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Removing Carbon Dioxide Through Seaweed Cultivation: Legal Challenges and Opportunities

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By Korey Silverman-Roati, Romany M. Webb, and Michael B. Gerrard
September 2021



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The cover photo depicts a seaweed farm near Saemangeum, Gunsan-si, South Korea



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EXECUTIVE SUMMARY

Scientists increasingly agree that carbon dioxide removal will be needed, alongside deep emissions cuts, to stave off the worst impacts of climate change. A wide variety of technologies and strategies have been proposed to remove carbon dioxide from the atmosphere. To date, most research has focused on terrestrial-based approaches, but they often have large land requirements, and may present other risks and challenges. As such, there is growing interest in using the oceans, which have already absorbed more than a quarter of anthropogenic carbon dioxide emissions, and could become an even larger carbon sink in the future.

This paper explores the ocean-based carbon dioxide removal strategy of seaweed cultivation. Seaweed cultivation involves the growing of kelp and other macroalgae to store carbon in biomass, which can then either be used to replace more greenhouse gas-intensive products or sequestered by sinking the seaweed. Seaweed is typically grown in coastal waters near shore, but research is investigating the possibility of cultivation further offshore, including on the high seas, and sequestration in the deep sea.

This paper examines the international and U.S. legal frameworks that apply to seaweed cultivation. Subsequent work will examine the relevant laws of selected other coastal countries.

Depending on where they occur, seaweed cultivation projects may be subject to international, national, state, and/or local jurisdiction. Under international law, countries typically have jurisdiction over activities within 200 nautical miles of their coastline. In the U.S., coastal states typically have primary authority over areas within three nautical miles of the coast, and the federal government controls U.S. waters further offshore.

Several U.S. states have adopted laws specifically regulating seaweed cultivation. While there are currently no international or U.S. federal laws dealing with seaweed cultivation, various general environmental and other laws may apply to projects. At the international and regional level, these include the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, and the Protocol to that Convention, the Convention on Biological Diversity, the United Nation Convention on the Law of the Sea, and the European Union Marine Strategy Framework Directive.

Potentially applicable U.S. federal laws include the Outer Continental Shelf Lands Act, the National Environmental Policy Act, the Endangered Species Act, the Coastal Zone Management Act, the Marine Protection, Research, and Sanctuaries Act, and the Clean Water Act. Projects may also be subject to state permitting laws and state and federal requirements to consult with Native American tribes and other stakeholders. The application of these laws will depend on, among other factors, the offshore location of the project, the materials and technology used, and whether the project makes use of the sea floor. None of these laws expressly prohibit seaweed cultivation in U.S. waters, but many impose permitting, environmental review, and other requirements that projects would have to meet. A full list of the requirements is included in Appendix A to this paper.

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1. INTRODUCTION

In the 2015 Paris Agreement, the international community set a goal of limiting global warming to “well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C.”¹ Achieving these goals will require a significant reduction in greenhouse gas emissions, to “net zero” around mid-century,² which will in turn require unprecedented systemic change across all economic sectors.³ Greenhouse gas removal will likely also be needed to offset residual emissions from difficult-to-abate sources and compensate for past excesses.⁴ All of the Intergovernmental Panel on Climate Change’s emissions pathways consistent with holding warming to 1.5°C,⁵ and most of those consistent with 2°C,⁶ assume deployment of greenhouse gas removal.

Because carbon dioxide and other greenhouse gases are relatively well-mixed in the atmosphere, greenhouse gas removal may occur anywhere it is effective. Past research has focused mainly on land-based approaches.⁷ Although research into their feasibility is ongoing, many land-based approaches require large amounts of land and other resources, which could lead to land-use conflicts and thus limit their deployment.⁸ This has led to growing interest in ocean-based greenhouse gas removal.

The oceans already act as significant carbon sink, removing approximately ten gigatons of carbon dioxide from the atmosphere every year.⁹ This paper discusses one strategy to increase ocean carbon dioxide removal – seaweed cultivation¹⁰– though a number of other strategies are also being considered. Together, if deployed at scale, ocean-based strategies could offer significant carbon removal potential. Due to the large extent of the oceans, and the fact that human activity therein is dispersed, ocean-based strategies could also reduce the possibility for conflicts. However, additional research is needed to fully evaluate the biodiversity impacts of widespread seaweed cultivation and other ocean-based carbon dioxide removal approaches. Ocean-based strategies may also present unique challenges in accurately measuring the amount of carbon dioxide removed and the longevity of its storage.

1 Paris Agreement, Dec. 12, 2015, Art. 2(1)(a).

2 Myles Allen et al., *Summary for Policymakers* in GLOBAL WARMING OF 1.5°C: AN IPCC SPECIAL REPORT (V. MASSON-DELMOTTE ET AL. EDS., 2018); OTTMAR EDENHOFFER ET AL., CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE, CONTRIBUTION OF WORKING GROUP III TO THE FIFTH ASSESSMENT REPORT BY THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2014), <http://perma.cc/T8J5-MBTA>. See also, e.g., UN ENV’T PROGRAM, EMISSIONS GAP REPORT 2020 (2020), <https://perma.cc/6G97-9X68>.

3 Allen et al., *supra* note 2, at 15.

4 UN Env’t Program, *supra* note 2, at 33-34.

5 Allen et al., *supra* note 2, at 17.

6 Edenhoffer et al., *supra* note 2, at 14-15.

7 See generally, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, NEGATIVE EMISSIONS TECHNOLOGIES AND RELIABLE SEQUESTRATION: A RESEARCH AGENDA (2019), <https://www.nap.edu/catalog/25259/negative-emissions-technologies-and-reliable-sequestration-a-research-agenda>.

8 *Id.* at 9-13.

9 Wil Burns & Charles R. Corbett, *Antacids for the Sea? Artificial Ocean Alkalinization and Climate Change*, 3 ONE EARTH 154, 154 (2020).

10 See *infra* Part 2.

This could, in turn, hinder their use in carbon credit schemes.

The U.S. has begun to direct funds towards ocean-based carbon dioxide removal. The U.S. Department of Energy's Advanced Research Project Agency – Energy (“ARPA-E”) is overseeing nearly \$50 million to study macroalgae development as part of the Macroalgae Research Inspiring Novel Energy Resources (“MARINER”) program.¹¹ The Consolidated Appropriations Act of 2021 authorizes the appropriation of a further \$60 million in fiscal year 2021 for the Secretary of Energy to study non-direct air capture carbon removal technologies¹² and directs the Secretary to establish a carbon dioxide removal “research, development, and demonstration program.”¹³ Among the technologies covered by the program is bioenergy with carbon capture and storage (“BECCS”), which could include seaweed cultivation (depending on the ultimate use of the seaweed).¹⁴

The European Union (“EU”) is similarly allocating millions of euros towards research into ocean-based carbon dioxide removal. The EU announced that it would provide over €7 million from 2020-2024 to study the feasibility and impacts of ocean-based carbon removal through a program called OceanNETs.¹⁵ This funding is in addition to over €5 million the EU is providing for a project, known as NEGEM, to explore the extent carbon dioxide removal is needed to achieve climate neutrality, and whether societal impacts could limit deployment.¹⁶

Though research into the technical and economic feasibility of ocean-based carbon dioxide removal is ongoing, legal analysis can serve to complement that work by identifying barriers and opportunities for research and deployment. This paper aims to provide a comprehensive analysis of the international and U.S. laws applicable to seaweed cultivation. Since currently no international or U.S. federal laws govern the use of seaweed cultivation for the purpose of carbon removal, various general environmental and other laws may apply depending on how and where seaweed cultivation projects are conducted. Several of the laws impose permitting, environmental review, and other requirements that projects would have to meet. A full list of the requirements is included in Appendix A to this paper.

The remainder of this paper is structured as follows: Part 2 introduces seaweed cultivation as a carbon dioxide removal technique. Part 3 then discusses key principles of international and U.S. law defining jurisdiction over the oceans. In part 4, we explore several international agreements that could apply to seaweed cultivation, while part 5 discusses applicable U.S. law. Part 6 concludes.

11 ARPA-E, *Macroalgae Research Inspiring Novel Energy Resources*, <https://arpa-e.energy.gov/technologies/programs/mariner>.

12 Consolidated Appropriations Act, 2021, H.R. 133, 116th Cong., §5001, 1087 (2020), <https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf>. (The Act authorizes \$175 million for carbon dioxide removal research, \$115 million of which is allocated to direct air capture prize competitions).

13 *Id.* at 1076-77.

14 *Id.* at 1077. In BECCS systems, combustion and storage would likely be conducted onshore. This paper is limited to the marine activities involved in seaweed cultivation, and does not explore land-based issues that might arise from the deployment of BECCS.

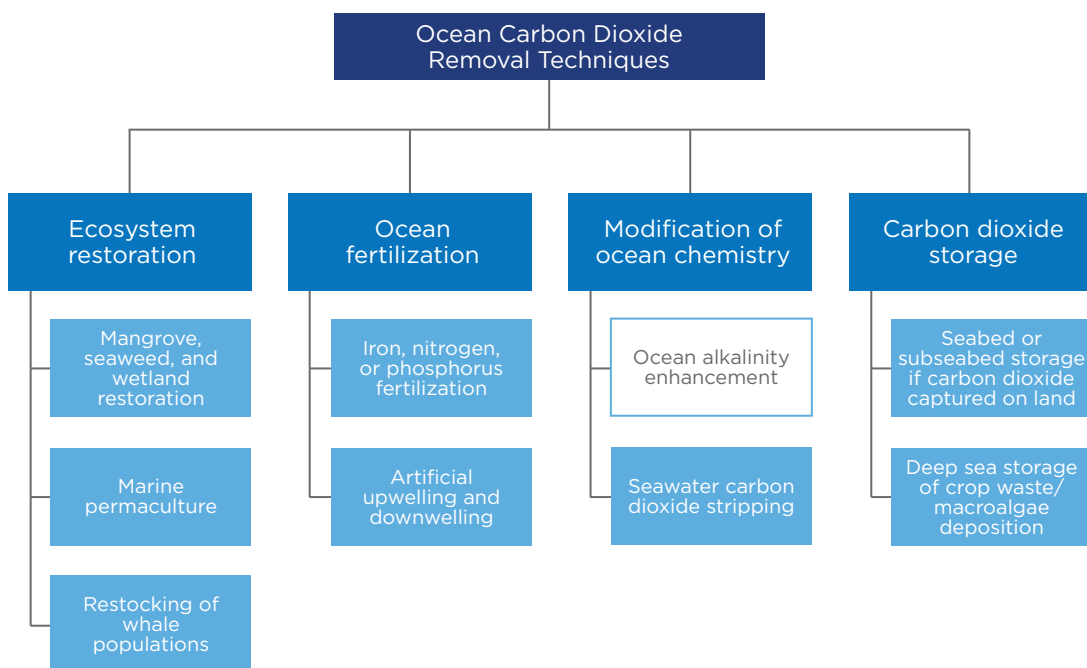
15 European Commission, *Ocean-based Negative Emission Technologies: Project Description*, <https://cordis.europa.eu/project/id/869357> (last updated Apr. 20, 2020).

16 European Commission, *Quantifying and Deploying Responsible Negative Emissions in Climate Resilient Pathways*, <https://cordis.europa.eu/project/id/869192> (last updated Oct. 14, 2020).

2. OVERVIEW OF SEAWEED CULTIVATION

Ocean-based approaches to carbon dioxide removal can take a number of forms, but may be divided into four broad categories as shown in Figure 1 below. Here, we focus on the ocean-based approach of seaweed cultivation, which can be categorized as both ecosystem restoration and carbon dioxide storage, depending on whether the seaweed is used to replace more greenhouse-gas intensive products or sunk in the deep sea to store the carbon dioxide it contains. A brief overview of the approach, its potential to remove carbon dioxide from the atmosphere, and possible co-benefits and risks is provided in this part.

