A PRECAUTIONARY APPROACH TO SEAWEED AQUACULTURE IN NORTH AMERICA

A POSITION PAPER BY THE SEAWEED COMMONS

SPRING 2022

Photo credit: Emma Geiger

Introduction

Our Mission

We are an international collective of seaweed growers, lifelong harvesters, scientists and advocates. We believe that the seaweed aquaculture industry should be developed with a precautionary approach: conservation-minded, at an appropriate scale, and with local ownership and control. Farms should be small-scale until knowledge gaps can be satisfactorily filled and the impact on wild coastal ecosystems and coastal communities is shown to be minimal.

History has shown that allowing corporations to scale up without appropriate regulations often results in far-reaching detrimental effects on both the environment and the socio-economic health of the communities where they operate.[1,2] Hence, allowing corporations to monopolize where and how seaweed is farmed risks devastating impacts on coastal ecologies, economies, and cultures. Without locally adapted and controlled regulatory frameworks, seaweed could become the next boom and bust crop that was supposed to "save the world."[3]

In order to support biodiversity, economically sustainable coastal communities, cultural vitality, and climate change resiliency, we ask collaborators to support the due process of scientifically evaluating best seaweed farming practices in North America. We seek regulatory frameworks based on those results before allowing corporations to build large-scale seaweed farms.

In the face of a rapidly growing seaweed industry, we are collectively issuing a warning call and demand for regulatory updates to mitigate risks to coastal ecosystems, the commons of the sea, the biodiversity of kelp forests, and the well-being of our human communities. We aim to achieve a more comprehensive understanding of how seaweed farming and harvesting impacts all of the above.

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Seaweed, as a primary producer and carbon sink, is already "saving the world." Without thoughtful research and regulation around the growing industry of seaweed farming, we risk the collapse rather than growth of its ecological capacities.

Our Position

As a group of seaweed growers, harvesters, scientists and advocates, we support a collaboratively managed and locally controlled seaweed industry. The Seaweed Commons supports an ecosystem-based approach to the development of the industry that is informed by research to ensure that farms are in appropriate locations, of an appropriate size, and protect biodiversity.

Photo credit: Lucianna McIntosh

Background

Seaweed Farming in Context

Written records show that seaweed farming began in the late 1600's in Japan. Since then, it has become a well-established industry in some parts of the world, including China, Japan, Korea and Indonesia. Seaweed is farmed for food, extractives such as carrageenan and alginates which are used as stabilizers, fertilizer, and livestock feed. In North America, seaweed farming is in its infancy. The first experimental seaweed farms in North America were pioneered in 1982 by Louis Druehl in the waters off the west coast of Vancouver Island in British Columbia, Canada. For the next twenty-five years or so, there has been the odd farm, primarily in B.C. and Maine, but no real industry was formed until around 2011, with significant growth of the industry happening in the last five years.

Unlike previous efforts to farm seaweed in North America, which were poorly funded, a small number of new and already powerful companies are receiving large sums of money from provincial/state governments, federal governments and venture capital. Government agencies such as the U.S. Department of Energy and US and Canadian marine-related federal departments are championing the concept of "The Blue Economy" and investing heavily in it. This has led to a rapidly increasing number of companies forming with plans to farm seaweed on a large scale. In many cases, these companies have no experience or knowledge of seaweeds, and often no experience in aquaculture or the marine environment. Some of these companies are proposing to form extremely large-scale seaweed farms on some of the most productive coastlines in North America, and in critically important and sensitive areas such as wild salmon habitat. Of great concern is the lack of primary research on the potential impacts of large-scale seaweed aquaculture, impacts which will vary from region to region. Equally concerning is the lack of a cohesive regulatory framework and oversight for this very fast-growing industry.

Seaweed as a Nourishing & Delicious Food

Seaweeds are the most concentrated food source of minerals on the planet and a rich source of vitamins A, B, C, D, E and K. They are a good source of protein and essential fatty acids. Seaweeds also contain unique, biologically active compounds that research suggests can help protect the body from chronic illnesses such as certain types of cancer, cardiovascular disease and type 2 diabetes.

Seaweed is an incredibly versatile food, adding the flavour of the ocean to a wide variety of dishes. Its powerful umami taste has traditionally been used to flavour broths such as dashi and miso soup. Seaweed can be ground up and sprinkled as a seasoning on top of savoury and sweet dishes to add a healthful, salty kick. Large pieces can be soaked and wrapped around fish before cooking and it can be chopped and stir-fried like a leafy green vegetable.

