

Washington Seaweed Aquaculture
ECONOMIC POTENTIAL ANALYSIS

Prepared for:

Maritime Blue & Ocean Strategies, Inc.

November 2025

Prepared by:

Confluence Environmental Company
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EXECUTIVE SUMMARY

Washington State has potential to lead the U.S. seaweed farming industry by leveraging its robust marine environment and existing seafood processing infrastructure, though the sector still faces hurdles to achieve that potential. Maritime Blue contracted with Confluence Environmental Company and Greene Economics, LLC to analyze the economic potential of the seaweed aquaculture industry in Washington, focusing on seaweed production (ocean-based only), the seaweed product supply chain, and related processing infrastructure.

The research team reviewed available literature and spoke with industry participants and stakeholders to understand the current status of the seaweed industry in Washington in the context of the regional (West Coast-wide) and national industries, with an eye on the potential opportunities for growth of the industry in Washington. Based on this information, the team developed four scenarios for the Washington seaweed industry, modeling the potential impacts of strategic support for expanded production, processing, and marketing beyond the natural growth of the industry absent any additional support (business as usual). The goal of the scenarios was less to forecast industry activity, but instead to outline pathways for industry growth and consider the economic ramifications under different investment assumptions. An economic analysis was conducted using the IMPLAN model, an input/output model broadly used for regional economic impact analysis. The scenarios include analyses of the benefits of growth from Washington's local industry as well as Washington's capacity to support the broader West Coast regional seaweed industry through investments in processing and commercialization.

The results of this regional economic analysis include the direct, indirect, and induced economic impacts for each scenario in terms of employment and output (total value of production – as is used in the Gross Domestic Product, or GDP for Washington) at Year 10. This means that in addition to analyzing the possible direct industry activity in terms of employment and economic output, the upstream “ripple effect” of the industry throughout the rest of the economy is evaluated, covering input suppliers and other economic contributions associated with the industry. State and local taxes generated from the seaweed industry in Year 10 are also estimated to demonstrate the fiscal impact of each scenario. Of note is that this analysis captures the upstream, or input industries associated with seaweed production and processing. Modeling of the additional potential downstream economic impacts is too speculative for a new industry such as seaweed; this analysis therefore represents only part of the full economic stimulus that could occur in the state. Analysis results are summarized in Table ES-1 and Figure ES-1 below.

Table ES-1. Summary of Regional Economic Impacts by 10-Year Scenario

Scenario	Total Employment	Total Output (GDP)	Total Tax Revenue
Current Values	7	\$1,641,139	\$38,071
Business as Usual (BAU)	174	\$55,671,078	\$1,843,614
Production Supported	330	\$78,993,158	\$2,966,217
Processing Supported	443	\$143,578,592	\$4,522,458
Marketing Supported	294	\$93,823,245	\$3,151,458

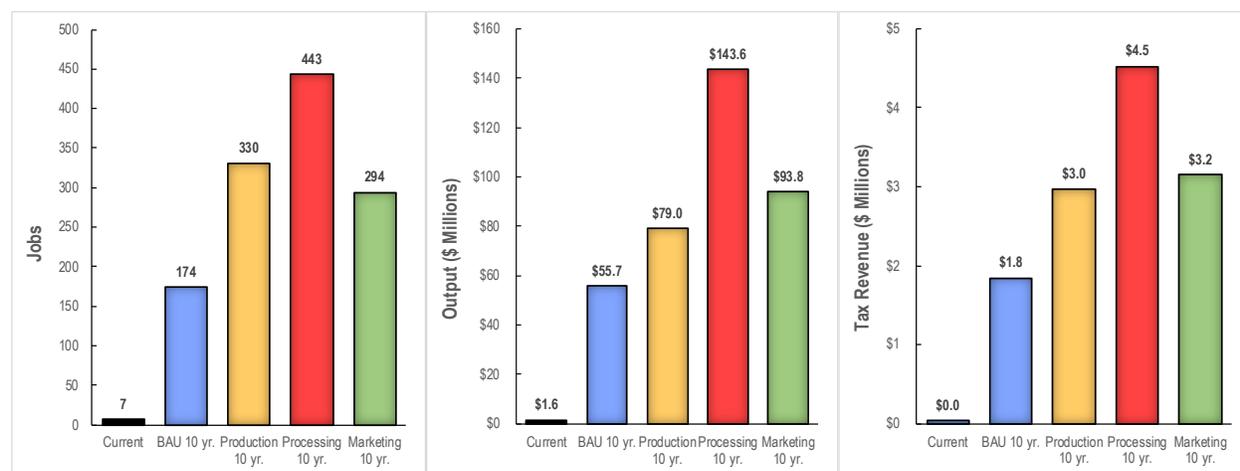


Figure ES-1. Summary of Regional Economic Impacts by Scenario in Year 10

Considering all three factors (total employment, output, and tax revenue at Year 10) of the analysis, the scenario that evaluates the application of strategic support for the *processing* sector has the most significant economic impact in Year 10, highlighting the critical role of processing infrastructure in this industry. This result is consistent with the findings of the research and outreach conducted for this project; the lack of processing infrastructure is a key limitation for the industry.

Outreach to the sector highlighted additional challenges including the complexities of the regulatory process and the nascency of the domestic seaweed market. However, the entrepreneurial capacity of industry participants, Washington’s access to major shipping lines and existing seafood, shellfish aquaculture, and terrestrial agriculture industries, among other factors, present significant opportunities for the Washington seaweed aquaculture industry. The report closes with a series of recommendations for Maritime Blue and industry proponents to consider:

1. Support development of secondary seaweed processing to allow Washington to serve as a hub for the region. This could include options to attract new and existing seaweed

processors and product development companies to Washington State for the purpose of generating accessible pathways for local and regional seaweed farmers.

2. Streamline permit and approval processes to facilitate easier entry into seaweed farming. Such streamlining could leverage existing strategies and approaches used to permit seaweed aquaculture in other states (e.g., pre-permitted areas) or for approving shellfish aquaculture farms in Washington (e.g., programmatic approvals).
3. Consider pathways to improve profitability of Washington-grown seaweed through educational campaigns or place-based marketing. For example, biostimulants made with Washington-grown seaweed could be targeted towards Washington's extensive agricultural industry, with emphasis on both ecological and economic benefits from sourcing locally.

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1.0 INTRODUCTION

Washington State has potential to lead the U.S. seaweed farming industry by leveraging its robust marine environment, established transportation networks, and existing seafood processing infrastructure. Recognizing this opportunity, Maritime Blue, a strategic alliance propelling the Pacific Northwest toward global leadership in ocean-based innovation, is administering an 18-month planning grant to support the collaborative advancement of Washington's emerging seaweed aquaculture industry. This report was produced with the support of Builders Vision. Working with established growers, Maritime Blue aims to determine optimal approaches for market development, shared infrastructure, and industry growth.

To advance this initiative, Maritime Blue contracted with Confluence Environmental Company (Confluence) and Greene Economics, LLC (Greene) to provide a Washington State-focused analysis of the economic potential of the seaweed aquaculture industry, including seaweed production, the seaweed product supply chain, and related processing infrastructure. With a long history of collaboration, Confluence and Greene brought complementary expertise to this work. Confluence has extensive background in natural resource management, environmental planning, and regulatory strategy, with direct experience in seaweed aquaculture permitting and operations. Greene has experience in regional economic analyses, including economic impact modeling using IMPLAN software for the shellfish industry, feasibility assessments, Washington permitting systems, and outreach and facilitation. This project was further supported by Ocean Strategies, Inc., which provided strategic communications to help make the report's technical findings clear and actionable, as well as aquaculture industry expertise that shaped the report's structure and key questions.

The primary objective of the study was to conduct a comprehensive analysis of the economic potential that a thriving seaweed aquaculture industry could generate within Washington State, and to identify the best opportunities for economic growth and success. This analysis centered on seaweed aquaculture as a commercial and economic opportunity rather than as a restoration strategy, though environmental benefits were noted. Seaweed, and particularly seaweed aquaculture, provides numerous ecosystem services incidental to cultivation, including improvements to water quality through nutrient bioextraction and habitat provisioning¹. Seaweed may also help mitigate the impact of stressors associated with climate change on shellfish², another significant aquaculture sector in Washington. Increasingly, these and other ecosystem services are being recognized through ecosystem service markets that are designed

¹ Cotas, J., Gomes, L., Pacheco, D., & Pereira, L. 2023. Ecosystem services provided by seaweeds. *Hydrobiology*, 2(1), 75-96. Available at: <https://doi.org/10.3390/hydrobiology2010006>

² Gobler, C. J., Young, C. S., Sylvers, L. H., Banik, U., Seo, D., & Doall, M. H. 2026. Seaweeds (*Ulva*, *Gracilaria*) significantly increase the growth rates of North Atlantic oysters, scallops, and clams grown in an aquaculture setting. *Aquaculture*, 743745. Available at: <https://doi.org/10.1016/j.aquaculture.2026.743745>

to provide payments for the provision of ecosystem services. In the future, such markets (e.g., for habitat, ecotourism, carbon credits) could become an important additional source of revenue for the seaweed industry. While beyond the scope of this report, consideration of the ecosystem services of seaweed and the associated economic benefit is worth further attention.

The study drew on the experiences of current Washington seaweed farmers, as well as an extensive literature review which provided information on potential future market demand and capacity for additional seaweed farming development in Washington State. Through research and interviews with diverse stakeholders, the team developed scenarios for Washington's seaweed farming industry growth, including production from existing farms as well as potential production from additional farms in the future. The analysis also assessed Washington's capacity to support the broader regional seaweed industry through investments in processing and commercialization activities.

The following report summarizes the work done to complete this study, including a final section on recommendations for industry proponents and Maritime Blue to consider as they endeavor to support the state's seaweed industry.

1.1 History

Growing seaweed for commercial use has the potential to benefit farmers, communities, and the environment. Under the right conditions, seaweed aquaculture can reduce the localized impacts of low-oxygen coastal "dead zones," mitigate the risk of harmful algal blooms, absorb excess nutrients from human activities, and support biodiversity within coastal marine ecosystems.³ Seaweed cultivation requires no fresh water, nor arable land, nor herbicides or pesticides, making it highly resource-efficient when compared to traditional agriculture.

In addition to these environmental benefits, seaweed is a valuable natural resource for human use and consumption. Seaweed, in some form or another, has been cultivated by humans for food, for medicine, and as a component material for thousands of years,⁴ but it wasn't until the First World War that it began to see industrial production in the U.S.⁵ As per Neushul's "Seaweed for War," kelp (a type and subset of seaweed) was an excellent source of potassium and could be burned to produce potash, a vital component for both fertilizers and black gunpowder. During the war, with German potash supplies cut off, the U.S. turned to domestic production, partially in the form of wild-harvested Californian giant kelp. After the end of the war, the resumption of German potash exports to the U.S. rendered the California kelp industry

³ NOAA Fisheries. Seaweed Aquaculture. Available at: <https://www.fisheries.noaa.gov/national/aquaculture/seaweed-aquaculture>

⁴ Ainis, et al. 2014. Using non-dietary gastropods in coastal shell middens to infer kelp and seagrass harvesting and paleoenvironmental conditions. *Journal of Archaeological Science*, Vol. 49: 343-360. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0305440314002027>

⁵ Neushul, P. 1989. Seaweed for War: California's World War I Kelp Industry. *Technology and Culture*. 30(3), 561-583. Available at: <https://gwern.net/doc/science/chemistry/1989-neushul.pdf>

non-competitive, and industrial kelp harvest and use severely declined throughout the country.⁶ However, seaweed production did not entirely vanish from the United States, and over the following decades new products were developed making use of its unique qualities.

In the 1980s, seaweed aquaculture in Washington State began with an ambitious attempt to cultivate nori seaweed (*Pyropia yezoensis*) in Puget Sound. The project aimed to capitalize on Washington's favorable year-round temperatures for *Pyropia* cultivation and the growing demand for nori sheets from the expanding sushi restaurant market.⁷ Despite initial technical success and the formation of the Pacific Northwest Nori Growers Association along with the development of several new businesses, the industry faced insurmountable regulatory and social challenges. Complex permitting requirements, heightened sensitivity to visual and operational impacts of proposed seaweed farms from shoreline property owners, and political resistance ultimately terminated *Pyropia* aquaculture in Washington's coastal waters by the late 1980s.⁸

In the 2010s, the U.S. seaweed farming industry began to pick up steam, with rapid production increases and millions of pounds of seaweed being farmed across the coastal U.S., primarily in Maine, Alaska and some farming in Washington State.⁹ Simultaneously, the value of seaweed and kelp to local ecosystems has become more widely recognized, and concerted efforts to raise its profile led to the designation of bull kelp as the official “Washington State Marine Forest” in April of 2025. Despite wide agreement on the ecological importance of native kelp species, significant regulatory, social license, and market access hurdles remain for would-be kelp farmers in Washington. Additional detail on the current seaweed farming process and the seaweed value chain is included in Section 1.3 and Appendix A.

1.2 Species and Products

The species of seaweed most commonly grown across the United States today include sugar kelp (*Saccharina latissima*), dulse (*Palmaria palmata*), *Gracilaria coronopifolia*, bull kelp (*Nereocystis luetkeana*), and *Ulva* spp.¹⁰ Sugar kelp is the most widely cultivated of these species, having been certified as fit for human consumption, processed food products, personal care products, health supplements, and fertilizer.¹¹ Figure 1 provides a breakdown of the different species grown in Washington as well as the common target markets.

⁶ Ibid.

⁷ Kim, et al. 2024. Opportunities, challenges and future directions of open-water seaweed aquaculture in the United States. *Phycologia*. 58 (5), 446-461. Available at: <https://doi.org/10.1080/00318884.2019.1625611>

⁸ Ibid.

⁹ Donovan, B. 2025. An economic and production analysis of seaweed farms in California and the Pacific Northwest. Available at: <https://digitalcommons.humboldt.edu/cgi/viewcontent.cgi?article=3340&context=etd>

¹⁰ Sea Grant. 2021. Commercially Cultivated Domestic Seaweed 101. Available at <https://seaweedhub.extension.uconn.edu/wp-content/uploads/sites/3646/2021/10/seaweed-infographic.png>

¹¹ Ibid.