Figure 1: Types of Ocean Carbon Dioxide Removal¹⁷



Seaweed cultivation refers to the growing of kelp and other macroalgae, which may be harvested for food, bioenergy, or other uses, or sunk in the ocean to sequester the carbon it contains. Seaweed is fast-growing, up to two feet per day, and is both present in the wild and grown for human consumption. Like terrestrial plants, seaweed uptakes carbon from the atmosphere as it grows and stores it in biomass. However, unlike land forests, carbon storage in seaweed is not vulnerable to fire and forest degradation. Wild seaweed grows mostly near

¹⁷ Based on figure in Antonius Gagern et al., Ocean Alkalinity Enhancement: Current State of Knowledge and Potential Role of Philanthropy 7 (2019), <https://perma.cc/A92F-AEY4>.

the shore, stores carbon in its biomass, and sequesters a small percentage of that carbon in the sediment below where it is grown. Some seaweed varieties, like kelp, contain gas-filled bladders in their leaves to help them float near the surface to access sunlight. Because of the bladders, the seaweed can float for long distances until the bladders burst, sinking the seaweed towards the deep-sea floor, where the carbon is sequestered for centuries to millions of years.¹⁸ A 2016 study estimated that naturally-occurring seaweed sequesters about 640 Mt of carbon dioxide per year (within a range of about 220 to 980 Mt of carbon dioxide per year), with approximately ninety percent of this sequestered in the deep sea.¹⁹

Strategies to utilize seaweed for carbon dioxide removal focus mainly on seaweed cultivation, as natural fluxes are large and deep-sea carbon deposits are difficult to trace for accounting purposes. In 2016, global annual cultivation of seaweed reached 31.2 million tons, with 96.5 percent cultivated in aquaculture and the rest harvested from natural populations.²⁰ This represents nearly a third of total global aquaculture production by weight. China accounts for about half of worldwide seaweed cultivation, and Indonesia, Japan, Korea, and the Philippines are also major producers.²¹ Cultivation is increasing, with an annual growth rate of approximately eight percent.²² Seaweeds are harvested for food, medicine, cosmetics, and bioenergy, with little current use solely for carbon offsetting.²³

Seaweed can either be grown on the sea floor, attached to a hard surface, or along anchored lines or nets.²⁴ Cultivation techniques using lines and nets that do not require the use of the sea floor are popular due to low installation and maintenance costs.²⁵ Seaweed growth requires adequate nutrients and light, and salinity, temperatures, and pH levels that do not limit growth.²⁶ Cultivation typically occurs within 110 nautical miles (“n.m.”) (200 kilometers) of shore, with many farms located less than one n.m. (two kilometers) from the coast. Research is investigating the potential for cultivation further out into the open ocean, including the use of floating platforms powered by solar panels²⁷ or co-located with offshore wind to utilize the in-place infrastructure to facilitate seaweed growth.²⁸

To offset emissions, cultivated seaweed may be used to replace more greenhouse gas-

18 Dorte Krause-Jensen and Carlos M. Duarte, *Substantial role of macroalgae in marine carbon sequestration*, 9 NATURE GEOSCIENCE 737, 739 (2016), <https://www.nature.com/articles/ngeo2790>.

19 *Id.* at 739.

20 Sara Garcia-Poza et al., *The Evolution Road of Seaweed Aquaculture: Cultivation Technologies and the Industry 4.0*, 17 INT’L J. ENVTL. RES. & PUB. HEALTH 6528, 6537 (2020).

21 *Id.* at 6537.

22 Halley E. Froehlich et al., *Blue Growth Potential to Mitigate Climate Change through Seaweed Offsetting*, 29 CURRENT BIOLOGY 3087, 3087 (2019).

23 *Id.* at 3087.

24 Garcia-Poza et al., *supra* note 20, at 6539.

25 *Id.*

26 *Id.* at 6537–6538.

27 Tim Flannery, *How farming giant seaweed can feed fish and fix the climate*, THE CONVERSATION (July 31, 2017), <https://perma.cc/4V6U-89RX>. The solar panels may be used to power the floating platforms to move from ideal cultivation locations to ideal sinking locations. Co-locating seaweed cultivation with solar panel-installed platforms, similar to offshore wind, can also help efficiently utilize limited marine space and provide infrastructure for seaweed growth and ship docking.

28 Bela H. Buck et al., *Offshore and Multi-Use Aquaculture with Extractive Species: Seaweeds and Bivalves in AQUACULTURE PERSPECTIVE OF MULTI-USE SITES IN THE OPEN OCEAN* 26 (Bela H. Buck & Richard Langan eds., 2017).

intensive products, or may be sunk in the deep sea. In order to be a truly carbon negative technology, the seaweed would likely need to be sunk or used in BECCS systems or as biochar. A 2019 study found that sinking seaweed has the potential to sequester 1,110 tonnes of CO₂ per square kilometer of seaweed cultivation area,²⁹ but notes that cost constraints would limit the ability of the industry to scale up cultivation for sequestration through sinking.³⁰ Utilizing seaweed for mitigation by replacing greenhouse gas-intense products may be more cost-effective, if not carbon negative. Seaweed biofuels could mitigate about 1,500 tons of carbon dioxide per square kilometer of seaweed cultivation area per year in terms of avoided emissions from fossil fuels.³¹ Seaweed could also be used to reduce cattle methane emissions, as a 2016 experiment showed that the addition of seaweed to cattle diet could reduce methane emissions from cattle production by ninety-nine percent,³² although research is still at a preliminary stage.

Seaweed cultivation may also have climate adaptation and environmental co-benefits. Dense seaweed areas are associated with a high pH which may help to protect coral and other calcifying organisms from the adverse effects of ocean acidification.³³ Seaweed farms provide oxygen-rich habitats, which can combat hypoxia in eutrophic coastal areas.³⁴ And because seaweed farms dampen wave energy, they can buffer against coastal erosion.³⁵ However, large-scale seaweed cultivation also brings environmental and ecosystem risks. By domesticating wild seaweed species and thus reducing genetic diversity, cultivation may make crops more susceptible to disease and parasites.³⁶ The introduction of non-native seaweed species can bring harmful impacts to local ecosystems.³⁷ Seaweed farms may remove light and nutrient resources from underlying and surrounding habitats.³⁸ Further, large-scale cultivation requires the addition of artificial material, like polymer rope, that may be discarded or lost causing pollution to marine environments.³⁹ Because large-scale cultivation has not been implemented in many countries, significant knowledge gaps exist over the ultimate environmental impact of such aquaculture operations.

29 Froehlich et al., *supra* note 22, at e2.

30 *Id.* at 3087.

31 Carlos M. Duarte et al., *Can seaweed farming play a role in climate change mitigation and adaptation?*, 4 FRONTIERS IN MARINE SCIENCE 1, 1 (2017).

32 *Id.* at 4.

33 *Id.*

34 *Id.* at 5.

35 *Id.* at 4.

36 Iona Campbell et al., *The Environmental Risks Associated With the Development of Seaweed Farming in Europe*, 6 FRONTIERS IN MARINE SCIENCE 1, 9 (2019).

37 *Id.*

38 *Id.* at 4–5.

39 *Id.* at 7.

3. JURISDICTION OVER THE OCEANS

Regulatory jurisdiction over the oceans is governed by international law. The relevant principles of international law and their application in the U.S. are discussed in this part.

3.1 International Legal Framework

The United Nations Convention on the Law of the Sea (“UNCLOS”) defines the extent of countries’ jurisdiction over the oceans. UNCLOS has been ratified or otherwise adopted by 167 countries and the European Union.⁴⁰ The U.S. has not ratified UNCLOS, but recognizes many of its provisions, including those discussed in this Part, as forming part of customary international law.⁴¹

Under UNCLOS, non-landlocked countries (“Coastal States”) have jurisdiction over areas within 200 n.m. of the low water line along their coasts (the “baseline”) and further in some circumstances.⁴² The 200 n.m. zone is generally divided into three key parts (see Figure 2), each of which has a different legal status as follows:

- The **territorial sea**, which comprises the waters and submerged land extending twelve n.m. from the baseline, and forms part of the sovereign territory of the Coastal State.⁴³
- The **exclusive economic zone** (“EEZ”), which comprises the waters situated beyond the territorial sea, up to 200 n.m. from the baseline.⁴⁴ Within the EEZ, the Coastal State has sovereign rights to explore, exploit, conserve, and manage natural resources and undertake other activities for the economic exploitation of the zone, among other things.⁴⁵
- The **continental shelf**, which comprises the submerged land extending beyond the territorial sea to the farthest of 200 n.m. from the baseline or the outer edge of the continental margin,⁴⁶ up to sixty n.m. from the foot of the continental slope or the point where sediment thickness is one percent of the distance thereto.⁴⁷ Each Coastal State has sovereign rights over its continental shelf for the purpose of exploring and exploiting natural resources.⁴⁸

40 United Nations, *Law of the Sea*, <https://perma.cc/AZ7L-APX4> (last updated Jan. 19, 2021).

41 *Id.* See also U.S. Dept. of State, *Law of the Sea Convention*, <https://perma.cc/A8A5-QA98> (last updated Mar. 7, 2019).

42 United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

43 *Id.* Art. 2-3.

44 *Id.* Art. 55 & 57.

45 *Id.* Art. 56.

46 The “continental margin” refers to the submerged prolongation of the land mass of the Coastal State. See *id.* Art. 76(1).

47 *Id.* Art. 76(5). The continental shelf cannot extend more than 100 n.m. from the 2,500 meter isobath or 350 n.m. from the baseline. See *id.*

48 *Id.* Art. 77.

Except as noted above, Coastal States generally do not have jurisdiction over areas more than 200 n.m. from shore, which form part of the high seas.⁴⁹ UNCLOS provides for “freedom of the high seas,” which is defined to include, “for both coastal and land-locked states: (a) freedom of navigation; freedom of overflight; freedom to lay submarine cables and pipelines . . . ; freedom to construct artificial islands and other installations . . . ; freedom of fishing . . . ; [and] (f) freedom of scientific research.”⁵⁰

3.2 U.S. Jurisdictional Areas

Consistent with international law the U.S. has claimed jurisdiction over all waters up to 200 n.m. from its coast (“U.S. waters”).⁵¹ Jurisdiction is shared among the coastal states, which have primary authority over areas within three n.m. of shore (and further in some cases) (“state waters”) and the federal government, which has authority over areas lying beyond state waters within U.S. territory (“federal waters”).

3.2.1 State Waters

Under the Submerged Lands Act of 1953 (“SLA”), the boundaries of each coastal state extend three n.m. from its coastline, except in the Gulf of Mexico, where the boundaries of Texas and Florida extend nine n.m. from the coastline.⁵² For the purposes of the SLA, a state’s “coastline” is defined as “the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters.”⁵³

Offshore waters within state boundaries fall under the primary jurisdiction of the relevant coastal state, though the federal government also has some regulatory authority within state waters. Each coastal state has title to, and ownership of, all lands beneath its state waters and the natural resources (including minerals, marine animals, and plant life) within those lands and waters.⁵⁴ The federal government has relinquished all of its rights to, and interests in, land and resources within state waters (though it retains some regulatory authority).⁵⁵

3.2.2 Federal Waters

Waters lying beyond state boundaries up to 200 n.m. from shore fall under the exclusive authority of the federal government. The federal government also has exclusive authority over offshore land, comprising the seabed and subsoil of the outer continental shelf (“OCS”). The federal Outer Continental Shelf Lands Act (“OCSLA”) defines the OCS as those “submerged

49 *Id.* Art. 86-87.

50 *Id.* Art. 87.

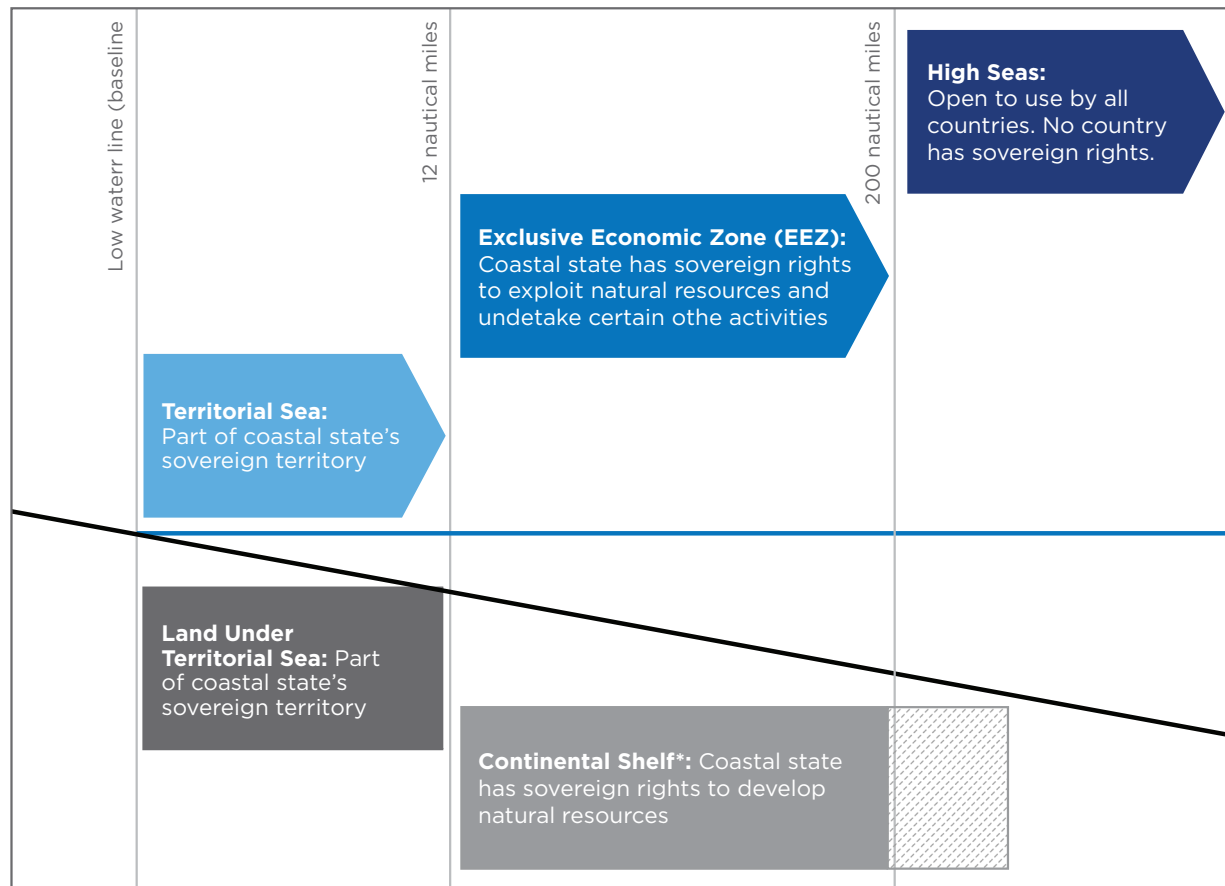
51 Proclamation No. 5030, 48 Fed. Reg. 10605 (Mar. 14, 1983).