Photo credit: Heather Cunliffe

Climate Change and the Critical Role of Seaweed

Seaweeds belong to a group of organisms known as algae, arguably the most important group of organisms on earth for the ecological health of our planet. Having evolved from Earth's most ancient life-forms, they produce an estimated 50 to 80 percent of global oxygen, absorb an estimated one third of atmospheric carbon dioxide and are the primary producers of the largest ecosystem on Earth: the ocean. Additionally, algae release dimethyl sulphide into the atmosphere when they die, which reacts with oxygen to form nuclei for cloud condensation, a process critical to the regulation of global climate.

Seaweeds, formally called "macroalgae," grow on most coastlines around the globe, and are especially abundant on temperate rocky shores. Kelp forest ecosystems, which grow sub-tidally in temperate waters on approximately twenty-five percent of the world's coastlines, are one of the most productive ecosystems on Earth. Kelp are incredibly fast-growing. For example, bull kelp can grow to thirty metres long in just six months. Consequently, kelp forests sequester carbon at a very rapid rate.[4]

The carbon offset market

There is a push for kelp farming to enter the carbon offset market. Carbon credits are given to companies and organizations for emission reductions, which can be sold to companies that produce large amounts of greenhouse gases in order to reduce their overall carbon footprint. In places where there is a cap-and-trade system, companies are legally obliged to keep their overall carbon dioxide emissions below a certain point to avoid being heavily taxed or fined. Currently, the science is insufficient to adequately quantify the carbon sequestration of kelp farms, particularly the long-term sequestration levels.[5] Furthermore, carbon credits may perpetuate "business as usual" for extractive industries instead of promoting solutions that address the root of the problem.

Ecological and Economic Impacts of Aquaculture

Vulnerability of large-scale single species farms

Not all aquaculture is equal, as has been exemplified by other types of aquaculture such as salmon farming.[6] Indeed, metrics such as scale can significantly affect not only the sustainability of aquaculture practices, but also the socio-economic equality and safety of the end product. In areas where large-scale seaweed aquaculture has occurred, negative impacts have included disease, invasive species, competition for nutrients and dilution of the native genetics.[7] While kelp farms have been touted as economic replacements for declining jobs in offshore fisheries,[8] it is important to consider how stable and sustainable these jobs will be when large-scale farms are permitted with so few safety rails in place to protect coastal communities from job and revenue loss. Single-species and large-scale farms are more vulnerable to outbreaks while genetically diverse and ecologically managed farms are more resilient.[9]

Case Study

Examples of poor management practices leading to disease outbreak and economic loss have already been documented in the growing seaweed farming industry globally. Between 2011 and 2013, an outbreak of "ice-ice" disease resulted in 15% loss in red seaweed (*Kappaphycus* spp.) production in the Philippines. The economic impact of ice-ice disease on red seaweed production in the Philippines is responsible for $310 million in revenue loss. Outbreaks also spread to Madagascar and Tanzania.[10]

Photo credit: Avery Resor

Human Health and Product Safety

If farmed seaweed is destined for the food market, it needs to be safe for human consumption. Seaweed naturally has higher levels of elements such as metals, and even though in wild seaweeds these metals are stored in molecules that are often biologically inert, the cleanliness of the water where seaweed is farmed is essential to its safety as a food source. In addition, while seaweeds are naturally concentrated in nutrients including vitamins, minerals, protein, essential fatty acids and other biologically active compounds, seaweed from large-scale farms where there is strong competition for nutrients may not reflect the nutrient profile of its wild counterparts or from small-scale, ecologically-minded seaweed farms.

Photo credit: Lucianna McIntosh

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Industry Expansion in Vulnerable Ecosystems

The global significance of British Columbia's coastal ecosystem

The waters off the west coast of B.C. Canada boast the highest seaweed diversity on the planet with an estimated 650 species, and the highest diversity of kelp with 30 defined species. Large intact swaths of kelp forests in this region remain healthy, unlike their counterparts in Northern and Central California where kelp forests, in particular bull kelp forests, have been decimated by the effects of the marine heatwave known as “the blob” and sea star wasting disease, and are further stressed by increasing sea surface temperatures. Five out of the seven species of Pacific salmon inhabit these waters with nine thousand distinct populations, many of which are at risk.

