, slowly trawling smaller mats of living sargassum out of inundated areas back to the open ocean where currents pass and can pick up the seaweed. This may be effective in multiple places and can be accomplished by boat and small net, so no benthic alteration is needed and therefore no permit is required from Army Corps of Engineers. A second and still experimental option is pumping of sargassum from the surface and shallow waters to deep waters. The increased pressure of deep water bursts the air pockets of the seaweed, allowing it to sink permanently. However, additional considerations for this option are needed for 1) identifying a viable place for the sargassum to sink that does not impact benthic habitats and 2) minimizing environmental impacts associated with operating an in-water pump.

Helpful Tips for Removing Sargassum

- Remove sargassum at low tide for easy access
- Removing fresh sargassum onshore prevents rotting and beach erosion
- Always leave some sargassum for beach nourishment
- Remove sargassum from high-use areas first and reassess the need for removal in other areas
- Rake sargassum into small piles to sun dry and remove later. This decreases the weight and smell of the seaweed while allowing for sand to remain on the beach.

Conclusion

While sargassum is no stranger to the shores of the U.S. Virgin Islands, massive inundations observed in the last decade have had negative impacts on the local community, the local environment, and local industries. The sargassum solution is not an easy one and removal practices that are successful at one location may not be successful in another. The Division of Fish and Wildlife encourages all those seeking best management practices for the collection and removal of nuisance sargassum to consult this document and associated agencies before acting. Remember, direct or assisted removal of sargassum by mechanized equipment requires a CZM permit and may require additional conditions to be met for permit approval. Finally, it is important to note that this is a living document and is subject to change due to the nature of the sargassum issue. In considering the ecological value, social implications, and economic impacts of sargassum in the Territory, stakeholders involved in management efforts must be adaptable. The Division of Fish and Wildlife thanks you for your cooperation in reviewing this document and adhering to its recommendations.

Additional Resources

Report on the development of a best practice guide for Caribbean fishers coping with sargassum influx events - BestPracticeGuideforCaribbeanFishersSargassum.pdf (FAO - Food and Agriculture Organization of the United Nations)

Sargassum Management Brief - CERMESSargassumManagementBrief2016.pdf (CERMES - Centre for Resource Management and Environmental Management, University of the West Indies)

Sargassum: A Resource Guide for the Caribbean - SargassumResourceGuideFinal.pdf (CAST - Caribbean Alliance for Sustainable Tourism)

Sargassum Uses Guide: A resource for the Caribbean researchers, entrepreneurs, and policy makers - SargassumResourceGuideFinal.pdf (CERMES – Centre for Resource Management and Environmental Management, University of the West Indies)

Pelagic Sargassum Influx in the Wider Caribbean Fact Sheet - GCFISargassumFactsheet2015En.pdf (GCFI – Gulf and Caribbean Fisheries Institute, Inc.)

Responding to Sargassum Influx Poster - SargassumResponsePoster.png (GCFI – Gulf and Caribbean Fisheries Institute, Inc.).

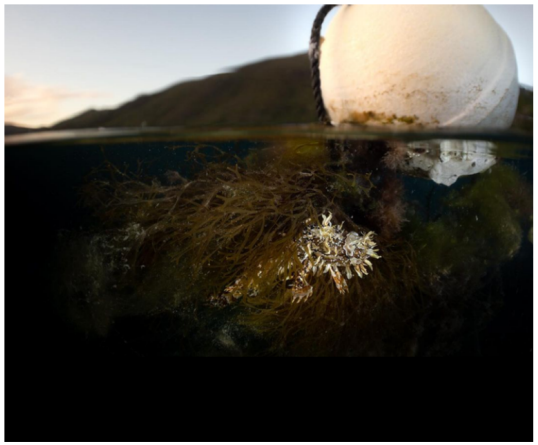


Figure 1.0 A sargassum fish in Brewer's Bay, St. Thomas. Dan Mele Photography 2021.

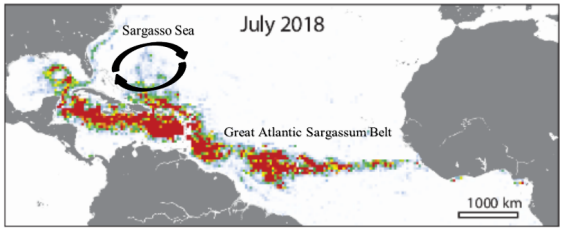
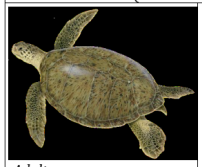


Figure 2.0 The Great Atlantic Sargassum Belt as compared to the historic Sargasso Sea. July 2018. Florida Atlantic University Harbor Branch Oceanographic Institute.

 Coki Beach, St. Thomas	 Lindquist Beach, St. Thomas	 Sapphire Beach, St. Thomas
Small inundation that is mostly dry at Coki Point Beach. No management action needed. If additional influx became problematic for beach side businesses, small manual removal is recommended.	Small to medium inundation of dry and fresh sargassum at Lindquist beach. Manual removal or UTV assisted removal in the more frequented beach and swim areas recommended. Medium-large quantities in relatively unused areas may be left alone.	Large inundation of fresh and rotting sargassum at Sapphire Beach. Large scale mechanized removal with machinery outfitted with claws recommended. May benefit from strategic booming to navigate the seaweed into a designated collection area.

Figure 3.0 Various levels of sargassum inundations around St. Thomas, Virgin Islands and appropriate removal recommendations.

