Ocean Cluster Analysis

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Opportunities for Seaweed in the Ocean Economy

The global seaweed industry is vast, diverse, and is experiencing consistent and significant growth. Within the last decade,global annual harvests of seaweed increased from 19 million metric tons in 2010 to an estimated 36 million metric tons in 2018. Worldwide, seaweed is increasingly becoming recognized as one of the largest under exploited resources on the planet. However, harnessing the full health and environmental benefits of seaweed for increased economic opportunity requires further developments in markets, processing systems, production systems, and innovations in the use of seaweed.

In Iceland, the seaweed industry has been solely based on wild cultivation and there are approximately 15 companies and startups utilizing seaweed in their products and research. Iceland's already established small seaweed industry presents significant opportunities for continued innovation and developments that would create more value. In developing both current and emerging uses of seaweed, Iceland can diversify their maritime industries in a way that is both economically significant and environmentally sound.

Worldwide, seaweed is increasingly becoming recognized as one of the largest under exploited resources on the planet. Seaweed is known to have an abundance of macro nutrients, micro nutrients, and vitamins, making it a viable food source capable of sustainable feeding the growing worldwide population. Seaweed oils contain long-chain omega-3 fatty acids making them comparable to fish oils in nutritional value and suitable alternative for the fish meal component in fish feed needed in aquaculture. Extracts from seaweed utilized in the cosmetic and pharmaceutical industry have been shown to have numerous health benefits for skin, digestion, and bone health. Seaweed acts as an underwater carbon sink by absorbing carbon dioxide from the water and releasing oxygen, helping to reduce ocean acidification.
As it grows, seaweed also absorbs inorganic nutrients in the water that are most often prevalent in highly urbanized areas where run-off from agricultural lands and sewage facilities is frequent and in fish farms where excess nutrients are released. Seaweed farms are recognized as enhancing biodiversity in the surrounding waters by providing nursery grounds for essential and endangered fishery species. Finally, if grown offshore, seaweed does not require any fertilizers, freshwater, or arable land. Large-scale seaweed farming, therefore, has strong potential to supplement future food supplies while easing the burden imposed on land from current farming practices.

In the era of climate change, seaweed essentially could be an innovative platform in protecting marine ecosystems while also harnessing increased economic opportunities. However, harnessing the full health and environmental benefits of seaweed for increased economic opportunity

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Current Seaweed Industry

The global seaweed industry is vast, diverse, and is experiencing consistent and significant growth. Within the last decade, global annual harvests of seaweed increased from 19 million metric tonnes in 2010 to an estimated 36 million metric tonnes in 2018. The current harvest is valued at an estimated USD 6 billion across all species and end-product formats. Population growth in high consumption regions, increased market penetration of less developed countries, new end-product innovations, and the increase of popular plant-based diets and product solutions have led to an annual global growth rate of 8%-10% in the seaweed market. The seaweed industry almost exclusively relies on aquaculture or "farming" of seaweeds to meet global demand. An estimated 97% (over 34 billion metric tonnes) of the global supply of seaweed is currently cultivated utilizing aquaculture, while 1 million metric tonnes are produced via wild harvesting. Food products for human consumption – including consumer food products, thickening agents, and clarifying agents - represent approximately 85% of total global seaweed production. The rest of production is used for fertilizers, animal feed, pharmaceuticals, cosmetics, and biofuel.

About 99% of seaweed aquaculture production is grown by various methods off the coasts of China, Indonesia, Philippines, South Korea, and Japan, where the market has long been established to use seaweeds for food products, animal feed, and thickening agents. China and Japan also represent more than 71% of all seaweed import volumes for human consumption. The long tradition of consuming seaweed, relatively simple technology needed to farm seaweed, low startup costs, the fast growth of seaweed, and access to cheap labor has significantly contributed to these countries' dominance in the seaweed industry. Although production and consumption are currently dominated and driven by countries within Asia, demand across the globe for increased seaweed consumption, production, and use is growing.

Emerging Innovations

Companies, entrepreneurs, and emerging research have recently developed innovative uses for seaweed. One such company, Loliware, a New York-based company, has developed Loliware Intelligent Seaweed Technology and has successfully created a plastic-free, biodegradable straw made from seaweed. The straw functions better than other alternatives that often require industrial composting facilities and typically function like plastic in the environment. After 18 hours of use, Loliware's straw becomes soft and will begin to biodegrade. Loliware plans to expand operations to create other plastic-free materials, offering seaweed's unique potential in revolutionizing plastic-free materials. Another company, Noptla, located in London, is also developing products using seaweed that will tackle the global plastic problem in the take-out industry. Noptla is a packaging company that produces plastic-free and chemical-free condiment packets and paper-based takeaway containers from seaweed harvested in France. Condiment packets and paper-based takeaway containers are usually not easily recycled and often end up as liter because of their chemical-based, eco-unfriendly coatings. Noptla's paper-based takeaway containers for food and condiment packets contain no chemicals or plastic. Instead, condiment packets are made from seaweed, and paper-based takeaway containers are lined with a seaweed-based extract, allowing them both to be compostable.