These waters are also home to the endangered southern resident killer whales (SRKW), who are dependent upon wild salmon for their survival. Several large, well-funded corporations have been founded in B.C. within the last five years, with one company claiming to be the largest cultivator of seaweed in North America. Several of these companies, with stated goals of farming seaweed at a very large scale, have no former experience with marine plants. In spite of the very fast growth of companies farming seaweed in B.C., there remain few regulations and very little oversight. There are no regulations around farm size, native seed collection and responsibility for farm-related marine debris. The only regulations around farm location are related to navigational safety (through Transport Canada) and avoidance of eelgrass and rockfish habitats. Is this the right place to experiment with the large-scale monocropping of seaweeds?

Kelp forest ecosystems are currently in a global state of decline at an estimated rate of two percent per year.[11] Phycologists point to increased incidences of marine heatwaves and warming ocean temperatures—climate change—as the most significant driver of this global decline.[12, 13] Ensuring that kelp farming is developed with a regenerative and restorative approach is critical to protect the world's wild kelp forest ecosystems.

The need for a balanced view of seaweed aquaculture in the media

We believe it is imperative that the voice of small-scale seaweed harvesters and farmers and seaweed experts, those who have been immersed in the world of seaweed for decades, be heard. So far, there has been a single narrative around seaweed aquaculture in the media: that seaweed farming will "save the planet" by mitigating climate change, providing a nutrient-dense sustainable food, and creating jobs. Large corporations with deep pockets can afford to market themselves widely, and unfortunately the media has latched onto "the bigger the better" narrative around seaweed aquaculture, even though there is no science to back this claim. It is prudent to note that large corporations may not have the singular goal of "saving the world," but may also have interests that include privatization, consolidation and corporate profit.

We believe that this narrative is misleading, and that the media has an obligation to provide clarity to the public, and present a more nuanced approach to seaweed aquaculture. In particular, the public deserves to know that there are known negative impacts of large-scale seaweed aquaculture, that there are significant knowledge gaps in what other impacts may be, and that metrics such as scale can significantly impact sustainability. Furthermore, the claim that kelp farming will "save the world from climate change" is not based on science. Scientific studies *have* shown that wild kelp forests sequester large amounts of carbon, some of which is stored for millennia, but the carbon sequestration ability of farmed kelp is only beginning to be studied, and is highly dependent upon where the farmed kelp ends up.

Knowledge Gaps:

The Need for Primary Research

Significant knowledge gaps exist that need to be filled in order to grow the seaweed aquaculture industry sustainably and equitably and to provide seaweed products that are safe for the consumer. Scientists in North America have only begun mapping the genetic baseline of seaweed populations around our coastlines. This research is necessary so that we can safeguard the resilience of wild diversity. Further research for setting industry best practices as well as infrastructure for monitoring and responding to disease and pest outbreaks is still needed before coastal communities can safely expand their seaweed farming sectors. Considerations such as farm size, local seed use, and ecological management play a role in ensuring that seaweed farms are economically viable in the long term.

Primary research is needed to assess the following impacts of large-scale seaweed aquaculture:

Ecological

- Shading (eg. effect on benthic species)
- Water attenuation (eg. effect on migrating salmon)
- Competition for nutrients (eg. plankton, wild seaweed, shellfish)
- Genetic contamination
  - Seaweed population genetics are very localized, and dilution of the native genetics reduces the ability to adapt to stresses such as climate change
- Marine debris from abandoned/decommissioned farms or lost in storms
- Impact on sensitive species (eg. marine mammals, salmon)
- Vulnerability of monocultures to disease and pathogens
- Specific diseases within monocultures and spread of such diseases to wild populations

Socio-economic

- Privatization (eg. reduced access for shellfish harvesters, shellfish farmers, access to fishing grounds and recreational access)
- Market research
  - Lack of certainty around the seaweed market in North America (seaweed is not a common part of the diet, it is still in experimental stages for use in biofuels and bioplastics)
- Providing maximum benefit to coastal communities, regulating against consolidation
  - Large-scale seaweed farms are being created/proposed in economically vulnerable coastal communities
- Failed crops (epiphytes, storms, weather, water temperature)
- Safety regulations for food production

Our Goals

- **To recognize the fragility of the marine environment and nearshore ecosystem, highlighted by past impacts of overfishing, overharvesting, unregulated large-scale aquaculture and the introduction of invasive and non-native species.**

- **To recognize the need for a regulatory framework to avoid repeating history, as above.**

- **To direct funding towards research on impacts of large-scale seaweed aquaculture on communities, environment, economy, etc.** Currently, many claims are being made based on other countries' models; there is an opportunity to define the standards expected in our unique ocean ecosystems.