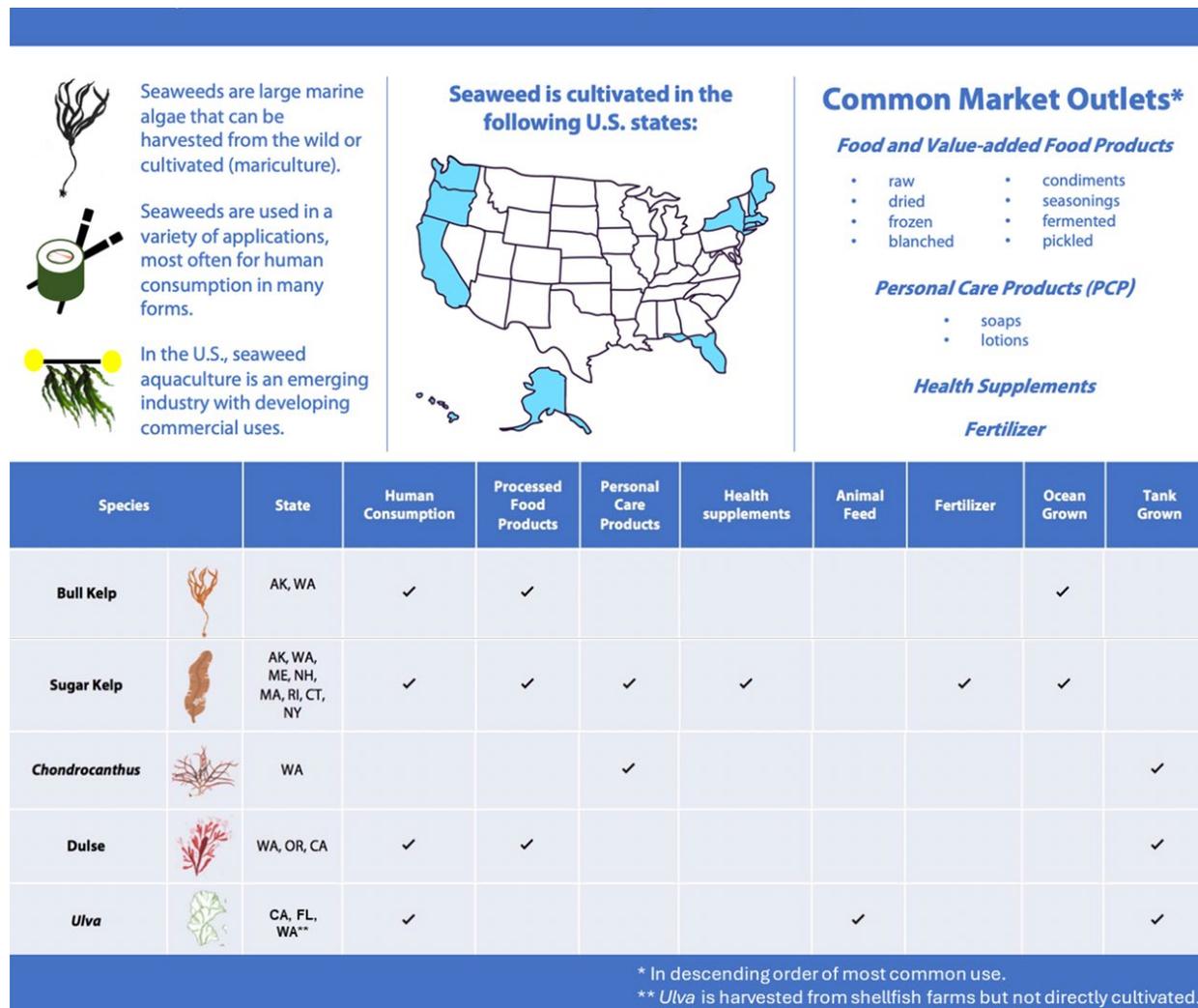


Figure 1. Commercially Cultivated Seaweed in Washington

Source: Adapted from Sea Grant 2021¹²

1.3 Seaweed Value Chain

Seaweed aquaculture, particularly ocean-based aquaculture in the U.S., follows a relatively standard series of production and processing steps. Once permits and approvals have been received (depending on federal, state, and local regulations), seaweed farmers can install gear for growing seaweed and establish their farm. Farmers must also identify a reliable seed source for their farm. For kelp species (like those grown in Washington), reproductive material must be collected from wild populations and then taken to a hatchery or nursery and raised in the lab to produce kelp “seed”. Seed is then planted on spools of line and left to grow out for several months, often late fall through spring. After harvesting, seaweed goes through primary processing (chopping, shredding, grinding, etc.) and stabilization (drying, freezing, chemical

¹² Ibid.

alteration) steps to create a product that can move into secondary processing or wholesale pathways. Secondary processing may occur to extract or create products for specific markets. An example of a secondary processing facility is a seaweed biorefinery, which is an integrated system that processes seaweed through a combination of physical, chemical, and biological methods to extract compounds (analog of an oil refinery). Figure 2 depicts the generalized steps in the seaweed value chain. The steps of the value chain that currently exist in Washington State (denoted by the red box) are discussed further in Appendix A.

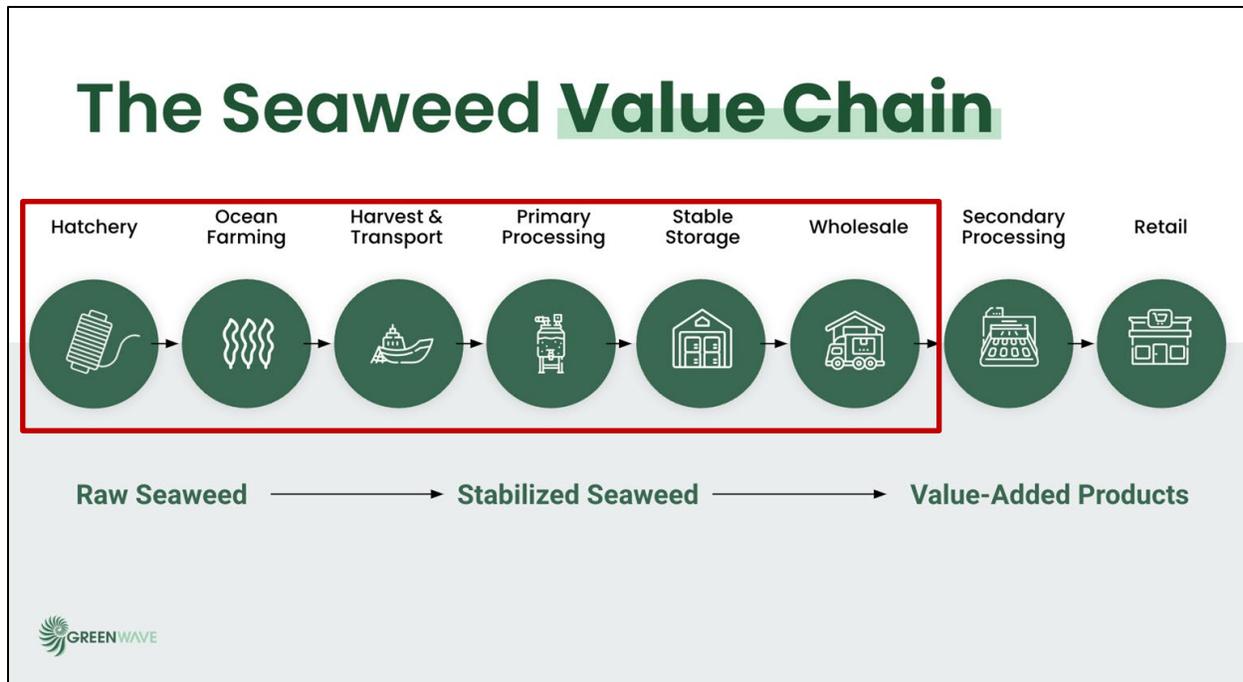


Figure 2. Generalized Seaweed Value Chain

Source: Adapted from GreenWave

1.4 Emerging Seaweed Product Markets

There are several seaweed products and markets expected to experience global growth within the coming years. Both the seaweed consumables and cosmetics markets are considered to already be well-established within the U.S. and are thus not included in this section. Figure 2 depicts ten global seaweed markets identified by the World Bank¹³ as having potential to expand.

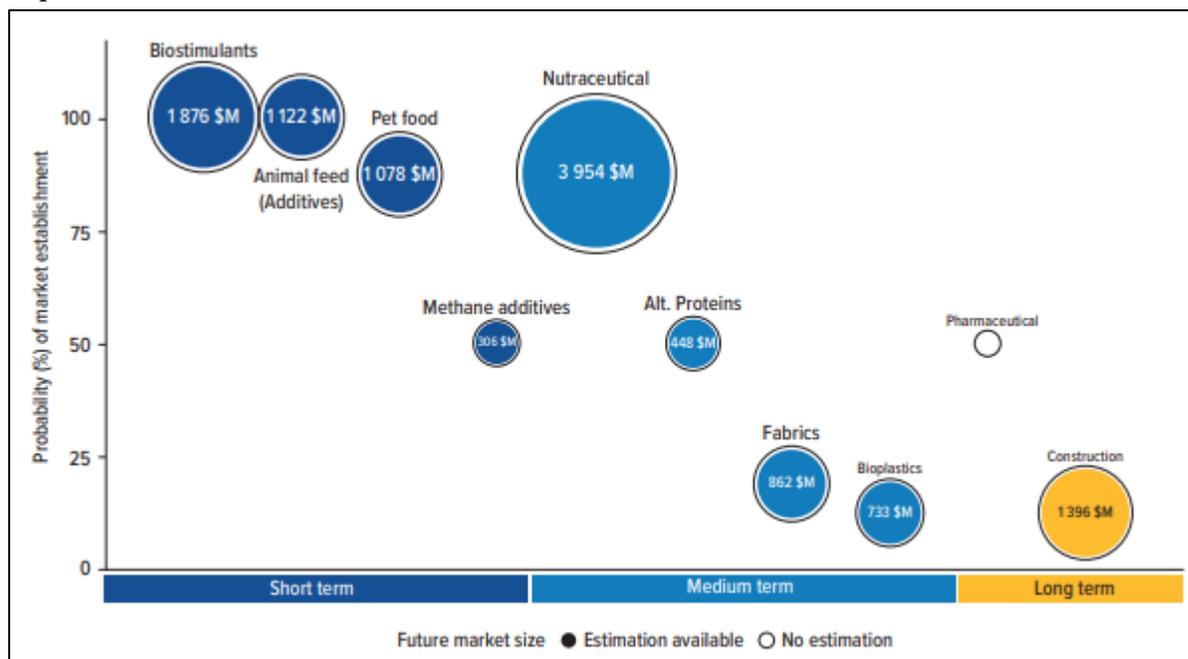


Figure 3. Predicted Seaweed Markets (Millions USD)

Source: The World Bank 2023¹⁴

The biostimulant, animal health and methane-reduction feed additive, and pet food markets have been determined to show promise in the short term (defined as ‘by 2025’ in the source report), meaning that they already display the makings of a competitive industry and are not likely to be hindered by scalability due to the relative simplicity of their production and processing infrastructure needs.¹⁵ Biostimulants are currently the fastest growing of the short-term markets.¹⁶ Biostimulants are a class of substance which enhance natural growth processes in plants and seaweed-based biostimulants have an established use history within the United States agricultural industry. Both seaweed-derived animal health and methane-reduction feed additives show promise as products which may help livestock operations improve animal productivity while cutting down on feed conversion ratios and methane emissions.¹⁷

¹³ The World Bank. 2023. Global Seaweed: New and emerging markets report. Available at: <https://www.worldbank.org/en/topic/environment/publication/global-seaweed-new-and-emerging-markets-report-2023>

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Ibid.

Nutraceuticals, which include seaweed products aimed at offering various health benefits and improving patient care, are currently seen as a medium-term market (defined as 2024-2028) due to the likelihood of regulatory barriers slowing their industrial growth.¹⁸ The alternative protein, fabric, and bioplastic markets for seaweed are also seen as having the potential for success over the course of the next several years but will likely experience difficulties in achieving scale as a result of their complex production processes and demand factors.¹⁹ Long-term markets (defined as after 2028) include construction and pharmaceuticals, which are viewed as being either too niche or too unreliable to count on for significant growth before 2030.²⁰

Projected growth of certain industries may be limited by supply of seaweed feedstock. If supplies are limited, it is possible that not all of these market projections will be feasible.

2.0 STATUS OF THE SEAWEED INDUSTRY

Though burgeoning regionally, the seaweed industry is multi-faceted. Understanding this complexity is necessary to effectively analyze the opportunities for increased industry activity in Washington. This section draws on multiple authoritative sources to provide the most comprehensive picture of the seaweed industry in the current moment. Totals differ between some sources; this reflects the market's dynamic growth rather than data limitations, and all relevant figures are presented to give readers full context for analyzing opportunities for increased seaweed production in Washington.

Though exact values vary, different sources are united on the current status of the industry, which is succinctly summarized by the World Bank:

“Although seaweed has been cultivated for decades in parts of Asia, there is growing support for producing a wider range of seaweed species in a broader range of geographical locations. In time, it is hoped that these can be used for a wider selection of seaweed-derived products in multiple industries. However, many of the uses currently being touted for seaweed products are still in their infancy and require further research and investment before their real potential can be ascertained.”²¹

2.1 Global Seaweed Production and Sales

Nearly all seaweed sold around the world today is produced in Asia's Pacific coastal waters, with China alone accounting for more than half of all production, and the Philippines accounting for an additional 27%.²² Figures for total production values run parallel to

¹⁸ Ibid.

¹⁹ Ibid.

²⁰ Ibid.

²¹ World Bank. 2023. Global Seaweed New and Emerging Markets Report. Available at:

<https://www.worldbank.org/en/topic/environment/publication/global-seaweed-new-and-emerging-markets-report-2023>

²² Ibid.

production volume and growth statistics, with China generating over \$12 billion worth of seaweed in 2023.²³ Comparatively, the total production value of seaweed in the U.S. in 2023 was \$649,000.²⁴ The implied price per ton shows that the small volume of U.S. production in 2023 saw the highest global price per ton at over \$1,000, with China following at a price of \$581 per ton. This high price point in the U.S. is reflective of the support that the industry has received at the state level but also suggests that U.S. seaweed is not globally competitive. Therefore, this analysis is primarily concerned with domestic markets. A breakdown of production data for each of these countries is shown below in Table 1.

Table 1. Comparing Commercial Seaweed in Top Producing Countries and the U.S.²⁵

Country	Volume (2013, tons)	Volume (2023, tons)	CAGR* (2013 - 2023)	Production Value (2023)	Implied Price (\$/ton)
China	11.7 million	21.7 million	6.3%	\$12.6 billion	\$581
Indonesia	9.3 million	9.8 million	0.5%	\$1.9 billion	\$194
Philippines	1.1 million	1.7 million	4.4%	\$634 million	\$373
South Korea	1.6 million	1.6 million	0.4%	\$228 million	\$143
United States	0.0	624	N/A	\$649,000	\$1,040
* Compound annual growth rate (CAGR)					

2.2 U.S. Seaweed Production and Sales

Seaweed aquaculture in the United States is a relatively young industry that lacks adequate processing infrastructure and demand when compared to the industry in Asian countries. According to the Census of Aquaculture conducted by the U.S. Department of Agriculture (USDA), in 2023 there were 33 farms in the United States reported to grow sea vegetables, wherein seaweed is grouped.²⁶ This was a significant increase from the number of farms reported in 2013 and 2018 (10 and 4, respectively).²⁷ ²⁸ It was also estimated that in 2023 the sea vegetable industry generated 496,000 pounds of product and saw a total sales value of \$1,313,000, with the average price per pound being estimated at \$2.65.²⁹ Table 2 provides a

²³ Seaweed Insights. 2023. Global Production Overview. Available at: <https://seaweedinsights.com/global-production/>

²⁴ Ibid.

²⁵ Ibid., with elaborations on data by the research team.

²⁶ USDA. 2023. Miscellaneous Aquaculture Production and Sales by Type – United States: 2023. Available here: https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Aquaculture/index.php

²⁷ Ibid., 2013. This report was accessible via the USDA website during the literature review phase but is no longer available.

²⁸ Ibid., 2018. Available here: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/index.php

²⁹ USDA. 2023. Miscellaneous Aquaculture Production and Sales by Type – United States: 2023 Available here: https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Aquaculture/index.php

breakdown of this information.^{30 31 32} It should be noted that the USDA Census of Aquaculture reports an increase in total sales for the industry in 2023 compared to other production data presented in this report. The explanation behind this discrepancy is likely related to variation within state reporting requirements, as well as the fact that seaweed is an emergent industry with limited national data.

Table 2. USDA Census of Aquaculture Results, Sea Vegetables, 2018-2023

Year	Farms	Total Weight (pounds)	Total Sales (2023 dollars)	Price per Tons (2023 dollars)
2013*	10	N/A	N/A	N/A
2018*	4	N/A	N/A	N/A
2023	33	496,000	\$1,313,000	\$530

* Data on total weight, total sales, and price per pound for 2013 and 2018 were omitted from the census due to privacy concern.

Source: USDA. 2023. Miscellaneous Aquaculture Production and Sales by Type – United States: 2023. Available at: https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Aquaculture/index.php

The following sections describe the status of seaweed aquaculture in the areas within the U.S. where production and/or processing infrastructure is most developed. These areas include Alaska, Maine, and Washington (with brief mention of other states with emerging industries). British Columbia, Canada is also discussed due to its proximity to Washington.

