

Integrating Seaweed Aquaculture into Canada's Blue Economy Strategy: A Call to Action



Submitted by:

CascadiaSeaweed

in concert with other players and concerned parties

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Seaweed:

An Agent of Change within the Blue Economy

Canada possesses all the fundamental elements and experience to grow seaweed into a booming source of economic, social, and environmental revenue

Potential to generate **30,000 jobs** in B.C. alone

Potential to become a **billion-dollar industry** in Canada

As of 2019, seaweed aquaculture generated close to **USD \$15 billion** per annum

85% of Canadians are urging the government to invest in cleaner technologies

Seaweed is a high-protein superfood with the potential to boost global food security

91% of Canadians say climate change is a serious issue

By 2050, The WBG estimates that the global seaweed industry will generate **USD \$28 billion** per annum and supply close to 10% of the world's food stores

Indigenous organizations and communities have expressed high interest in partnering with non-Indigenous aquaculture companies to stimulate growth

Seaweed aquaculture represents an **untapped source of natural carbon that can be harnessed to achieve net-zero emissions**

High Level Panel for a Sustainable Ocean Economy: **"scale up environmentally responsible commercial farming of seaweed and algae"**

Coastal ecosystems sequester **20 times** more carbon per acre than terrestrial forests

With 14 genera and over 600 species, **B.C. has one of the most diverse seaweed flora in the world**

Positive impacts along the supply chain: R&D, farming, primary and secondary processing, distribution, storage, community engagement

Animal feed composed of only **3% seaweed** can decrease livestock methane emissions by nearly **80%**

● Introduction

The purpose of this submission is to present the significant and timely opportunities for seaweed production and processing on Canadian coasts. This budding industry has the potential to stimulate the economy through job generation and new consumer markets, to foster reconciliation through partnerships with Indigenous communities, and to benefit our precious marine ecosystems through habitat restoration, carbon sequestration, and mitigation of rising ocean pH levels. In its strategy to build a sustainable blue economy, the Government of Canada cannot overlook the advantages of seaweed farming.

This call to action is backed by the expert opinions of Cascadia Seaweed and partner signatories, listed on pages 14 and 15. The unified voice of all signatories herein carries no small weight and must be heard with the greatest attention and urgency.

As the Blue Economy Strategy (BES) engagement paper underscores, ocean health is “under increasing pressure from overexploitation, pollution and climate change” according to the latest climate report from the World Meteorological Organization, sea-level rise is accelerating as ice caps at the Arctic and Antarctic poles continue to melt and the world’s oceans continue to store heat and acidify. The intensifying incidence of natural disasters such as hurricanes, heatwaves, wildfires, and droughts has resulted in billions of dollars in damage and displaced millions of people. The year 2020 was in the top three warmest years ever recorded, all of which have occurred over the past six years [1].

The recent global pandemic has only exacerbated the human impact of these phenomena and further revealed the fragile ties between our economy and environment. Concentrations of CO₂ increase in the oceans just as they do on land, but the oceans suffer more than double the damage as they already act as a global cooling system, storing 90% of the Earth’s heat. Now more than ever, the world must invest in greener technologies and behaviours to maintain global temperatures within 1.5 °C above pre-industrial levels and protect ecosystem services. As of 2020, mean temperatures approach this threshold, hovering at 1.2 °C ± 0.1 °C [1]. With the longest coastline in the world and a rich marine biodiversity, Canada has the opportunity to cultivate a green resource with the potential to curb climate change, address food insecurities, and secure the sustainability of the blue economy: seaweed.

Signatories were surprised and concerned that seaweed was not mentioned in the BES consultation. Stakeholders in Canada’s emerging seaweed sector are urging the federal government to invest in the development of the industry, which will invariably contribute to revitalizing remote, rural, Indigenous, and coastal communities and to driving growth and innovation in sustainable, regenerative aquaculture.