- **To create an organization whose members pledge to adopt a set of ethics and practices throughout their operations that are governed by neutral bodies to hold members accountable.** Membership of such an organization could be a baseline requirement for governmental approval of licensing and funding.

- **To take into account traditional growing, harvesting, and processing techniques and considering these techniques as viable practices within regulations.**

- **To thoughtfully develop the seaweed aquaculture industry with a regenerative lens and local community focus.** A collection of case-studies of small-scale farms following these principles could be used as a guide for others entering the sector.

Photo credit: Emma Geiger

Proposed metrics to be regulated and regionally determined

Ecological

- Maximum farm size
- Farm location
- Make use of marine spatial planning and area-based management to identify environmentally and socially appropriate locations for the siting of aquaculture operations.
- Introduce restrictions to seed/spore distribution for marine aquatic plant species as a means of preserving genetic diversity. Ex.: Alaska's regulations require that each year seeds/spores are harvested from within 50 km of a farm site and from at least 50 different plants to protect genetic diversity.
- Stipulate a Condition of Licence to disallow the transport of seed or plants between pre-determined zones, or the use of growing infrastructure between zones that has yet to follow biosecurity measures.
- Mandate that non-native and hybridized marine aquatic plants are not to be discharged into the nearshore or marine environment.
- Introduce data collection requirements for new farm applications in areas of historical/present plant surveys, species' competition considerations, seafloor shading impacts and bio-density impacts which may be relevant to large-scale farms.
- Stipulate a Condition of Licence to hold sublessees liable for any long-term marine debris.

Socio-economic

- Introduce limitations to lease/licence size for new growers or harvesters until proof of concept or direct-to-market traction is demonstrated.
- Introduce a level playing field in the licence application process for all operators, weighed by skills and experience in the sector.
- Highlight the need for a state/provincially endorsed sector organization for the marine aquatic plants industry that is not facilitated by any one corporation.
- Within the approval process for farms, ensure that small outfits, and/or companies that are run by or support and employ minority groups are given equal opportunity for licensing.
- As part of the licensing process, weigh in factors that include education and experience.
- Ensure that any funding allocated to this sector is done fairly rather than the majority of funds going to a limited number of companies.

Conclusion

The impacts on ocean ecosystems of monocropping marine plants in North America are unknown. To allow seaweed aquaculture at the scale some companies are proposing without due scientific process to assess the potential impacts, is to conduct a massive experiment on our coastlines. Therefore, we, the undersigned, insist that policy-makers take a precautionary approach to the development of the seaweed aquaculture industry in order to protect wild seaweed populations, coastal ecosystems and the welfare of coastal communities.

Signed,

AMANDA SWINIMER

AMANDA SWINIMER IS A SEAWEED HARVESTER, AUTHOR, BUSINESS OWNER, AND EDUCATOR WHO LIVES AND WORKS ON THE WEST COAST OF VANCOUVER ISLAND, CANADA. SHE IS THE OWNER/OPERATOR OF DAKINI TIDAL WILDS, ESTABLISHED 2003, HAND-HARVESTING WILD EDIBLE SEAWEED. SHE HOLDS A BSC IN MARINE BIOLOGY AND IS THE AUTHOR OF THE SCIENCE AND SPIRIT OF SEAWEED: DISCOVERING FOOD, MEDICINE AND PURPOSE IN THE KELP FORESTS OF THE PACIFIC NORTHWEST.