For the textile industry, brown seaweed has become a unique resource. AlgiKnit, an emerging biomaterials company located in New York, produces kelp-derived yarn and is currently working with brands to create a supply-chain for clothing, footwear, and accessories. The kelp-derived yarn is biodegradable and has the potential to reduce the number of clothes that end up in landfills each year. For the agricultural industry, research in Australia from CSIRO and its partners has discovered that feeding cattle Asparagopsis taxiformis, a red seaweed common in Australian waters, eliminates their methane production – a greenhouse gas known to be more toxic to the atmosphere than CO2. They have since created FutureFeed and are currently running trials with cattle that are proving significant results for methane reduction in the cattle industry. However, CSIRO estimates that millions of tonnes of red seaweed are

needed to feed the worldwide cattle market. A burgeoning company located in Sweden, Volta Greentech, recently started by young entrepreneurs looks to tackle this problem by developing a scalable, sustainable, and automated land-based seaweed cultivation system to produce seaweed feed needed for the worldwide cattle industry.

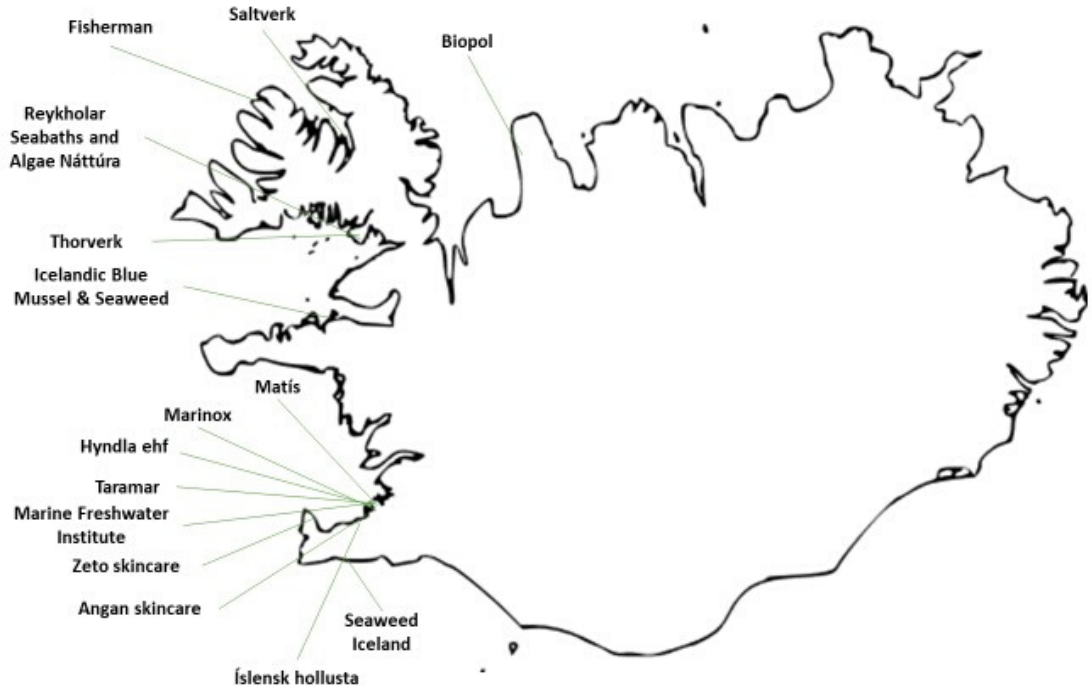
Food entrepreneurs are also incorporating seaweed in recipes and marketing their seaweed meals as being both healthy for the body and the ocean. Mark Kulsdom, Co-founder and CEO of The Dutch WeedBurger, has created seaweed based Weed Sauce, Sea Nuggets, Weed Dogs, Seawharmas, and Weed Burgers. The company's innovative seaweed based food products have lured eaters to seaweed all across Europe. Kulsdom and his company The Dutch Weed Burger has since become one of the most iconic Dutch seaweed entrepreneurs in the region. David Chang, a popular New York chef and food entrepreneur, has also started to experiment with seaweed in recipes. Chang recently teamed up with Sweetgreen, a restaurant serving simple, seasonal and healthy food in the US, to create a sweet potato and kelp bowl as a way to further introduce seaweed as food in the US. Western societies are starting to not only enjoy seaweed meals, but they are also demanding it.

Other innovations include further developments in seaweed based biofuel, extraction of high-value compounds from seaweed, seaweed based aquaculture feed, and incorporating seaweed farms in integrated multitrophic aquaculture technology. However, further research and developments are needed in these innovations before they are fully operational.

Increased Seaweed Innovation in Iceland?