Hawksbill Sea Turtle (*Eretmochelys imbricata*)		
 *Adult*		**ADULTS** Length 75-90 cm; Mass up to 150 kg **HATCHLINGS** Length ~30 mm; Mass approximately 5 gm

	Juvenile	
Green Sea Turtle (*Chelonia mydas*)		
 *Adult*	 *Juvenile*	**ADULTS** Length 80-120 cm; Mass up to 300 kg **HATCHLINGS** Length 30-40 mm; Mass 25-30 gm
Leatherback Sea Turtle (*Dermochelys coriacea*)		
 *Adult*	 *Juvenile*	**ADULTS** Length 140-180+ cm; Mass up to 300-640 kg **HATCHLINGS** Length ~50 mm; Mass 40-50 gm
Signs of Sea Turtles		
 *Sea turtle tracks*	 *Hatchlings in sargassum*	 *Sea turtle in sargassum*
 *Sea turtle nest*	 *Hatched sea turtle eggs*	 *Trapped sea turtle*
Roseate Tern *(Sterna dougallii dougallii)*		

<table>
<tr><td> 
Adult</td><td> 
Juvenile</td><td>ADULTS
Length 33-36 cm; Mass 90-140 gm
*slightly smaller than a Mourning Dove</td></tr>
<tr><td colspan="3">Signs of Terns</td></tr>
<tr><td> 
Roseate nesting on 2 eggs</td><td> 
Group of terns</td><td> 
Terns and gulls in sargassum</td></tr>
</table>

Figure 4.0 *Endangered Species in Sargassum*

Figure 5.0 Mechanical rake at the Ritz-Carlton, St. Thomas.

Figure 6.0 Boom channeling sargassum influx to the left side of the bay for mechanical collection at the Ritz-Carlton, St. Thomas.

Two black-necked stilts in the sargassum at the Ritz-Carlton

Appendix L. Sargassum Community Survey Questionnaire

[Note: Questions with an asterisk required an answer to proceed with the survey.]

1. On which island in the USVI do you live? (If you live on a boat, choose the island off of which your boat is moored.)*

   Hassel Island Lovango Cay St. Croix St. John
   St. Thomas Water Island Other (specify): _____

2. What is sargassum (sargasso)?

3. Where does sargassum that arrives in the USVI come from?

4. Do other islands in the Caribbean have sargassum like we do in the USVI?*

   Yes No Not Sure/I Don't Know

5. Do you believe that sargassum has any benefits?*

   Yes No Not Sure/I Don't Know

[If someone chooses "No" or "Not Sure/I Don't Know" then the respondent skipped to question 7.]

6. If yes, what benefits does sargassum have?

7. Have you ever been impacted by sargassum?*

   Yes No Not Sure/I Don't Know

[If someone chooses "No" or "Not Sure/I Don't Know" then the respondent skipped to question 9.]

8. If yes, what did sargassum impact (choose all that apply):

   Your business / industry / job Your property (land) / home / HOA
   Your boat Your recreational activities
   Other (specify): _____

9. Do you believe that exposure to sargassum, in water or on land, has ever affected your health?*

   Yes No Not Sure/I Don't Know

[If someone chooses "No" or "Not Sure/I Don't Know" then the respondent skipped to question 11.]

10. If yes, did you experience (choose all that apply):

    Breathing problems Headache
    Itchiness and/or rash Red or stinging eyes

Other (please specify): _____

11. Which areas and/or beaches on your island in the USVI receive the most sargassum?*

12. Do you believe that something is being done to manage, prevent, or monetize the sargassum that arrives in the USVI?*

    Yes No Not Sure/I Don't Know

[If someone chooses "No" or "Not Sure/I Don't Know" then the respondent skipped to question 14.]

13. If yes, what is being done to manage, prevent, or monetize sargassum locally?

14. Do you think that a territory-wide committee on sargassum should be created?*

    Yes No Not Sure/I Don't Know

[If someone chooses "No" or "Not Sure/I Don't Know" then the respondent skipped to question 16.]

15. If yes, which agencies, businesses, groups, and/or individuals would you recommend be on the committee?

16. Do you have any final thoughts, recommendations, or notes that you would like to add related to sargassum in the USVI?

17. Would you like to be contacted if we conduct future interviews with community members on the impacts of sargassum in the territory?*

    Yes No

[If someone chooses "No" then the survey is ended.]

18. Please let us know your name and where we can contact you.*

    Name Company Email Address Phone Number

Appendix M. List of Sargassum Stakeholders Interviewed

Representatives from the following sectors were interviewed:

Government, Federal
- NOAA Fisheries, Coral Reef Conservation Program Fisheries
- NOAA Fisheries, Habitat Conservation Division
- NOAA Fisheries, Marine Debris Program
- USACOE
- USFWS, Caribbean Ecological Services Field Office

Government, Territorial
- DPNR-CZM
- DPNR-DFW
- VIPA
- VIWAPA

Academia and Education
- Ivanna Eudora Kean High School, St. Thomas
- UVI, St. Croix and St. Thomas
- VI-EPSCoR, St. Croix

Civil Society
- Coral Bay Community Council, St. John
- Save Coral Bay, Inc., St. John
- Smith Bay Park, Magen's Bay Authority, St. Thomas
- St. Croix Environmental Association
- St. Thomas Yacht Club, St. Thomas
- The Nature Conservancy, St. Croix
- U.S. Virgin Islands Conservation Society

Hotels, Villa, and Marina Operators
- American Yacht Harbor, Island Global Yachting LLC (IGY) Marinas, St. Thomas
- Antilles Resort, St. Croix
- Bolongo Bay Resort, St. Thomas
- Divi Carina Bay Resort and Casino, St. Croix
- King Christian Hotel, St. Croix
- Prestige Property Management LLC, St. Thomas
- Ritz-Carlton Club, St. Thomas
- Sapphire Beach Resort and Marina, St. Thomas
- Seashore Allure Boutique Hotel, St. John
- U.S. Virgin Islands Hotel and Tourism Association

Commercial and Recreational Fisherfolk
- Double Header Sportfishing, St. Thomas
- Feel Good II, St. Thomas
- Mixed Bag, St. Thomas

- See & Ski Powerboat Rentals, St. Thomas
- St. Thomas/St. John Fisheries Advisory Committee
- U.S. Virgin Islands Game Fishing Club