2.2.1 Alaska

Alaska is a notable state within the realm of seaweed aquaculture due to its vast capacity for production. The state possesses the longest coastline in the United States and is home to more than five hundred different species of seaweed, including some of the largest kelp beds in the world. Seaweed synergizes well with the state’s cold, fertile waters and significant established maritime industry. However, while Alaska is capable of significant seaweed production, the state has little processing capacity or infrastructure, and is a significant distance from many major markets and distribution centers.

The seaweed industry in Alaska generates a wide array of value-added food products, such as seaweed salsa, hot sauce, and dried kelp snacks and seasonings. During 2022, 871,000 wet pounds of seaweed were produced in Alaska (436 tons or 395 metric tons), and the state

³⁰ USDA. 2013. Ibid.

³¹ USDA. 2018. Miscellaneous Aquaculture Production and Sales by Type – United States: 2018. Available here: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/index.php

³² USDA. 2023. Miscellaneous Aquaculture Production and Sales by Type – United States: 2023. https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Aquaculture/index.php

currently possesses a total of about 30 active commercial farms.³³ It has been suggested that factors such as increases in processor-farming contracting, processing capacity, product development, distribution, and marketing have resulted in stabilization and growth for the seaweed farming industry within Alaska.

There are currently 95 entities partnered with the state as a part of the Alaska Mariculture Cluster grant project to help increase seaweed production, 73 of which have either received or are currently pending an aquatic permit, and 21 of which are processors or supporting entities.³⁴ In 2022, the McKinley Research Group published a study³⁵ of the Alaskan seaweed mariculture industry which built upon the results of a similar study performed in 2021.³⁶ This report included projections under low, medium, and high growth scenarios. By 2032, significant growth was projected for annual revenue generated both by individual farms (24-64% annual growth) and from value-added processing (32-96% annual growth), showing an overall industry growth rate range of 27-81% annually.³⁷ Under these same scenarios, production of seaweed was forecasted to increase from an annual total of 570,000 wet pounds (265 tons) to between 10 million and 170 million wet pounds (5,000 to 85,000 tons) by 2032.³⁸ Growth was anticipated to continue to increase into the future, but to slowly taper off over time, with the industry revenue growth rate for the period of 2022 to 2042 being estimated at 20-41% annually.³⁹

Despite projected growth in this industry, the Alaskan seaweed market has its roadblocks. For example, an informed subject matter expert on the growing industry remarked that market demand and product shipping costs have presented major challenges for farmers and processors. There has been much recent exploration of seaweed as an agricultural biostimulant, which shows promise as a successful business venture, but the lack of significant agricultural infrastructure in Alaska has hindered the growth of such a sub-industry within the state.

Washington already processes a significant portion of Alaskan seafood and could thus be well positioned to become a seaweed processing hub for the region with the right series of

³³ Sea Grant. 2024. State of the States Presentation – 2024 Update. Available at: https://seaweedhub-extension.media.uconn.edu/wp-content/uploads/sites/3646/2024/02/2024-State-of-the-States_For-Posting_Feb2024.pdf

³⁴ Southeast Conference and Hatch Innovation Services. Alaska Mariculture Insights. Available here: <https://alaska.seaweedinsights.com/>

³⁵ McKinley Research Group. 2022. Alaska Seaweed Industry Expansion Scenarios. Prepared for Alaska Fisheries Development Foundation. Available at: <https://afdf.org/asset/63507e1c2d8beb/Alaska-Seaweed-Industry-Expansion-Scenarios-compressed-1.pdf>

³⁶ McKinley Research Group. 2021. Alaska Seaweed Market Assessment. Prepared for Alaska Fisheries Development Foundation. Available at: <https://afdf.org/asset/6351530fe48f8/Alaska-Seaweed-Market-Assessment-2021-08-FINAL-CORRECTED.pdf>

³⁷ McKinley Research Group. 2022. Alaska Seaweed Industry Expansion Scenarios. Prepared for Alaska Fisheries Development Foundation. Available at: <https://afdf.org/asset/63507e1c2d8beb/Alaska-Seaweed-Industry-Expansion-Scenarios-compressed-1.pdf>

³⁸ Ibid.

³⁹ Ibid.

investments. However, there are questions surrounding the role of Alaska as a raw materials provider while the Washington State economy benefits through value-added processing.

2.2.2 Maine

Maine is the top producer of seaweed in the U.S. and has been commercially producing seaweed since 2017. Maine produced over one million wet pounds (or 500 tons or 453 metric tons) of seaweed in 2022 and possesses more than 40 active commercial farms.⁴⁰ The majority of these farms are located within the Casco Bay, Mid-Coast, and Downeast regions of the state. Additionally, four commercial seaweed nurseries and a combination of stabilization and primary processing (drying, blanching, freezing, shredding, etc.) and secondary processing (product manufacturing, packaging, etc.) processing facilities support the state industry's goal of generating value-added consumer goods and food products like seaweed salads, kimchi, teas, smoothie cubes, snack bars, beverages, and spice blends. The Maine seaweed industry has grown significantly since its establishment, and is supported by local processing facilities. Due to these factors, its seaweed markets are more developed than those on the West Coast. This advanced industry can provide insights and guidance for the developing seaweed industry in Washington.

In addition, Maine is home to Atlantic Sea Farms, a notable operation within the seaweed industry due to its large-scale production efforts, which utilize an established network of lobster fishermen who grow seaweed for the company during their off-season. However, according to industry experts, Atlantic Sea Farms has reportedly made the decision to reduce their manufacturing capacity in 2025, citing issues involving an overinvestment into the equipment required to produce their range of seaweed-based consumables and consumer packaged goods. This downsizing, alongside other challenges associated with the development of the Maine seaweed market, represents a step back for the regional industry. Despite this fact, Atlantic Sea Farms are still a significant contributor to their local economy and are expected to continue growing at rate which is more realistically aligned with current capacity. These fluctuations are typical of a new and evolving industry.

2.2.3 British Columbia, Canada

While not technically covered under the banner of U.S. seaweed aquaculture, the province of British Columbia, Canada is still worthy of note while discussing the current state of West Coast seaweed farming. B.C. contains approximately 2.5 million hectares of coastline suitable for growing seaweed, but data availability regarding the scale of its seaweed industry – including the number of licenses, the total amount of leased coastline, and the total economic output – is

⁴⁰ Sea Grant. 2024. State of the States Presentation – 2024 Update. Available at: https://seaweedhub-extension.media.uconn.edu/wp-content/uploads/sites/3646/2024/02/2024-State-of-the-States_For-Posting_Feb2024.pdf

currently lacking.⁴¹ In 2024, the environmental research firm LGL developed a strategic plan to expand seaweed aquaculture within the regional district of Mount Waddington.⁴² This plan states that the varieties of seaweed currently grown within the region include Bull, Winged, Giant, and Sugar kelp, and stresses the opportunities provided as a result of the province's rich coastal biodiversity as well as its robust commercial fishing, marine tourism, and mariculture industries.

A 2025 report from the David Suzuki Foundation⁴³ found that the region contains suitable environmental conditions for both nearshore and offshore seaweed aquaculture, although it should be noted that offshore facilities would require a sizable infrastructure lift in order to become fully operational. Current land-based seaweed aquaculture efforts in B.C. include nurseries, which grow seaweed to a variety of maturation levels, as well as phytoplankton which act as a food source for the plants during cultivation.⁴⁴ The two largest growers in the region, Cascadia Seaweed and Seaforest, made use of approximately 65 hectares of coastline for seaweed farming in 2021,⁴⁵ the former of which reportedly produced over 500 metric tons of seaweed in 2024.⁴⁶ However, concerns regarding the potential environmental impact of the industry's continued growth in the region were recently raised, including issues with seaweed providing competition for light and nutrients within the marine ecosystem, the disruption of local food webs, and risks associated with carbon sequestration via the deep-water sinking of seaweed.⁴⁷

2.2.4 Washington and Other States

Several other states also produced seaweed in 2022, including Connecticut, Hawaii, Massachusetts, Rhode Island, and Washington, with the total landings for each ranging between 3,800 to 14,500 wet pounds and the number of active ocean farms per state ranging

⁴¹ Laird, K. 2025. Seaweed aquaculture expands in B.C. as regulations play catch-up. Haida Gwaii Observer. Available here: <https://www.haidagwaiiobserver.com/news/seaweed-aquaculture-expands-in-bc-as-regulations-play-catch-up-8241950>

⁴² LGL Limited. 2024. Seaweed Industry Development Plan. Available here:

<https://www.rdmw.bc.ca/media/2024%2010%2004%20RDMW%20Seaweed%20Industry%20Development%20Plan%202024.pdf>

⁴³ David Suzuki Foundation. 2025. Columbia: Policy, Regulations and Recommendations for Mitigating Potential Ecological Effects. Available here: <https://david Suzuki.org/science-learning-centre-article/seaweed-aquaculture-in-british-columbia-policy-regulations-and-recommendations-for-mitigating-potential-ecological-effects/>

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ Laird, K. 2025. Seaweed aquaculture expands in B.C. as regulations play catch-up. Haida Gwaii Observer. Available here: <https://www.haidagwaiiobserver.com/news/seaweed-aquaculture-expands-in-bc-as-regulations-play-catch-up-8241950>

⁴⁷ David Suzuki Foundation. 2025. Columbia: Policy, Regulations and Recommendations for Mitigating Potential Ecological Effects. Available here: <https://david Suzuki.org/science-learning-centre-article/seaweed-aquaculture-in-british-columbia-policy-regulations-and-recommendations-for-mitigating-potential-ecological-effects/>

between 3 and 10.⁴⁸ Other states with burgeoning but small seaweed aquaculture industries include California, New Hampshire, New York, and Oregon.⁴⁹

Washington has a great deal of potential for seaweed development, with its large coastline, sheltered waters, existing fishing and shellfish industry, and regular arctic currents, all of which combine to create an excellent habitat for seaweed.⁵⁰ Therefore it is not a surprise that seaweed aquaculture has had a resurgence in Puget Sound over the last decade.

Blue Dot Sea Farms became the first permitted seaweed aquaculture operation in Puget Sound when it added kelp cultivation to its primary oyster farming business in 2018, building on an experimental permit originally issued to the 5-acre shellfish operation for climate adaptation research. The farm continues to grow sugar kelp alongside oysters on suspended lines in Hood Canal, while also participating in research initiatives focused on cultivation techniques, local ecological impacts, and climate change mitigation for their shellfish operation.

Lummi Island Sea Greens followed Blue Dot, becoming the second fully permitted commercial seaweed farm in Washington in 2023, operating within the footprint of a tribal pink salmon reef net fishery with a mission to provide the local community with healthy sea greens with a low carbon footprint. Their innovative dual usage of reef net site allows for year-round income to fishers, and the organization also runs a nonprofit aimed at raising awareness about the Salish Sea and sustainable fishing.

Two additional seaweed farms have been permitted in Washington State – Pacific Sea Farms and Vashon Kelp Forest. Both farm footprints would be situated in Colvos Passage off the coast of Vashon Island, however neither farm is active at this time. Pacific Sea Farms received their commercial lease to grow sugar kelp in 2024, but their lease was subsequently terminated in 2025 after a gear failure that resulted in a violation of the terms of the lease. Vashon Kelp Forest aims to grow a mix of bull and sugar kelp and hopes to support research on kelp forest conservation and co-benefits. They have not, however, received their lease to operate at the time of publication of this report.

The permitting and approval process for seaweed farms is more complex and less streamlined than the permitting processes for other comparable aquatic industries.⁵¹ This is in part due to the infancy of the industry, but also due to competing marine uses and strong opinions about local marine ecosystems. In Washington, a patchwork of regulatory agencies with various jurisdictions also require a series of authorizations and permits from prospective farmers, including the Washington Departments of Natural Resources, Fish and Wildlife, and Ecology;

⁴⁸ Sea Grant. 2024. State of the States Presentation – 2024 Update. Available at: https://seaweedhub-extension.media.uconn.edu/wp-content/uploads/sites/3646/2024/02/2024-State-of-the-States_For-Posting_Feb2024.pdf

⁴⁹ Ibid.

⁵⁰ Buckner, et al. Building Capacity for Kelp (Laminariales) Mariculture in the Salish Sea: Ecological Considerations and Initial Farm Design Guidance. Available at: https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/mfr851-44_1.pdf

⁵¹ Ibid.

the U.S. Army Corps of Engineers; and the local jurisdiction. The permitting and approval process is described and discussed further in Appendix A.

Despite regulatory challenges, various commercially relevant seaweed species, including sugar kelp, occur naturally around the Puget Sound, highlighting this region’s ideal conditions for seaweed production.⁵² Additionally, Washington State has a robust, well-established shellfish farming and seafood industries, which set the state up nicely for additional aquaculture industries like seaweed. Data on U.S. seaweed imports and seaweed consumption is lacking, making it difficult to accurately estimate the existing local consumer market for seaweed in the Puget Sound region, but popular grocery stores specializing in east-Asian imports such as H-Mart and Uwajimaya stock a variety of seaweed products amongst their inventory, specifically sugar kelp products (often sold as kombu or dashi kombu).⁵³

2.2.5 U.S. Seaweed Market Summary

The key states, types of seaweed grown, number of growers, and tons of seaweed in the U.S. are summarized in Table 3 below. Maine and Alaska are the leading producers, with Washington and the other states following with much smaller production. Because the industry is relatively new and evolving in the U.S., these production estimates fluctuate from year to year.

Table 3. Summary of Seaweed Production by State

State	Predominant Species	Number of Growers	Tons of Wet Seaweed
Alaska	Bull kelp, ribbon kelp, sugar kelp	30	395
Maine	Skinny kelp, sugar kelp, winged kelp	40	454
Washington	Bull kelp, sugar kelp, dulse, <i>Chondrocanthus</i>	2	4.5
Other States (combined)	Sugar kelp, <i>Gracilaria coronopifolia</i> , <i>Gracilaria tikvahiae</i> , <i>Gracilaria pacifica</i> , <i>Ulva</i>	47	126

3.0 RESEARCH AND OUTREACH METHODOLOGY

This section details the research and outreach that was conducted to inform this economic analysis. An extensive review of literature on seaweed aquaculture with attention to the potential expansion of seaweed production in Washington was first completed. An annotated literature review is provided as an appendix to this report (refer to Appendix B). These resources are also cited throughout the report where appropriate.

⁵² Buckner, et al. Building Capacity for Kelp (Laminariales) Mariculture in the Salish Sea: Ecological Considerations and Initial Farm Design Guidance. Available at: https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/mfr851-44_1.pdf

⁵³ McKinley Research Group. 2021. Alaska Seaweed Market Assessment. Available at: <https://afdf.org/asset/6351530fe48f8/Alaska-Seaweed-Market-Assessment-2021-08-FINAL-CORRECTED.pdf>

Additionally, the research team conducted interviews with different participants in the industry focusing on lessons learned and future opportunities. The information collected was used to develop four future growth scenarios for the Washington seaweed industry (see Sections 5 and 6).

The research team facilitated a series of 16 interviews with industry stakeholders and representatives to better understand the diversity of perspectives on seaweed aquaculture along the West Coast of the U.S. A list of the individuals interviewed for the project is provided Table 4 below.