This submission urges the Government of Canada to stimulate growth in the initial stages of the national seaweed industry by;

- i) streamlining the tenure regulations for seaweed cultivation, designing a separate approval track, and fostering interdepartmental coordination to connect stakeholders with relevant authorities;
- ii) investing in production and processing techniques and infrastructure, particularly food processing as it is the highest-value product in the short term, to create regional value production points; and
- iii) investing in phycology, policy, and marketing research along with specialized training programs for the future seaweed workforce.

● Environmental and Economic Potential

As a food source, seaweed possesses all the right components to become the primary plant-based protein of the future.

The BES engagement paper supports the appeal from the United Nations Food and Agriculture Organization (FAO) to scale and adapt aquaculture to address the increased global demand for seafood. In this same spirit, the FAO recently identified seaweed as a valuable marine resource that “sustains the livelihoods of millions of people in coastal communities throughout the world” [2]. Looking to the future of marine farming, the World Bank Group (WBG) also acknowledges that seaweed “could represent a transformational change in the global food security equation and in the way we view and use the oceans” [4]. Seaweed has been harvested worldwide for centuries, and its positive impacts on both the economy and society are no secret. Canada must seize this opportunity and prioritize development in seaweed production and processing to carry its aquaculture industry forward.

Seaweed is a fast-growing, nutritionally dense crop that requires no fertilizer or pesticides and very little intervention to grow. However, the potential of macroalgae remains largely unexplored in Canada. Seaweed boasts a dry weight protein content of 10 to 30%, depending on the species, and is rich in macronutrients such as sodium, calcium, and potassium; in micronutrients like iodine, iron, zinc, and a host of antioxidants; in essential vitamins B12, K, and C; and in long chain omega-3 fatty acids. As a food source, seaweed possesses all the right components to become the primary plant-based protein of the future. As of 2019, seaweed aquaculture generated close to USD 15 billion per annum, representing 5.4% of the world’s aquaculture production [3]—and it continues to grow at an impressive pace. By 2050, The WBG estimates that the global seaweed industry will generate USD 28 billion per annum and supply close to 10% of the world’s food stores [4], driving innovation not only in food security, but also in emerging areas of algal biofuel, fertilizer, compost, water filtration, biopackaging, medicine, and agri-feed. For example, an Australian study conducted through the Commonwealth Scientific and Industrial Research Organization demonstrated that livestock feed composed of at least 2% seaweed, *Asparagopsis taxiformis* in this case, made methane production “virtually undetectable” in artificial rumen [5]. Similar research in which live sheep were fed a high-fibre pellet diet containing only 3% of dried *A. taxiformis* resulted in methane mitigation of up to 80% [6]. With livestock emitting around 14.5% of anthropogenic greenhouse gases [7], that is no small feat.

Canada is uniquely positioned to nurture this marine resource and benefit from its wide array of applications: a recent, large-scale, collaborative study published by the U.S. National Oceanic and Atmospheric Administration, the University of Adelaide, and The Nature Conservancy recognized the North American eastern and western coasts as “high-opportunity marine ecoregions” for restorative shellfish and seaweed aquaculture [8]. Canada’s year-round access to Arctic waters may also present an opportunity to expand seaweed cultivation in the future as ocean conditions shift. Canada is more than capable of fully harnessing the potential of seaweed aquaculture and generating significant socioeconomic and environmental return on investments.

The environmental benefits of seaweed cultivation are just as worthwhile and transformative as the market potential. Coastal ecosystems sequester 20 times more carbon per acre than land forests, and marine plants such as macroalgae are vital to this process [9]. Growing seaweed, which is highly efficient at storing carbon, effectively represents a marine equivalent to afforestation and can play a critical role in curbing climate change. A recent study published in *Current Biology* suggests seaweed aquaculture in only 0.065% of the viable ocean waters could entirely offset carbon emissions from the United States’ USD 50 billion aquaculture industry [10]. Canadian aquaculture can reap the same advantages and set the example for sustainable, diversified marine farming on the global stage. Beyond carbon capture, seaweed absorbs excess nutrients in the water to grow, counteracting ocean acidification and deoxygenation. Seaweed also shares a symbiotic relationship with neighbouring marine life, acting as food and protection while thriving off existing ecosystem services like nitrogen- and phosphorous-rich waste from fish [11] and water