52 43 U.S.C. § 1312 (providing that “[t]he seaward boundary of each original coastal State is approved and confirmed as a line three geographic miles distant from its coast line”). See also *id.* § 1301(b) (defining the term “boundaries” and providing that “in no event shall the term boundaries . . . be interpreted as extending from the coast line more than three geographical miles in the Atlantic Ocean or the Pacific Ocean, or more than three marine leagues into the Gulf of Mexico”). A “marine league” is equivalent to three n.m. Thus, in the Gulf of Mexico, the boundaries of Texas and Florida extend nine n.m. from the coastline. See *generally* *U.S. v. Louisiana*, 100 S.Ct. 1618 (1980), 420 U.S. 529 (1975), 394 U.S. 11 (1969), 389 U.S. 155 (1967), 363 U.S. 1 (1960), 339 U.S. 699 (1950).

53 43 U.S.C. § 1301(c).

54 *Id.* § 1311(a)(1).

55 *Id.* § 1311(b).

Figure 2: Offshore Zones Identified in UNCLOS⁵⁶

* The continental shelf typically extends 200 n.m. from shore. However, in some circumstances, it may extend beyond this point to the farthest of 100 n.m. from the 2,500 meter isobath or 350 n.m. from the baseline.

lands lying seaward and outside of the area [subject to state jurisdiction] . . . and of which the subsoil and seabed appertain to the U.S.”⁵⁷ As discussed in subpart 3.2.1 above, state jurisdiction typically ends three n.m. from shore (except in Texas and the west coast of Florida, where it ends nine n.m. from shore), at which point the OCS begins. The OCS extends to the seaward limit of U.S. jurisdiction, defined under international law as the farthest of:

- 200 n.m. from the baseline (i.e., normally the low-water line along the coast); or
- if the continental margin exceeds 200 n.m., a line:

⁵⁶ ROMANY M. WEBB & MICHAEL B. GERRARD, OVERCOMING IMPEDIMENTS TO OFFSHORE CARBON DIOXIDE STORAGE: LEGAL ISSUES IN THE U.S. AND CANADA 8 (2019), <https://perma.cc/92MV-4Y5Q>.

⁵⁷ *Id.* § 1331.

- sixty n.m. from the foot of the continental shelf; or
- beyond the shelf foot where the sediment thickness is one percent of the distance thereto.⁵⁸

The OCS cannot, however, extend more than 350 n.m. from the baseline or 100 n.m. from the 2,500 meter isobath (i.e., a line connecting the depth of 2,500 meters).⁵⁹

58 UNCLOS, *supra* note 41, Art. 76(1) & (4).

59 *Id.* Art. 76(5).

4. INTERNATIONAL LEGAL FRAMEWORK FOR SEAWEED CULTIVATION

Activities performed at sea are governed by various international agreements to which individual countries have consented to be bound, as well as customary international law, which comprises universal legal standards that are binding on all countries. While there are no agreements dealing specifically with the governance of ocean-based carbon dioxide removal, several instruments contain provisions that could apply to research or commercial-scale operations. These include UNCLOS, the Convention on Biological Diversity (“CBD”), the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (“London Convention”), and the Protocol to that Convention (“London Protocol”). Various rules of customary international law could also apply to ocean alkalinity enhancement projects. The relevant agreements and rules and their application to ocean carbon dioxide removal via seaweed cultivation are discussed in this Part.

4.1 Relevant International Agreements

4.1.1 Convention on Biological Diversity

Adopted in 1992, the CBD aims to promote “the conservation of biological diversity, [and] the sustainable use of its components.”⁶⁰ At the time of writing, the CBD had been ratified or otherwise accepted by 195 countries, as well as the European Union.⁶¹ The U.S. had signed, but not ratified, the CBD.⁶²

Article 7 of the CBD requires parties to, “as far as possible and as appropriate,” identify projects “which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects.”⁶³ Under Article 14 of the CBD, parties must require environmental impact assessments of the projects, “with a view to avoiding or minimizing [their] adverse effects.”⁶⁴ For projects that could have transboundary effects, parties must “[p]romote . . . notification, exchange of information and consultation” with potentially affected countries.⁶⁵ In the case of “imminent or grave” transboundary damage, parties must “notify immediately the potentially affected” countries, and “initiate

60 Convention on Biological Diversity, May 22, 1992 [hereinafter “CBD”].

61 Convention on Biological Diversity, *List of Parties*, <https://perma.cc/ZY3W-9PC3> (last visited Jan. 19, 2021).

62 *Id.* Article 18 of the Vienna Convention on the Law of Treaties provides that a country which has signed, but not ratified, a treaty is “obliged to refrain from acts which would defeat the object and purpose of a treaty . . . until it shall have made its intent clear not to become a party to the treaty.” This has been interpreted as requiring signatories to avoid acts that would make it more difficult or impossible for other parties to comply with the relevant agreement. Some researchers have argued that this requirement forms part of customary international law and thus applies to countries that are not party to the Vienna Convention (including the U.S.). However, even if this is the case, the obligation only applies until the country has signaled “its intent . . . not to become a party to the treaty.” The U.S. has arguably done this by failing to ratify the CBD for nearly thirty years (despite having signed it in 1993). See generally, Curtis A. Bradley, *Treaty Signature*, in *THE OXFORD GUIDE TO TREATIES* 208 (Duncan B. Hollis ed., 2012).

63 CBD, *supra* note 60, Art. 7(c).

64 *Id.* Art. 14(1)(a).

65 *Id.* Art. 14(1)(c).

action to prevent or minimize” any damage.⁶⁶ Parties should also have in place “national arrangements for emergency responses” to projects that represent a “grave and imminent danger to biological diversity.”⁶⁷

Provided the above requirements are met, the CBD would not prevent countries from undertaking or authorizing seaweed cultivation or other carbon dioxide removal projects, even if those projects adversely affect biodiversity.⁶⁸ However, the Conference of the Parties to the CBD has adopted a series of non-binding decisions, which recommend that countries avoid such projects to the extent that they constitute “geoengineering activities.”

A decision applying broadly to “geoengineering activities” was adopted by the Conference of the Parties to the CBD in 2010.⁶⁹ The decision “invite[d] Parties and other Governments” to consider specified guidelines “on ways to conserve, sustainably use and restore biodiversity and ecosystem services while contributing to climate change mitigation and adaptation.”⁷⁰ The guidelines recommended that countries:

[e]nsure . . . in the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering, and in accordance with the precautionary approach and Article 14 of the Convention, that no climate-related geo-engineering activities that may affect biodiversity take place, until there is in place an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts, with the exception of small scale scientific research studies that could be conducted in a controlled setting . . . and only if they are justified by the need to gather specific scientific data and are subject to a thorough prior assessment of the potential impacts on the environment. (Internal citations omitted.)⁷¹

That guidance was reaffirmed by the Conference of the Parties to the CBD in 2012⁷² and again in 2016.⁷³

The 2010 decision defined geoengineering to mean “any technologies that deliberately reduce solar insolation or increase carbon sequestration on a large scale that may affect biodiversity.”⁷⁴ The Secretariat to the CBD subsequently determined, and the Conference of the Parties agreed, that geoengineering should be defined more broadly to include any

66 *Id.* Art. 14(1)(d).

67 *Id.* Art. 14(1)(e).

68 The CBD applies to all activities carried out under the jurisdiction or control of a party thereto, regardless of whether they occur within or beyond the area under the party’s national jurisdiction. *See id.* at Art. 4(b).

69 Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Tenth Meeting, Decision X/33, Art. 8 (2010) [hereinafter “2010 Decision”].

70 *Id.*

71 *Id.* Art. 8(w).

72 Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Eleventh Meeting, Decision XI/20, Art 6-9 (2012) [hereinafter “2012 Decision”].

73 Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Thirteen Meeting, Decision XIII, Art. 14 (2016).

74 2010 Decision, *supra* note 69, at footnote 3.

“[d]eliberate intervention in the planetary environment of a nature and scale intended to counteract anthropogenic climate change and its impacts.”⁷⁵ That definition would encompass seaweed cultivation and other ocean carbon dioxide removal projects undertaken for the purpose of mitigating climate change. Nevertheless, the decision’s impact on ocean carbon dioxide removal projects is limited because it is non-binding, and merely “invites” countries to “consider” the guidelines provided.

4.1.2 United Nations Convention on the Law of the Sea

Often described as the “constitution of the oceans,” UNCLOS defines countries’ rights and responsibilities with respect to the management and use of offshore areas. At the time of writing, UNCLOS had been ratified or otherwise adopted by 167 countries and the European Union and signed, but not ratified or adopted, by an additional fourteen countries.⁷⁶ The U.S. has neither signed nor ratified UNCLOS. Notably, however, the U.S. has ratified the Agreement for Implementation of the Provisions of UNCLOS Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (“Straddling Fish Stocks Agreement”).⁷⁷ The U.S. recognizes many other UNCLOS provisions as forming part of customary international law.

Article 194 of UNCLOS imposes a general obligation on parties to take all necessary measures to “prevent, reduce and control pollution of the marine environment.”⁷⁸ That obligation was reiterated and elaborated on in the Straddling Fish Stocks Agreement, which requires parties to “minimize pollution” and “protect biodiversity in the marine environment,” among other things.⁷⁹

For the purposes of UNCLOS, pollution is defined broadly to mean:

the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of the sea water and reduction of amenities.⁸⁰

Under this definition, substances or energy added to the marine environment in order to stimulate seaweed growth or the sinking of cultivated seaweed in the open ocean⁸¹ could be

⁷⁵ SECRETARIAT TO THE CONVENTION ON BIOLOGICAL DIVERSITY, CDB TECHNICAL SERIES NO. 66, GEOENGINEERING IN RELATION TO THE CONVENTION ON BIOLOGICAL DIVERSITY: TECHNICAL AND REGULATORY MATTERS 23 (2012), <https://perma.cc/LFU6-5RAU>; 2012 Decision, *supra* note 72, Art. 5.

⁷⁶ United Nations, *Chronological Ratifications of, and Accessions and Successions to the Convention and Related Agreements*, <https://perma.cc/JK47-SZG5> (last visited Jan. 9, 2020)

⁷⁷ Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, Sept. 8, 1995 [hereinafter “Straddling Fish Stocks Agreement”]. At the time of writing, there were 91 parties to the Straddling Fish Stocks Agreement. See United Nations, *supra* note 76.

⁷⁸ UNCLOS, *supra* note 42, Art. 194(1).

⁷⁹ Straddling Fish Stocks Agreement, *supra* note 77, Art. 5.

⁸⁰ UNCLOS, *supra* note 42, Art. 1(1)(4).

⁸¹ The sinking of naturally occurring seaweed, since it would not be “introduced” into the marine environment, is unlikely to be considered pollution.

considered forms of pollution if they harm the marine environment.⁸² As the risk of harm is likely to vary between projects, a case-by-case assessment would need to be undertaken.⁸³ The assessment should consider not only the risks posed by the project but also its likely effectiveness in sequestering carbon dioxide and thus mitigating climate change.⁸⁴ This is relevant because carbon dioxide and certain impacts of climate change (e.g., ocean acidification) also arguably constitute pollution for the purposes of UNCLOS.⁸⁵

Article 196 of UNCLOS similarly imposes an obligation to “prevent, reduce and control pollution of the marine environment” resulting from “the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto.”⁸⁶ Although seaweed may be grown in its native habitat or in an area where it has long been cultivated, seaweed cultivation could also involve the introduction of species that are new to particular environments. Thus, similar to the assessment of pollution from substances added to stimulate growth and sinking, compliance with UNCLOS will require assessment of the marine environment risks of introducing new seaweed species.

If ocean carbon dioxide removal projects were found to involve pollution of the marine environment, either through added substances or the introduction of non-native species, UNCLOS would require the party under whose jurisdiction it occurs to:

- take all necessary measures to minimize the adverse impacts of the project and ensure that it does not cause damage to other states or their environments;⁸⁷
- notify affected countries and competent international authorities of any imminent or actual damage from the project;⁸⁸ and
- study the risks and effects of the project and publish the results of that study.⁸⁹

According to UNCLOS, countries that fail to fulfil these requirements “shall be liable in accordance with international law.”⁹⁰ The 2001 United Nations Resolution on the Responsibility of States for Internationally Wrongful Acts provides that, where a country breaches an international obligation and that breach causes harm to another, the former must cease the offending conduct and “offer appropriate assurances and guarantees of non-repetition.”⁹¹ The country must also make “full reparation” for any injuries caused by its conduct through

82 See generally, Jesse L. Reynolds, *International Law*, in CLIMATE ENGINEERING AND THE LAW 57, 76-77 (Michael B. Gerrard & Tracy Hester eds., 2018).

83 *Id.* at 77.

84 *Id.* at 77-78.

