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# **In Pursuit of Sea Vegetable Market Expansion:**

## **Consumer Preferences and Product Innovation**

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*Summary Report*



## Acknowledgements

This project was completed in support of the Island Institute's goal of improving year-round employment for residents of Maine's island and coastal communities. The vision for a consumer- focused investigation of sea vegetable preferences was posed by Island Institute Economic Development Director Briana Warner with assistance from Marine Economic Development Associate James Crimp. Product benchmarking, ideation, prototype development, and testing was facilitated by consulting principal investigator Jim Griffin with assistance from Dr. Christine Stamm. Special gratitude is offered to Sebastian Belle of the Maine Aquaculture Association, Des Fitzgerald of the Maine Venture Fund, the University of Maine Darling Center, Paul Dobbins of Ocean Approved, and Seraphina Erhart of Maine Sea Vegetable Inc. The Island Institute is grateful for the incredible support provided by Lex and Chrissie Sant for this report and for furthering the responsible growth of the edible seaweed aquaculture industry in Maine.

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Dr. Griffin's research interests include seafood sustainability in the commercial sector and work-integrated learning, faculty development, and outcomes assessment in higher education. He has written for or been quoted by dozens of publications including the *Global Aquaculture Advocate*, *Foodservice Director Magazine*, *Seafood Source*, *Undercurrent News* and the *Shelby Report* and appeared on local and national broadcast television including multiple appearances on *The Today Show* and *CNN International*. Griffin holds undergraduate and graduate degrees from Johnson & Wales University and a Doctorate in Education from the School of Education at Boston University.

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Briana Warner serves as Economic Development Director of the Island Institute. She is responsible for overseeing the development and implementation of programming to address island and remote coastal communities' priorities related to strengthening diverse economies and workforce development initiatives.

Prior to joining the Island Institute, Briana started Maine Pie Line, a wholesale bakery that exclusively employed newly resettled refugees. The business received extensive media coverage in *The Boston Globe*, *Portland Press Herald*, and other national and local media outlets and was awarded the Portland Entreverge Award. Briana's work with the company earned her a spot as one of the 50 national semi-finalists for the prestigious "Eater Young Guns" award in 2014.

Before launching Maine Pie Line, Briana served with the U.S. Department of State as a Foreign Service Officer. While in the Foreign Service, Briana served as a Political Officer and Special Assistant to the U.S. Ambassador to the European Union in Brussels, Belgium, and the Political/Economic Section Chief in Conakry, Guinea. She also served at the U.S. Embassy in Tripoli, Libya. Briana holds a B.A. from George Washington University and an M.A. from Yale University in International Affairs and Economic Development.



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*Photos courtesy of Dr. James E. Griffin*



# Introduction

**T**his summary report begins with an overview of market potential for seaweed in Maine, a detailed description of the purpose behind the research conducted, and the benefits the results could potentially have on the coastal economy. A discussion of the seaweed market value in the U.S. follows along with a brief summary of the growth of consumer interest in seaweed as measured by Google search data.

An overview of research targeted at gathering evidence of product innovation in foodservice and grocery retail is included along with examples of sea vegetable use, or the lack thereof, in both categories. Procedures used during product innovation are shared and a list of final prototypes presented.

**A full report is available to businesses through the Island Institute. The full report includes details of consumer research, methodology, and individual, scalable recipes and research sources. See the last page of this booklet for more information.**





## Purpose of this Study

**T**here is growing interest in commercial cultivation of edible seaweed in Maine, yet very little is known about consumer preferences when it comes to food products that include seaweed as an ingredient. This report provides a first-ever set of consumer- tested food product prototypes that feature seaweed. The data in this report is strategically valuable to those currently operating in or intending to enter any point in the seaweed supply chain from cultivation to manufacture of finished goods.

The lack of data and insight into consumer preferences for products using seaweed is a barrier to entry for growers and processors. As a result, there are few commercial processors of edible seaweed in the U.S. and very little variation in products available to customers. Without additional exploration and investment targeted toward expanding consumer interest and product options, there will be few outlets for new seaweed growers to sell their harvest.