Homeowners and Homeowners' Associations
- Anchorage Condominiums, St. Thomas
- Colony Cove, St. Croix
- Cowpet Bay East, St. Thomas
- Mill Harbor Condominiums, St. Croix
- Regatta Point Villas, St. Thomas
- Sapphire Beach Resort and Marina, St. Thomas
- Sugar Beach Resort Hotel, St. Croix

Inter-Island Transportation Operators
- Big Red Barge, St. John-St. Thomas
- Seaborne Airlines, St. Croix-St. Thomas
- Water Island Ferries, Water Island-St. Thomas

Tour Operators
- Caribbean Sea Adventures, St. Croix
- Coki Dive Center, St. Thomas
- Coral World Ocean Park, St. Thomas
- Take It Easy Charters, St. Thomas

Other Private Sector Businesses
- Beachy Clean, St. Thomas
- Boschulte Landscaping LLC, St. Thomas
- Playland Marine LLC, St. Thomas
- Seven Seas Water, St. Croix
- SSVI Expert LLC, St. Thomas
- St. Croix Renaissance Park, St. Croix

Appendix N. Photos of Sargassum Impacts Throughout the Territory

A coral thicket in eastern Coral Bay, St. John in 2014 (left) and one year later in 2015 (right). In less than a year, the primarily staghorn coral thicket had been smothered by mats of sargassum.
[Photo: Coral Bay Community Council]

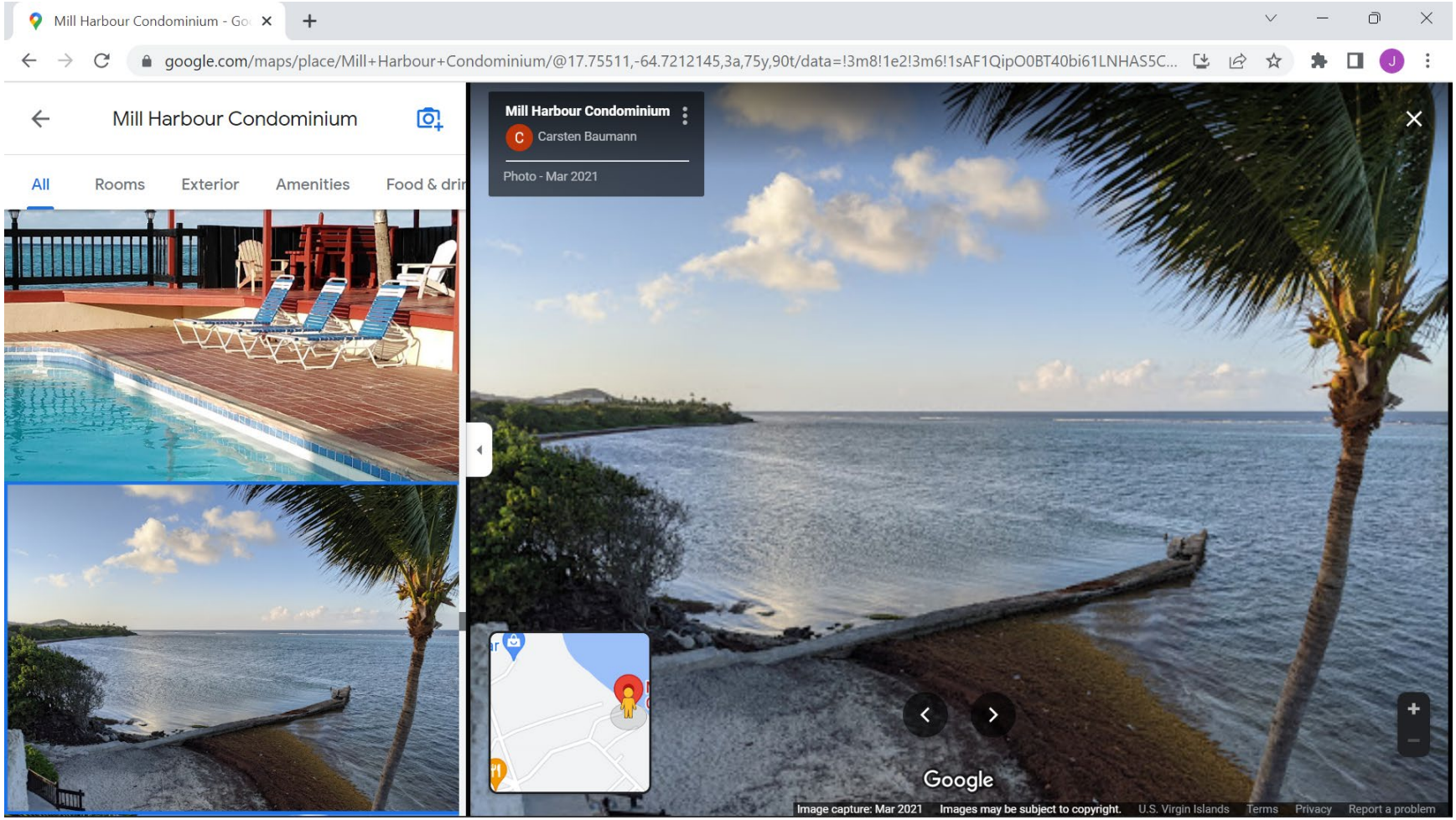
A hawksbill hatchling in sargassum mat, Coral Bay, St. John, October 2015.
[Photo: Coral Bay Community Council]

A kit surfer attempts to wade out beyond the sargassum at the Ritz-Carlton Club in Great Bay, St. Thomas, June 2021. [Photo: J. Nielsen-Bobbit/Bioimpact, Inc.]