filtration from shellfish [12]. Seaweed farmers have even observed the rejuvenation of depleted fish stocks in surrounding areas as a result of seaweed aquaculture, but current scientific knowledge on the topic is limited. The Nature Conservancy has partnered with the University of New England and the University of Auckland to fill this gap and examine the relationship between seaweed farms and fish in the temperate marine zones of Maine and New Zealand [13]. Results will confirm the potential of similar benefits in Canadian waters. Technology advancements in seaweed cultivation can target both production efficiency and, by extension, innovation in seaweed reforestation for marine conservation. The sustainability of Canada's growing aquaculture industry is crucial, and the benefits of seaweed cultivation towards this endeavor, along with Canada's commitments to climate action, cannot be discounted.

Under the Canadian Net-Zero Emissions Accountability Act [14], Canada has committed to achieving net-zero carbon emissions by 2050. Introduced in the House of Commons in November 2020, the Act holds Canada accountable to "establish a legally binding process to set five-year national emissions-reduction targets for 2030, 2035, 2040, and 2045, as well as develop credible, science-based emissions-reduction plans to achieve each target." Seaweed aquaculture aligns with these commitments, representing both a mitigator of greenhouse gases and a powerful, untapped source of natural carbon that can be harnessed on the global scale to achieve net-zero emissions.

Canada is also one of the 14 signatories on the High Level Panel for a Sustainable Ocean Economy [15]. The Panel acknowledges that "the actions we take now can safeguard the ocean's capacity to regenerate, in order to deliver substantial economic, environmental and social value and offer powerful solutions to global challenges." As a signatory to this international initiative, Canada commits to achieving the goals outlined in the 2030 Agenda for Sustainable Development and to "mutually reinforcing transformations in five critical areas: ocean wealth, ocean health, ocean equity, ocean knowledge and ocean finance." Under the umbrella of ocean wealth, Canada has committed to "scale up environmentally responsible commercial farming of seaweed and algae to provide food and create alternatives for products such as fuels, aquaculture and agriculture feedstocks, biotech, and viable and sustainable plastic alternatives."

Climate change is a top priority for Canadians. In a recent survey on climate opinion conducted through the Canadian Nuclear Association, 91% of Canadian respondents cited climate change as a serious issue, while 88% reported that climate change has adversely impacted their lives in some way. The global repercussions of the pandemic have only intensified these concerns, and 85% of Canadians are urging the government to invest in cleaner technologies [16]. Environmental health and economic prosperity are intimately tied, as is made evident in the term "blue economy." Fluctuations in ocean pH and temperature will generate ripple effects across all facets of human life, including the loss of trillions of dollars in GDP if the world's access to marine resources was to disappear. Seaweed farming is an avenue to clean technologies and a sustainable blue economy with the potential to become a billion-dollar market in Canada.

The evidence that Canada can benefit from this market is already available in real time. China, Indonesia, Japan, and South Korea may be the four largest cultivators of seaweed, but other countries are both taking advantage of and creating the seaweed aquaculture market in their own jurisdictions. These include the United States, the United Kingdom, Australia, France, Ireland, Spain, Iceland, and Norway. The 2020 "Hidden Champion of the Ocean" report, published by Seaweed for Europe and funded by the German SUN Institute Environment and Sustainability, paints the picture of a growing and concerted seaweed industry in Europe that could produce 9.1 million fresh tons of seaweed, create 115,000 jobs, and mitigate 6 million tons of carbon by 2030. This represents a potential European seaweed market of close to €9.3 billion (USD 11.7 billion) [17]. In developing its own market analysis of and approaches to seaweed, Canada will have a wealth of international experience and partnerships to draw from.

● Value Chain Diversification

British Columbia has one of the most diverse seaweed flora in the world, with 14 unique genera and over 600 species

Although the Canadian seaweed industry is still in its infancy, Canada's existing strengths in aquaculture can easily be adapted to accommodate the production and processing of this new resource. Firstly, the water-based infrastructure required to produce seaweed is significantly less intensive than traditional aquaculture systems. Seaweed cultivation requires only lines, floats, and anchors with no need for on-site human habitation. Secondly, the workforce, processing facilities, route to market, and basic regulatory framework are similar to the needs of the current industry, which presents interesting opportunities for collaboration and innovation.