To address this problem, this research project focuses on the development and assessment of ten prototype food products that include seaweed as a key ingredient. Each of the food products developed is appropriate for production and sale at both foodservice and grocery retail and is scalable. Sensory assessment of each product was conducted. Results are intended to:

- 1. Provide food manufacturers, retailers, and commercial restaurants with concepts that ease or inspire the sale of food products that feature seaweed grown in Maine.**
- 2. Provide food manufacturers, retailers, and commercial restaurants with consumer data about sensory perceptions (including detailed comments) of products that feature seaweed.**
- 3. Inspire growth in the consumption of Maine grown and harvested seaweed both locally and regionally, with an emphasis on the end user (consumer).**

More specifically, this research project focuses on three key objectives:

- 1. Concept Development:** The creation of 10 prototype value-added food products that feature seaweed grown or harvested in Maine, appropriate for production and sale at foodservice and grocery retail.
- 2. Product Assessment:** Sensory assessment of each prototype food product by a Maine-based consumer panel.
- 3. Dissemination:** Development and dissemination of the results of this work to local, regional, and national audiences as appropriate.



## Overview and Market Potential

**M**aine has the potential to be a leader in U.S.-grown edible seaweed products. The growth of Maine's edible seaweed industry could provide important income diversification opportunities for a coast that is critically dependent on a commercial lobster fishery monoculture. It also could provide needed winter and early spring season revenue for seafood processors and jobs for their seasonally employed staff. Despite potential growth opportunities, the domestic market for edible seaweed and seaweed products remains underdeveloped and most growers and harvesters in Maine simply dry their product for sale in raw form with minimal focus on value-added products.

The market uses and geography for domestic edible seaweed consumption have yet to be studied and quantified in Maine—or anywhere in the Northeast U.S. Likewise, the market in the U.S. is still very new, and opportunities for expansion are not understood. In recent years, the Island Institute industry partners and prospective growers have informed the Island Institute of the need for a study focused on potential value-added products; moreover, a recent broad, qualitative, interview-based study concluded that market research for edible seaweed would be necessary for Maine's industry to achieve its potential for economic growth. This study, the 2015 "Maine Algae Cluster Market Report," recommended that in the future an organization could... "conduct in-depth analysis of the U.S. market for Maine's current and prospective algae products" in order to help Maine growers "position themselves for growth and diversification." We intend for this study to be a first step toward fulfillment of this recommendation, and that the findings outline the market and economic potential for newly developed, value-added edible Maine seaweed products.

There is great enthusiasm for expanding seaweed aquaculture in Maine as an economic opportunity for coastal communities. According to the study completed by the Maine Algae Cluster, the "sea vegetable industry holds considerable potential for expansion, including expanded sale of both fresh and dry sea vegetables as well as value-added products that include sea vegetables grown in Maine. With a total value of \$30 billion in the U.S., the organic foods market is large and fast-growing. Sea vegetables occupy a relatively small share (estimated at about less than one-hundredth of one percent), comprised mainly of dried products imported from Asia. There is room to grow within the segment, both as the organic market expands, and by displacing imported product. The results of this report may help growers and processors capitalize on opportunities. The sea vegetables industry in Maine would benefit from clear guidance regarding expansion possibilities."

Aquaculture, in a broader sense, is a growth opportunity in Maine and seaweed has the potential to be a factor in this growth. A recent Gulf of Maine Research Institute report, "Maine Farmed Shellfish Market Analysis," concludes that Maine is uniquely positioned to leverage and expand its aquaculture industry to capture a greater share of the shellfish marketplace for oysters, mussels, and scallops due to several competitive advantages that include: high-quality products made possible by Maine's cold, clean waters; available space for aquaculture expansion; strong consumer brand affinity for Maine products; strategic location near distribution centers; proximity to large population

centers with high shellfish consumption (the Northeast region consumes approximately 20% of all U.S. shellfish); and experience with, and commitment to, best aquaculture practices. The findings suggest that Maine has the potential to become a national leader in the farmed shellfish aquaculture market and to quadruple its landed value by 2030 .

Similar economic growth might be possible for Maine's edible seaweed products, particularly in comparison to similar products from Asia. Moreover, these products are environmentally sustainable—perhaps even helping to remediate the levels of CO<sub>2</sub> in the Gulf of Maine, as the Island Institute's preliminary research, conducted in partnership with Bigelow Laboratories for Ocean Science, suggests. Seaweed has significant health benefits, something which the “kelp is the new kale” tagline attempts to leverage with today's health conscious consumer. A better understanding of national and international market needs and trends around edible seaweed, paired with direct knowledge about consumer preferences and impressions of food products that feature seaweed, might enable seaweed processors and producers to more effectively innovate their products to meet market demands.