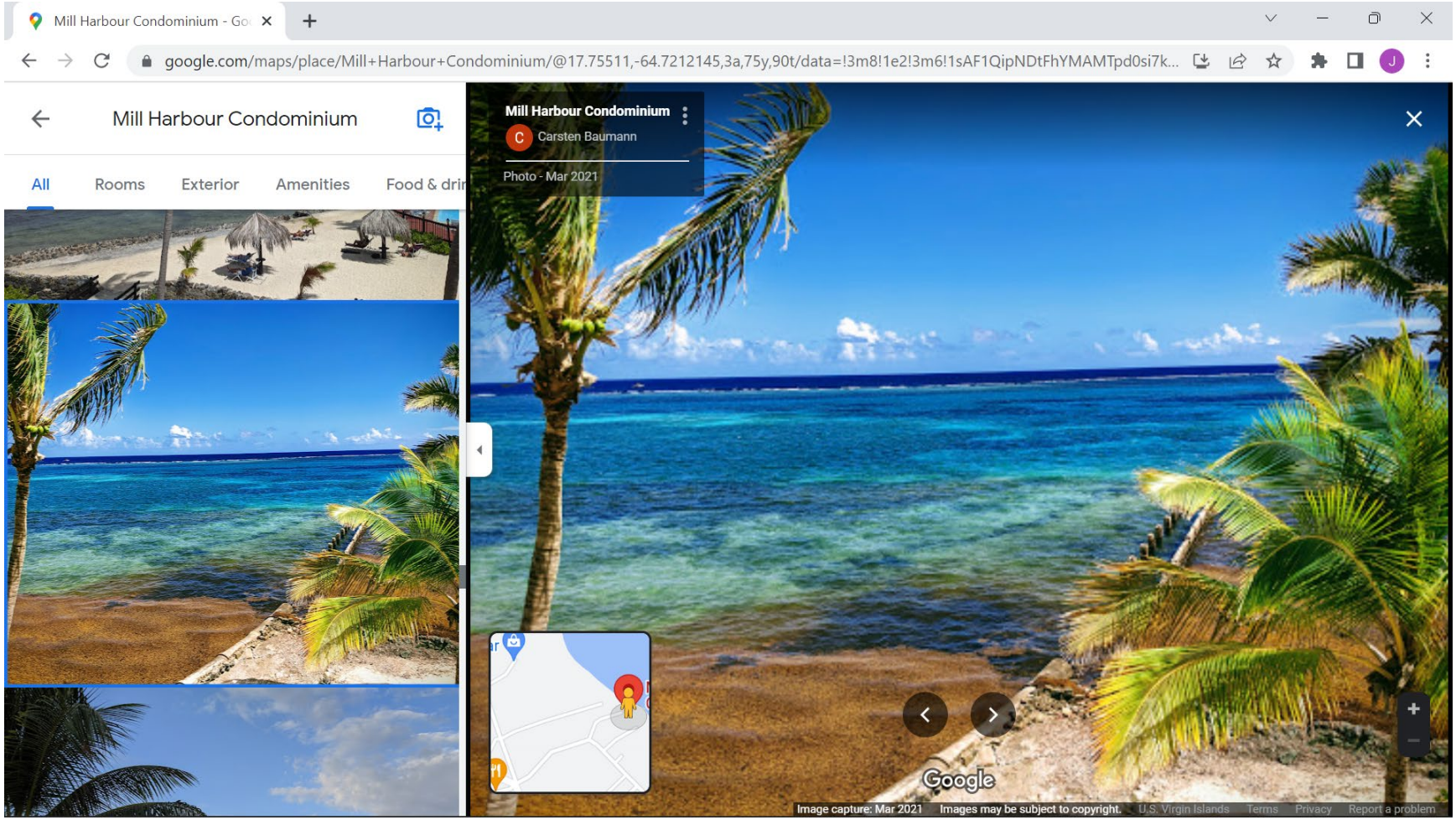
Sargassum along the northern side of Great Bay towards Cabrita Point, St. Thomas, June 2021
[Photo: J. Nielsen-Bobbit/Bioimpact, Inc.]

Fisherfolk clean fish in sargassum-filled Gallows Bay, St. Croix, January 2021
[Photo: J. Nielsen-Bobbit]

An image of a green sea turtle among sunken sargassum at Jumbie Beach, St. John posted on Facebook in 2021.