The ease of setup can be seen in the marine farms Cascadia Seaweed has already installed in partnership with Indigenous communities on Vancouver Island. Cascadia's seaweed farms are designed with horizontal, parallel lines suspended below the surface and moored at each end with cement anchors and most materials are sourced from local businesses on the island. Assembled on land, one hectare of seaweed farm infrastructure requires only two to three days to set up before being deployed and installed 100 m to 200 m offshore. Once the farm is in place, spools seeded with nursery-grown kelp sporophytes are wrapped around the cultivation lines. Along with regular farm maintenance, water conditions and growth rate must also be monitored and recorded on a weekly basis. Around five months later, the seaweed is ready to be harvested and transported for primary and secondary value processing. As Cascadia continues to grow, farms will be cultivated with various species of seaweed that can be harvested at different times of the year. Certain species of seaweed can also grow year round and can be harvested and processed at regular intervals, providing a steady stream of economic generation. British Columbia has one of the most diverse seaweed flora in the world, with 14 unique genera and over 600 species. This diversity presents a wealth of possibilities for research, cultivation, and innovation accessible only on Canada's western coast. B.C. waters are ideal for the cultivation of commercially valuable seaweed species like sugar kelp (*Saccharina latissima*), winged kelp (*Alaria marginata*), dulse (*Palmaria mollis*), and sieve kelp (*Neogagarum*), all of which Cascadia is planning to grow and harvest. However, bioprospecting other native species to uncover valuable active components for new pharmaceutical and industrial compounds also represents an exciting research opportunity.

The most accessible seaweed product with the highest value in the short term is food for human consumption, especially due to the increasing demand for plant-based options. This form requires the least amount of processing and can be used to grow the industry while providing high-quality, plant-based protein in creative ways that appeal to the North American palate. Seaweed can be eaten as a snack in its dried state and can also be enjoyed pickled, fermented, steeped, and boiled in a variety of forms. Seaweed can easily be combined with other ingredients to make flavourful and nutritious products such as seaweed butter, bread, pasta, and seasonings [18]. All these options retain seaweed's nutritional benefits and present consumers with health-conscious alternatives to more common, less nutritionally dense foods.

Signatories are aware that the unconventional nature of seaweed presents a barrier to access in the Western market. An essential step to integrating seaweed into the North American diet will be to work with food companies, culinary organizations, and chefs to bring seaweed to supermarkets and tables. An example of this initiative has already been demonstrated in a recent partnered publication between Knorr, a multinational food corporation, and the World Wildlife Fund called "Future 50 Foods." Two of the foods identified were species of seaweed, *Porphyra umbilicalis* and *Undaria pinnatifida* [19].

When the national seaweed industry becomes more established, Canada can explore the super-processing potential of seaweed into higher-value, globally coveted hydrocolloids like carrageenan, alginates, and

agar, which are used in many food, pharmaceutical and biotechnological applications. The FAO highlights that, in the food industry, these hydrocolloids are required as “thickening agents in confectionaries, bakery products, salad dressings, ice creams, sweets and desserts (e.g. puddings, chewing gum, jams, jellies), dairy products such as chocolate milk, beverage mixes and processed meats, sausages and fish, as well as in clarifying of beers and wines.” In the pharmaceutical industry, these compounds are also invaluable “as binders, stabilizers, emulsifiers, and for creating moulds in dentistry” [20]. The global seaweed-derived hydrocolloid market generates a gross annual income over USD \$1 billion, a figure which is only expected to increase as the international seaweed industry grows [20]. With such diversified opportunities for seaweed products, Canada must factor both production and processing into its industry framework. Investing in the infrastructure and facilities required to derive the greatest potential from seaweed—as opposed to exporting raw product—will secure Canada’s position as a leader in the field and will set the foundations for innovation, independence, and wealth generation.