85 *Id.* at 76 (asserting that “GHGs and probably global warming qualify under UNCLOS as pollution of the marine environment”).

86 UNCLOS, *supra* note 42, Art. 196(1).

87 UNCLOS, *supra* note 42, Art. 194, 196, 202-209, & 211-212.

88 *Id.* Art. 198.

89 *Id.* Art. 204-206.

90 *Id.* Art. 235(1).

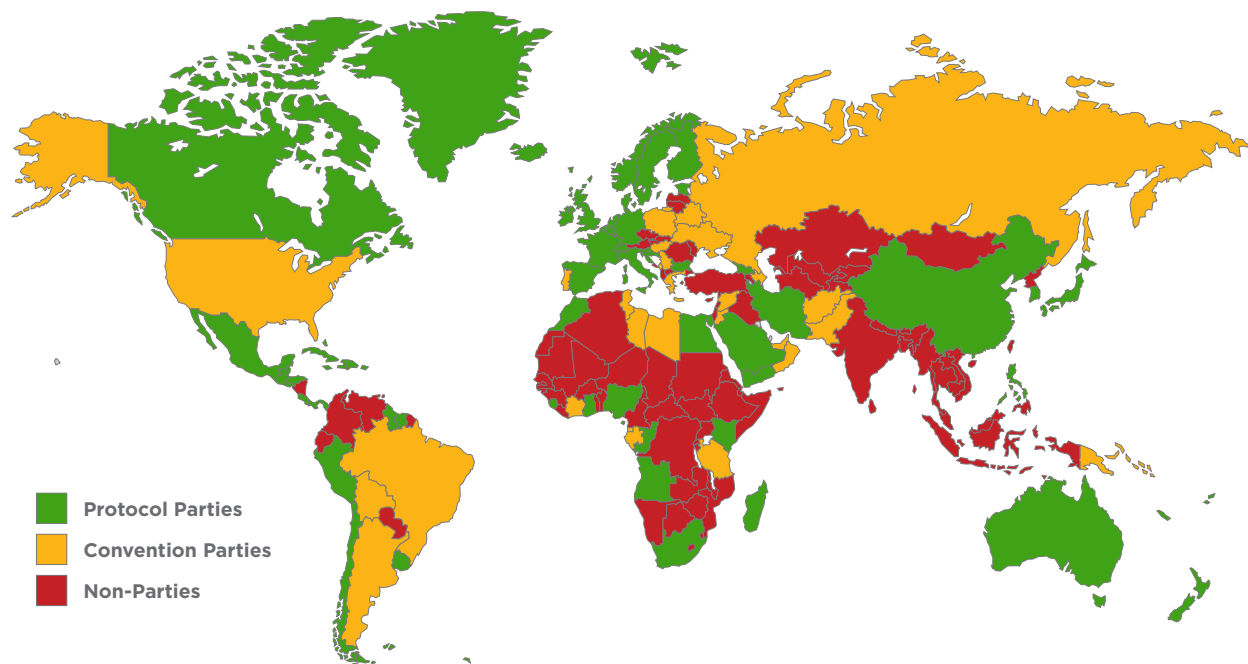
91 Resolution Adopted by the United Nations General Assembly, Responsibility of States for Internationally Wrongful Acts, A/RES/56/83 (Jan. 28, 2002) at Art. 30. See also *id.* Art. 2 (specifying when a country will be considered to have committed a “wrongful act”).

restitution (i.e., action to re-establish the status quo ante), compensation (i.e., payments to cover any “financially assessable damage”), or satisfaction (i.e., “an acknowledgement of the breach, an expression of regret, a formal apology,” or similar statement).⁹²

4.1.3 London Convention and Protocol

The London Convention was adopted in 1972 with the aim of “promot[ing] the effective control of all sources of pollution of the marine environment,” particularly those resulting from the “dumping” of “waste or other matter” at sea.⁹³ In 1996, the parties to the London Convention adopted a new protocol, which is intended to update the Convention and will eventually replace it once ratified by all contracting parties.⁹⁴ The London Protocol sets more ambitious goals than the London Convention, aiming to “protect and preserve the marine environment from all sources of pollution,” and to “prevent, reduce and where practicable eliminate pollution caused by dumping” of “waste or other matter.”⁹⁵

Figure 3: Parties to the London Convention and London Protocol¹⁹⁶



92 *Id.* Art. 31 & 34. See also *id.* Art. 35 (defining “restitution”), Art. 36 (defining “compensation”), & Art. 37 (defining “satisfaction”).

93 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972 [hereinafter "London Convention"], Art. I-II.

94 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters,
Nov. 7, 1996 [hereinafter “London Protocol”], Art. III.

95 Id.

96 *Id.*

Table 1: Contracting Parties to the London Protocol

Angola	France	Marshall Islands	South Africa
Antigua and Barbuda	Guatemala	Mexico	Spain
Australia	Georgia	Morocco	Suriname
Barbados	Germany	New Zealand	Sweden
Belgium	Ghana	Netherlands	Switzerland
Bulgaria	Guyana	Nigeria	Tonga
Canada	Iceland	Norway	Trinidad and Tobago
Chile	Ireland	Peru	United Kingdom
China	Islamic Republic of Iran	Philippines	Uruguay
Congo	Italy	Republic of Korea	Vanuatu
Denmark	Japan	Saint Kitts and Nevis	Yemen
Egypt	Kenya	Saudi Arabia	
Estonia	Luxembourg	Sierra Leone	
Finland	Madagascar	Slovenia	

At the time of writing, there were eighty-seven parties to the London Convention, and fifty-three parties to the London Protocol (see Figure 3 and Table 1).⁹⁷ For countries that are parties to both instruments, the London Protocol supersedes the London Convention. The U.S. has only ratified the London Convention and is, therefore, bound only by its terms.⁹⁸

Both the London Convention and London Protocol require parties to adopt domestic laws to regulate the dumping of waste and other matter within offshore areas under their jurisdiction (i.e., the territorial sea and EEZ) and, outside of those areas, by vessels or aircraft that are registered, or were loaded, within their territory.⁹⁹ Parties to the London Convention must prohibit the dumping of eight substances listed in Annex I to the Convention (“prohibited substances”),¹⁰⁰ but can permit the dumping of other (non-prohibited) substances.¹⁰¹ The London Protocol is more restrictive, requiring parties to prohibit the dumping of all

97 International Maritime Organization, *Map of Parties to the London Convention/Protocol*, <https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Parties%20to%20the%20LCLP%20February%202019.pdf> (last updated Feb. 22, 2019).

98 Env'tl. Prot. Agency, *Ocean Dumping: International Treaties*, <https://perma.cc/9KSU-756N> (last updated Feb. 28, 2019).

99 London Convention, *supra* note 93, Art. VII; London Protocol, *supra* note 94, Art. 10.

100 The prohibited substances are (1) organohalogen compounds, (2) mercury and mercury compounds, (3) cadmium and cadmium compounds, (4) persistent plastics and other persistent synthetic material, (5) crude oil and petroleum products and wastes, (6) radioactive wastes or matter, (7) materials produced for biological or chemical warfare, and (8) industrial waste.

101 London Convention, *supra* note 93, Art. IV.

substances, except the eight listed in Annex I to the Protocol (“allowed substances”).¹⁰²

Both the London Convention and London Protocol define “waste or other matter” broadly to include “material of any kind, form or description.”¹⁰³ In both instruments, “dumping” is defined to mean the “deliberate disposal of waste or other matter at sea from vessels, aircraft, platforms, or other man-made structures.”¹⁰⁴ Notably, however, the definition expressly excludes the “placement of matter for a purpose other than mere disposal thereof, provided that such placement is not contrary to the aims of” the London Convention or Protocol (the “dumping exemption”).¹⁰⁵

Most seaweed cultivation activities are unlikely to involve dumping within the terms of the London Convention and London Protocol, at least where the waste streams from cultivation can be diverted back to land. Research activities are unlikely to be covered by the London Convention and Protocol, as the Parties to those instruments indicated in a 2008 resolution that certain carbon dioxide removal projects (in the resolution’s case, ocean fertilization projects) that constitute “legitimate scientific research” should be regarded as a “placement of matter for a purpose other than mere disposal.”¹⁰⁶ In order for research projects that involve dumping to qualify for the dumping exemption, Parties would still need to ensure that the research was not contrary to the aims of the Convention or Protocol. To do so, they may be required to put in place conditions to minimize environmental disturbance and maximize scientific benefits.¹⁰⁷

Nevertheless, in some situations, large-scale seaweed cultivation projects could involve dumping under the London Convention and Protocol. Sinking seaweed at sea for the purpose of carbon sequestration, if done by allowing or engineering seaweed to float to the deep sea on its own, would not constitute dumping because the seaweed would not be disposed from vessels, aircraft, platforms, or other man-made structures. However, floating platforms that both grow and sink seaweed could be used, and ships could be used to transport seaweed cultivated near shore to the deep sea for sinking. In these cases, when the seaweed is sunk, the key determination would be whether sequestration constitutes a sufficient purpose beyond mere disposal of the seaweed and whether that purpose is not contrary to the aims of the London Convention and Protocol. If it is found to have a sufficient alternative purpose and not to be contrary to the aims of the Convention and Protocol, the project would not involve dumping.

102 London Protocol, *supra* note 94, Art. 4. The allowed substances are (1) dredged material, (2) sewage sludge, (3) fish waste and material from industrial fish processing operations, (4) vessels, platforms, and other man-made structures at sea, (5) inert, inorganic geological material, (6) organic material of natural origin, (7) certain bulk items primarily comprising iron, steel, concrete, and similarly unarmful materials, and (8) carbon dioxide streams from carbon dioxide capture processes for sequestration. *Id.* Annex 1.

103 London Convention, *supra* note 93, Art. III; London Protocol, *supra* note 94, Art. I.

104 London Convention, *supra* note 93, Art. III; London Protocol, *supra* note 94, Art. I.

105 London Convention, *supra* note 93, Art. III; London Protocol, *supra* note 94, Art. I.

106 Resolution LC-LP.1(2008) on the Regulation of Ocean Fertilization, Art. 3 (Oct. 31, 2008) [hereinafter “2008 Resolution”]. The resolution defined “ocean fertilization” to mean “any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans,” but expressly excluded “conventional aquaculture, or mariculture, or the creation of artificial reefs.” *Id.* Art. 2 and Footnote 3.

107 See Resolution LC-LP.2(2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilization (Oct. 14, 2010).

Seaweed cultivation does not typically involve the use of fertilizer, but widespread seaweed cultivation in the open ocean is relatively under-studied, so as-yet unknown substances may be required to stimulate growth. The addition of growth-stimulating substances to ocean waters could constitute dumping under the London Convention and London Protocol. Further, if seaweed cultivation is to scale up to levels relevant to multi-megatonne or gigatonne-level carbon dioxide removal, more waste in the forms of nets and lines may be generated that could in turn be “dumped” in a manner implicating the London Convention and London Protocol.

If seaweed cultivation involves activities that are deemed to be “dumping” and do not meet the “placement” exemption, then such activities would be subject to the terms of the London Convention and London Protocol. For non-research projects, the Protocol and Convention differ in their approach to regulating dumping. Parties to the London Convention could, consistent with that instrument, permit the dumping of any substance that is not a prohibited substance (listed in Annex I), in connection with non-research projects.¹⁰⁸ The London Convention explicitly prohibits the dumping of persistent synthetic materials, like rope and netting,¹⁰⁹ so seaweed cultivation projects would need to ensure that such materials were not dumped in the ocean. Notably, however, Parties to the London Convention could permit the dumping of the seaweed itself and other non-synthetic substances. In contrast, Parties to the London Protocol could not permit dumping associated with seaweed cultivation projects, unless they involved the use of allowed substances (listed in Annex I to the Protocol).¹¹⁰ Some of the materials that could be dumped in seaweed cultivation, like dredged material and organic material of natural origin, which could include seaweed itself, appear on the list of potentially allowable substances.¹¹¹ Any other material would be categorically excluded from dumping.

In sum, Parties to both the London Convention and London Protocol could permit dumping associated with non-research seaweed cultivation projects, though Parties to the London Protocol could only permit the dumping of organic or dredged material.

4.1.4 Potentially Relevant European Union Instruments

The EU has not adopted explicit regulations applicable to ocean-based carbon dioxide removal.¹¹² However, general environmental rules and standards may apply to ocean carbon dioxide removal strategies. The Treaty on the Functioning of the European Union (“TFEU”) establishes that EU environmental policy must be based on the precautionary principle.¹¹³ Although the precautionary principle is not defined by the TFEU, the EU General Court, formerly called the Court of First Instance, has found that the principle applies in situations where there is scientific uncertainty about a preventive measure.¹¹⁴ In such situations, the

¹⁰⁸ London Convention, *supra* note 93, Art. IV

¹⁰⁹ London Convention, *supra* note 93, Annex 1.

¹¹⁰ London Protocol, *supra* note 94, Art. 4.

¹¹¹ *Id.* Annex 1.

¹¹² Ralph Bodle et al., Options and Proposals for the International Governance of Geoengineering, Ecologic Institute, Berlin 106 (2014); Stefan Schäfer et al., The European Transdisciplinary Assessment of Climate Engineering (EuTRACE): Removing Greenhouse Gases from the Atmosphere and Reflecting Sunlight away from Earth 92 (2014).