Table 4. List of Interviewed Parties

Name	Organization	Expertise
Mike Kollins	Vashon Kelp Forest	Production
Mike Spranger & Gretchen Aro	Pacific Sea Farms	Production
Jon Kroman & Joth Davis	Blue Dot Sea Farms	Production
Larry Mellum & Riley Starks	Lummi Island SeaGreens	Production
Adam James	Hama Hama Oyster Company	Production
Jessi Florendo	Puget Sound Restoration Fund	Production
Matthew Perkins	Macro Oceans	Processing
Matt Obee	Cascadia Seaweed	Processing
Catherine O'Hare	Sway the Future	Processing
Emily Power	Ocean Made	Processing
John Smet	Pacific Kelp Co.	Processing
Briana Murphy	Mothers of Millions	Processing
Alex Huller	Alaska Fisheries Development Foundation	Industry
Rod Fujita	University of California, Santa Cruz	Industry
Brian Donovan	California State Polytechnic University, Humboldt	Industry
Sarah Gutzmann	Simon Fraser University, British Columbia	Industry

In addition to industry participants and experts interviewed for this project, the Confluence and Greene team received guidance and feedback from experts conducting concurrent analyses and efforts with Maritime Blue support. These include Sam Garwin and Kendall Barbery of GreenWave and Tiffany Waters and Molly Bogeberg of The Nature Conservancy.

4.0 SEAWEED OPPORTUNITIES IN WASHINGTON

Washington is well-suited for seaweed and kelp aquaculture, given the area suitable for farming within the inland waters of Puget Sound. The following information is based on the research and outreach conducted and identifies key strengths and challenges for the industry in

Washington State. Section 7.0 of this report builds on these strengths and challenges and incorporates the results of the economic analysis into a set of key recommendations for the industry. Additional information related to the seaweed value chain in Washington is available in Appendix A.

Starting a farm in Washington typically requires many years (approximately 3-5) of planning and permitting before receiving authorization from required federal, state, and local entities. Regulatory issues involving the time and cost of receiving permits and leases for farming operations were cited by interviewees as major challenges and have hindered the growth of seaweed aquaculture in Washington. Farmers in Washington grow sugar kelp using typical hatchery, farming, and harvest techniques. Based on interviews and for the purpose of this analysis, primary processing and stabilization of harvested seaweed are considered to be part of farm operations in Washington. There are a variety of low-cost ways to conduct primary processing and stabilization (including sun drying and co-packing agreements), which farmers have been successfully employing at small scales in Washington. Seaweed that is grown in Washington is currently being sold in a fresh or stabilized form, and distribution is handled by each farmer directly. At this time, secondary processing is not being conducted in the state but is occurring outside of Washington through a variety of methods (refer to Appendix A for more detail). There is currently a lack of processing and distribution infrastructure supporting the commercial seaweed industry in Washington and across the West Coast, and different operations present unique needs within this space. Washington's geographic position and access to major trade lines make it an ideal location for a seaweed distribution or processing hub. Specifically, Washington's ports have valuable assets for scaling a regional seaweed industry, including industrial space, cold storage and warehousing, intermodal and ocean shipping connections, and maritime workforce and equipment. Ports would be meaningful strategic partners for seaweed processing and logistics. Public-private partnerships in support of processing infrastructure may help to minimize the risk taken on by any one entity.

There is little evidence that consumable seaweed products will ever support a large-scale profitable industry such as exists in the Asian markets, but the opportunities to access smaller scale, high-value seaweed food markets in restaurants (such as the efforts of both Blue Dot Kitchen and Lummi Island SeaGreens) and other on-site locations are promising for small-scale Washington seaweed growers. Still, to sustain an economically viable business over the long term, farms will need to target multiple markets, complementary to maximize the revenue coming in from each harvest. Markets for biostimulants, cosmetics, and other value-added products are also prominent opportunities for Washington growers as well as regional producers, particularly if they are marketed regionally. There is significant entrepreneurial capital in this industry. Growers, processors, and product developers have learned from mistakes, and continue to invest, with the conviction that the seaweed industry in Washington will produce worthwhile future returns.

Key challenges center around the limited market demand for seaweed products and the barriers to entry that currently exist in Washington. Both of these forces work to limit the potential draw for new entrants; the process of obtaining approvals is challenging, and it is unlikely that a farm would be profitable, at least in the near term. Industry participants generally cited other motivations (i.e., ecological benefits, restoration) for entering the seaweed farming industry. Ultimately, the sentiments expressed by those interviewed help to create a clearer picture of the current status of the commercial seaweed industry and what areas need the most assistance in order for such operations to flourish. There are several ways in which Washington State could help to support the growth of the seaweed industry, from funding broad infrastructure development activities and educational campaigns to improving the regulatory hurdles associated with permitting. This context was used in the development of the economic scenarios described and analyzed in Sections 5 and 6 below.

5.0 ECONOMIC ANALYSIS METHODOLOGY

The following section details the analytic approach for measuring the economic potential of the seaweed farming industry in Washington. Assumptions for each scenario informed the inputs to the IMPLAN model used to evaluate the economic potential (revenue, employment, and taxes) for each scenario. Section 5.1 details the basis and assumptions for each scenario. Section 5.2 provides background on the mechanics of the IMPLAN model.

5.1 Scenarios

To explore the economic potential for Washington State seaweed, four future scenarios were developed and analyzed. The scenarios were determined based on the research and outreach process and then reviewed with Maritime Blue and Ocean Strategies staff. The goal of the scenarios is not to forecast industry activity, but to outline pathways for industry growth and consider the economic ramifications under different investment assumptions (investment in production expansion, processing facilities, and marketing).

5.1.1 Business as Usual Scenario

This scenario assumes that there is no external manipulation of market forces, but the industry continues to grow, and market forces operate to provide incentives for producers, processors, and retailers. The scenario assumes that:

- The active farms in Washington continue producing, and that over time they expand production acreage via either the establishment of new sites or the expansion of existing ones.
- Further, it is assumed that over the next 10 years, an additional four to ten farms of similar size come into production.

- The farms conduct primary processing and stabilize their seaweed on or very near the farm or at sea.
- A small secondary processing facility is developed via private investment which would service farms in Washington as well as the surrounding region.
- Farmers and processors seek arrangements to sell their diverse, small-batch, unique products at local and regional retail facilities (e.g. at Pike Place Market). Producers also cultivate local customers for less-processed seaweed outputs, such as restaurants for edible seaweed, and niche agricultural producers to use lightly processed (e.g., just dried) seaweed for compost or fertilizer.

Within the confines of this scenario, the Washington State seaweed industry would be expected to continue its expansion at a slow, linear growth rate which reflects current conditions. This rate takes into account the various market and regulatory barriers currently hindering the growth of the industry within the state. These barriers are likely to produce an uneven growth pattern from year to year, which is assumed to result in a linear growth pattern over time. Total production acreage and employment in Year 1 of this scenario is evaluated at 40 acres and 7 employees. By Year 10, it is estimated that a total of 30 employees will be added to the seaweed production workforce; however, it should be noted that there is a high amount of variance associated with this value due to factors which exist outside the scope of this analysis. The development of a secondary processing facility under this scenario represents a private investment of \$15 million and is reflective of interests expressed by several anonymous facility operators who are currently discussing the construction of such a facility. This investment also implies that seaweed feedstocks from areas such as Alaska, California, and British Columbia would be processed within Washington.

5.1.2 Production Supported Scenario

This scenario assumes that external support allows seaweed farms to expand – both in number and/or in size – to encompass a larger share of the area suitable for seaweed production in Washington State over the next 10 years vs. the area expected under BAU. While there is no available assessment of area suitable for seaweed production, basic biophysical characteristics (e.g., depth, current speed, temperature) were used to generally inform suitable areas within the inland waters of Washington. A small fraction of biophysically suitable area is included as approved and farmed in this scenario. This scenario assumes that:

- Support outside of typical market forces allows for increased production beyond the BAU Scenario.
- Farmers still conduct their own primary processing and stabilization.
- Increased numbers of farms as well as increased average farm size results in production expanding beyond that which is forecasted in the BAU, to approximately 2,000 acres in 2036.
- Secondary processing capacity still follows the BAU trajectory.

The targeted investments in production assumed in this scenario could take many forms. For example, regulatory changes to simplify permitting or policy incentives to invite new farmers might lead to an increased number of farms, an expansion of the farms currently operating within Washington, or a combination of these two outcomes. It is difficult to predict the exact outcomes of such investments using the information available, but it is estimated that the total acreage of the industry in Year 10 would be significantly greater (2000 acres) than the acreage presented in Year 10 under the BAU. There is also greater potential for collaboration amongst farms under this scenario due to their expanded resources, allowing for the aggregation of their harvests or a shared investment in the development of a small secondary processing facility – but processing infrastructure investment is still assumed to be as is presented in the BAU.

5.1.3 Processing Supported Scenario

This scenario looks at the economic value of targeted investment to support the development of a more advanced secondary processing facility in Washington State, which could handle a significantly larger quantity of seaweed, allowing for inflows of a larger percentage of seaweed grown in Alaska, British Columbia, or other nearby regions as compared to the BAU. This facility could leverage existing seafood processing and distribution channels, but assumes the construction of a new facility. This scenario builds on the idea of Washington serving as a hub for processing and distribution of a variety of seaweed products sourced from across the West Coast – a concept repeatedly supported by all industry participants contacted. This scenario assumes:

- Support outside of typical market forces increases processing capacity beyond the BAU scenario through the creation of an additional processing facility serving a wider range of producers and markets.
- Seaweed production in Washington, and its associated employment, remains at the BAU rate and does not expand proportionally to meet the new processing capabilities.
- Washington thus takes on a more significant processing and distribution role within the West Coast regional seaweed industry, leveraging its unique geographical attributes and existing seafood industry infrastructure to act as a generalized hub for West Coast seaweed.

It is important to note that this scenario assumes a *total* of \$40 million is invested in both the smaller and a new larger processing facility, so there is an additional \$25 million investment above the \$15 million assumed in the BAU scenario. The IMPLAN model does not require processing facility specifics to conduct an economic impact analysis, just the value of investment. Therefore, there is great flexibility in how this money is invested – i.e., what products can be developed. Similar to the Production Supported scenario, a given processing company and/or a united group of seaweed farmers could use this investment for the development of a single facility, or multiple smaller processing facilities could develop which could support the manufacturing of more niche seaweed products.

5.1.4 Marketing Supported Scenario

Retail sales represent one final step within the seaweed aquaculture industry value chain. This scenario explores how a marketing campaign might enhance demand for regional seaweed aquaculture products, and the potential economic impacts associated with such an effort. This scenario assumes that:

- Support outside of typical market forces allows for increased marketing beyond the BAU scenario. This could take the form of a shared marketing campaign designed to elevate “West Coast Seaweed” among regional consumers and purchasers, as a food or other select product or “hero” ingredient.
- The resulting increased market demand spurs seaweed production in Washington to double from the BAU scenario, resulting in 60 employees by Year 10.
- An investment of \$25 million allows secondary processing capacity to expand through the development of a large processing facility capable of manufacturing a wide variety of seaweed products. In this scenario, the \$25 million investment replaces \$15 million investment used in the BAU. This change is based on how demand experiences a shift through marketing support.

One strategy to support the growth of the seaweed aquaculture industry would be via a widespread, shared marketing campaign that focuses on advertising the myriad benefits provided by Washington-grown seaweed products generally, as opposed to the specific selling points of one individual business entity. The principles of social marketing campaigns could be employed to frame seaweed as providing a ‘net societal good,’⁵⁴ appealing to recent market trends which suggest that American consumers desire more sustainably produced products. However, it should be stated that several individuals from throughout the outreach process commented that conflicts exist between the markets for consumer products (cosmetics, etc.) and corporate products (biostimulants, etc.), and the ethos of seaweed as a material may be impacted by its close association with any one of these individual product markets. Our model is product-agnostic, and thus does not explore this complexity.

5.1.5 Summary of Scenarios

Table 5 summarizes the various assumptions about improved support for seaweed processing, production, and marketing that inform the different IMPLAN scenarios. It is important to note that expanded processing is not necessarily based on expanded production in Washington. Processing expansion is subject to change based on shifting markets, with options for the development of either or both a large facility with the capability to generate multiple different products or a smaller facility more focused in scope. The processing infrastructure would be

⁵⁴ Henley, N., S. Raffin, & B. Caemmerer. 2011. The application of marketing principles to a social marketing campaign. Available at: https://www.researchgate.net/profile/Sandrine-Raffin/publication/235289958_The_application_of_marketing_principles_to_a_social_marketing_campaign/links/55046d480cf231de0772c3b5/The-application-of-marketing-principles-to-a-social-marketing-campaign.pdf

supported by seaweed feedstocks sourced from outside of Washington State, such as those from Alaska, California or Vancouver, B.C. Additionally, the model does not consider specific target products or markets for seaweed, and assumes that general development of the industry will follow natural economic forces. This is assumed because the industry is undergoing rapid growth at this stage, with many innovative product ideas under development including agricultural biostimulants, bioplastics, cosmetics, and others in addition to the food products that have already been developed. A forthcoming analysis of processing technology options for a selection of seaweed products being explored by Washington’s current farms will provide more specific projections of specific investment costs and expected returns. Table 5 highlights assumptions about both production (acres of seaweed growing) and processing capacity (investment required to produce the improved capacity) for each scenario. Pink shading indicates differences from the Business as Usual scenario (BAU).

Table 5. Scenario Assumptions

Growth Mechanism	Business as Usual (BAU)	Production Supported	Processing Supported	Marketing Supported
Processing (Year 3), Investment	Smaller Facility Investment (\$15 M)	Smaller Facility Investment (\$15 M)	Smaller and Larger Facility Investments (\$15 M plus \$25 M = \$40 M)	Just Larger Facility Investment (\$25 M)
Production (Year 10), Acres	120	2,000	120	240

5.2 IMPLAN

When a new industry emerges, it is critical to not only consider its direct economic impact (new jobs, products created, etc.) but also to assess the economic linkages to other industries, such as input suppliers who receive additional sales as a result of the activity generated by the emerging market. Therefore, if seaweed aquaculture is stimulated through any of the scenarios beyond BAU, there will be a backward (indirect) linkage to upstream facilities which will need to meet increased demand from the seaweed industry inputs (e.g. spores, farm equipment, engineers, etc.). These upstream impacts can be analyzed in a regional economic impact analysis. In addition to the indirect linkages, there are induced impacts that are generated by household spending from workers and proprietors, who have additional profits from the industry. For each of the scenarios above, such a regional economic impact analysis has been completed.

The research team used a model called IMPLAN, which is an Input/Output model developed by the U.S. Government and the University of Minnesota (IMPLAN 2024) to estimate the economic impacts of the seaweed industry in Washington State for four future scenarios described in Section 5.1. IMPLAN was chosen because it utilizes regional data to ensure its

results are regionally-specific. This data has been compiled from multiple sources and includes hundreds of industrial sectors. In addition to being widely used in regional economic analyses, the model and its methodology have been extensively reviewed in various professional and economic journals.

IMPLAN data are gathered from various sources. Employment and wage and salary income at the state and county levels are provided via the Bureau of Labor Statistics. National, state, and county-level proprietors, proprietor income, and the relationship between employee compensation and wage and salary income (to infer benefits) are provided via the Bureau of Economic Analysis. Data supplied on behalf of the U.S. Census Bureau include the number of firms by size at the national, state, county, and zip-code levels.

IMPLAN model results typically produce three types of impact estimates. These impacts represent different, yet related, industry contributions made by seaweed production and its associated economic activity in the region. The sum of the three different impacts represents the total impact from seaweed aquaculture in the state. Each of the three are described as follows:

1. **Direct impacts** indicate the initial contribution to economic activity resulting from seaweed aquaculture in the state. In other words, direct impacts measure the total amount of economic activity in terms of the output and employment added to the local economy as a result of seaweed production.
2. **Indirect impacts** measure the response by local industries to the demand generated via inter-industry transactions. These impacts trace the “ripple effect” throughout the regional economy as local industries vary in terms of output and employment based on the demand for seaweed products.
3. **Induced impacts** are representative of the response within local industries to changes in household incomes produced as a result of any direct or indirect effects (i.e., increased household incomes due to increased employment); this is a further “ripple” derived from the original direct impacts.