The Island Institute has targeted, in support of its mission, the growth of shellfish and seaweed aquaculture as a key income diversification strategy for fishermen and fishing communities along the coast of Maine. Growth of the edible seaweed market in Maine could help diversify Maine's fishery and create a sustainable, alternative source of income for career fishermen and women, their children, and working waterfront communities—this is our true motivation. The Island Institute's Aquaculture Business Development (ABD) program is currently providing comprehensive support to over 40 Maine residents, primarily lobster fishermen that are interested in starting seaweed and shellfish farms. The first iteration of this program resulted in the formation of two new seaweed farms, and we expect five more to be initiated by the fall of 2017.

Though seaweed aquaculture is fairly easy to get started, and has low capital costs, the Institute has been cautious about encouraging too many fishermen to start their own edible seaweed farms. At the moment, there is only one processing company in Maine that is willing to buy edible seaweeds to use in value-added products. As a result, seaweed farmers not selling to this one buyer need to market and sell their raw product themselves. More opportunities must be created for seaweed farmers to sell their line-grown edible seaweed products directly to buyers and processors for edible seaweed aquaculture to be a viable. This study will help to create those opportunities with an emphasis on creating end-user market “pull.”

## Seaweed Market Value and Consumption

Though consolidated domestic data on seaweed aquaculture and market value is hard to find, global data is available. A 2016 United Nations (U.N.) University policy brief reports that seaweed aquaculture contributed to 49% of global mariculture production of 27.3 million tons in 2014 and continues to experience rapid expansion. The U.N. estimates a global seaweed aquaculture

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The domestic market for edible seaweed and seaweed products remains underdeveloped.

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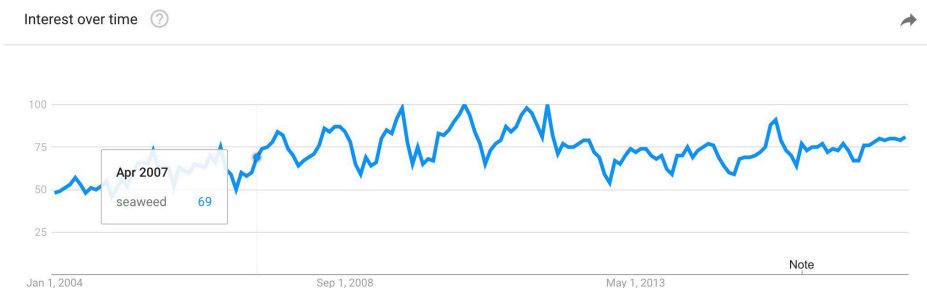
industry worth \$6.4 billion in 2014. Research suggests that 13% of the seaweed harvested in 2014 was used for the production of hydrocolloids, 12% in agriculture including use as fertilizers, and 75% for human consumption—mostly in Asia.

Data pertaining to U.S. seaweed consumption is sparse, but detailed research has been conducted in Europe that may help inform strategies in the U.S. In 2013 Ireland's Bord Iascaigh Mhara (BIM), the country's seafood development agency, commissioned a study of the European market for sea vegetables. The report estimated the wholesale European seaweed market to be approximately EUR24 million with France, the UK, Germany and Spain comprising 80% of the market. The report projects market growth of between 7-10 percent per year with demand centered on foodservice use of species specific to Asian cuisines such as nori, wakame, and kombu. Of particular note is the report's recommendation to focus Irish market development on edible seaweed species such as kelp and dulse that are not part of existing and saturated offerings produced by Asian suppliers, with an emphasis on growing retail sales and consumption.

## Consumer Interest

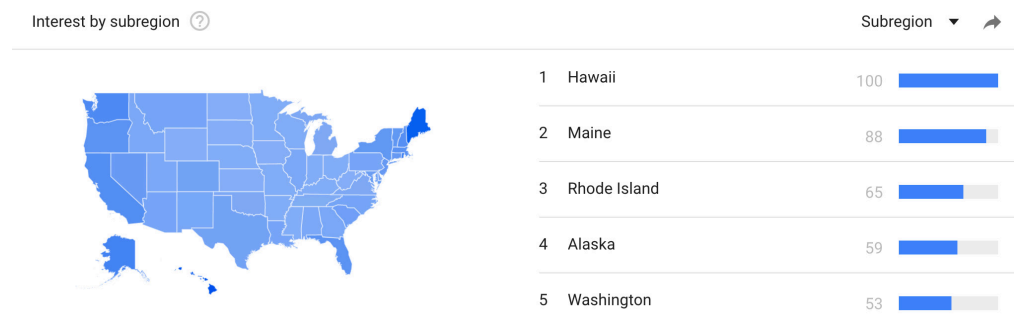
Limited data about consumer interest and perceptions about seaweed consumption exists. However, general information about consumer interest was gleaned from other sources including Google Trends. A Google Trends analysis of national search volume for the term seaweed, which is reported on a 100 point index (see Y axis below), has steadily increased over the past decade from 57 to 81.