SEVERINE FLEMING

SEVERINE OWNS AND OPERATES SMITHEREEN FARM, A DIVERSE 200 ACRE ORGANIC FARM ON COBSCOOK BAY, IN PEMBROKE, ME FOCUSED ON VALUE ADDED PRODUCTS FROM LAND AND SEA. SHE IS DIRECTOR OF GREENHORNS, A YOUNG FARMERS CULTURAL ORGANIZATION AND PUBLISHER OF THE NEW FARMERS ALMANAC. SINCE 2019 GREENHORNS' SEAWEED COMMONS PROGRAM HAS HOSTED MEETINGS, TRAININGS AND ADVOCACY THAT ENCOURAGES THE INCOMING GENERATION OF SEA-FARMERS AND WILD HARVESTERS TO PARTICIPATE IN REGULATORY, ETHICAL AND ECOLOGICAL APPROACHES TO THE PUBLIC TRUST

AVERY RESOR

AVERY RESOR IS THE CO-FOUNDER/OPERATOR OF DAYBREAK SEAWEED CO. WHERE SHE WORKS WITH REGENERATIVE OCEAN FARMERS TO BRING SEAWEED INTO THE EVERYDAY KITCHEN. FOR OVER 15 YEARS, AVERY HAS WORKED WITH FARMERS FROM THE U.S. TO EAST AFRICA TO BOLSTER PRODUCTIVITY, RESILIENCE, AND FOOD SOVEREIGNTY. AVERY STUDIED MARINE BIOLOGY AT DUKE UNIVERSITY MARINE LAB AND EARNED A MASTER OF DEVELOPMENT PRACTICE FROM U.C. BERKELEY.

SARAH HOLDEMAN

SARAH IS A FARMER AND SEAWEED ADVOCATE WHO IS DELIGHTED TO JOIN THE SEAWEED COMMONS NETWORK IN IMAGINING AND ADVOCATING FOR DIVERSE, RESILIENT, LOCALLY DETERMINED SEAWEED ECONOMIES. SHE ALSO WORKS TO SUPPORT EQUITABLE LAND TENURE AS COMMUNICATIONS SPECIALIST FOR THE AGRARIAN TRUST.

ELENA BIRD

ELENA IS THE PROGRAM COORDINATOR FOR SEAWEED COMMONS, PROJECT MANAGER FOR GREENHORNS, AND A RESEARCHER + AGROECOLOGY M.S. STUDENT AT THE UNIVERSITY OF WISCONSIN-MADISON, THEIR RESEARCH FOCUSES ON ALTERNATIVE ECONOMIES OF KNOWLEDGE AND RESOURCES SHARING IN FOOD GROWING SYSTEMS.

BROOK FADER

BROOKE FADER IS A FOUNDING MEMBER OF SLOW FISH CANADA AND COMMUNITY LEADER OF SLOW FOOD VANCOUVER ISLAND & GULF ISLANDS. HER VOLUNTEER FOOD ADVOCACY WORK IS DEDICATED TO CONNECTING LOCAL PEOPLE TO LOCAL FOOD. THIS ETHOS IS REFLECTED IN HER RESTAURANT, WILD MOUNTAIN FOOD & DRINK IN SOOKE, WHICH IS CERTIFIED BY THE SLOW FOOD CHEF'S ALLIANCE AS A CATALYST FOR A LOCAL FOOD ECONOMY. IN APRIL 2022, BROOKE WAS PUBLISHED BY CANADIAN FOOD STUDIES FOR CO-CREATING THE SLOW FOOD RELATIONSHIP BAROMETER.

JIM MCISAAC

JIM IS THE EXECUTIVE DIRECTOR OF THE T.BUCK SUZUKI FOUNDATION, A FISHERIES FOUNDATION WORKING TO PROTECT HABITAT, PREVENT POLLUTION, PROMOTE SUSTAINABLE FISHERIES AND CONNECT THEM TO OUR LOCAL FOOD SYSTEMS!
JIM IS PACIFIC VICE-PRESIDENT OF THE CANADIAN INDEPENDENT FISH HARVESTER'S FEDERATION, REPRESENTING 14,000 FISH HARVESTERS ACROSS CANADA. HE IS THE COORDINATOR FOR THE BC COMMERCIAL FISHING CAUCUS. THE CAUCUS INCLUDES THE FISHERMEN'S UNION, THE NATIVE FISHING ASSOCIATION, AREA A CRAB FISHERMEN'S ASSOCIATION, AND BC SHRIMP HARVESTERS ASSOCIATION.