¹¹³ Consolidated version of the Treaty on the Functioning of the European Union, Article 191(2) (2012), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN>.

¹¹⁴ Case T-13/99, Pfizer Animal Health v. Council, 2002 E.C.R. II-3318, 3375.

Court reasons that political institutions should determine an appropriate level of protection for society from the preventive measure, and that scientific experts should undertake a risk assessment before the preventive measure is deployed.¹¹⁵ Research into ocean carbon dioxide removal and trials of different approaches could be justified as a way of informing decisions on deployment under the precautionary principle. The TFEU clarifies that, in areas of research and technological development, the EU has competency to define and implement programs, but this shall not prevent Member States from exercising their own competency.¹¹⁶ In other words, the EU may establish its own programs to research seaweed cultivation strategies, but this would not prevent Member States from separately researching these strategies. Proposed amendments in 2020 to the European Climate Law, although they do not lay out specifics, state that “[t]he natural sink of forests, soils, agricultural lands and wetlands should be maintained and further increased and carbon removal technologies, such as carbon capture and storage and carbon capture and utilisation, should be made cost-effective and deployed.”¹¹⁷

Ocean carbon dioxide removal activities in EU waters would need to be in accord with the EU Marine Strategy Framework Directive, which applies to the territorial seas of Member States and extends out to the edge of each State’s jurisdictional rights,¹¹⁸ meaning typically the EEZ up to 200 n.m. from shore.¹¹⁹ The Directive aims to protect and preserve the marine environment, and prevent and reduce inputs with a view to phasing out marine pollution,¹²⁰ defined as:

[T]he direct or indirect introduction into the marine environment, as a result of human activity, of substances or energy, including human-induced marine underwater noise, which results or is likely to result in deleterious effects such as harm to living resources and marine ecosystems, including loss of biodiversity, hazards to human health, the hindering of marine activities, including fishing, tourism and recreation and other legitimate uses of the sea.¹²¹

As described above, large-scale seaweed cultivation may require the addition of materials to ocean waters, which could have potentially harmful impacts on biodiversity. Both strategies, but especially seaweed cultivation, could compete for space with fishing, tourism, and recreation in the oceans.

In order to ensure pollution is avoided, EU Member States were required to develop and implement a marine strategy by 2016, including an assessment of the environment status of

115 *Id.* at 3375–81

116 Consolidated version of the Treaty on the Functioning of the European Union, Article 4(3) (2012), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN>.

117 Proposal for a Parliament and Council Regulation 2020/0036 at 7 (2020) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0080&from=EN>.

118 Council Directive 2008/56/EC, Art. 3(1)(a) 2008 O.J. (L 164). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0056-20170607>.

119 Ronan Joseph Long, *The Marine Strategy Framework Directive: A New European Approach to the Regulation of the Marine Environment, Marine Natural Resources and Marine Ecological Services*, 29 J. ENERGY & NAT. RESOURCES L. 1, 22–23 (2011).

120 Council Directive, *supra* note 118, Art. 1(2).

121 *Id.* at Art. 3(8).

marine waters, and a program of measures to achieve or maintain good environmental status.¹²² If Member States do not meet their reporting obligations, the Commission may refer them to the European Court of Justice.¹²³ Member States must review these marine strategies every six years,¹²⁴ so if seaweed cultivation were ramped up, Member States may need to demonstrate in their review that the plans result in the avoidance of harm to the marine environment.

Several other EU directives and policy initiatives may also apply to seaweed cultivation. Two stand out as especially relevant. The Marine Strategy Framework Directive aims to ensure that aquaculture development does not negatively affect biodiversity, introduce invasive species, or contribute to eutrophication.¹²⁵ The Maritime Spatial Planning Directive states that use of maritime spaces for multiple purposes requires integrated planning of space usage.¹²⁶ Thus, for seaweed cultivation to expand significantly in the EU for carbon dioxide removal purposes, cultivation will need to avoid both biodiversity and competing space challenges. Currently, however, there is no EU licensing scheme for seaweed cultivation specifically or aquaculture more generally.¹²⁷

4.2 Relevant Principles of Customary International Law

Seaweed cultivation projects could implicate the so-called “no harm” rule of customary international law. Under the no harm rule, as articulated in the 1992 Declaration of the United Nations Conference on the Environment and Development, each country has a “responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other [countries] or of areas beyond the limits of national jurisdiction.”¹²⁸ The International Tribunal for the Law of the Sea described the rule as imposing an obligation of “due diligence” on countries to “exercise best possible efforts” or “do the utmost” to avoid or minimize transboundary environmental damage.¹²⁹ What constitutes best efforts will depend on the circumstances.¹³⁰ At a minimum, however, countries must closely oversee activities that

¹²² *Id.* at Art. 5(2).

¹²³ See, e.g., European Commission, *Marine environment: Commission decides to refer BULGARIA to the Court of Justice of the EU over late reporting under the Marine Strategy Framework Directive* (2020), https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1234

¹²⁴ Council Directive, *supra* note 118, Art. 17(2).

¹²⁵ Consolidated Council Directive 2008/56/EC, Annex I, 2008 O.J. (L 164), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN>.

¹²⁶ Council Directive 2014/89/EU, Preamble, 2014 O.J. (L 257) 135, 135, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089&from=EN>.

¹²⁷ Bodle et al. & Schäfer et al., *supra* note 112.

¹²⁸ Declaration of the United Nations Conference on Environment and Development, Principle 2, UN Doc A/CONF.151/26/Rev. 1, June 3-14, 1992. The no harm rule was first articulated by an arbitral tribunal in the so-called “Trail Smelter” dispute between the United and Canada. See *Trail Smelter (United States v. Canada)*, Awards, 3 Reports of Intl. Arbitral Awards 1905 (1938 & 1941). The rule was subsequently recognized by the International Court of Justice. See *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, ICJ Rep 226 (July 1996); *Case Concerning Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgement, I.C.J. Rep. 2010, 14 (Apr. 2010) [hereinafter “Pulp Mills Case”].

¹²⁹ *Responsibilities and Obligations of States Sponsoring Persons and Entities with respect to Activities in the Area*, Advisory Opinion, Int’l Tribunal for the Law of the Sea, Case No. 17, 110 (Feb. 2011).

¹³⁰ *Id.* at 117 (noting that “due diligence is a variable concept. It may change over time as measures considered sufficiently diligent at a certain moment may become not diligent enough in light, for instance of new scientific or technical knowledge. It may also change in relation to the risks involved in the activity”).

could cause transboundary environmental damage (e.g., by adopting and strictly enforcing relevant domestic laws).¹³¹ In this regard, the International Court of Justice (“ICJ”) has stated that the due diligence obligation “entails not only the adoption of appropriate rules and measures, but also a certain level of vigilance in their enforcement and the exercise of administrative control applicable to public and private operators, such as the monitoring of activities undertaken by such operators.”¹³² Thus, to fulfil their obligation under the no harm rule, countries may need to adopt domestic laws and take other measures to mitigate the environmental impacts of seaweed cultivation and other ocean carbon dioxide removal projects.¹³³

The ICJ has also recognized that countries have a procedural obligation, under customary international law, to “undertake an environmental impact assessment where there is a risk that [a] proposed . . . activity may” cause “significant” transboundary environmental damage.¹³⁴ There is no agreed upon definition of what constitutes “significant” damage. However, the International Law Commission has interpreted the term as requiring damage that is more than merely “detectable,” but not necessarily “serious” or “substantial.”¹³⁵

Prior to undertaking or authorizing a project that has the potential to cause transboundary environmental damage, countries must conduct a preliminary assessment to determine whether there is a risk of significant damage.¹³⁶ Projects that are found to present such risks must undergo a more comprehensive environmental impact assessment. Under international law, the assessment must be completed prior to the commencement of the project, but countries otherwise have broad discretion in conducting the assessment.¹³⁷ In this regard, the ICJ has observed that international law does not “specify the scope and content of an environmental impact assessment” and thus “it is for each [country] to determine in its domestic legislation or in the authorization for the project, the specific content of the environmental impact assessment required in each case.”¹³⁸ The U.S. and many other countries do, however, have domestic laws governing the conduct of environmental impact assessments. Many countries’ laws require consultation with potentially affected parties and the general public during the environmental impact assessment. Moreover, where the environmental impact assessment confirms that a project could cause significant transboundary environmental harm, the relevant country must notify and consult with other potentially affected countries and relevant international organizations.¹³⁹

131 *Id.* at 111 – 116. See also Pulp Mills Case, *supra* note 128, at 187 & 197.

132 Pulp Mills Case, *supra* note 128, at 197.

133 As discussed in Part 2, depending on where and how they are performed, seaweed cultivation projects could have a range of harmful effects on marine ecosystems (e.g., reducing genetic diversity and harming native species).

134 Pulp Mills Case, *supra* note 128, at 204.

135 INTERNATIONAL LAW COMMISSION, DRAFT ARTICLES ON PREVENTION OF TRANSBOUNDARY HARM FROM HAZARDOUS ACTIVITIES, WITH COMMENTARIES 152 (2001), <https://perma.cc/7BB3-B4MM>.

136 Certain Activities Carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua), Judgement, ICJ Rep. 2015, 665 at 706-707 (Dec. 2015) [hereinafter “Certain Activities Case”].

137 Pulp Mills Case, *supra* note 128, at 205.

138 *Id.*

139 Certain Activities Case, *supra* note 136, at 707.

5. U.S. LAWS GOVERNING SEAWEED CULTIVATION

As discussed in Part 3 above, the U.S. has jurisdiction over offshore areas extending 200 n.m. from its coast, and further in some circumstances.¹⁴⁰ Under international law, the U.S. has full “sovereign rights” within that area, including rights to explore, exploit, conserve, and manage natural resources.¹⁴¹ The U.S. is responsible for protecting and preserving the marine environment and must oversee marine scientific research and the development and use of artificial islands and other structures within its jurisdictional areas.¹⁴² This part discusses key U.S. federal and state laws that could apply to seaweed cultivation projects undertaken in areas under U.S. jurisdiction.

5.1 Siting Facilities in U.S. Waters

Seaweed cultivation projects could, in some circumstances, require the installation of offshore structures, either floating or moored. For example, the seaweed may be grown on lines or other structures, which could be anchored to the seabed or free-floating. Non-anchored, free-floating techniques are popular due to low installation and maintenance costs.¹⁴³ Some seaweed cultivation projects may also be co-located with offshore energy facilities, including wind turbines, which would likely need to be anchored to the seabed.¹⁴⁴ In order to take advantage of higher wind speeds further from shore, the turbines would likely be situated in federal waters, but some seaweed cultivation projects could occur closer to shore.

5.1.1 Projects in U.S. Federal Waters

Both anchored and floating offshore structures, including those used to grow seaweed, require authorization from the U.S. Coast Guard (“USCG”) under the aids to navigation program.¹⁴⁵ Before issuing such authorization, USCG must confirm that the structure is appropriately marked and complete any necessary environmental and other reviews under the National Environmental Policy Act (“NEPA”), Endangered Species Act (“ESA”), the Coastal Zone Management Act (“CZMA”), and other statutes.¹⁴⁶

NEPA requires federal agencies, including USCG, to prepare an environmental impact statement (“EIS”) for any major federal action “significantly affecting the quality of the human environment.”¹⁴⁷ The requirement applies whether the agency takes the action itself

¹⁴⁰ See *supra* Part 3.1.

¹⁴¹ UNCLOS, *supra* note 42, Art. 56(1)(a).

¹⁴² *Id.* at Art. 56(1)(b).

¹⁴³ Garcia-Poza et al., *supra* note 20, at 6539.

¹⁴⁴ Floating wind turbines, although not yet a widely used technology, are in early development. See Xin Shen et al., *Study of the unsteady aerodynamics of floating wind turbines*, 145 ENERGY 793, 793 (2018).

¹⁴⁵ 33 C.F.R. § 64.21 (requiring the owner or operator of an offshore structure to “apply for Coast guard authorization” prior to installation). See also *id.* §§ 64.03 (indicating that the regulations apply to structure located in “waters subject to the jurisdiction of the U.S.”) & 64.04 (defining “structure”).

¹⁴⁶ *Id.* §§ 64.21, 64.23, & 66.01-5. See also U.S. Coast Guard, Aids to Navigation Manual Administration (2005), https://media.defense.gov/2017/Mar/29/2001724016/-1/-1/O/CIM_16500_7A.PDF.