**Figure 1. Google Search: Seaweed**  
July 2007 – July 2017



Interestingly, as noted in Figure 2 below, Maine ranks second as a subregion to Hawaii in search volume followed by Rhode Island, Alaska, and Washington. Though search volume and interest is growing nationally, Maine appears to be the Eastern Seaboard leader in this regard.

**Figure 2. Google Search: Seaweed – Interest by Subregion**  
July 2007-July 2017





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## *Growing interest in seaweed may be due to its health benefits.*

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The attractive nutritional profile of seaweed, including naturally high levels of calcium, antioxidants, potassium, iron, folic acid, fiber, and omega-3 fatty acids, has been well documented. In recent years, researchers have studied the benefits of seafood consumption on human health. A meta-analysis of research on the effects seaweed consumption on the brain suggests that seaweed has the potential to help in the defense of disorders like depression, Alzheimer's disease, and dementia. Seaweed, as both a commodity and as an ingredient in prepared foods, has the potential to be viewed as a functional food with benefits to human health.

## Concept Development and Product Innovation

The first phase of concept development included a thorough literature review and a detailed online search for food products sold in the United States featuring seaweed—other than those using nori. Though nori is widely consumed, a majority of its use is focused on Asian products and sushi and the species presents limited opportunity for growers in Maine at present. After analyzing domestic data, the search for seaweed innovation was expanded to Europe. Europe was selected as a second-stage benchmark with the belief that consumer preferences there align better with the U.S. than other regions like Central and Eastern Asia. Detailed data was gleaned from both grocery retail and foodservice with high-end restaurants demonstrating the most extensive and innovative use of seaweed. Evidence of product innovation at grocery retail proved extremely limited in the U.S. and in Europe. High end restaurants in Europe, particularly in Spain, Ireland, and the U.K., proved to be the most advanced and innovative. Examples of inventive seaweed products were collected from European restaurant menus and websites, and a group of high-end restaurants were selected for further analysis. Seaweed innovation at four European restaurants and one domestic restaurant was investigated in detail.



*Stuffed oyster with crispy alaria.*

Once the analysis of a sampling of high-end restaurants was completed, a detailed analysis of the products sold at a selection of supermarket retailers was conducted, including one in the U.K. and three in the U.S. A brief review of the sale of seaweed at wholesale was also conducted. Once these data were collected, sorted, coded, and analyzed the knowledge gained was used to develop an initial set of food product prototypes that feature seaweed. Ideas gleaned from high end restaurants led the way for product innovation.

## High-End Restaurants as Trendsetters – A Sampling

This section provides a brief summary of research focused on sea vegetable use in fine restaurants in the United Kingdom, Spain and Ireland. Fine dining restaurants in primary markets (London, Paris, Dublin, Madrid, New York, Chicago) are often seen as culinary innovators that initiate major food trends, which eventually permeate second and third-tier markets in both foodservice and grocery retail. The information provided below highlights findings at influential restaurants in the United Kingdom, Spain, and Ireland, as well as Chicago. Though the number of restaurants, retailers, and distributors profiled during this project were extensive, those highlighted below proved to be most influential and important.



### The Fat Duck – Bray, UK

The Fat Duck is known as one of the best and most innovative restaurants in the world. Chef Heston Blumenthal has earned three Michelin Stars at the restaurant and gained a global reputation for his storytelling approach to menu development and service. One of the items offered on the menu is a Cornish crab and caviar dish featuring sea vegetables as a component. Blumenthal developed the dish after reflecting on time spent as a child foraging in and around tidal pools while on holiday at the seashore with his family. The dish is served in a black ceramic bowl that resembles a tidal pool and sea vegetables including samphire are visible in the dish.



### The Clove Club – London, UK

The Clove Club, located in the Shoreditch neighborhood of London is ranked #26 by the publication, "The Worlds 50 Best Restaurants." The restaurant also maintains one Michelin star. In June of 2017, the restaurant was benchmarked. Sea vegetables are creatively used in more than just savory menu items. The restaurant uses them to infuse cocktails with notes of umami and of the ocean where appropriate. A cocktail called Rock Pool listed on the summer menu featured dulse infused Soju. Soju is a clear distilled spirit made in Korea. U.K.-based Harris distillery has also followed this path with their award-winning sugar kelp infused gin.