KRISTINA LONG

KRISTINA LONG SELLS A VARIETY OF KELP & SEAWEED FOOD PRODUCTS UNDER THE BRAND, SEA FOREST. SHE AND HER TEAM HAVE BEEN FARMING KELP IN BC SINCE 2016 AND CONTINUE TO INVEST IN INNOVATIONS WITHIN THE MARINE PLANT SECTOR. SEA FOREST AND SALISH SEA KELP CO. ARE PARTICIPATING IN NSERC FUNDED RESEARCH TO FURTHER PROMOTE THE PROTECTION OF NATIVE PLANT SPECIES' GENETIC DIVERSITY AS WELL AS TO FURTHER DEVELOP THE MARKET FOR THIS BURGEONING INDUSTRY.

ALEXANDRA MORTON

ALEXANDRA MORTON IS AN INDEPENDENT BIOLOGIST WHO HAS WORKED FOR 35 YEARS TO PROTECT WILD SALMON FROM THE LACK OF PRECAUTION THAT MARRED THE DEVELOPMENT AND GROWTH OF THE BC SALMON FARMING INDUSTRY. MORTON FOUNDED SALMON COAST FIELD STATION, HAS WRITTEN SEVERAL BOOKS AND CURRENTLY WORKS AS SCIENCE ADVISOR FOR THE NAMGIS FIRST NATION.

TERRY D'SELKIE

TERRY D'SELKIE HAS BEEN HARVESTING SEAWEED AS THE OWNER OF OCEAN HARVEST SINCE 1999. SHE ETHICALLY HAND-HARVESTS ONLY FROND TIPS, AND SUN-DRIES 11 TYPES OF WILD SEAWEEDS FROM THE MENDOCINO COAST OF CALIFORNIA. TERRY IS AN HERBALIST, A RETIRED EDUCATOR OF 35 YEARS, AND HAS BEEN AN ENVIRONMENTAL AND ANIMAL ACTIVIST FOR THE MAJORITY OF HER LIFE.

ROWEN MONKS

ROWEN IS A RESEARCH TECHNICIAN AND GRADUATE OF MARINE BIOLOGY AND OCEANOGRAPHY AT THE UNIVERSITY OF VICTORIA WHO LIVES IN UCLUELET, BC. ROWEN STARTED A LONG-TERM MONITORING PROGRAM IN 2019, MAPPING KELP FORESTS IN CLAYOQUOT SOUND TO MONITOR DISTRIBUTION SHIFTS AND EXPLORE DRIVERS OF CHANGE.

COLLES STOWELL

COLLES BRINGS THE SUSTAINABLE SEAFOOD MESSAGE TO CLASSROOMS AND COMMUNITIES AS PRESIDENT OF ONE FISH FOUNDATION. THE NON-PROFIT HE LAUNCHED TO ENCOURAGE FOLKS OF ALL AGES TO CARE ABOUT WHERE THEIR SEAFOOD COMES FROM, HOW IT WAS HARVESTED OR GROWN, AND THE BENEFITS OF SUPPORTING COMMUNITY-BASED FISHERIES. HE'S A MEMBER OF THE SLOW FISH NORTH AMERICA OVERSIGHT TEAM, COLLABORATING WITH SLOW FOOD USA, SLOW FISH INTERNATIONAL, NORTH AMERICAN MARINE ALLIANCE, AND THE LOCAL CATCH NETWORK. HE IS A BOARD MEMBER OF THE SUSTAINABLE FISHERIES FOUNDATION.

ANGELA WILLARD

ANGELA WILLARD IS A CLINICAL HERBALIST AND EDUCATOR WORKING WITH SEAWEED THERAPEUTICS. SHE HAS DEDICATED THE PAST 15 YEARS TO STUDYING ITS BENEFICIAL IMPACTS UNDER THE GUIDANCE OF LEADING PHYCOLOGY RESEARCHERS WORLDWIDE, WITH AN EMPHASIS ON SEAWEED FOR HEALTH. SHE IS THE CREATOR OF THE SEAWEED THERAPEUTICS COURSE OFFERED THROUGH THE WILD ROSE COLLEGE OF HERBAL MEDICINE. ANGELA IS THE FOUNDER OF SEAWEED GARDENS~ AN INITIATIVE TO LEARN THE SUSTAINABLE PRACTICE OF CULTIVATING KELP FORESTS IN THE PRISTINE WATERS OF THE DISCOVERY ISLANDS IN BRITISH COLUMBIA.