Tax revenue is also produced through the IMPLAN model. These impacts are part of the total output estimates and therefore are not added on top of the output results. It is not feasible for the IMPLAN to determine the potential forward linkages in the economy – meaning any stimulus that occurs from the sale of seaweed products that undergo secondary processing and then are used as inputs to another product such as sales at a restaurant or improved agricultural yields. As a result, the scenarios may be considered a lower end estimate of the actual total stimulus to the economy.

6.0 ECONOMIC POTENTIAL OF SEAWEED INDUSTRY IN WASHINGTON

IMPLAN was used to develop four sets of economic impacts in Washington State, one for each of the four future seaweed industry scenarios presented in Section 5.1. During each modeling

effort, model assumptions were adjusted to reflect the number of growers and seaweed processing facility investment in Washington that corresponded with each scenario.

Additionally, for each scenario, it is assumed that the construction associated with additional processing facilities would occur during Year 3. Construction of these facilities creates positive economic impacts in terms of employment and economic output, although these impacts occur only in the construction year, and therefore are considered separately. Consequently, these impacts are not included in the impacts for Year 10, as the Year 10 impacts are presented as an annual result, and would presumably continue into the future. The total economic impacts for Year 10 are key results from this research. By Year 10, the market will be more mature, and it is anticipated that under each scenario, the trajectory for future activity in the sector will become clearer. After Year 10, the processing facilities will be more established and there will be sufficient supply to match processing capacity (be that locally produced, or provided from other West Coast areas). The Year 10 results are the annual (i.e., yearly) economic impacts that could be expected under each scenario in the long term. Sections 6.1 offers an overview of the economic impacts in terms of employment and output for the four scenarios. Construction impacts (assumed to occur in Year 3) are presented in Section 6.2. Following that, results are shown for the fiscal impacts of each scenario – tax revenues garnered by local and state agencies are found in section 6.3.

More detailed results for each scenario are presented in sections 6.4 through 6.7, with each showing the jobs and revenues for production (growing seaweed), and processing. A discussion of the results concludes this chapter.

6.1 Summary Scenario Comparison – 2036

This section summarizes the economic impact anticipated for each of the four seaweed aquaculture industry scenarios examined. These results represent the annual impacts associated with these scenarios in the year 2036 (as opposed to the cumulative impacts over the full 10-year period). Summary tables include the direct, indirect, induced, and total economic impacts for each scenario for employment and output. Results are provided both in terms of employment, or numbers of jobs supported, and in terms of output, or GDP contributions in the state.

These tables also include a column titled “multiplier.” Input-output models like IMPLAN produce “multipliers” that offer a quick way to understand how stimuli in one sector translates into the indirect and induced categories. For example, a multiplier of 1.5 means that for every direct job or dollar output, an additional 0.5 jobs or 50 cents is generated in the region. A larger multiplier indicates a larger ‘ripple effect’.

6.1.1 Regional Economic Impact – Employment

Table 6 below shows the regional economic impact, measured in employment, for all four scenarios in Year 10. The Processing Supported Scenario contributes the largest number of jobs

to the regional economy (443). This is due to the fact that seaweed processing is a more labor-intensive industry than seaweed production and includes the employment generated as a result of construction efforts. It also has a significant multiplier of 3.0, meaning that for every job directly created by the seaweed industry an additional two are generated within the regional economy. These results come from assumptions-based IMPLAN data from similar industries (general seafood processing or aquaculture, for example) and from interviews with producers and processors.

The Production Supported Scenario contributes the second largest number of jobs (330), closely followed by the Marketing Supported Scenario (294). The BAU Scenario contributes the fewest number of jobs in Year 10 (174), though it does have the second largest multiplier out of the four scenarios (2.3).⁵⁵ It should be noted that the processing sector has a higher employment multiplier (based on data in IMPLAN drawn from seafood processing, than the production sector, so generally if the focus of the scenario is on processing, the multiplier is expected to be higher than when the focus is on production. However, in the cases where there is expected growth in both sectors, the extent to which the scenario leans towards production or processing will determine the direction of the multiplier (smaller or larger, respectively).

Table 6. Regional Economic Impacts of All Scenarios (Employment – Year 10)*

Scenario	Direct Contribution	Indirect	Induced	Total	Multiplier
BAU	75	52	47	174	2.3
Production Supported	218	33	78	330	1.5
Processing Supported	150	179	115	443	3.0
Marketing Supported	135	78	81	294	2.2
*These are the annual results for year 10, and so they exclude the economic stimulus from construction in year 3					

The total employment for each scenario at Year 10 is also shown graphically in Figure 4.

⁵⁵ The higher multiplier reflects the higher ratio of employment in processing to employment in production found in the BAU compared to the production scenario.

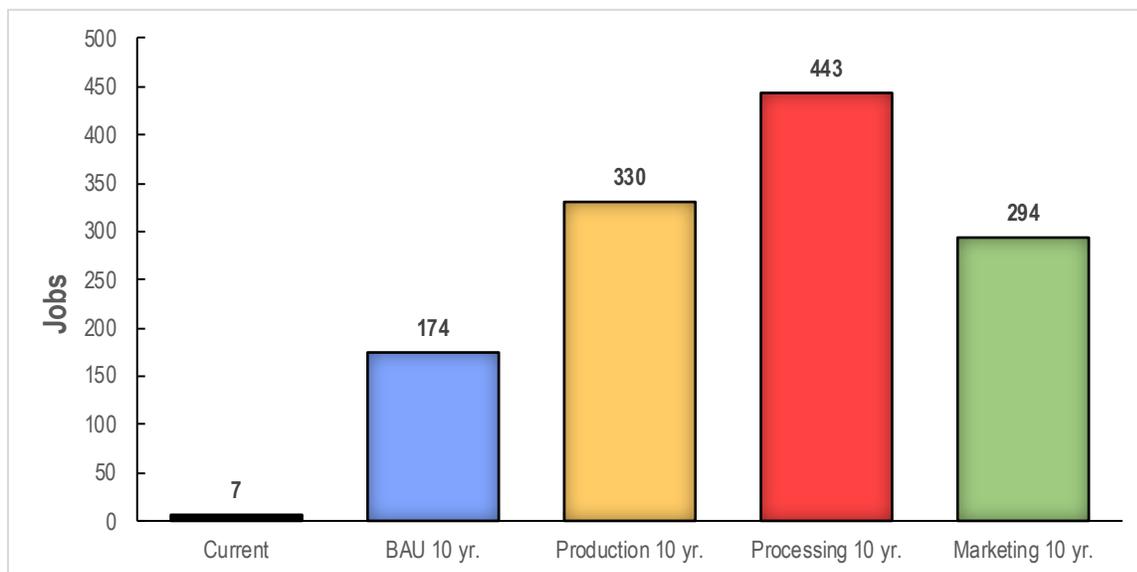


Figure 4. Total Employment by Scenario in Year 10

6.1.2 Regional Economic Impact – Economic Output

Table 7 shows the regional economic impact, measured in economic output, for all four scenarios in Year 10. Once again, the Processing Supported Scenario has the most significant economic impact, contributing over \$143 million in economic output to the state economy, and largest multiplier (1.8). When considering economic output, the Marketing Supported Scenario produces the second largest output at \$94 million. The Production Supported Scenario is close behind at \$79 million and trailed by the BAU scenario at \$56 million. The BAU and Marketing Supported Scenarios both have a multiplier of 1.7. For each scenario, the largest economic output contribution is direct.

Table 7. Regional Economic Impacts of All Scenarios (Output – Year 10)

Scenario	Direct contribution	Indirect	Induced	Total	Multiplier
BAU	\$32,560,442	\$11,968,393	\$11,142,243	\$55,671,078	1.7
Production Supported	\$52,386,978	\$8,081,372	\$18,524,808	\$78,993,158	1.5
Processing Supported	\$79,872,072	\$36,569,906	\$27,136,614	\$143,578,592	1.8
Marketing Supported	\$55,658,558	\$19,065,195	\$19,099,493	\$93,823,245	1.7

Note: These are the annual results for year 10, and so they exclude the economic stimulus from construction in year 3

The total economic output for each scenario at Year 10 is also shown graphically in Figure 5.

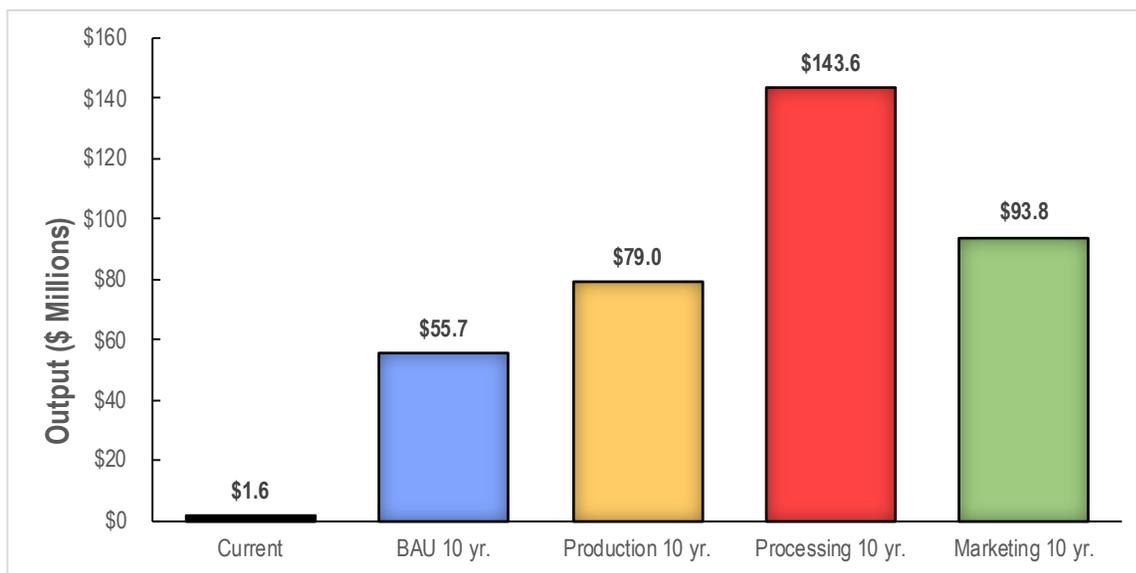


Figure 5. Total Output by Scenario in Year 10

6.2 Summary Scenario Comparison – Infrastructure Construction

The following table shows the regional economic employment impacts that would occur under the different scenarios for the construction of new processing infrastructure (see Table 8). This is assumed to occur in Year 3 for each scenario, and these impacts are for one year only. The other impacts in this report mostly show annual results that will recur each year, but for these construction impacts, they only will occur in the year in which the processing infrastructure is built.

Table 8. Regional Economic Impacts of Infrastructure Construction for All Scenarios (Jobs)

Scenario	Direct Contribution	Indirect	Induced	Total
BAU	58	17	21	96
Production Supported	58	17	21	96
Processing Supported	154	44	57	256
Marketing Supported	97	28	36	160

Notably, the Processing Supported scenario shows the most significant results in terms of employment due to the increased degree of construction efforts necessitated by the scenario parameters. Additionally, the amount of infrastructure development present in the Production Supported scenario mirrors that of the BAU, because the assumptions about infrastructure are the same in both scenarios.

Table 9 shows the economic impacts of constructing the processing infrastructure in terms of economic output. A similar pattern is seen, whereby the Processing Supported scenario has the greatest overall economic impact, which is expected due to the greater Direct investment in that scenario. Both the BAU and the Production Support scenarios once again share identical results.

Table 9. Regional Economic Impacts of Infrastructure Construction for All Scenarios (Output)

Scenario	Direct Contribution	Indirect	Induced	Total
BAU	\$15,000,000	\$5,332,362	\$5,074,610	\$25,406,972
Production Supported	\$15,000,000	\$5,332,362	\$5,074,610	\$25,406,972
Processing Supported	\$40,000,000	\$14,219,633	\$13,532,293	\$67,751,925
Marketing Supported	\$25,000,000	\$8,756,944	\$9,273,969	\$43,030,913

6.3 Regional Economic Impact – Tax Revenue

Table 10 shows how the regional economic impact also generates taxes for local and state organizations. Results are for all four scenarios in Year 10. The Processing Supported Scenario generates over \$4.5 million in taxes, that is, \$1.6 million in local taxes and \$2.9 million in state taxes. The Production and Marketing Supported Scenarios both generate approximately \$3 million in tax revenue, approximately two thirds of which is state revenue, and the other third local. The seaweed industry under the BAU Scenario generates just under \$2 million in tax revenue.

Table 10. Regional Economic Impacts of All Scenarios (Taxes – Year 10)

Scenario	Local	State	Total
BAU	\$653,993	\$1,189,620	\$1,843,614
Production Supported	\$1,052,219	\$1,913,998	\$2,966,217
Processing Supported	\$1,604,271	\$2,918,187	\$4,522,458
Marketing Supported	\$1,117,931	\$2,033,528	\$3,151,458

*These are the annual results for year 10, and so they exclude the economic stimulus from construction in year 3.

The total tax revenue for each scenario at Year 10 is shown in Figure 6.

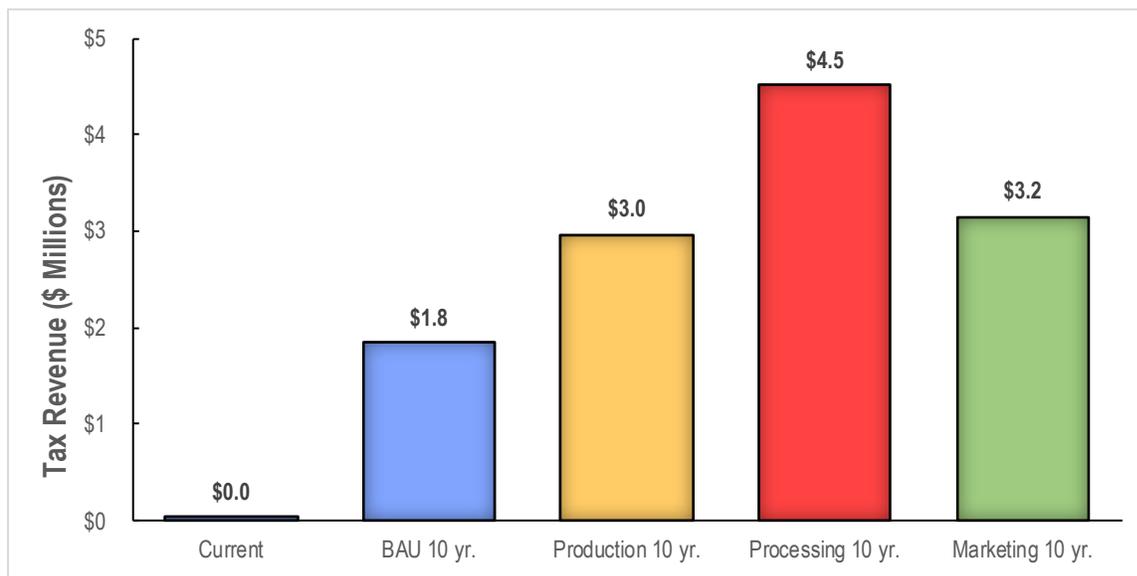


Figure 6. Total Tax Revenue by Scenario in Year 10

6.4 Detailed Results from the BAU Scenario

In the first scenario, there is no external manipulation of market forces. The industry continues to grow, and the market forces operate to provide incentives for producers and processors to operate in Washington State. As shown in Table 11, linear growth for growers is assumed,⁵⁶ a small secondary processing facility is developed (\$15 million), and producers continue to serve local customers.