¹⁴⁷ 42 U.S.C. § 4321 et seq., 4332(2)(C).

or authorizes or funds the action.¹⁴⁸ The EIS must assess the natural, economic, social, and cultural resource effects of the action, and the agency is required to release relevant documents to the public and consider their input.¹⁴⁹

Under the Endangered Species Act (“ESA”), USCG may be required consult with the Fish and Wildlife Service (“FWS”) before taking any action that may affect terrestrial or freshwater species, which have been listed as endangered¹⁵⁰ or threatened^{151,152} USCG may also be required to consult with FWS to ensure activities do not harm seabirds under the Migratory Bird Treaty Act.¹⁵³ Where an action may affect endangered or threatened marine species, or could harm “essential fish habitat” designated under the Magnuson-Stevens Fishery Conservation and Management Act, USCG may be required to consult with the National Marine Fisheries Service (“NMFS”).¹⁵⁴

Where the USCG authorized construction will affect¹⁵⁵ land or water use or natural resources in state waters, and the relevant state has adopted a management plan under the CZMA, USCG must ensure consistency with the state plan.¹⁵⁶ In such situations, USCG must submit a consistency determination to the relevant state,¹⁵⁷ and, if the state objects to the determination, USCG must work with it to address the objection.¹⁵⁸

Some seaweed cultivation projects, like those co-located with offshore wind turbines, may require use of the seabed. Persons wishing to make use of the outer continental shelf (“OCS”)—i.e., the seabed underlying U.S. federal waters (extending three, or in Texas and west coast of Florida, nine to 200 n.m. from the coast)—must obtain approval from the federal government.¹⁵⁹ The Department of the Interior’s Bureau of Ocean Energy Management (“BOEM”) is authorized to lease areas of the OCS under the OCSLA.¹⁶⁰ Under section 8(p)(1) of the OCSLA, BOEM may only grant leases for activities that:

148 40 C.F.R. § 1508.18(a).

149 42 U.S.C. 4332(2)(C).

150 A species is considered “endangered” if it “is in danger of extinction throughout all or a significant portion of its range.” See 16 U.S.C. § 1532(6).

151 A species is considered “threatened” if it “is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” See *id.* § 1532(20).

152 *Id.* § 1536(a)(2).

153 16 U.S.C. § 703(a).

154 *Id.* § 1855(b)(2).

155 An activity “will affect” land or water use or natural resources if it has “any reasonably foreseeable effect on any coastal use or resource . . . Effects are not just environmental effects, but include effects on coastal uses. Effects include both direct effects which result from the activity and occur at the same time and place as the activity, and indirect (cumulative and secondary) effects which result from the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.” 15 C.F.R. § 930.11(g).

156 16 U.S.C. § 1456(c).

157 *Id.* § 1456(c)(1)(C); 15 C.F.R. § 930.39.

158 If resolution cannot be reached, BOEM may only proceed with leasing after serving the state with a notice, which clearly describes how leasing is consistent with the state management plan, to the maximum extent practicable. See 15 C.F.R. § 930.43.

159 ADAM VANN, CONG. RESEARCH SERV., R40175, WIND ENERGY: OFFSHORE PERMITTING 3 (2012), <https://perma.cc/36W3-3E66> (indicating that “[u]se of federal and federally controlled lands, including the OCS [i.e., the outer continental shelf], requires some form of permission”).

160 43 U.S.C. § 1301 et seq.

- (A) support exploration, development, production, or storage of oil or natural gas . . . ;
- (B) support transportation of oil or natural gas, excluding shipping activities;
- (C) produce or support production, transportation, or transmission of energy from sources other than oil and gas; or
- (D) use, for energy-related purposes or for other authorized marine-related purposes, facilities currently or previously used for activities [relating to oil, gas, and other mineral development on the OCS].¹⁶¹

BOEM could issue leases for the development of wind turbines to power seaweed cultivation projects under paragraph (C) above. Leases must be issued through a competitive auction process, unless BOEM determines that there is no competitive interest in the area.¹⁶² BOEM can propose areas for leasing on its own motion or accept requests from interested parties but, in both cases, must publish a notice in the Federal Register seeking expressions of interest in the area.¹⁶³ If an expression(s) of interest is received, BOEM must auction leases,¹⁶⁴ otherwise leases will be issued on a non-competitive basis.¹⁶⁵

When issuing leases, BOEM must comply with various procedural requirements, including conducting an environmental review, and consulting with other federal, state, and local government agencies as follows:

- As explained above, NEPA requires federal agencies, including BOEM, to conduct an environmental review for any major federal action “significantly affecting the quality of the human environment.”¹⁶⁶
- Under the ESA, BOEM must consult with FWS before issuing any lease or taking any other action that may affect threatened or endangered species. BOEM may also be required to consult with FWS and NMFS under other species protection laws (e.g., the Migratory Bird Treaty Act and Magnuson-Stevens Fishery Conservation and Management Act) as explained above.¹⁶⁷
- BOEM is also required to ensure authorized activities do not harm historic properties and religious sites of importance to American Indians. The National Historic Preservation Act requires federal agencies to take into account the effect of any license authorization on historic properties.¹⁶⁸ On the OCS, these include shipwrecks, sunken aircraft, and prehistoric archeological sites.¹⁶⁹ If a place of religious significance to American Indians may be affected, BOEM may need to consult with Indian religious

¹⁶¹ 43 U.S.C. § 1337(p)(1).

¹⁶² *Id.* § 1337(p)(3). See also 30 C.F.R. Part 585, Subpart B. For a more detailed discussion of federal requirements on BOEM leasing, see ROMANY M. WEBB & MICHAEL B. GERRARD, POLICY READINESS FOR OFFSHORE CARBON DIOXIDE STORAGE IN THE NORTHEAST 17-21 (2017), <https://perma.cc/V3NF-7VE5>.

¹⁶³ 30 C.F.R. §§ 585.210 & 585.230.

¹⁶⁴ *Id.* §§ 585.220 & 585.231.

¹⁶⁵ *Id.* §§ 585.212 & 585.231.

¹⁶⁶ See *supra* notes 145-47.

¹⁶⁷ See *supra* notes 148-53.

¹⁶⁸ 54 U.S.C. §§ 306101-31

¹⁶⁹ BOEM, *National Historic Preservation Act*, <https://perma.cc/N6KH-2CWN> (last visited Jan. 21, 2020).

practitioners pursuant to the American Indian Religious Freedom Act.¹⁷⁰

- BOEM must consult with other federal agencies with an interest in, and state and local governments affected by, the lease.¹⁷¹ BOEM must also ensure consistency with any relevant state management plan under the CZMA.¹⁷²

Once BOEM has completed the various reviews and consultations, it will evaluate the effect of leasing on the human, marine, and coastal environments.¹⁷³ It must then develop measures to mitigate any adverse effects.¹⁷⁴

With a BOEM-issued lease in hand, the lessee has the right to install and operate facilities on a designated portion of the OCS,¹⁷⁵ subject to the lessee obtaining any necessary approvals from other agencies.¹⁷⁶ If the lessee wishes to install a structure that will be permanently or temporarily attached to the seabed, he/she/it must obtain a permit from the Army Corps of Engineers (“ACE”).¹⁷⁷ Thus, for example, an ACE permit would be required to anchor or otherwise attach offshore wind turbines or other facilities to the seabed. In issuing permits, ACE evaluates the probable impacts of construction of the facility on the public interest, balancing its beneficial and detrimental effects.¹⁷⁸ As part of this balancing test, ACE will consider the need for the construction, and its likely effect on other uses of the area.¹⁷⁹ In addition, if the construction is in an area with recognized historic, cultural, scenic, conservation, recreational, or similar values, ACE must consider its likely effects on those values.¹⁸⁰ ACE must also complete any necessary environmental and/or other reviews, for example, under NEPA¹⁸¹ and work with the relevant coastal state(s) to ensure the project is consistent with any management plan(s) adopted under the CZMA.¹⁸²

If the structure extends significantly above the surface of the water, additional requirements may be imposed by Federal Aviation Administration (“FAA”) regulations. Under the

170 BOEM, *Characterizing Tribal Cultural Landscapes Volume I: Project Framework* (2017), <https://perma.cc/J9ZP-EUAE>; 42 U.S.C. §1996.

171 43 U.S.C. § 1337(p)(7) (requiring the BOEM to “provide for coordination and consultation with the Governor of any State or the executive of any local government that may be affected by a lease”); 30 C.F.R. § 585.203 (providing that, when awarding leases, the BOEM will consult with “relevant federal agencies” and “any affected State, the executive of any affected local government, and any affected Indian Tribe”).

172 See *supra* notes 154–57.

173 30 C.F.R. § 585.211(b)(2).

174 *Id.* § 585.211(2).

175 *Id.* § 585.200(a).

176 *Id.* For a more detailed discussion, see Webb & Gerrard, *supra* note 162, at 24–26.

177 33 C.F.R. § 322.3(a)–(b).

178 *Id.* § 320.4(a)(1).

179 *Id.* § 320.4(a)(2).

180 *Id.* § 320.4(e).

181 *Id.* §§ 320.4(h), 325.2(a)(4). ACE’s NEPA review will need to be coordinated with any reviews undertaken by other federal, state, and/or local agencies.

182 16 U.S.C. § 1456(c). Under the CZMA, all federally-approved actions that affect coastal uses or resources must be consistent with state management plans, to the maximum extent practicable. See *id.* § 1456(c)(3). This includes actions undertaken by non-federal agencies that require federal approval. Such actions are deemed to affect coastal uses or resources if they occur within state waters and the relevant state has listed the action in its management plan. See 15 C.F.R. § 930.53. Actions requiring ACE permits have been listed in the management plans adopted by Connecticut, Delaware, Massachusetts, New Jersey, New York, Rhode Island, and Virginia.

regulations persons proposing to construct structures above 200 feet must generally notify the FAA in advance.¹⁸³ If the FAA determines that the structure may result in obstruction or interference with the navigable airspace, the agency will then conduct a study to assess the extent of the hazard.¹⁸⁴ Following the study, the FAA may make one of three findings: (1) a finding of “no hazard,” in which case the structure can be installed without marking or lighting; (2) a finding of “no hazard, subject to conditions,” in which case the structure can only be installed if specified marking, lighting, or other requirements are met; or (3) a finding of “hazard,” in which case the structure cannot be installed.¹⁸⁵ Wind turbines are typically required to meet white paint and synchronized red light requirements.¹⁸⁶

Additional permits and other regulatory requirements could also apply, depending on the nature and location of the offshore structures to be installed. For example, projects involving anchoring or discharging of material in a marine sanctuary would require a permit from NOAA.¹⁸⁷

Finally, construction of structures may also raise supply chain considerations. To the extent that any construction is deemed to be engaging in trade, the vessels carrying construction materials may need to obtain a certificate of documentation with endorsement for that trade from the U.S. Coast Guard.¹⁸⁸ Trade includes the transportation of merchandise between points within 20 n.m. of shore,¹⁸⁹ which could include transportation of construction materials. The Jones Act further requires that shipping between U.S. ports must be conducted by U.S.-flag ships,¹⁹⁰ and within U.S. waters extending 200 n.m. offshore, platforms attached to the seabed must be serviced by U.S.-flag ships, if the ship departs from a U.S. port.¹⁹¹ Building out the infrastructure of these projects would thus require investment both in the projects themselves and likely in U.S.-flag ships capable of carrying supplies to build and service them.

5.1.2 Projects in U.S. State Waters

The construction of anchored and floating offshore structures for the purposes of seaweed cultivation in state waters is likely to require state aquaculture permits. Several states have laws dealing specifically with aquaculture or seaweed farming. For example, in Alaska, permits are required from the Alaska Department of Fish and Game and Department of Natural Resources to engage in seaweed farming in state waters.¹⁹² Alaska offers many permittees a Joint-Agency Aquatic Farming Application that can be used to obtain the required a site lease from the state Department of Natural Resources, a farm operation permit from the Department of Fish and Game, and a Special Area Permit from the Department of Fish and

183 14 C.F.R. § 77.9.

184 49 U.S.C. § 44718(b). See also 14 C.F.R. § 77.27-77.31.

185 14 C.F.R. § 77.31. See also Fed. Aviation Admin., FAA Determinations, <https://perma.cc/G7QT-U99T> (last visited Aug. 5, 2021).

186 Fed. Aviation Admin., *Wind Turbine FAQs*, <https://perma.cc/K3XD-2TVF> (last updated Jan. 21, 2021).

187 See, e.g., 15 C.F.R. §§ 922.61-62.

188 42 U.S.C. § 12102.

189 46 C.F.R. § 67.3.

190 46 U.S.C. § 50101.

191 JOHN FRITTELLI, CONG. RESEARCH SERV., R45725, SHIPPING UNDER THE JONES ACT: LEGISLATIVE AND REGULATORY BACKGROUND 9 (2019), <https://fas.org/sqp/crs/misc/R45725.pdf>.

192 ALASKA STAT. ANN. § 16.40.100 (West 2012) Alaska Department of Fish and Game, *Applying for Operation Permit*, <https://perma.cc/7AXF-WS3V> (last visited Jan. 21, 2021).