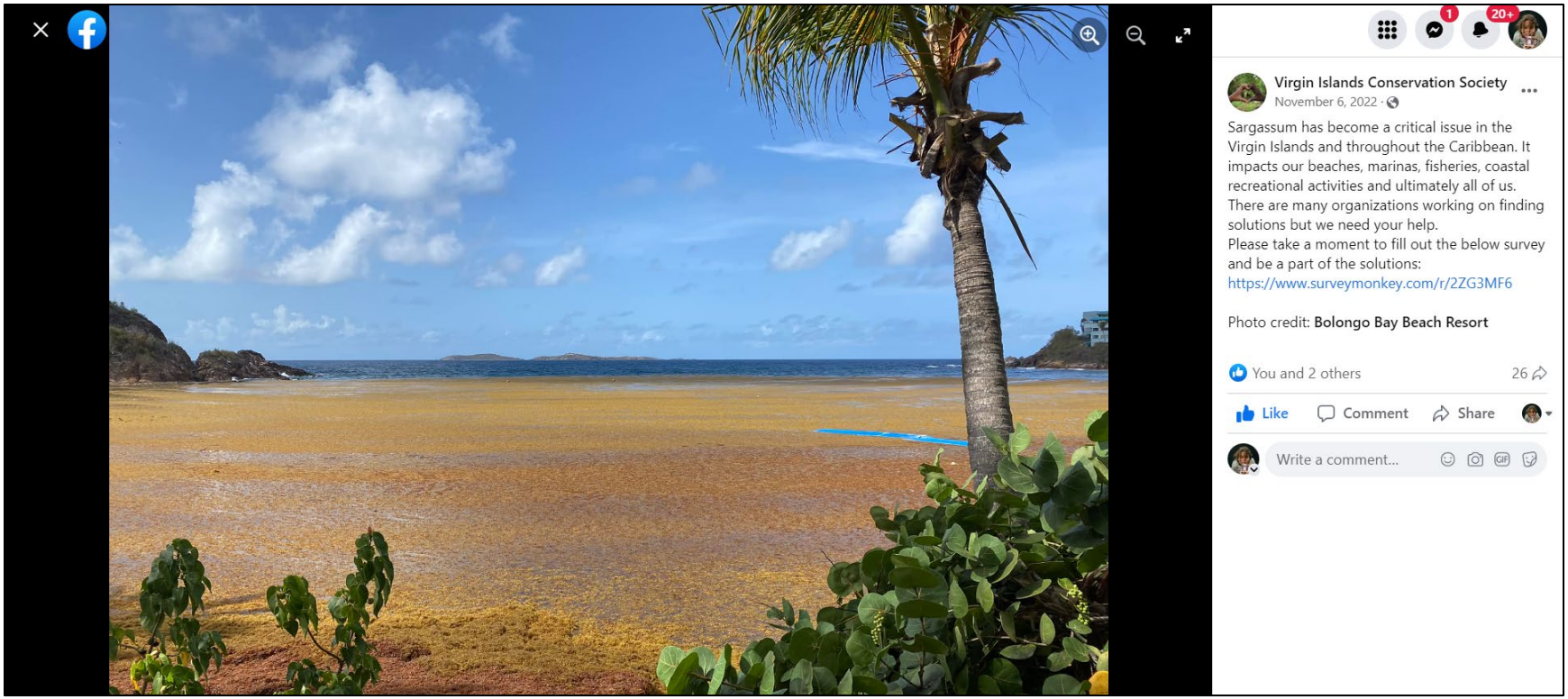


A screenshot of an image posted on Google in March 2021 of sargassum at Mill Harbour Condominiums on St. Croix.



Another screenshot of an image posted on Google in March 2021 of sargassum at Mill Harbour Condominiums on St. Croix.

Sargassum at Divi Carina Bay Resort & Casino, Turner Hole, St. Croix, August 2021.
[Photo: J. Nielsen-Bobbit/Bioimpact, Inc.]



An image of Bolongo Bay on St. Thomas posted on Facebook by the Virgin Islands Conservation Society.

An image of sargassum in the USVI posted on Facebook by the VI Source, June 2018.

News Local news

Sargassum: The Good, the Bad and the Smelly

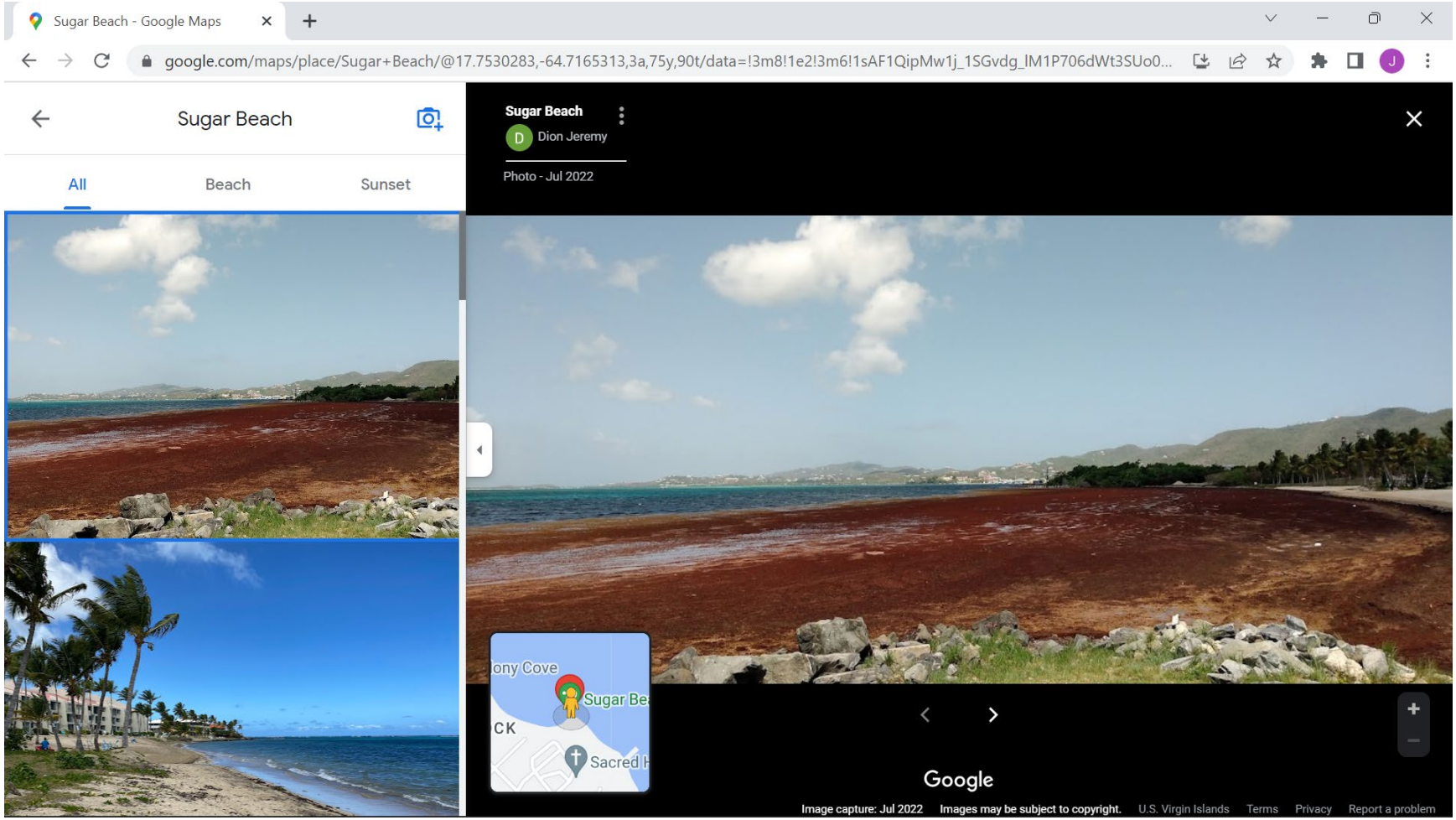
Gerard Sperry June 23, 2018

Sargassum is breaking down near Coki Point, seen above, and Margaritaville, and creating a serious smell. (Photo by Alain M. Brin, Blue Glass Photography)