Given the urgency of climate change and the rapidly declining health of our oceans, designing a framework that ensures sustainability from both an environmental and economic perspective is critical. A proactive method of fostering resilience in the Canadian industry and connecting with international partners as seaweed cultivation evolves is to create a genetic repository of native seaweed crops, a process known as macroalgal germplasm banking. These terrestrial gene banks hold live plant matter in the embryonic stage (i.e. seeds and spores) that farmers and scientists can access should a certain type of species become unavailable. The largest seed bank in the world is currently the Svalbard Global Seed Vault, located on the Norwegian island of Spitsbergen. As environmental fluctuations and increasing human impact threaten global biodiversity, germplasm banks are essential to preserving valuable genetic strains and diversity and to ensuring conservation and restoration in an economically viable manner [21]. Genetic banking is already being done with a number of target microalgae and many terrestrial plants, and the same efforts must be focused on macroalgae and marine ecosystems.

Signatories are conscious of the longer-term timelines and heavy investments required to build processing facilities and germplasm banks. However, smaller investments can be made in the shorter term to optimize the first stages of the seaweed value chain in seed production and harvest. Pre-processing components of the industry are still in development and in dire need of scale to demonstrate proof of concept. By leveraging existing licenses in the shellfish and finfish industries, algal seed production and harvest represent a concentrated and immediate opportunity for growth. Canada already has a strong aquaculture framework on which to build the pillars of a thriving seaweed industry. Infrastructure for shellfish and finfish can be seasonally adapted to process seaweed products. Along with investments in initial production stages, investments for research in phycology, regulatory policy, and barriers to market will be crucial to paving the way forward. Funds directed towards the development of training programs both in and outside of post-secondary institutions and within remote, rural, Indigenous, and coastal communities will also be key to building the workforce of tomorrow for seaweed aquaculture.



● Community and Human Impact

Seaweed presents a unique opportunity to engage coastal and Indigenous communities in both the development of the industry at large and the day-to-day operations of farm management and maintenance. The aquaculture sector in Canada is not on the National Commodities list, which would enable foreign workers to travel and work in Canada through the Seasonal Agriculture Worker Program [22]. Current regulations restrict the labour force of seaweed farming to local communities and thus reinforce the need to reach out and provide the necessary training to future seaweed farmers across the country. The Canadian Agricultural Human Resources Council (CAHRC) points out that “aquaculture has the second-highest percentage of operators with a need for more workers than they can find.” In 2014, 58% of aquaculture operators were unable to find enough workers, compared to 41% for the agriculture sector, and the CAHRC predicts this labour gap will continue to widen. Through strategic approaches to attracting, retaining, and growing the workforce in the seaweed industry, Canada has the potential to generate close to 30,000 jobs in British Columbia alone based on similar estimates in the European context [17].

The greatest labour challenges in Canadian aquaculture are the rural location of operations, rural depopulation, and the consequent barrier to worker mobility. Aquaculture workers are also subject to a high and often underreported level of occupational health and safety hazards [23], which not only affects the morale and productivity of current workers but also feeds into the negative perceptions potential workers have of the industry. These issues must be taken into consideration in developing strategies to attract and retain workers. Given that seaweed aquaculture is still in its early stages, the Government of Canada has an invaluable chance to attract and build the workforce as it builds this climate-positive industry. With two-thirds of Canada’s aquaculture concentrated on the coasts of Atlantic Canada and British Columbia [22], investments in seaweed farms will serve to create value production points in these areas that will capitalize on existing infrastructure, increase the financial value of operations, and create a powerful sense of ownership for the workers from local communities. Many of these workers may already have experience in the shellfish and finfish sectors, which will hugely facilitate training in the emerging seaweed sector.