Game if the farm is located in critical habitat area, state refuge, or sanctuary.¹⁹³ Other states with permitting requirements include California, where the owners of aquaculture facilities are required to register yearly with the Department of Fish and Wildlife.¹⁹⁴ The aquaculture permits required to operate aquaculture farms in California state waters include a Fish and Wildlife permit for seabed and water column activity, a Coastal Development Permit, and permits from local jurisdictions.¹⁹⁵ In Maine, an aquaculture farm lease is required from the state Department of Marine Resources.¹⁹⁶ Maine includes a Limited Purpose Aquaculture License option, which allows applicants to apply for a one-year license on no more than 400 square feet without the extensive review required for standard leases.¹⁹⁷ Connecticut issues aquaculture seaweed producer licenses¹⁹⁸ and requires permits from the state Department of Agriculture and Department of Energy and Environmental Protection.¹⁹⁹

Notably, some states' aquaculture laws only provide for the issuance of permits for shellfish or finfish and do not anticipate the permitting of seaweed cultivation.²⁰⁰ For instance, this is true in New Jersey,²⁰¹ Delaware,²⁰² and Washington.²⁰³ The statutes and regulations in these states do not expressly prohibit seaweed cultivation, but the lack of permitting guidelines may make such operations more difficult. The North Carolina Department of Agriculture and Consumer Services issues aquaculture licenses for only a set list of species, none of which include seaweed.²⁰⁴ Under North Carolina law, "[a]ll other species are prohibited from propagation and production unless the applicant for the permit first obtains written permission from the Wildlife Resources Commission."²⁰⁵

Various other state approvals may also be required. For example, seaweed cultivation projects that require the use of the seabed will need additional approvals for that use. Generally, as the land underlying state waters is publicly owned, a lease or similar authorization must be obtained from the relevant coastal state prior to the construction of any facilities utilizing

193 *Id.*

194 CAL. FISH & GAME CODE § 15101 (West 2018).

195 California Department of Fish and Wildlife, *Permit Guide to Aquaculture in California*, <https://permits.aquaculturematters.ca.gov/Permit-Guide#454737-local-jurisdictions-counties-harbor--special-districts> (last visited Aug. 11, 2021).

196 State of Maine Department of Marine Resources, *Aquaculture Lease Applications and Forms*, <https://perma.cc/HT5G-B2RE> (last visited Jan. 21, 2021).

197 *Id.*

198 Connecticut Department of Agriculture, *Seaweed*, <https://portal.ct.gov/DOAG/Aquaculture1/Aquaculture/Seaweed/Seaweed> (last visited Aug. 11, 2021).

199 Connecticut Department of Agriculture, *Cultivation of Kelp in the State of Connecticut*, <https://portal.ct.gov/DOAG/News/2015/CULTIVATION-OF-KELP-IN-THE-STATE-OF-CONNECTICUT> (last visited Aug. 11, 2021).

200 For instance, New Jersey's aquaculture permits only apply to shellfish operation. State of New Jersey Department of Agriculture, *New Jersey Aquaculture*, <https://www.jerseyseafood.nj.gov/aquaculture.html> (last visited April 23, 2021).

201 State of New Jersey Department of Agriculture, *New Jersey Aquaculture*, <https://www.jerseyseafood.nj.gov/aquaculture.html> (last visited April 23, 2021).

202 Delaware Division of Fish and Wildlife, *Shellfish Aquaculture*, <https://dnrec.alpha.delaware.gov/fish-wildlife/fishing/shellfish-aquaculture/> (last visited Aug. 11, 2021).

203 State of Washington Department of Ecology, *Aquaculture*, <https://ecology.wa.gov/Water-Shorelines/Shoreline-coastal-management/Aquaculture> (last visited Aug. 11, 2021).

204 North Carolina Department of Agriculture and Consumer Services, *NCDA&CS Aquaculture License Information*, <http://www.ncagr.gov/markets/aquaculture/license.htm> (last visited Aug. 11, 2021).

205 N.C. GEN. STAT. ANN. § 106-761(b) (West 1997).

the seafloor.²⁰⁶ Several coastal states have established environmental review requirements, sometimes referred to as little NEPAs, that require an assessment of the environmental impacts of permitted activities.²⁰⁷ Many of the little NEPAs provide that if a federal EIS is prepared, no additional state EIS is required.²⁰⁸ In some states, state jurisdiction over coastal waters overlaps with local jurisdiction. For example, New York courts have recognized municipality ownership of submerged lands in some instances.²⁰⁹ This could create overlapping state and local permitting processes for aquaculture activities.²¹⁰

Seaweed cultivation projects in state waters may also require various federal approvals. For example, vessels carrying materials to seaweed farms would likely need to obtain a certificate of documentation from the U.S. Coast Guard.²¹¹ Permits may also be required from ACE under the Rivers and Harbors Act (“RHA”) and the CWA. Under RHA, ACE permits are required for certain regulated activities, including the placement or removal of structures and modification of the navigable waterway, conducted within three miles of the shore.²¹² Seaweed farms could interfere with navigation and thus require ACE permits even if they do not involve structures attached to the sea floor. CWA section 404 permits are required to discharge dredge and fill materials into waters within three miles of the shore.²¹³ This in turn would trigger a CWA section 401 water quality certification requirement from the state or tribe in which the discharge originates.²¹⁴ Aquaculture projects may require CWA permits when they discharge seabed sediments that qualify as fill materials under the Act.²¹⁵ These permits may either be issued as general permits, if impacts are minor, or individual permits, with more lengthy and complicated requirements.²¹⁶ Some analysis suggests that seaweed operations would require individual ACE permits, since large-scale commercial seaweed aquaculture is a relatively novel activity in the U.S. with little known environmental impacts.²¹⁷

206 See e.g., CONN. GEN. STAT. § 22a-361 (providing that a certificate is required to erect any structure in the tidal, coastal, or navigable waters of the state). See also Webb & Gerrard, *supra* note 162, at 52-55.

207 NEPA.gov, *States and Local Jurisdictions with NEPA-like Environmental Planning Requirements*, <https://perma.cc/Z674-SSZJ> (last visited Jan. 21, 2021). Examples include the California Environmental Policy Act, the New York State Environmental Quality Review Act, and similar acts in several other coastal states.

208 For instance, in California, state or local agencies are directed to use the federal EIS rather than preparing a state environmental assessment when the state assessment has not yet been completed and the EIS complies with state guidelines. CAL. CODE REGS. tit. 14, § 15221.

209 See, e.g., *Town of Oyster Bay v. Commander Oil Corp.*, 96 N.Y.2d 566, 572 (N.Y., 2001).

210 For instance, the Town of Islip, New York established a Bay Bottom Licensing Program, approved by the New York State Department of Environmental Conservation (DEC). See Town of Islip, *Great South Bay Shellfish Cultivation Facility*, <https://perma.cc/F43D-LQG5> (last visited Jan. 21, 2021). Across New York, DEC is responsible for issuing commercial fishing and aquaculture permits. 6 C.R.R.-N.Y. § 48.3(a).

211 42 U.S.C. § 12102; 46 C.F.R. § 67.7, 67.3 (Any vessel that engages with fisheries must obtain a certificate, and fisheries under these regulations include marine vegetation).

212 33 U.S.C. § 403.

213 *Id.* § 1344.

214 *Id.* § 1341(a)(1). Section 401 applies to discharges into U.S. waters (up to 2.6 n.m. from shore). *Id.* The state or tribe where the discharge originates must certify that the activity will meet water quality standards. *Id.*

215 Eric Laschever et al., *U.S. Aquaculture’s Promise: Policy Pronouncements and Litigation Problems*, 50 ENVTL. L. REP. 10826, 10828 (2020).

216 Catherine Janasie & Amanda Nichols, *Navigating the Kelp Forest: Current Legal Issues Surrounding Seaweed Wild Harvest and Aquaculture*, 33 NAT. RESOURCES & ENV’T 17, 18 (2018).

217 *Id.*

5.1.3 Projects Implicating Tribal Rights

Some seaweed cultivation projects, especially if they have a large impact on fish habitat, may implicate tribal rights. Native American tribes have secured rights to protect their property and way of life through several treaties with the U.S. government, in turn recognized through congressional legislation and judicial decisions. Several treaties secure the rights of Native Americans to fish in historical fishing waters. For instance, the 1855 Treaty of Point Elliott states: “The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory.”²¹⁸ The geographic scope of the fishing rights is not specified in the treaties, but the Washington Supreme Court recognized that they would extend to areas ceded to the United States by the tribes, and those areas “actually used” and occupied for an extended period of time.²¹⁹ As recognized by the 9th Circuit, tribal rights to take fish create an implied duty on the part of state and federal governments to avoid damage to such fish habitat.²²⁰ Seaweed cultivation projects could, if implemented on a wide enough scale, impact the ability of tribes to take fish from historically-recognized ocean fishing areas. Consultation with tribes with rights to fish in affected areas could address such concerns.

Where seaweed cultivation projects require permitting from U.S. federal agencies, and where those projects have substantial direct effects on Indian tribes, consultation is required with the tribes affected. Executive Order 13175 states: “Each agency shall have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications.”²²¹ Policies that have tribal implications are “regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on one or more Indian tribes”²²² Permits granted by federal agencies to seaweed cultivation projects that may implicate treaty rights, such as those to take fish in historical fishing areas, may thus require consultation with tribes. NOAA has prepared guidelines for such consultations, which detail the procedures for initiating consultation, responding to requests for consultation, and determining consultation structure.²²³

The western coastal states of Alaska, Washington, Oregon, and California each have established policies for consultation with native tribes where state agency activities will affect or significantly affect tribal interests. In Alaska, federally recognized tribes and the state government signed a Millennium Agreement in 2001 that directed tribes and the state to develop an effective process to consult on issues of mutual concern.²²⁴ The Alaska Department of Environmental Conservation developed a consultation policy for “any department action(s)

218 Treaty with the Dwamish, Suquamish, etc., (commonly known as Treat of Point Elliot), art. 5, Jan. 22, 1855, 12 Stat. 927.

219 State v. Buchanan, 138 Wash. 2d 186, 207 (1999).

220 See Richard Du Bey, Andrew S. Fuller & Emily Miner, *Tribal Treaty Rights and Natural Resource Protection: The Next Chapter United States v. Washington - The Culverts Case*, 7 AM. INDIAN L. REV. 54, 55 (2019).

221 Exec. Order No. 13175, 65 F.R. 67249 § 5(a) (2000).

222 *Id.* § 1(a).

223 NOAA, NOAA PROCEDURES FOR GOVERNMENT-TO-GOVERNMENT CONSULTATION WITH FEDERALLY RECOGNIZED INDIAN TRIBES AND ALASKA NATIVES (2013).

224 Millennium Agreement between the Federally Recognized Sovereign Tribes of Alaska and the State of Alaska, art. V(a)(16), April 11, 2001.

that significantly or uniquely affect a tribe.”²²⁵ The policy outlines a consultation process where the department and the affected tribe will agree upon participants, timeline, and communication in the consultation.²²⁶ The State of Washington similarly signed a Centennial Accord with federally recognized tribes in the state,²²⁷ and the state Department of Ecology works with tribes on environmental impact statements and other matters of concern to the tribes.²²⁸ In Oregon, the tribal consultation framework has been codified by the state legislature in Senate Bill 770, which states that “a state agency shall make a reasonable effort to cooperate with tribes in the development and implementation of programs of the state agency that affect tribes.”²²⁹ The Oregon Department of Environmental Quality responded by drafting a tribal relations policy that establishes a tribal liaison and states that the agency consults with tribal nations on water quality issues that affect tribal interests.²³⁰ In California, Assembly Bill No. 52 establishes “a new category of resources in the California Environmental Quality Act called “tribal cultural resources” that considers the tribal cultural values in addition to the scientific and archaeological values when determining impacts and mitigation.”²³¹ To establish whether a project could cause “a substantial adverse change in the significance of a tribal cultural resource,”²³² the law requires state agency consultation with native tribes prior to the issuance of an environmental impact report for a project.²³³ As described above in Section 5.1.2, seaweed cultivation projects in state waters may require state agency approval, and where that approval might affect tribal rights to the oceans such as traditional fishing rights or tribal cultural resources recognized in California, the state agencies may in turn be required to consult with affected tribes.

5.2 Discharging Materials into U.S. Waters

Seaweed cultivation projects that involve discharging materials into ocean waters may, depending on exactly where they occur, be regulated under the Marine Protection, Research, and Sanctuaries Act (“MPRSA”).²³⁴ Adopted to implement the U.S.’ obligations under the London Convention, the MPRSA regulates “the dumping of all types of materials into ocean waters” within twelve nautical miles of the U.S. coast and further in some circumstances.²³⁵

225 ALA. DEP’T ENVTL. CONSERVATION, DEPARTMENT OF ENVIRONMENTAL CONSERVATION POLICY ON GOVERNMENT-TO-GOVERNMENT RELATIONS WITH THE FEDERALLY-RECOGNIZED TRIBES OF ALASKA (2002).

226 *Id.*

227 Centennial Accord between the Federally Recognized Indian Tribes in Washington State and the State of Washington, August 4, 1989.

228 State of Washington Department of Ecology, Working with tribal governments, <https://ecology.wa.gov/About-us/How-we-operate/Tribal-relations>.

229 OR. REV. STAT. § 182.164 (2020).

230 Oregon Department of Environmental Quality, Tribal Government Relations, <https://www.oregon.gov/deq/about-us/Pages/tribal.aspx>.

231 Cal. Assem. Bill 52, 2013-2014 ch. 532.

232 CAL. PUB. RES. CODE § 21084.2 (2015).

233 *Id.* § 21080.3.1.

234 33 U.S.C. § 1401.

235 *Id.* § 1401(b).