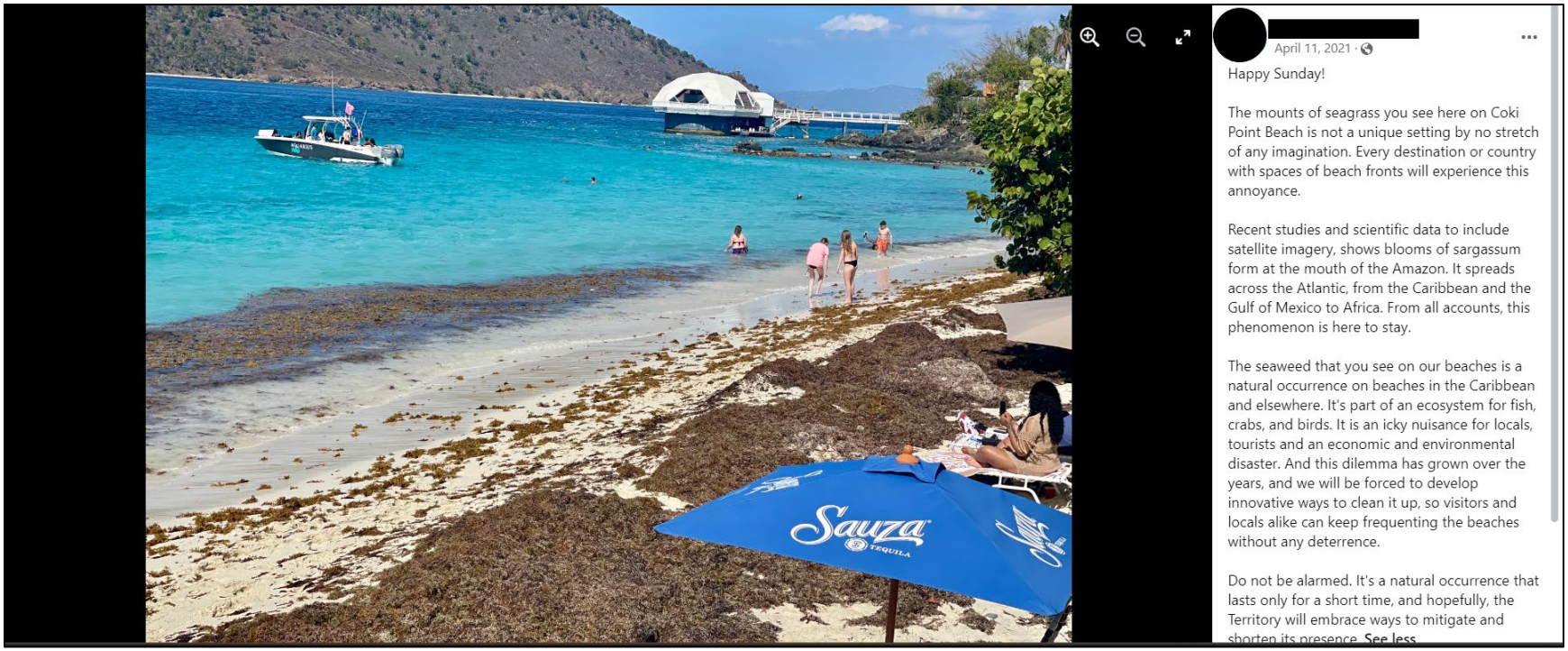
Degraded water quality as a result of sargassum in Water Bay, St. Thomas, published online in the St. Thomas Source, June 2018. [Source: https://stthomassource.com/content/2018/06/23/sargassum-the-good-the-bad-and-the-smelly]

Sargassum stuck within the vessel slips at Sapphire Bay Marina on St. Thomas, August 2022.
[Photo: J. Nielsen-Bobbit/Bioimpact, Inc.]

Sargassum along the shore by the pool at Sapphire Beach Resort on St. Thomas, August 2021.
[Photo: J. Nielsen-Bobbit/Bioimpact, Inc.]



A screenshot of an image posted on Google in July 2022 of sargassum at Sugar Beach Condominiums on St. Croix.



An image of Coki Beach on St. Thomas posted on Facebook, April 2021.

Sargassum in Crown Bay Marina, St. Thomas, November 2022.
[Photo: J. Nielsen-Bobbit/Bioimpact, Inc.]

Appendix O. Proposed Standardization of Terms of Research on Pelagic *Sargassum* Species

[Source: SargNet sargassum listserv, June 2022]

Proposal for standardization of terms of research on pelagic *Sargassum* species

If scientific names are properly used they should be:

Sargassum spp. –referring to more than one species of the genus *Sargassum (C. Agardh)*

Sargassum fluitans III (*S. fluitans* is the species, III indicates the morphotype according to the classification of Parr 1939)

Sargassum natans I

Sargassum natans VIII

Etc.

"The genus *Sargassum* (C. Agardh)" is correct, but using "*Sargassum*" (in italics or underlines with capital letter) without a species epithet, sp. or spp. is not.

To further clarify, "sargassum" can be used as a common name (non-taxonomic descriptor), but then it should not be written in italics or and with capital letter. For example, "Great Atlantic *Sargassum* Belt" is not correct, as sargassum is used a common name (it could be written as Great Atlantic *Sargassum* spp. Belt), we suggest to write as "Great Atlantic Sargassum Belt". Sargassum (common name indicating more than one species, can be used either as singular or plural; for example, "kelp" is singular, and it is used as a common name for various species of brown algae.

Other terms:

Pelagic sargassum – common name (lower case, not italics) referring to the mix of floating sargassum species/morphotypes

Sargasso – same as above

Influx – arrival of sargassum into a broad area (e.g. the Caribbean Sea, the Mexican EEZ, etc.)