Table 11. Direct Elements of BAU (Year 10)

Scenario Element	Direct Contribution	Direct Employment	Assumptions
Growers	\$4,173,464	30	<ul style="list-style-type: none"> ▪ Linear growth in employment ▪ 120 acres in Year 10 ▪ IMPLAN sector 14 – Animal production, except cattle and poultry and eggs ▪ Employment impact (add 23 new employees to sector)

⁵⁶ For this scenario, linear growth was assumed for the sake of simplicity. In reality, increases in the number of employed growers will not be the same year to year, but it is assumed that across the ten-year timeline the number of growers will steadily increase.

Scenario Element	Direct Contribution	Direct Employment	Assumptions
Processing	\$28,386,978	45	<ul style="list-style-type: none"> 1 new processing facility IMPLAN Sector 87 – Seafood product preparation and packaging Employment impact (adds 45 new employees to sector)
Subtotal Annual	\$32,560,442	75	
Infrastructure Construction	\$15,000,000	58	<ul style="list-style-type: none"> IMPLAN Sector 46 – Construction of Manufacturing Structures

Results from the economic impact modeling for this scenario in terms of employment in Year 10 are shown in Table 12. The total contribution of the industry is 174 jobs, with seaweed growers supporting 42 overall and seaweed processing supporting a total of 162 jobs. Because the indirect jobs in processing include the direct jobs in the growing process, the 30 direct jobs attributed to the growers were removed from the total (see Overlap row in Table 12) results in a total of 174 jobs. The majority of the jobs are a direct contribution (75), followed by indirect (52), and then induced (47).

Table 12. Regional Economic Impacts of BAU (Employment – Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	30	6	7	42
Processing	45	76	41	162
Overlap	0	-30	0	-30
Total	75	52	47	174

Table 13 includes the total economic output, or GDP type of stimulus associated with the Washington seaweed industry in Year 10 for the BAU Scenario. The industry generates over \$55.6 million in economic output including from the growers and processing, and accounting for overlap. The largest contributor to the economic output is processing (about \$48 million when the double counting is subtracted), with a grower contribution of about \$7 million.

Table 13. Regional Economic Impacts of the BAU Scenario (Output - Year 10)

Scenario Element	Direct Stimulus	Indirect	Induced	Total
Growers	\$4,173,464	\$1,380,949	\$1,545,620	\$7,100,033
Processing	\$28,386,978	\$14,760,908	\$9,596,623	\$52,744,508
Overlap	\$0	-\$4,173,464	-\$0	-\$4,173,464

Scenario Element	Direct Stimulus	Indirect	Induced	Total
Total	\$32,560,442	\$11,968,393	\$11,142,243	\$55,671,078

6.5 Detailed Results from the Production Supported Scenario

The Production Supported Scenario assumes that seaweed farms in Washington expand significantly to encompass 2,000 acres by Year 10. Table 14 below shows the assumptions for Year 10 under this scenario. Note that the processing in this scenario is the same as in the BAU, and the infrastructure construction is the same as in the BAU Scenario.

Table 14. Direct Elements of Production Supported (Year 10)

Scenario Element	Direct contribution	Direct Employment	Assumptions
Growers	\$24,000,000	173	2,000 acres in Year 10
Processing	\$28,386,978	45	Same as BAU
Subtotal Annual	\$52,386,978	218	
Infrastructure Construction	\$15,000,000	58	Same as BAU

Results for the economic impacts related to employment in Year 10 for this scenario are provided in Table 15. In Year 10 the seaweed industry in Washington will contribute a total of 330 jobs to the state economy. The largest portion of the seaweed employment will be associated with growers (244) and then processing with a net impact of 86 jobs (162 minus 76). Like in the BAU Scenario, the total number of jobs accounts for overlap between the indirect jobs associated with the categories, which prevents double counting.

Table 15. Regional Economic Impacts of Production Supported (Employment – Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	173	33	38	244
Processing	45	76	41	162
Overlap	0	-76	0	-76
Total	218	33	78	330

As shown in Table 16, the output associated with this scenario contributes a total of nearly \$79 million in economic output in Year 10. Growers contribute the most to this total (about \$41 million) with processing totaling about \$38 million in contribution once the overlap is subtracted. The primary difference between the BAU and Production Supported Scenarios is

that the growers are contributing a lot more to the regional economy – about \$41 million compared to \$7 million in the BAU.

Table 16. Regional Economic Impacts of Production Supported (Output - Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	\$24,000,000	\$8,081,372	\$8,928,185	\$41,009,558
Processing	\$28,386,978	\$14,760,908	\$9,596,623	\$52,744,508
Overlap	\$0	-\$14,760,908	\$0	-\$14,760,908
Total	\$52,386,978	\$8,081,372	\$18,524,808	\$78,993,158

6.6 Detailed Results from the Processing Supported Scenario

The Processing Supported Scenario assumes the state leans into processing facility development to not only support seaweed growers in Washington, but those in Alaska, British Columbia, and other nearby regions. Under this scenario, Washington becomes a hub for processing and distributing seaweed products sourced from across the West Coast. The number of Washington growers is expected to match those presented in the BAU scenario (see Tables 11-13). The defining element of this scenario is the support for development of a substantial secondary processing facility capable of making more-refined products at larger scale. Table 17 shows the assumptions about the direct contributions of the industry in terms of employment and output for this scenario.

Table 17. Direct Elements of Processing Supported (Year 10)

Scenario Element	Direct contribution	Direct Employment	Assumptions
Growers	\$4,173,464	30	Same as BAU
Processing	\$75,698,608	120	<ul style="list-style-type: none"> ▪ High-capacity biorefinery ▪ Employment impact (add 75 new employees to sector)
Subtotal Annual	\$79,872,072	150	
Infrastructure Construction	\$40,000,000	154	<ul style="list-style-type: none"> ▪ \$40 million construction cost for 2 processing facilities

Table 18 includes the employment associated with the seaweed industry during Year 10 for the Processing Supported Scenario, which assumes heavy support for seaweed processing. The total number of job contributions associated with processing (431, or 401 once the overlap is subtracted) is significant due to the heavy processing support assumed for this scenario. Compared to the other scenarios, the Processing Supported Scenario has the largest number of jobs linked to the seaweed industry for Year 10.

Table 18. Regional Economic Impacts of Processing Supported (Employment – Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	30	6	7	42
Processing	120	203	108	431
Overlap	0	-30	0	-30
Total	150	179	115	443

This scenario also displays the largest economic output of all the scenarios for Year 10 (see Table 19). The economic output totals over \$143 million, the majority of which is associated with processing (\$136 million, after subtracting the overlap). Growers in Washington contribute over \$7 million, as in the BAU. For each category the direct contributions are most significant. Economic benefit to Washington outpaces the other scenarios here because the state is essentially building on expanded production from outside Washington for feedstock to the processing facilities. If this scenario is pursued, it will be important to establish safeguards to ensure economic benefits are shared equitably between the participating farmers across states.

Table 19. Regional Economic Impacts of Processing Supported (Output - Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	\$4,173,464	\$1,380,949	\$1,545,620	\$7,100,033
Processing	\$75,698,608	\$39,362,421	\$25,590,993	\$140,652,023
Overlap	\$0	-\$4,173,464	\$0	-\$4,173,464
Total	\$79,872,072	\$36,569,906	\$27,136,614	\$143,578,592

6.7 Detailed Results from the Marketing Supported Scenario

The Marketing Supported Scenario assumes that the state focuses on market support via specific, targeted marketing campaigns for seaweed products. In this scenario, the BAU acreage is doubled, and rather than making additional investments into expanding simple processing facilities (as in the BAU and Production scenarios), a large capacity processor (biorefinery) is constructed (as in the Processing scenario), but not the smaller one assumed in the BAU (see Table 20).

Table 20. Direct Elements of Marketing Supported (Year 10)

Scenario Element	Direct Contribution	Direct Employment	Assumptions
Growers	\$8,346,928	60	Double the BAU acreage
Processing	\$47,311,630	75	Large capacity processor
Overlap	N/A	N/A	N/A
Subtotal Annual	\$55,658,558	135	
Infrastructure Construction	\$25,000,000	97	\$25 million processing facility

In Year 10, under the Marketing Supported Scenario, the seaweed industry in Washington contributes 294 total jobs to the state workforce (see Table 21). The majority of these are associated with processing (270, or 210 when the overlap is subtracted) and the growers contribute 85 jobs, most of which are direct (60). Of total 294 jobs, almost half are direct contributions (135), followed by induced contributions (81), and then indirect (78).

Table 21. Regional Economic Impacts Marketing Supported (Employment – Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	60	12	13	85
Processing	75	127	68	270
Overlap	0	-60	0	-60
Total	135	78	81	294

Table 22 shows the total economic output for each Marketing Supported Scenario element in Year 10. The economic output totals nearly \$94 million. Processing accounts for nearly \$80 million (\$87.9 million minus \$8.3 million) of this total, and with double the growing acreage of the BAU scenario, the grower contribution to the economic output is almost double (\$5.7 million).

Table 22. Regional Economic Impacts of Marketing Supported (Output - Year 10)

Scenario Element	Direct contribution	Indirect	Induced	Total
Growers	\$8,346,928	\$2,810,610	\$3,105,122	\$14,262,659
Processing	\$47,311,630	\$24,601,513	\$15,994,371	\$87,907,514
Overlap	\$0	-\$8,346,928	\$0	-\$8,346,928
Total	\$55,658,558	\$19,065,195	\$19,099,493	\$93,823,245

6.8 Regional Economic Impact Discussion

Taking all three factors (employment, economic output, and tax revenue) into account, the Processing Supported Scenario provides the most significant economic benefit in Year 10. It also possesses the greatest multiplier effect of all the scenarios. The Production Supported, and Marketing Supported Scenarios are similar in overall results, with the Production Supported Scenario contributing the second most in terms of employment but third most in terms of output (see Table 6 and Table 7 and Figure 4 and Figure 5 above), and the Marketing Supported Scenario contributing the second most in terms of output but third most in terms of employment. Both result in similar tax contributions. The BAU Scenario has a far smaller economic impact than the other three scenarios in all three categories. It has less than half the employment, output, and tax contributions of the Processing Supported Scenario. This suggests that the seaweed aquaculture industry in Washington State may not reach its full potential without targeted strategic support by government agencies or other external entities.

The multipliers seen in the analysis (see Tables 6 and 7 above) are favorable relative to comparable industries, ranging from 1.5 to 1.8 for output and 1.5 to 3.0 for employment. For comparison, a recent analysis by Greene Economics for the Department of Health on the existing Washington State shellfish industry suggested a multiplier of 1.4 for employment and 1.7 for output.⁵⁷ These only reflect the farming aspect of shellfish, and not the further processing. The high results for processing are comparable to other similar results for chemical

⁵⁷ Greene Economics. 2025. Washington Shellfish Fee Review Recommends Public Funding for Biotxin Testing. Available here:

https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=Shellfish%20Fee%20Assessment%20August%2028%202025_6c1d9be6-d2c8-4756-b514-e50dd211554c.pdf

processing. For example, the researchers found an output multiplier of 1.6 and an employment multiplier of 3.5 for a proposed methanol plant along the Columbia River.⁵⁸

7.0 RECOMMENDATIONS

Based on the takeaways of the research and outreach process, and supported by the results of the economic analysis, the following recommendations for consideration are presented for Maritime Blue and industry proponents:

1. Support development of secondary seaweed processing in Washington State to allow for Washington to serve as a processing hub for the region. This could include evaluating options to attract new and existing seaweed processors and product development companies to Washington State.
2. Streamline permit and approval processes to facilitate easier entry into seaweed farming. Such streamlining could leverage existing strategies and approaches used to permit seaweed aquaculture in other states (e.g., pre-permitted areas) or for approving shellfish aquaculture farms in Washington (e.g., programmatic approvals).
3. Consider pathways to improve profitability of Washington-grown seaweed through educational campaigns or place-based marketing. For example, biostimulants made with Washington-grown seaweed could be targeted towards the state's extensive agricultural industry, with emphasis on both ecological and economic benefits from sourcing them locally.

The seaweed aquaculture industry in Washington could provide significant benefits to the state, including jobs and revenue through direct, indirect, and induced economic pathways. However, these benefits will not be fully realized without targeted support of the industry as it grows. The scenarios presented here consider support of three different elements of the seaweed value chain (production, processing, and marketing), based largely on specific industry needs identified by interviewees. Consistent with feedback from industry participants and experts, providing support for the development of processing infrastructure within the state is likely to result in the greatest economic impact through the jobs and revenue generated. Support for the production and marketing steps of the value chain would also help to realize economic potential by easing barriers to entry and stimulating demand. Seaweed farming has a variety of ecological and economic benefits and could be an incredibly valuable industry in Washington with the right support.

⁵⁸ BergerABAM, Geotechnical Resources Inc., RAMBOLL ENVIRON, Archaeological Investigations Northwest Inc., Kittelson & Associates Inc., AcuTech Consulting Group, ECONorthwest, Geosyntech. 2016. Final Environmental Impact Statement. Prepared for Port of Kalama and Cowlitz County. September 2016.

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https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/index.php

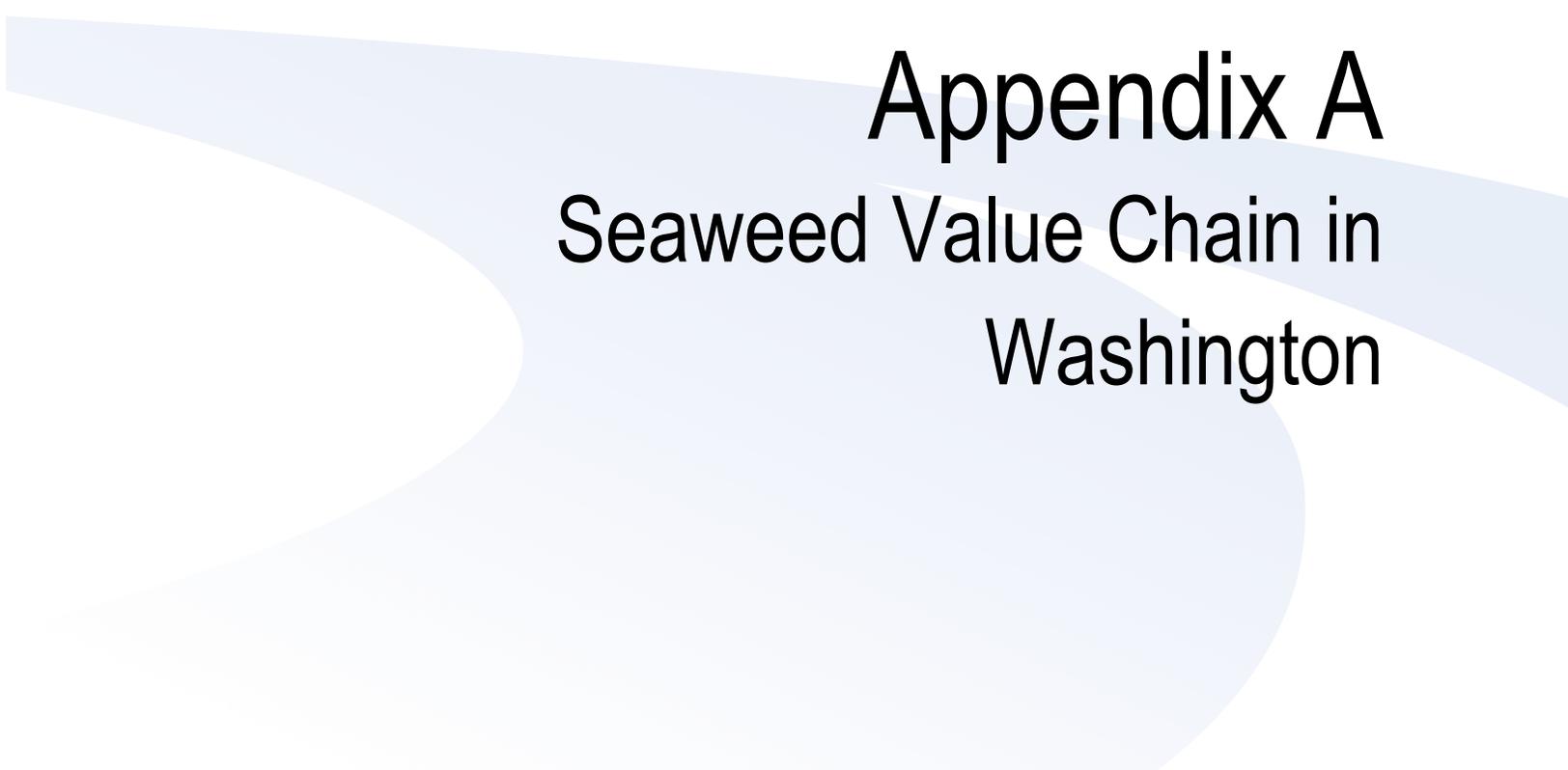
USDA. 2023. Miscellaneous Aquaculture Production and Sales by Type – United States: 2023.