The MPRSA defines “dumping” broadly to include any “disposition of material.”²³⁶ Notably, however, the MPRSA excludes from the definition of dumping “the construction of any fixed structure or artificial island []or the intentional placement of any device in ocean waters or on or in the submerged lands beneath such waters, for a purpose other than disposal, when such construction or such placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program” (the “MPRSA exemption”).²³⁷

Certain aspects of seaweed cultivation could involve “dumping” within the terms of the MPRSA. For example, the MPRSA definition would encompass the addition of fertilizers or substances to ocean waters to stimulate seaweed growth as that involves a “disposition of material” and does not involve the construction of any structure or placement of any device into ocean waters, meaning that the MPRSA exemption does not apply. The exemption might, however, apply to other aspects of seaweed cultivation. The installation of nets, lines, or other seaweed growing media might be viewed as involving the construction of structures or placement of devices into ocean waters for a purpose other than disposal. The view taken may ultimately depend on the nature of the growing media (i.e., because the MPRSA exemption only applies to “structures” and “devices”), how it is deposited into ocean waters (i.e., because the MPRSA only applies where materials are transported for dumping via vessel or other vehicle (see below)), and whether the deposition is regulated by other agencies (i.e., because the MPRSA exemption only applies where the deposition is “otherwise regulated by Federal or State law” or under an “authorized Federal or State program”).

In general, and with some exceptions, the MPRSA prohibits the dumping of materials into ocean waters without a permit from the Environmental Protection Agency (“EPA”). Permits are required where:

- the materials to be dumped are transported via vessel, aircraft, or other vehicle from within the U.S. (regardless of where the dumping occurs);²³⁸ or
- the materials are transported via vessel, aircraft, or other vehicle from outside the U.S. and:
 - transportation occurs on a vessel registered in the U.S. (regardless of where the dumping occurs); or
 - the dumping occurs within twelve nautical miles of the U.S. coast (regardless of

236 *Id.* § 1402(f). There are several exceptions to the definition for: (1) “a disposition of any effluent from any outfall structure to the extent that such disposition is regulated under the provisions of the Federal Water Pollution Control Act . . . or under the provisions of the Atomic Energy Act of 1954;” (2) “a routine discharge of effluent incidental to the propulsion of, or operation of motor-driven equipment on, vessel;” (3) “the construction of any fixed structure or artificial island []or the intentional placement of any device in ocean waters or on or in the submerged lands beneath such waters, for a purpose other than disposal, when such construction or such placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program.”

237 *Id.*

238 *Id.* § 1411(a)(1) (prohibiting any person transporting material from the U.S. for the purpose of dumping it into ocean waters). See also *id.* § 1402(b) (defining “ocean waters” to mean “those waters of the open seas lying seaward of the baseline from which the territorial sea is measured”).

how the materials are transported).²³⁹

EPA can only issue permits under the MPRSA if satisfied that the dumping of materials into ocean waters “will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.”²⁴⁰ EPA regulations provide for the issuance of several different types of permits, including:

- research permits, which are available where dumping occurs as part of a “research project,” where EPA determines that “the scientific merit of a proposed project outweighs the potential environmental or other damage that may result from dumping;”²⁴¹
- general permits, which may be issued for the dumping of materials that “will have minimal adverse environmental impact and are generally disposed of in small quantities;”²⁴² and
- special permits, which may be issued for the dumping of other materials that meet specified criteria established by EPA.²⁴³ The criteria relate to the effects of dumping on the environment and other ocean users and the available alternatives to dumping.²⁴⁴

Dumping can only occur at sites designated by EPA. The designated sites must be chosen so as to mitigate any adverse impacts of dumping on the environment “to the greatest extent practicable.”²⁴⁵ Where EPA decides to authorize dumping through a research or general permit, it may specify the designated site for dumping in the permit itself.²⁴⁶ In contrast, where dumping is authorized through a special permit, a separate site designation is required.²⁴⁷ When doing a separate designation, EPA must select sites that will “minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfish, and regions of heavy commercial or recreational navigation.”²⁴⁸ In selecting sites, EPA must consider:

- (1) Geographical position, depth of water, bottom topography and distance from coast;
- (2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;
- (3) Location in relation to beaches and other amenity areas;
- (4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any;

²³⁹ *Id.* § 1411(a)(2) & (b).

²⁴⁰ *Id.* § 1412(a).

²⁴¹ 40 C.F.R. § 220.3(e).

²⁴² *Id.* § 220.3(a).

²⁴³ *Id.* § 220.3(b).

²⁴⁴ *Id.* Pt. 227.

²⁴⁵ 33 U.S.C. § 1412(c).

²⁴⁶ *Id.* § 228.4(a) & (d).

²⁴⁷ *Id.* § 228.4(b).

²⁴⁸ 40 C.F.R. § 228.5.

- (5) Feasibility of surveillance and monitoring;
- (6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;
- (7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);
- (8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;
- (9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;
- (10) Potentiality for the development or recruitment of nuisance species in the disposal site;
- (11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.

Before issuing a site designation, EPA may need to conduct an environmental review under NEPA,²⁴⁹ and may be required to consult with other federal and state bodies under:

- Section 7 of the ESA, which requires federal agencies to consult with the National Marine Fisheries Service about any activity that could affect endangered or threatened marine species or their habitat.²⁵⁰
- Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, which requires federal agencies to consult with the National Marine Fisheries Service before conducting, authorizing, or funding any action that may adversely affect waters designated as “essential fish habitat.”²⁵¹
- Section 307 of the Coastal Zone Management Act, which requires federal agencies to ensure that any actions affecting land or water use or natural resources within the boundaries of a coastal state (i.e., typically three nautical miles from shore) are performed in a manner consistent with any applicable state coastal management plan to the maximum extent practicable.²⁵² The federal agency must provide the state with

249 42 U.S.C. § 4321 et seq. NEPA requires federal agencies to prepare an environmental impact statement (EIS) in relation to any major federal action that “significantly affect[s] the quality of the human environment.” *See id.* § 4332(2)(C). That requirement has been held not to apply to actions taken under the MPRSA, but EPA voluntarily conducts a NEPA review when designating sites pursuant to the Act. *See* Policy and Procedures for Voluntary Preparation of National Environmental Policy Act (NEPA) Documents, 63 Fed. Reg. 58045, 58046 (Oct. 29, 1998).

250 16 U.S.C. § 1563(a)(1). A species is considered “endangered” if it “is in danger of extinction throughout all or a significant portion of its range.” *See id.* § 1532(6). A species is “threatened” if it “is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” *See id.*

251 *Id.* § 1855(b)(2).

252 16 U.S.C. § 1456(c).

a “consistency determination,” which describes the action and its expected effects, and explains how it is consistent with the state coastal management plan.²⁵³ If the state objects, the federal agency must work with it to address the objection.²⁵⁴

253 *Id.* § 1456(c)(1)(C); 15 C.F.R. § 930.39.

254 40 C.F.R. § 930.34.

6. CONCLUSION

Deep economy-wide cuts in carbon dioxide and other greenhouse gas emissions are essential to avert the worst impacts of climate change. However, many scientists now agree that simply cutting future emissions will not be enough, and it will also be necessary to remove previously-emitted carbon dioxide from the atmosphere. There is growing interest in the potential for enhanced carbon dioxide removal via the oceans, which have absorbed approximately twenty-five percent of all carbon dioxide released into the atmosphere to date.¹

A number of approaches have been proposed for increasing carbon dioxide removal and storage in the oceans. One option is to increase carbon dioxide uptake is seaweed cultivation, which involves the farming of kelp and other macroalgae that absorbs carbon dioxide as it grows and stores it in biomass.²

The legal framework applicable to seaweed cultivation and other carbon dioxide removal projects will differ depending on precisely where they occur. Under international law, each country has jurisdiction over areas within 200 n.m. of its coastline, and further in some circumstances.³ In the U.S., coastal states have primary control over areas within three n.m. (or, in Texas and on the west coast of Florida, nine n.m.) of the coast, while the federal government controls U.S. waters further offshore.⁴

There are no international or U.S. federal laws dealing specifically with use of the oceans for carbon dioxide removal, but various general environmental and other laws could apply to projects depending on how they are conducted. Moreover, projects conducted in areas under the jurisdiction of other countries, would be subject to their laws. Potentially applicable laws in key countries will be explored in a series of (forthcoming) papers convened by the authors.

1 Gagern et al., *supra* note 17, at 9.

2 See *supra* Part 2.

3 See *supra* Part 3.1.

4 See *supra* Part 3.2.

APPENDIX A: PERMITTING REQUIREMENTS TABLE

The table below identifies the minimum permitting requirements for key water-based activities likely to be undertaken in connection with seaweed cultivation projects in U.S. waters. All seaweed cultivation projects in U.S. waters that involve the listed activities will require the listed permits. Depending on the specifics of each project, additional permits may also be required for the listed activities. For example, construction or other activities that could harm marine or other species or their habitats may require permits under the Endangered Species Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, and other species protection laws.

Table A1: Minimum Permitting Requirements for Water-Based Activities Undertaken in Connection with Seaweed Cultivation Projects in U.S. Waters

Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Construction / operation of structures floating structures (not attached to the seabed) (e.g., seaweed lines or other growing medium)	U.S. state waters	State aquaculture license	Varies (often state natural resources agency)	Varies. Several states issue aquaculture licenses for seaweed while several others only anticipate finfish or shellfish operations. In states that only anticipate finfish or shellfish operations, express consent from the natural resources agency may be required to cultivate seaweed.
		State construction approval	Varies (often state environmental agency)	Varies. Some states require an environmental review and consultation with governments, tribal, other stakeholders.
		Authorization under the Aids to Navigation Program	U.S. Coast Guard (USCG)	USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Documentation under the National Environmental Policy Act (NEPA)	USCG	USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
	U.S. federal waters	Consistency determination under the Coastal Zone Management Act (CZMA)	Varies (often state environmental agency)	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA. ⁶
		Authorization under the Aids to Navigation Program	USCG	USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Documentation under NEPA	USCG	USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.

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Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Construction / operation of structures floating structures (not attached to the seabed) (e.g., seaweed lines or other growing medium)	U.S. federal waters	Consistency determination under the CZMA	Varies (usually state environmental agency)	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with any state coastal management plan adopted under the CZMA. [^]
Construction / operation of structures attached to the seabed (e.g., wind turbines)	U.S. state waters	State lease (or similar) authorizing occupation of state submerged land	Varies (often state land management agency)	Varies. Some states require an environmental review and consultation with local governments, Native American tribes, and other stakeholders prior to lease issuance.
		State construction approval	Varies (often state environmental agency)	
		Permit under Rivers and Harbors Act (RHA)	U.S. Army Corps of Engineers (USACE)	USACE must evaluate the probable effect of construction on the public interest. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Authorization under the Aids to Navigation Program	USCG	USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Documentation under NEPA	USACE / USCG	USACE / USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
		Consistency determination under the CZMA	Varies (often state environmental agency)	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA. [^]

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Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Construction / operation of structures attached to the seabed (e.g., wind turbines)	U.S. federal waters	Federal lease or other instrument authorizing occupation of federal submerged land	U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM)	Leases can only be issued for activities specified in the Outer Continental Shelf Lands Act (includes renewable energy development). BOEM must consider the effect of leasing on the human, marine, and coastal environments. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Permit under the RHA	USACE	USACE must evaluate the probable effect of construction on the public interest. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Authorization under the Aids to Navigation Program	USCG	USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Documentation under NEPA	BOEM / USACE / USCG	BOEM / USACE / USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
Discharge of materials into ocean waters (e.g. fertilization of seaweed)~	U.S. state waters	Consistency determination under the CZMA	Varies (usually state environmental agency)	The state must be satisfied that the federal action is consistent "to the maximum extent practicable" with any state coastal management plan adopted under the CZMA.^
		Dump site designation under the MPRSA@	U.S. Environmental Protection Agency (EPA)	EPA must consider the physical, chemical, and biological characteristics of the proposed dump site and the impacts of past dumping in areas with similar characteristics. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Ocean dumping permit under the MPRSA	EPA	EPA must consider the need for, and effects of, dumping.
		Documentation under NEPA	EPA	EPA must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.

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Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Discharge of materials into ocean waters (e.g. fertilization of seaweed)-	U.S. state waters	Consistency determination under the CZMA	Varies (often state environmental agency)	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA. [^]
		Dump site designation under the MPRSA#@	EPA	EPA must consider the physical, chemical, and biological characteristics of the proposed dump site and the impacts of past dumping in areas with similar characteristics. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
		Ocean dumping permit under the MPRSA#	EPA	EPA must consider the need for, and effects of, dump-ing.
	U.S. federal waters	Documentation under NEPA	EPA	EPA must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
		Consistency determination under the CZMA#	Varies by state (usually state environmental agency)	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA. [^]

* The issuing agency may be required to consult with other government agencies under the CZMA, Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, National Historic Preservation Act, and other federal laws. Consultation may also be required with Native American tribes and other stakeholders.

[^] The federal agency authorizing the activity must provide the relevant state with a “consistency determination,” explaining how its actions are consistent “to the maximum extent practicable” with any state coastal management plan adopted under the CZMA. The state must agree with the consistency determination. If it disagrees, the federal agency must work with the state to address its objections.

Only required if materials are discharged within 12 nautical miles of the U.S. coast or, if discharge occurs further offshore, using a vessel that is registered or was loaded in the U.S.

-An open question remains over whether certain activities associated with seaweed cultivation (e.g., placement of lines and nets) will qualify for a dumping exception under the MPRSA. If they qualify for the exception, discharge permits would not be required.

@ Separate site designation only required if dumping is authorized through a special permit.



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