(Sargassum/Sargasso) raft – agglomeration of pelagic *Sargassum* spp. (pelagic sargassum or sargasso) on the ocean surface

Other descriptors of the pelagic agglomerations are: windrows, aggregations, pelagic mats, pelagic masses

Inundation – the arrival of large amounts of pelagic sargassum overwhelming shorelines and bays where it beaches or is trapped

Beaching – when stranding on beach (can be any quantity)

Wrack – seaweed or seagrass distributed along the shoreline (can be any quantity)

Sargassum (Sargasso) Brown tide – the plume of brown, poor water quality that occurs when sargassum is left in the nearshore and starts to degrade

Sargassum (Sargasso) Golden tide – fresh healthy mats of sargassum floating out at sea

Sargassum bloom – refers to the expansion of the sargassum population

Avoid:

Invasion – a term to be avoided since it does not really fit the definitions of an invasive species and is certainly native to the North Atlantic

Brown/Golden Tide without specifying it concerns Sargassum (Sargasso); e.g. Sargassum Brown Tide. Blooms of other (micro) algae have already been named Golden or Brown tides.

Appendix P. Proposed Structure of a USVI Sargassum Working Group

Local Sargassum Working Group

The purpose of the working group would be to finalize and implement the sargassum management plan of the USVI. This would include keeping abreast of the current sargassum activities and their impacts in the territory, exploring funding ideas and new management techniques, inter-agency information sharing, and public outreach so that the community is aware of sargassum's impacts on the environment and community health. The working group should also help ensure that the public is aware of sargassum policies and permitting requirements and identify and evaluate new opportunities for sargassum valorization.

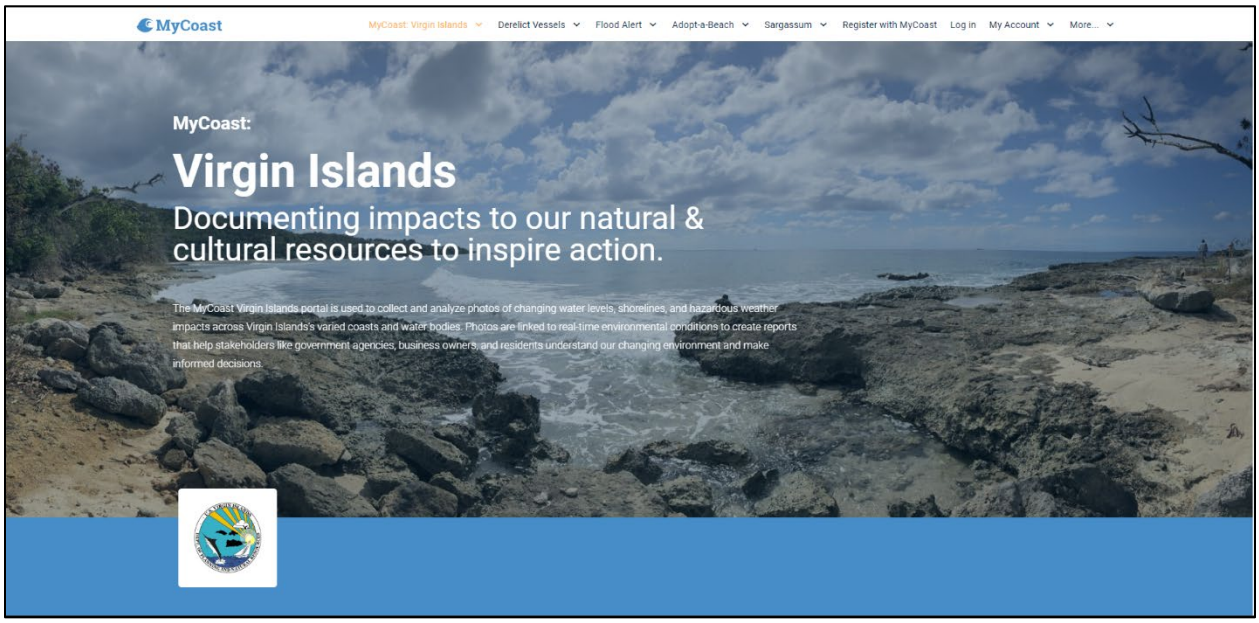
The working group should not be so big that nothing can be accomplished. Priorities will need to be set at the beginning and details like quora determined. The group should be chaired by an agency within DPNR, either CZM or DFW, and should, at minimum, include at least one representative from each of the following:

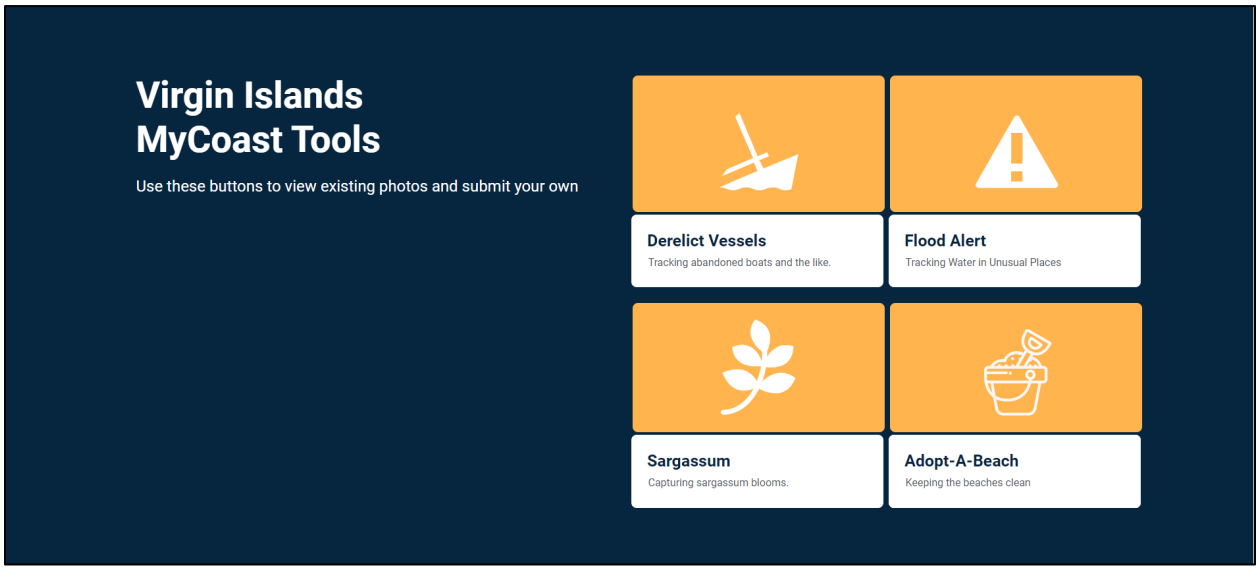
- DPNR-CZM
- DPNR-DFW
- VI Department of Public Works
- VIWMA
- VIWAPA
- Sea Turtle Animal Rescue (STAR)
- USVI Department of Tourism
- VI Department of Health
- UVI
- VI-EPSCoR
- Caribbean Fisheries Management Council (CFMC)
- St. Croix Environmental Association (SEA)
- The Environmental Association of St. Thomas
- TNC
- East End Marine Park
- Environmental Consultants
- Coral Bay Community Council (CBCC)
- Coral World Ocean Park
- HTA
- VI Game Fishing Club
- Fisherfolk
- VI Professional Charter Association (VIPCA)
- Other Tour Operators – e.g., dive shops, ferry operators
- Marina Operators – e.g., American Yacht Harbor, Green Cay Marina
- Coastal HOAs – e.g., Mill Harbour Condominiums, Colony Cove, Anchorage Condominiums
- Other private sectors – e.g., waste haulers, beach landscapers

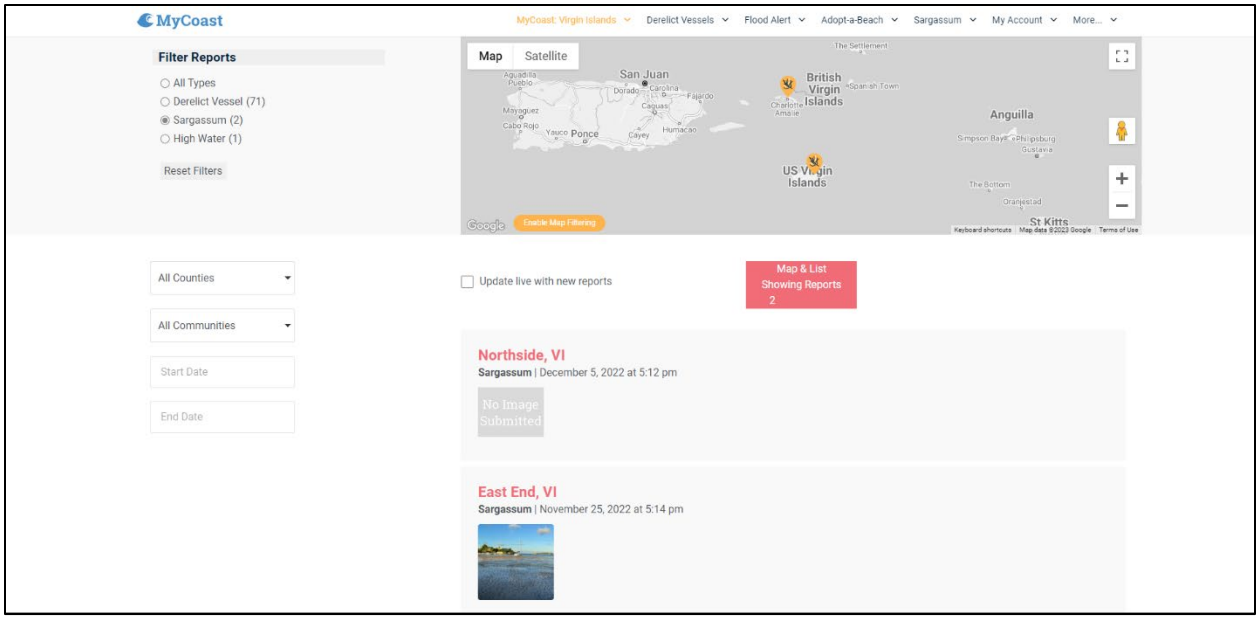
A core group of stakeholders could be selected to meet regularly – e.g., monthly, while the larger group of stakeholders meets less frequently – e.g., quarterly. Subgroups could also be created to better tackle, and achieve, priorities. For example, a coastal HOA or tour operator subgroup.

Additional government agencies to consider inviting to the task force include the U.S. Coast Guard, the U.S. Virgin Islands Territorial Emergency Management Agency (VITEMA), the VI Port Authority, the Governor and/or Lieutenant Governor's Office, the Department of Education, the VI Department of Agriculture, and any interested members of the VI Legislature. Other groups to consider include local yacht clubs, media groups, industrial ports – e.g., Limetree Bay and St. Croix Renaissance Park, and Ivanna Eudora Kean High School.

Appendix Q. MyCoast Virgin Islands, Citizen Science Reporting Portal
[Source: https://mycoast.org/vi, accessed 3/21/2023]






MyCoast
MyCoast: Virgin Islands
Derelict Vessels
Flood Alert
Adopt-a-Beach
Sargassum
My Account
More...
Filter Reports
All Types
Derelict Vessel (71)
Sargassum (2)
High Water (1)
Reset Filters
Map
Satellite
San Juan
British Virgin Islands
US Virgin Islands
Anguilla
Ponce
Enable Map Filtering
All Counties
All Communities
Start Date
End Date
Update live with new reports
Map & List Showing Reports 2
Northside, VI
Sargassum | December 5, 2022 at 5:12 pm
No Image Submitted
East End, VI
Sargassum | November 25, 2022 at 5:14 pm