Available at:

https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Aquaculture/aqua_1_008_008.pdf

The World Bank. 2023. Global Seaweed: New and emerging markets report. Available at:

<https://www.worldbank.org/en/topic/environment/publication/global-seaweed-new-and-emerging-markets-report-2023>

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Appendix A

Seaweed Value Chain in Washington

The following information is based on the research and outreach conducted for the Washington seaweed aquaculture economic potential analysis project. The goal of this appendix is to document the seaweed value chain as it currently exists in Washington, as well as possible infrastructure and markets that could exist through additional investment. The information presented here is additionally discussed and summarized in Section 4 of the report.

STARTING A FARM

Starting a farm in Washington typically requires many years (approximately 3-5) of planning and permitting before receiving full authorization. Most farmers start by determining an appropriate site for their farm. This process includes consideration of depth, wave action, currents, sediment movement, navigation, accessibility, and other factors that help to determine the suitability of a given location for growing seaweed. Consideration of these factors may be based on local knowledge and familiarity with the site and/or through conversations with experts (oceanographers, marine engineers, etc.). Additionally, the siting process should involve conversations with tribes whose usual and accustomed areas (U&As) include the proposed site. Engagement with the local community is also an important step in the siting process as it can help determine the likely success of gaining authorization. There is currently no standardized set of criteria in Washington State for determining an appropriate site nor a set of sites that have been pre-assessed or set aside for aquaculture.

After identifying a site for the proposed farm, farmers must then draft their proposal (i.e., determine size of the farm, species to be grown, type of gear, etc.) and begin the process of engaging regulatory agencies. In Washington, work conducted in the water (including seaweed farming) typically requires permits from federal, state, and local entities. The U.S. Army Corps of Engineers has jurisdiction of activities below the high tide line and must consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service before issuing a permit. Tribal consultation is also conducted through this process to ensure preservation of tribal treaty rights. State agencies, including the Department of Health, Department of Ecology, and Department of Natural Resources (DNR), manage and authorize activities that involve the harvest of food products from Washington's waters, which may influence water quality, and that occur on state-owned aquatic lands (SOAL), respectively. In Washington, conducting activities on SOAL is accomplished with a limited term lease (typically 4 years) issued and managed by the DNR. Finally, a shoreline substantial development permit is likely required through the local city or county. Obtaining permits and authorizations from each of these entities may require public notices, hearings, and input from qualified professionals, in addition to significant time, cost, and effort. It can also often be the case that agencies (as well as the local community) may have different priorities or perspectives, putting the farmer in the position of needing to persuade or defend their proposal.

FARM OPERATIONS

Once a farm is permitted and established, farm operations can begin. Farmers must first identify a reliable seed source for their farm. In Washington, farming currently focuses on kelp species, and therefore the process for obtaining seed described here is specific to kelp (not seaweed at large). Reproductive material (“sorus”, plural “sori”) used to make seed for aquaculture is required to be collected according to DNR's Sori Collection Protocols for Commercial Kelp Aquaculture in Washington State as a condition of DNR lease agreements.¹ Notably, the protocols require that sori must be collected from at least 50 individual “parents” and from healthy kelp beds as close to the farm site as possible. The intent of these protocols is to ensure sustainable collection practices, maintain genetic diversity among wild kelp populations, and limit the spread of invasive or pest species and disease. After collection, the reproductive material must be taken to a nursery and raised in the lab to produce kelp “seed” (sporophytes). Seed is typically attached to spools of line that can then be strung on gear at the farm for grow-out. Contamination in the nursery is the most likely source of failure, necessitating regular care and maintenance. Inviolate reproductive material can be another factor contributing to seed failure. At the time of this report, there is one kelp nursery in Washington supplying seed to commercial seaweed farms and one or two additional nurseries that support kelp restoration or research efforts.

Sugar kelp seed is typically planted in late fall (November) and is left to grow out through April or May. No inputs (i.e., feed, fertilizer) are required for growth once outplanted; kelp and other seaweeds rely on sunlight and dissolved nutrients in the water. Fouling (i.e., growth of unwanted marine organisms) on the seaweed is a concern during the grow out phase, particularly if the seaweed is destined for a food market. The longer the seaweed is left in the water (and the warmer the water gets into spring), the more likely the seaweed is to be colonized by fouling organisms. Farmers try to maximize their harvest by monitoring their crop and limiting the fouling to the extent possible.

Based on interviews and for the purpose of this analysis, primary processing and stabilization of seaweed products are considered to be a part of farm operations in Washington. Primary processing refers to the initial steps of chopping, shredding, grinding, or otherwise breaking down the full blades of seaweed to make them more manageable and/or desirable prior to potential further processing for stabilization and end-use. Depending on the target market (e.g., restaurants), primary processing may be minimal. Stabilization refers to additional steps taken to ensure that the seaweed will not decompose or degrade prior to secondary processing or getting to market. Stabilization may involve drying, freezing, or chemically altering the

¹ Washington Department of Natural Resources (DNR). 2024. Sori Collection Protocols for Commercial Kelp Aquaculture in Washington State. Available at: https://dnr.wa.gov/sites/default/files/2025-07/aqr_aqua_kelp_proto.pdf

seaweed (e.g., by adding acid or fermenting), and must be done within hours of harvest, unless cold storage is accessible. There are a variety of low-cost ways to conduct primary processing and stabilization (including sun drying and co-packing agreements), which farmers have been successfully employing at small scales in Washington. Seaweed can then be sold wholesale or direct to the consumer in a stabilized form.

SECONDARY PROCESSING AND DISTRIBUTION

Once seaweed is stabilized, secondary processing can occur to extract or create the products needed. Seaweed that is grown in Washington is currently being sold in a fresh or stabilized form, and distribution is handled by each farmer directly. Transportation is costly and challenging when seaweed is fresh. Primary processing and stabilization infrastructure are typically necessary within proximity to farms due to the limited shelf-life of freshly harvested seaweed and are ideally water-adjacent (i.e., at the dock or floating). Once it has been stabilized, the distribution of seaweed is akin to the transport of any other food product or dry good. Secondary processing can be conducted regionally, assuming infrastructure is accessible by road or by water. Secondary processing of seaweed is occurring outside of Washington through a variety of methods.

Secondary processing approaches and infrastructure vary in cost and complexity. An example of a cost-effective approach that can be responsive to market demand is a modular processing facility. In a modular facility, processing equipment is containerized and portable, allowing for individual elements to be purchased separately and added to a processing line as market demand dictates. This type of approach is likely to be more suitable for small-scale and regional markets but may limit the types or quantities of products that can be produced.

With greater investment, specific seaweed extracts can be obtained through the use of a seaweed biorefinery, a higher cost and integrated system that processes seaweed through a combination of physical, chemical, and biological methods to extract compounds (analog of an oil refinery). Seaweed biorefineries are expensive but often necessary for targeting many high-value markets (e.g., cosmetics and nutraceuticals). Seaweed biorefinery processes could be included within a modular facility, assuming availability of appropriate equipment.

To maximize the value obtained from a seaweed harvest, a cascading approach can be employed. Cascading secondary processing refers to a stepwise processing approach that utilizes the highest-value components first and then makes additional products from the remaining, byproduct components of the seaweed. Cascading processing seeks to ensure near-complete utilization of the seaweed with minimal waste. There are a variety of possible cascades that could be applied to maximize value from a single harvest of seaweed; cascading processing may or may not involve seaweed biorefinery techniques.

Optimal secondary processing techniques depend largely on target markets and products, though certain processing approaches (e.g., modular or cascading processing) could allow a single facility to support multiple end products.

PRODUCTS AND MARKETS

Overall, the commercial seaweed market in Washington and on the West Coast of the U.S. generally is viewed, by those directly involved, to be new and relatively unsupported. The consumables market was widely accepted as niche due to the disinterest shown by the general American public in seaweed as a food and the plethora of consumable seaweed products from pre-established Asian markets. The cosmetics market shows promise, with several businesses already presenting strong initial results among consumers and established plans for forward expansion. Among those interviewed, another widely appealing market is that of biostimulants, which are consistently referenced as profitable and the fastest growing endeavor within the commercial seaweed industry. Several other niche markets show promise as well, despite their current lack of scale. These include products such as plastic-substitute packaging materials and home-gardening planter pots constructed out of specific seaweed components. Of interest in the planter pot example is that Ocean Made, the company producing the pots, has been collaborating with a manufacturing facility in Pomeroy Washington (Palouse Fiber), thereby stimulating economic activity on both sides of the state, while also making use of the byproducts generated via Macro Oceans, exemplifying a practical application of the cascading biorefinery model.

It is worth noting that certain markets (e.g., biostimulants, plastic-substitute packaging) require substantial volumes of seaweed to be profitable. Global competition is also likely to be an issue for some markets. Supporting the development of cascading biorefinery infrastructure or a modular model would enable the growth of multiple markets.



Appendix B

Annotated Bibliography

Ainis, A.F., R.L. Vellanoweth, Q.G. Lapeña, & C.S. Thornber. 2014. Using non-dietary gastropods in coastal shell middens to infer kelp and seagrass harvesting and paleoenvironmental conditions. *Journal of Archaeological Science*, 49, 343-360.

This study examines prehistoric shell middens along the California Channel Islands to infer historical kelp and seagrass harvesting practices using non-dietary gastropod remains. The geographic focus is archaeological sites in southern California, but its methods and findings provide insight into long-term human–seaweed interactions along the U.S. Pacific coast. Although not directly addressing modern industry, the research highlights the ecological persistence and productivity of kelp ecosystems under human exploitation. This contributes to understanding the sustainability potential of seaweed farming in Washington, where similar temperate kelp species occur. The paleoecological perspective underscores that kelp-based economies can coexist with resilient ecosystems over long timeframes.

Blakeley, Mike, & Blakeley, Elaine. 2024. Lessons Learned Marketing Seaweed Products in the U.S., Seagreen Insights, USA.

The goals of this study were to inform start-ups and investors what strategies have proven successful for established companies and to identify where funders can best support the seaweed aquaculture sector. The authors interviewed 28 professionals operating in the U.S. seaweed sector. The top needs for marketing assistance identified by the producers interviewed were 1) industry representation, 2) funding for sampling, 3) more data on production and end market sales, and 4) consumer feedback. Given the general lack of familiarity of consumers with seaweed, sampling is considered to be the best way to gain customers. Other lessons learned included the importance of terminology, food safety, and restaurant partnerships.

Brayden, C., & Coleman, S. 2024. Maine seaweed benchmarking: Economically assessing the growth of an emerging sector. *Aquaculture Economics & Management*, 28(3), 491-514.

This paper benchmarks the economic performance of Maine’s emerging seaweed industry, analyzing farm-scale production, costs, yields, and market diversification. The geographic focus is Maine, U.S., providing a comparative case for other U.S. coastal regions. It addresses multiple *value chain components*, including *production*, *processing*, and *marketing*, with a focus on financial viability. Key findings include a decline in median breakeven price above total costs from US \$6.89/lb in 2017 to US \$0.66/lb in 2022, reflecting improvements in efficiency and scale. Labor costs per pound harvested also decreased significantly over this period, and median yields increased by approximately 28% (from 3.3 to 4.24 lbs per foot of grow-line), demonstrating productivity gains. The report highlights that farms are diversifying into multiple product types, including fresh edible seaweed and value-added products, although detailed revenue breakdowns are not publicly provided. For Washington State, these metrics offer important

benchmarks for assessing economic potential, scaling strategies, and market development in a comparable U.S. context.

Buckner, E., N. Naar, G. Adams, J. Davis, S. Matson, & D. Tonnes. 2023. Building Capacity for Kelp (Laminariales) Mariculture in the Salish Sea: Ecological Considerations and Initial Farm Guidance. *Marine Fisheries Review*, 85(1-4), 52-81.

This paper outlines ecological and operational guidance for establishing kelp mariculture in the Salish Sea, including environmental considerations, farm design, and regulatory context. The geographic focus is Washington State and British Columbia waters—directly applicable to WA. It addresses production and process stages of the value chain, offering practical frameworks for site selection, species choice, and ecosystem monitoring. The authors emphasize balancing economic development with ecological resilience, identifying data needs for scaling kelp farming responsibly. For Washington’s economic potential, the work provides foundational knowledge for expanding mariculture while maintaining environmental quality. It also situates kelp farming as a contributor to coastal community diversification and climate resilience.

Brown, Alex. 2022. WA seaweed farming could boom but permitting remains difficult.

Cascade PBS. Available at: <https://www.cascadepbs.org/environment/2022/03/wa-seaweed-farming-could-boom-permitting-remains-difficult/>

This Cascade PBS article examines the growing interest in commercial seaweed farming in Washington State, highlighting both its economic promise and the regulatory hurdles constraining industry development. The geographic focus is statewide, with emphasis on the Puget Sound and coastal areas. The piece centers on policy and permitting components of the seaweed production value chain, describing challenges such as complex leasing procedures, overlapping jurisdictions, and uncertain environmental requirements. It provides context on early pilot farms and entrepreneurs seeking entry into the market. For Washington’s economic potential, Brown’s reporting underscores that regulatory streamlining and clearer permitting guidance are essential precursors to sector growth. The article offers an accessible synthesis of how governance directly influences investment and industry expansion.

Donovan, B. 2025. An economic and production analysis of seaweed farms in California and the Pacific Northwest.

This study sought to analyze the current state of the seaweed aquaculture industry along the Western United States, specifically the states of California, Oregon, and Washington. The research surveyed nine seaweed farmers from these states regarding the economic, commercial, and production processes involved with their operations. Results showed that California was the fourth-largest producer of farmed seaweed in the country, and that farms which cultivated Pacific Dulse were the most profitable. Other major species cultivated within the region included bull Kelp, Sea Lettuce, and Giant Kelp. The study concluded with a series of

recommendations suggesting that the industry focus on streamlining the regulatory process and expanding into new markets, such as pharmaceuticals, nutraceuticals, and cosmeceuticals.

Dowell, F. 2024. Feasibility Study of Native Seaweed Aquaculture in Washington State.

University of Washington. Available at:

<https://digital.lib.washington.edu/server/api/core/bitstreams/73dc2908-d64f-4f3c-9547-a7e975bf4ac1/content>

This Masters thesis assesses the biological, technical, and economic viability of cultivating native seaweed species in Washington State waters. The geographic scope is explicitly regional, with site analyses across the Puget Sound and outer coast. It primarily addresses the production and processing stages of the value chain, evaluating species performance, infrastructure needs, and potential product markets. The report also considers environmental co-benefits, including nutrient uptake and habitat enhancement, alongside logistical challenges in scaling operations. For Washington's economic potential, Dowell provides critical baseline data and a roadmap for integrating native seaweed farming into existing maritime industries. The study serves as a key reference for investors, policymakers, and communities considering commercial expansion.