WEATHERLY BATES

WEATHERLY IS CO-OWNER AND FOUNDER OF ALASKA SHELLFISH FARMS, A VERTICALLY INTEGRATED SHELLFISH AND SEAWEED FARM IN KACHEMAK BAY, ALASKA. WEATHERLY HAS BS IN AQUACULTURE AND FISHERIES TECHNOLOGY AND HAS BEEN MANAGING SUCCESSFUL AQUATIC FARMS SINCE 2003, FIRST IN MAINE, THEN IN ALASKA SINCE 2007. WEATHERLY IS VICE PRESIDENT OF ALASKA SHELLFISH GROWERS, MEMBER OF PACIFIC COAST SHELLFISH GROWERS ASSOCIATION, MEMBER OF SHELLFISH GROWERS CLIMATE COALITION, AND MANAGES THE LARGEST PRODUCER OF FARMED AQUATIC PRODUCTS IN ALASKA.

References

1.Knott, C., & Neis, B. (2017). Privatization, financialization and ocean grabbing in New Brunswick herring fisheries and salmon aquaculture. Marine Policy, 80, 10–18. https://doi.org/10.1016/j.marpol.2016.10.022.

2. Pinkerton, E. (2017). Hegemony and resistance: Disturbing patterns and hopeful signs in the impact of neoliberal policies on small-scale fisheries around the world. Marine Policy, 80, 1–9. https://doi.org/10.1016/j.marpol.2016.11.012.

3. Adams, Lucy. (2019) "Is there a problem with salmon farming?" *BBC News*. (2019, May 20). https://www.bbc.com/news/uk-scotland-48266480

4. Hurlimann, S. (2019, July 4). How Kelp Naturally Combats Global Climate Change. Science in the News. https://sitn.hms.harvard.edu/flash/2019/how-kelp-naturally-combats-global-climate-change/

5. Temple, James (2021). "Companies hoping to grow carbon-sucking kelp may be rushing ahead of the science." MIT Technology Review. Sept. 19, 2021. . Retrieved April 5, 2022, from https://www.technologyreview.com/2021/09/19/1035889/kelp-carbon-removal-seaweed-sinking-climate-change/.

6. The Global Spread of Infectious Salmon Anaemia. (2009). Retrieved April 5, 2022, from https://thefishsite.com/articles/the-global-spread-of-infectious-salmon-anaemia

7. Cottier-Cook, E. J., Nagabhatla, N., Badis, Y., Campbell, M. L., Chopin, T., Fang, J., He, P., Hewitt, C. L., Kim, G. H., Huo, Y., Jiang, Z., Li, X., Liu, F., Liu, H., Liu, Y., Lu, Q., Luo, Q., Mao, Y., Msuya, E., ... Gachon, C. M. M. (2016). Safeguarding the future of the global seaweed aquaculture industry. https://www.sams.ac.uk/t4-media/sams/pdf/globalseaweed-policy-brief.pdf

8. Held, Lisa. (2021, July 20). Kelp at the Crossroads: Should Seaweed Farming Be Better Regulated?. Civil Eats. https://civileats.com/2021/07/20/kelp-at-the-crossroads-should-seaweed-farming-be-better-regulated/

9. Cottier-Cook, et. al. (2016). p. 5.

10. Cottier-Cook, et. al. (2016). p. 4.

11. Wernberg, T., Krumhansl, K., Filbee-Dexter, K., & Pedersen, M. F. (2019). Chapter 3—Status and Trends for the World's Kelp Forests. In C. Sheppard (Ed.), World Seas: An Environmental Evaluation (Second Edition) (pp. 57–78). Academic Press. https://doi.org/10.1016/B978-0-12-805052-1.00003-6

12. Filbee-Dexter, K., Wernberg, T., Grace, S. P., Thormar, J., Fredriksen, S., Narvaez, C. N., Feehan, C. J., & Norderhaug, K. M. (2020). Marine heatwaves and the collapse of marginal North Atlantic kelp forests. Scientific Reports, 10(1), 13388. https://doi.org/10.1038/s41598-020-70273-x.

13. Wernberg, T. 2018. "Flattening of global kelp forests: tales of turf, temperature and tropical herbivores." Presentation, 5th joint meeting of the Phycological Society of America and International Society of Protistologists. August 2, 2018. Vancouver, BC.