Indigenous coastal communities are essential partners in the development of Canada’s seaweed industry. In a 2016 survey of 40 Indigenous organizations and communities involved in Canadian aquaculture, 42% of respondents in operational aquaculture also expressed high interest in partnering with non-Indigenous companies to stimulate growth. A total of 70% of respondents involved in planning aquaculture expressed interest in collaboration, 50% with non-Indigenous partners and 20% with Indigenous partners [24]. When asked how Canada could foster growth in aquaculture with Indigenous communities, respondents proposed that;

- i) First Nations must take the lead in identifying sites and species with development potential in their territories and formalize development opportunities with potential partners;
- ii) all partners must agree on aquatic resource management and aquaculture operations frameworks with aquaculture proponents;
- iii) governmental arrangements and revenue sharing mechanisms must be co-managed so First Nations can maintain and retain oversight; and
- iv) support mechanisms such as development services, access to working capital, and specialized training opportunities must be in place to nurture a healthy, skilled workforce.

In developing the necessary partnership agreements and social licenses with Indigenous communities, the Government of Canada must meet these demands. Indigenous communities must have rights to aquaculture resources in their territories, and all decisions must be conditional on meaningful consultation, consent, and business development. Dynamic collaborations will ensure a sustainable, prosperous industry and align directly with the commitment in the Calls to Action from the Truth and Reconciliation Commission “to meaningful consultation, building respectful relationships, and obtaining the free, prior, and informed consent of Indigenous peoples before proceeding with economic development projects” [25].

Indigenous respondents in all sectors of aquaculture, including hatcheries, finfish, shellfish, and processing, described a labour force that relies in large part on seasonal and part-time work, which is also a reality for many non-Indigenous workers in the industry. Seaweed aquaculture will provide a range of full-time and part-time jobs in academia, policy, management, and skilled labour that can lead to exciting careers and opportunities for individuals and communities mainly dependent on seasonal work. Social licensing is the first step to establishing economic opportunities in seaweed aquaculture. A farm cannot exist without farmers. Future skilled workers will likely be unable to afford specialized training on their own, and a strategy to catalyze the industry must take into consideration the need for investments in education.



● Unique Regulatory Framework

Signatories understand the straw-man nature of this proposal: the strategy to establish and scale the seaweed industry in Canada is predicated on science, policy, and community engagement that is still in development. However, seaweed does not require a eureka moment—existing expertise in aquaculture is only waiting to be developed and applied. This submission has demonstrated that Canada possesses all the fundamental elements and experience to grow seaweed into a booming source of economic, social, and environmental revenue. Strengthening this knowledge base is the last step to setting a direction along which Canadian seaweed farming can thrive.



The most immediate requirement in the industry is for investments in coordination and research to design a regulatory framework that will secure the future of production and processing in Canada. To appropriately scale macroalgal production on the Canadian coastline from the perspective of ocean sciences, more research is needed in;

- i) genetic interactions between cultivated and wild crops;
- ii) impacts of seaweed cultivation on surrounding ecosystems;
- iii) epiphytes and diseases;
- iv) area utilization; and v) threats from climate change [28].

Signatories are more than ready to begin this important work, but streamlined federal support is essential. In addition to open and transparent lines of communication between federal and provincial ministries and stakeholders in seaweed

aquaculture, Canada needs a centralized, one-stop shop for seaweed regulation and approval to truly unlock the industry’s potential. Current licensing timelines for establishing seaweed farms in Canada are unacceptable and effectively stymie the industry before it has any time to gain traction. If Canada does not invest in and centralize regulation for seaweed farming, other jurisdictions will, and the country with the longest coastline will be left behind.

To develop its own regulations, Canada can turn to a number of countries that have already translated small-scale seaweed aquaculture into legislation. For example, in the Government of Ireland’s most recent National Marine Planning Framework Baseline Report, seaweed is officially identified as one of the country’s sources of aquacultural revenue [26]. As of March 2018, Ireland received a total of 17 applications, 13 from seaweed companies, for seaweed harvesting and cultivation licenses under the country’s Foreshore Act. The Act requires residents to request a permit to remove or disturb beach material, including “seaweed whether growing or rooted on the seashore or deposited or washed up thereon by the action of tides, winds, and waves or any of them” [26]. Seaweed aquaculture in Ireland has traditionally been limited to wild harvesting, but a number of companies interested in cultivation were nonetheless well

positioned to request licenses within existing regulations and governmental capacity at the senior level [27]. Policies are bound to adapt as these companies continue to grow, and stakeholders will be able to inform these policies as they are developed, which presents an ideal situation for all involved. Canada's initial regulatory framework around seaweed does not have to be comprehensive but instead proactive and dynamic. Without a direct, regulated avenue for licensing with a reasonable turnaround and a dedicated internal capacity at the senior level, seaweed aquaculture in Canada does not stand a chance.