Froehlich, H. E., Gentry, R. R., & Halpern, B. S. 2017. Conservation aquaculture: Shifting the narrative and paradigm of aquaculture's role in resource management. *Biological Conservation*, 215, 162-168.

This paper attempted to recontextualize the historically adverse relationship between conservation and aquaculture by highlighting the ways in which modern aquaculture approaches can be operationally implemented to result in net environmental benefits. Some of the benefits referenced include the restoration of oyster bed habitats, the aquarium trade of endangered coral reef species, and the alleviation of strain placed on ocean ecosystems by wild harvest activities via the increased production of cultivated aquaculture operations. The authors also stressed the importance of incorporating conservation principles into the aquaculture industry as it expands rapidly.

Froehlich, H. E., Gentry, R. R., Lester, S. E., Cottrell, R. S., Fay, G., Branch, T. A., Gephart, J. A., White, E. R., & Baum, J. K. 2021. Securing a sustainable future for US seafood in the wake of a global crisis. *Marine Policy*, 124, 104328.

This paper was written in response to the 2020 Executive Order on Promoting American Seafood Competitiveness and Economic Growth, which proposed the deregulation of wild-capture fisheries and prioritized the development of offshore aquaculture operations. The research attempted to outline several principles to help guide the sustainable implementation of this executive order. These principles included making precise and strategic reforms which support wild fisheries, integrating new aquaculture practices which utilize an ecosystem-based

approach, improving data collection regarding aquaculture, addressing general social resistance to aquaculture, and reconciling American nationalism within the context of a global market.

Froehlich, H. E., Gentry, R. R., Lester, S. E., Rennick, M., Lemoine, H. R., Tapia-Lewin, S., & Gardner, L. 2022. Piecing together the data of the US marine aquaculture puzzle. *Journal of Environmental Management*, 308, 114623.

The primary goal of this study was to assess the current state of data availability with regard to the United States (US) aquaculture industry. The analysis incorporated information from across 23 different marine coastal states using a suite of publicly available datasets (U.S Department of Agriculture, National Oceanic and Atmospheric Administration, etc.). The results of this analysis revealed a large data gap, representative of millions of US dollars in unreported value, which suggested that the US aquaculture industry is likely more diverse and abundant than what has previously been reported.

Fujita, R., Augyte, S., Bender, J., Brittingham, P., Buschmann, A. H., Chalfin, M., Collins, J., Davis, K. A., Gallagher, J. B., Gentry, R., Gruby, R. L., Kleisner, K., Moritsch, M., Price, N., Roberson, L., Taylor, J., & Yarish, C. 2023. Seaweed blue carbon: ready? Or not? *Marine Policy*, 155, 105747.

In an attempt to address increasing greenhouse gas emissions and meet United Nations Sustainable Development Goals, the authors of this study engaged a collection of subject matter experts in a system mapping exercise to determine the potential for marine seaweed as a carbon sequestration tool. This exercise resulted in several conclusions, chief among them being that conservation and restoration efforts involving seaweed are associated with a low-level of risk and are likely to produce a myriad of ecological, economic, and social benefits. The carbon sequestration potential for these efforts is minimal to nonexistent. There is greater potential for carbon sequestration in an approach which significantly expands current seaweed farming efforts before sinking large amounts of seaweed biomass to the ocean floor, but this strategy is associated with a much higher level of risk. The final approach discussed involves creating seaweed-based alternatives to popular emissions-intensive products; this idea shows initial promise, but the paper acknowledges that more research is required before such products could be brought to market scale.

Gentry, R. R., Alleway, H. K., Bishop, M. J., Gillies, C. L., Waters, T., & Jones, R. 2020. Exploring the potential for marine aquaculture to contribute to ecosystem services. *Reviews in Aquaculture*, 12(2), 499-512.

This study aimed to map the biological production potential for marine aquaculture across the globe using an approach which incorporated elements of physiology, allometry, and growth theory. The analysis found copious amounts of space along the coastlines of nearly every marine-facing country which would be suitable for aquaculture production. Utilizing just a

small fraction of this space would allow the world to meet its current demand for wild-capture fish protein, meaning that economic and governance factors are more likely to limit the development of the aquaculture industry than spatial availability.

Gentry, R. R., Froehlich, H. E., Grimm, D., Kareiva, P., Parke, M., Rust, M., Gaines, S. D., & Halpern, B. S. 2017. Mapping the global potential for marine aquaculture. *Nature Ecology & Evolution*, 1(9), 1317-1324.

As the extent to which the aquaculture industry may be able to contribute to ecosystem service provisioning is not currently well understood, this study aimed to review the existing knowledge surrounding marine aquaculture activities by examining a total of 129 peer-reviewed papers, which describe nine distinct ecosystem services provided by aquaculture operations. Some services, like nutrient absorption via kelp aquaculture, have been well established within the available literature, while others, like how aquaculture interacts with the cultural service of tourism, require additional research before they can be adequately quantified. Additionally, the paper noted that farm type played a large role in which services were offered, such as how fish farms were most often the operations associated with providing habitat services.

Hansen, Gayle I. 1989. Nori farming in Anacortes, Washington: a political dilemma. Poster session presented at the 13th International Seaweed Symposium, Vancouver, Canada, and the 4th Northwest Algal Symposium, Rosario Beach, Washington. Available at: <http://ir.library.oregonstate.edu/concern/defaults/1v53k318p>.

This conference poster describes early efforts to establish *nori* (*Porphyra*) farming in Anacortes, Washington, and explores the social and political barriers that emerged. The geographic focus is local (Anacortes and Rosario Beach), representing one of the earliest attempts at seaweed aquaculture in the state. The analysis addresses production feasibility and regulatory acceptance, particularly public perception and policy resistance. Hansen documents community opposition and complex governance issues that prevented pilot-scale implementation. For Washington's economic potential, this historical case provides lessons on stakeholder engagement, communication, and the importance of social license for new aquaculture sectors. It illustrates how non-technical factors can significantly influence the success of seaweed ventures.

Heidkamp, C. P., Krak, L. V., Kelly, M. M. R., & Yarish, C. 2022. Geographical considerations for capturing value in the US sugar kelp (*Saccharina latissima*) industry. *Marine Policy*, 144, 105221.

This paper documents information gained during a series of interviews investigating the market differences and opportunities for growth of the sugar kelp industry in Maine, Alaska, and Connecticut. These locations vary in the maturity of the market, number of active farms,

scale of production, processing infrastructure, and distribution mechanisms. The authors highlight the differences in the seaweed supply chain in each location, particularly as it relates to requirements for food safety, processing capacity, strong seafood branding, and proximity to large markets. Maine is unique in its relatively cheap and developed coastal infrastructure, percentage of the population consuming health foods, and permitting process amenable to a variety of scales of operation. Alaska boasts vast stretches of undeveloped coastline and an established seafood brand and distribution system. Connecticut has the most stringent food safety standards but does allow farmers to sell at a high price point due to the transparent regulatory process and brands associated with established shellfish and seafood markets. Regional origin labels, eco-labels, and quality labels are explored and discussed as a means for increasing the profitability of sugar kelp.

Henley, N., S. Raffin, & B. Caemmerer. 2011. The application of marketing principles to a social marketing campaign. *Marketing Intelligence & Planning*, 29, 697-706.

Although not specific to seaweed, this article examines how marketing principles can be effectively applied in social marketing campaigns to influence behavior and build awareness. The document outlines strategies such as audience segmentation, message framing, and behavior-based targeting. For the Washington seaweed industry, the study offers transferable insights into promoting sustainable seafood products and increasing consumer demand for local seaweed-based goods. Its relevance lies in supporting the market development phase of the value chain, particularly for branding Washington seaweed as both eco-friendly and regionally distinctive.

Island Institute. 2020. Edible Seaweed Market Analysis. Available at:

<https://oceansalaska.org/wp-content/uploads/2021/06/Edible-Seaweed-Market-Analysis-1.17.20.pdf>

This market analysis assesses the current and projected demand for edible seaweed products in the U.S., with a primary focus on Maine's emerging industry. The study reviews consumer trends, product categories, pricing, and distribution channels, positioning seaweed as a sustainable and healthy food source. It addresses the marketing, distribution, and processing components of the value chain, identifying bottlenecks such as limited processing capacity and fragmented supply chains. While geographically centered on the U.S. East Coast, its findings are broadly transferable to Washington's context. For Washington, the report provides useful benchmarks for understanding national market trajectories and value-added opportunities in edible seaweed products. It highlights the potential for coastal states to capture premium markets through quality assurance, branding, and local food system integration.

Kim, J., Stekoll, M., & Yarish, C. 2019. Opportunities, challenges and future directions of open-water seaweed aquaculture in the United States. *Phycologia*, 58(5), 446-461.

The authors open this paper with a review of seaweed aquaculture in the United States to date. Notably, there is a description of *Pyropia* (formerly *Porphyra*) farming that occurred in Washington State in the 1980s. Seed was imported from Japan and pilot-scale farms were operated during the 1982 and 1983 winter growing seasons using modified Japanese technologies. Private companies obtained permits for farming; waters around the San Juan Islands were identified as most suitable. However, regulatory hurdles and social resistance limited the viability of the industry, and opposition by stakeholder groups eventually resulted in its termination. The kelp aquaculture industry in the northeastern United States was identified as one of the fastest growing industries (at least at the time of writing), noting a critical approach of emphasizing the environmental benefits of the practice. Success was also attributed to the development of technologies suitable for operating in US waters, strong domestic markets, and strong support from coastal managers and stakeholders. The authors highlight that product diversification and enhanced biomass-to-biofuel conversion efficiency will be important for the economic viability of the industry.

Lester, S. E., Gentry, R. R., & Froehlich, H. E. (2024). The role of marine aquaculture in contributing to the diversity and stability of US seafood production. *Marine Policy*, 160, 105994.

The intention of this paper was to explore the benefits of expanding the United States aquaculture industry within the context of increasing environmental, economic, and political stressors; the authors hypothesized that a more diverse marine industry may be more stable and resilient in response to such stressors. The results of the analysis, which made use of regional production data, showed that an approach to industrial aquaculture development which focuses on diversity has the potential to result in a stronger seafood industry across local, regional, and national scales.

Leppäniemi, M., & H. Karjaluo. 2008. Mobile Marketing: From Marketing Strategy to Mobile Marketing Campaign Implementation. *International Journal of Mobile Marketing*. 3.

This article explores the strategic design and implementation of mobile marketing campaigns, outlining how digital tools can extend brand reach and customer engagement. Its geographic focus is international and theoretical, drawing on examples from early adopters in Europe and North America. The paper contributes to the marketing and communication components of the seaweed value chain by demonstrating how digital outreach, personalization, and mobile platforms can influence purchasing behavior. Although not specific to seaweed or aquaculture, it provides conceptual guidance for producers seeking to promote local seaweed products through modern, tech-enabled marketing approaches. For Washington's seaweed sector, the relevance lies in how digital branding and storytelling could connect regional farms with urban consumers and sustainability-minded markets.

LGL Limited. 2024. Seaweed Industry Development Plan. Prepared for Regional District of Mount Waddington. 113 pp. Available at:
<https://www.rdmw.bc.ca/media/2024%2010%2004%20RDMW%20Seaweed%20Industry%20Development%20Plan%202024.pdf>

Commissioned by the Regional District of Mount Waddington in British Columbia, this development plan outlines a regional strategy for expanding the seaweed industry, including cultivation, processing, and commercialization pathways. The geographic focus is coastal British Columbia, immediately adjacent to Washington’s northern boundary, offering strong contextual parallels. The plan addresses the entire value chain—from production feasibility and infrastructure needs to market development and governance frameworks. It emphasizes regional coordination, investment in processing hubs, and partnerships with Indigenous communities. For Washington, the report provides a valuable comparative model for regional planning and policy alignment in seaweed sector growth. Its proximity and shared ecological conditions make it especially relevant to assessing cross-border economic opportunities and best practices for sustainable industry development.

McKinley Research Group. 2021. Alaska Seaweed Market Assessment. Prepared for Alaska Fisheries Development Foundation. 76 pp.

The key takeaways from this report center around the limited market demand for most seaweed products. For the industry to succeed, demand for existing seaweed products needs to grow considerably, and additional markets need to emerge. In Alaska, the seaweed industry faces additional infrastructure and logistics challenges, as access to markets requires significant transport. Authors suggest that subsidies for production and R&D are likely necessary for continued development of current and potential markets. In 2021, Alaska produced an estimated 440,000 wet pounds of seaweed, up from about 18,000 pounds in 2017. The number of farms has also significantly grown in that time.

McKinley Research Group. 2022. Alaska Seaweed Industry Expansion Scenarios. Prepared for Alaska Fisheries Development Foundation. 7 pp.

This paper consisted of an update to a 2017 report which assessed the potential for future economic growth within Alaska’s mariculture industry. The metrics utilized for this projection included acres under cultivation, seaweed farm production volume, and associated job revenue. The range for the annual revenue generated via the Alaskan mariculture industry in 20 years is projected to lie between \$18 million and \$450 million. The variability of this projection is based on uncertainties involving market variance and the unknown viability of new mariculture technologies. In the lowest growth scenario, the Alaskan mariculture industry is expected to survive through the success of low-volume, high-value products like specialty foods. The higher growth scenarios involve strong support from the public sector for high-volume

seaweed products such as animal feeds, biostimulants, fertilizers, nutritional products, and bioplastics. The authors also note that since the last iteration of this report, several companies have made significant progress towards raising capital for the establishment of new mariculture operations within Alaska.

Neushul, P. 1989. Seaweed for War: California’s World War I Kelp Industry. *Technology and Culture*, 30(3), 561-583.

This historical study traces the development of California’s kelp industry during World War I, when kelp was harvested to produce potash and acetone for munitions and fertilizers. The geographic focus is California’s coast, with detailed discussion of industrial processes, technology adoption, and government–industry collaboration. The paper addresses the processing and industrial application components of the seaweed value chain, showing how external demand can drive rapid sectoral expansion. Although set in an earlier era, it provides instructive parallels for contemporary seaweed development in Washington, particularly regarding the mobilization of technology, infrastructure, and policy to support new markets. The case illustrates both the economic potential and volatility of seaweed-based industries under shifting market and policy conditions.

Pérez-Lloréns, J.L. 2019. Seaweed Consumption in the Americas. *Gastronomica*, 19(4), 49-59.

This article surveys the history, cultural patterns, and emerging trends of seaweed consumption across the Americas, from traditional coastal diets to modern gastronomic uses. The assessment spans North, Central, and South America, with particular emphasis on how culinary acceptance and awareness shape demand for edible seaweed products. The study focuses on the marketing and consumption ends of the value chain, highlighting evolving consumer preferences, restaurant innovation, and regional disparities in market development. For Washington, the analysis underscores the importance of cultural familiarity and culinary integration in building domestic markets for farmed seaweed. It suggests that expanding consumer education and chef-driven promotion could strengthen local demand and improve the economic viability of Washington’s seaweed industry. The article thus situates seaweed not only as a resource but as a culturally embedded food with growing market potential.

The World Bank. 2023. Global Seaweed: New and emerging markets report. 190 pp.

Through analysis of existing and potential global markets for seaweed, this report identified ten seaweed markets with the potential to grow by an additional \$11.8 billion USD by 2030. The most promising markets in the short term (defined as before 2025) include biostimulants, animal feeds, pet foods, and methane-reducing additives. Emerging markets in the medium term (2024-2028) include nutraceuticals, alternative proteins, bioplastics, and fabrics. These markets all face significant costs for production and therefore need additional work before being viable. Finally, long-term potential markets (after 2028) include pharmaceuticals and

construction materials. Regardless of the market, availability of seaweed, pricing challenges, and regulatory barriers were identified as challenges that need to be addressed in order for the industry to achieve its full potential.