In Iceland, the seaweed industry has been solely based on wild cultivation and there are approximately 15 companies utilizing seaweed in their products and research. Many small scale companies and locals forge for seaweed along Iceland's coastline to produce food products. Established edible seaweed food products include sun-dried seaweed snacks, marinated seaweed, seaweed based seasonings, and the use seaweed in local recipes. Some of the companies that harvest wild seaweed along the Icelandic coastline for food products are Fisherman, Saltverk, Íslensk hollusta, and Seaweed Iceland. Given the growing demand for plant-based food products and the increase in consumers' desires for food that is both healthy and environmentally friendly, Iceland has a unique opportunity to increase their seaweed based food industry. Food entrepreneurs and local chefs can create unique food products from the underexploited resource and use the pristine and environmentally friendly nature of Iceland as a marketing platform to get people to eat more seaweed.

Iceland's capacity to sustainably harvest and process seaweed has long been established by the company Thorverk. Thorverk, located in the Westfjords, harvests wild seaweed from Breiðafjörður to produce geothermally dried and milled seaweed that can be used for fertilizer, animal feed, cosmetics, and pharmaceuticals. Traditionally, Thorverk's products were used for fertilizer and animal feed – products of low-value. More recently, Thorverk's seaweed has been used in the cosmetic and pharmaceutical industry to produce products that have higher value. Companies within Iceland like Algae Náttúra, Taramar, and the emerging company Zeto have been using Thorverk's seaweed to create skincare that benefits both skin and health. Taramar and Zeto have especially been innovative by sustainably extracting bioactive compounds from the dried seaweed to make high-value skincare products. Also, a recently established innovative company under Matís called Marinox is working on extracting bio-actives from wild cultivated seaweed found on Iceland's pristine coasts. Their mission is to become a leader in the development and production of the highest quality bio-actives extracted from seaweed to create increased value from the underutilized natural resource. They have since developed and launched UNA skincare that contains unique bio-active substances from Icelandic seaweed. Although it is still relatively in its infancy, Iceland is slowly becoming a leader in extracting high-value compounds from seaweed to create high-value products. Thorverk's established wild seaweed harvesting and processing also presents the opportunity for researchers and entrepreneurs to develop seaweed based bio-plastics and bio-textiles from Icelandic seaweed that would create even more value.



Picture 1. The location of seaweed companies- and startups in Iceland.

Beyond this, the company Hyndla has teamed up with the Marine Freshwater Research Institute (MFRI) to experiment with growing seaweed for the food supplement and pharmaceutical industry. Thus far, Hyndla and the MFRI has successfully cultivated Schizymenia, a red seaweed recently found on Iceland's shores, in tanks. This success has indicated that under controlled conditions and in utilizing Iceland's water and sustainable energy, this seaweed can be grown in considerable quantities for use, mitigating the need for wild harvesting of this species. If sustainable land-based cultivation were to become even more successful, Iceland has the opportunity to potentially partner with companies like Volta Greentech and others who are looking to establish large-scale land-based cultivation of seaweed that is sustainable and uses low-cost energy.

Although research and developments are relatively new, seaweed also has the potential to be a suitable fish feed for aquaculture. A new system called Integrated Multitrophic Aquaculture has recently emerged as a closed-loop zero-waste farming system that incorporates seaweed. Byproduct waste from fish is absorbed by seaweed as it grows and the seaweed is then processed into fish feed – closing the loop of waste and excess feed typically needed in aquaculture.

Iceland's growing aquaculture industry presents the opportunity to develop this further and possibly incorporate the system into the country's aquaculture industry. Iceland's already established small seaweed industry presents significant opportunities for continued innovation and developments that would create more value. In developing both current and emerging uses of seaweed, Iceland can diversify their maritime industries in a way that is both economically significant and environmentally sound.

Role of Clusters

Ocean Clusters have an important role to play in developing more interest and collaboration in seaweed. The seaweed industry is at its very early stage and therefore ocean clusters and Bio Marine, an international networking community of blue bio economy enthusiasts, are the perfect platforms for networking and acceleration. Cluster collaboration can be an important tool to share ideas and knowledge in this emerging and fast growing industry.

Picture 2. Current seaweed use in Iceland and future opportunities

Author

The author of this analysis is Michaela Garland research member at Project Blue, Southern Connecticut State University . She is also a member of a team led by professor C. Patrick Heidkamp to establish the Long Island Sound Ocean Cluster in Connecticut. Michaela was an intern at the Iceland Ocean Cluster earlier this year. One of her research area was to map seaweed businesses and startups in Iceland and study how the ocean clusters in Connecticut and Iceland could collaborate on developing more startups in seaweed.

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References

Bjerregaard, R., Valderrama, D., Radulovich, R., Diana, J., Capron, M., Mckinnie, C. A., ... & Forster, J. (2016). Seaweed aquaculture for food security, income generation and environmental health in tropical developing countries. World Bank Group, Washington, DC.

Ferdouse, F., Holdt, S. L., Smith, R., Murua, P., & Yang, Z. (2018). The global status of seaweed production, trade and utilization. Food and Agriculture Organization of the United Nations.

Zuckerman, Catherine. (2017, November). This Seaweed is Good for You – And for the Environment. Retrieved from https://www.nationalgeographic.com/magazine/2017/11/explore-sustainability-kelp-farming-seaweed/