Norway can also provide Canada with an example of effective seaweed regulation. Experimental cultivation in Norway began around 2005, and the first official permits for commercial seaweed cultivation were issued in 2014. The Government of Norway created special licenses for seaweed farming applications according to the country's Aquaculture Act. Applications are managed in a concerted effort through the Directorate of Fisheries, The Norwegian Coastal Administration, the Norwegian Food Safety Authority, The County Governor's Environmental Department, The Norwegian Water Resources and Energy Directorate, and municipal authorities. All actors work together to identify potential conflicts in their areas of oversight [28]. Successful applicants have begun building their farms to benefit from the commercial potential of Norwegian waters. Relevant to Canada in this case is not only Norway's unified approval process, but also their approach to policy development: experimental, small-scale production was vital to building Norway's seaweed framework. With minimal investments into research, community engagement, and farming and processing infrastructure, Canada can support one or more regional value production points to inform future policies of the larger industry.



● Conclusion

Seaweed is an aquacultural resource with significant market potential that can restore coastal ecosystems and communities. Canada's eastern and western coastlines have been identified as ideal environments for seaweed farming operations. If this confluence of advantages was not reason enough to invest in Canadian macroalgal production, existing expertise in hatcheries, shellfish, finfish, and seafood processing should engender well-deserved confidence.

Historically, Canada's involvement in the seaweed sector has mostly been limited to the east coast. For example, the internationally recognized Atlantic Regional Laboratory (ARL), funded through the National Research Council, has made noteworthy advancements in phycology, adding to universal seaweed knowledge and creating unique algal strains now employed by Acadian Seaplants. No significant federal input has been directed to B.C.'s seaweed sector—this must change for Canada to move forward. Canada is uniquely positioned to build a thriving seaweed industry on the solid foundations of its aquaculture framework. The engine to drive seaweed farming along the world's longest coastline is already in place and only requires the fuel to set the gears in motion.

Signatories have highlighted the need to establish social licenses and engage with coastal and Indigenous communities, the high costs of super-processing facilities and germplasm banks, the lengthy and disconcerted process for seaweed licensing approvals, and the challenge of adapting seaweed products to the North American palate. However, investigating these complex issues and cultivating seaweed are not mutually exclusive. In fact, they must be conducted simultaneously to inform one another and contribute to a sustainable system.

Through this submission, signatories are urging the Government of Canada to scale seaweed aquaculture by;

- i) streamlining the tenure regulations for seaweed cultivation, designing a separate approval track, and fostering interdepartmental coordination to connect stakeholders with relevant authorities;**
- ii) investing in production and processing techniques and infrastructure, particularly for food processing as it is the highest-value product in the short term, to create regional value production points; and**
- iii) investing in phycology, policy, and marketing research along with specialized training programs for the future seaweed workforce.**

Human industries have severely impacted ocean health, contributing to pollution, deoxygenation, acidification, rising temperatures, and decreasing biodiversity. The socio-environmental implications of the current aquacultural model are under global scrutiny. Canada has the opportunity to shift this narrative and not only mitigate, but also reverse the degradation of ocean health through sustainable seaweed farming that benefits from and strengthens marine ecosystems. With a calculated approach, Canada can nurture an emerging field of research on the international stage to attract top talent and generate significant revenue through meaningful collaboration with remote, rural, Indigenous, and coastal communities.

The benefits of seaweed aquaculture are clear, and the way forward is paved with invaluable expertise. Canada must act now and must act fast to build a blue economy for future generations.

● References

1. "State of the Global Climate 2020." World Meteorological Organization, 2021.
2. "The Global Status of Seaweed Production, Trade and Utilization." FAO, 2018.
3. "FAO Aquaculture News, May 2021 - no. 63." FAO, 2021..
4. "Seaweed Aquaculture for Food Security, Income Generation and Environmental Health in Tropical Developing Countries." World Bank Group, 2016.
5. "The red macroalgae *Asparagopsis taxiformis* is a potent natural antimethanogenic that reduces methane production during in vitro fermentation with rumen fluid." *Animal Production Science*, 2016.
6. "Asparagopsis taxiformis decreases enteric methane production from sheep." *Animal Production Science*, 2016.
7. "Tackling Climate Change Through Livestock - A Global Assessment of Emissions and Mitigation Opportunities." FAO, 2013.
8. "A global spatial analysis reveals where marine aquaculture can benefit nature and people." *PLOS ONE*, 2019.
9. "How Kelp Naturally Combats Climate Global Change." SITN, Harvard University, 2019.
10. "Blue growth potential to mitigate climate change through seaweed offsetting." *Current Biology*, 2019.
11. "Seaweed: The New Trend in Water Purification." *UConn Today*, 2010.
12. "Restorative aquaculture: can farming shellfish and seaweed provide habitat benefits?" *The Fish Site*, 2019.
13. "Assessing the habitat benefits of kelp aquaculture in New Zealand and Maine." *The Fish Site*, 2021.
14. "Canadian Net-Zero Emissions Accountability Act." Government of Canada, 2020.
15. "Transformations for a Sustainable Ocean Economy." High Level Panel for a Sustainable Ocean Economy, 2020.
16. "Climate change, meeting Canada's climate targets and the future of energy." Canadian Nuclear Association, Abacus Data, 2020.
17. "Hidden Champion of the Ocean." *Seaweed for Europe*, 2020.
18. "Seaweed products to sample." *New York Times*, 2019.
19. "Future 50 Foods." Knorr, WWF, 2019.
20. "Seaweed Hydrocolloid Production: An Update on Enzyme Assisted Extraction and Modification Technologies." *Marine Drugs*, 2015.
21. "Microalgal germplasm banking for conservation, food security, and industry." *PLOS Biology*, 2020.
22. "Aquaculture Labour Market Forecast to 2025." Canadian Agricultural Human Resources Council, 2015.
23. "Occupational injuries and diseases in aquaculture – A review of literature." *Aquaculture*, 2019.
24. "Aboriginal Aquaculture in Canada Initiative—National Socio-Economic Analysis Report." Gardner Pinfold Consultants Inc., 2016.
25. "Calls to Action." Truth and Reconciliation Commission of Canada, 2015.
26. "National Marine Planning Framework Baseline Report." Government of Ireland, 2018.
27. "The seaweed resources of Ireland: a twenty-first century perspective." *Applied Phycology*, 2020.
28. "Seaweed aquaculture in Norway: recent industrial developments and future perspectives." *Aquaculture Int*, 2017.

Signatories

This call to action is backed by the expert opinions of Cascadia Seaweed and partner signatories, listed below. The unified voice of all signatories herein carries no small weight and must be heard with the greatest attention and urgency.

Signature:



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Name: Gerald Shaffer

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Organization: Pacific Seaweed Industry Association

Signature:

Chrissy Chen

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Organization: Tsawout First Nation

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David Parker

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Organization: Ocean Regenerative Aquaculture, Inc.

Signature:

Louis Druehl

Name: Louis Druehl

Organization: Canadian Kelp Resources, Ltd.

Signatories

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Signature:

George Hanson

Name: George Hanson, President & CEO

Organization: Vancouver Island Economic Alliance/Foreign Trade Zone Vancouver Island

Signature:

Pat Deakin

Name: Pat Deakin

Organization: City of Port Alberni, BC, Canada

Signature:

Jesse Thompson

Name: R jesse Thompson

Organization: Commercial fisherman.

Signature:

Martin Davis

Name: Mayor Martin Davis

Organization: Village of Tahsis

Signature:

Ryan Brush

Name: Ryan Brush

Organization: Aquatrans Distributors

Signature:



Name: Erik Lyon

Organization: Rising Tide Shellfish

Signature:

Colin Bates

Name: Colin Bates

Organization: Ocean Wise