### El Club Allard – Madrid, Spain

Chef Maria Marte of the two Michelin Star El Club Allard restaurant in Madrid uses sea vegetables on a regular basis. Spanish chefs are at the forefront of using a wide variety of sea vegetables in both traditional and avant-garde preparations. Chef Marte serves what she calls "Sea Rice", consisting of a sea vegetable-infused risotto of squid pellets (center right), a crispy sea vegetable crisp (bottom left), and sea vegetable salad (top left). Her unabashed use of sea vegetables in multiple forms is common in high-end restaurants in Madrid, Barcelona, and San Sebastian.



### Chapter One Restaurant – Dublin, Ireland

Chef Ross Lewis has earned one Michelin star for his acclaimed Chapter One Restaurant in Dublin. He features dishes deeply rooted in Irish ingredients, culture, and cooking techniques. Sea vegetables are extensively used and remain constantly on the menu. A standout item is Cured Sea Trout, Smoked Haddock and Sea Lettuce. Lewis' use of sea vegetables is both bold and colorful. Kelp and sea lettuce are also offered as components or garnishes on a number of dishes.



### Smyth Restaurant – Chicago, IL

Closer to home, here in the U.S., innovative chefs are starting to use sea vegetables more frequently. Chef John Shields and his wife Karen Urie Shields of Smyth Restaurant continue to garner national attention, earning a top 50 spot on *Bon Appétit* magazine's best new restaurants in America list for 2017. A dish consisting of frozen shaved radish, raw oyster, and sea vegetable is served as part of an eight-course degustation menu. Smyth uses sea vegetables on an ongoing basis in multiple forms, including as a flavoring component in stocks and broths, a component in fermented preparations, and as a garnish on finished dishes (like the radish and oyster on the left).

## Supermarket Retail



### Marks & Spencer Supermarkets – London, UK

Marks & Spencer is a leading British retailer operating in the upper-mid market of the supermarket retail sector. The brand is known for high quality packed fresh and prepared foods and for chef-driven culinary innovation. Though the BIM report of 2014 reports market growth in the U.K., fresh sea vegetables are limited. The only sea vegetable offered is fresh samphire in 100g clear plastic packages imported from Israel.



### Mariano's Supermarket – Chicago, IL

Most traditional U.S. supermarkets, including Mariano's in Chicago, carry seaweed in one of two forms: a) dry in nori sheets in the form of seaweed snacks like those shown on the right, or b) in wet marinated form in the sushi or deli case. It is uncommon to find seaweed products in other fresh or dried forms or to find products that aren't primarily nori or wakame based.



### Wegman's Supermarket – Chestnut Hill, MA

Upscale U.S. supermarkets like Wegman's in Chestnut Hill lack fresh or fresh frozen seaweed and value added products that use seaweed in some form. Like other markets in the U.S., Wegman's offers dry (shelf stable) nori and wakame and a chilled wet salad located in the sushi case. The chilled wet salad is produced by a third party purveyor using farmed seaweed (generic) from Korea.



### C-Mart Supermarket – Boston, MA

Though traditional U.S. supermarkets lack a variety of seaweed products, ethnic Asian markets in most major cities like C-Mart on Lincoln Street in Boston, offer multiple varieties and facings. C-Mart has three linear feet of seaweed offerings including seven facings and three discernable varieties (kelp, laver, nori). It isn't unusual to find labels on these products that fail to disclose in English the exact variety of seaweed in the package. China is the country of origin most frequently listed.

### Wholesale – U.K. vs. U.S.

Few if any wholesale options for procuring fresh or fresh frozen sea vegetables exist. Chefs and supermarket operators interested in procuring fresh product must go directly to the source or procure product online when available. Sources are limited and often unreliable.



In the UK, this is different. Billingsgate Market (London's main wholesale fish market) reports that sale of fresh sea vegetables is but a minor category when compared to overall market sales. However, several wholesale operators regularly offer fresh sea vegetables—the most common variety being samphire. Other varieties offered when in season include two types of dulse, sea lettuce, bladderwrack, and samphire.



## Results

**R**esults from this research suggest that use of sea vegetables in fine dining in London, Madrid, and Dublin is alive and well. Prominent chefs are using sea vegetables in multiple innovative and creative preparations and interpretations. It appears that ongoing use of sea vegetables is helping to improve market acceptance. In the U.K., a trend is emerging where sea vegetables are being used to infuse and flavor cocktails and spirits. In London, fresh sea vegetables can be acquired at wholesale on an ongoing basis though the varieties change according to season and availability. From a sensory perspective, skilled chefs are pairing fresh or fresh frozen (slacked) seaweed with other ingredients that complement and balance its overall flavor. Seaweed is used as a highlight in various dishes and leveraged for its briny flavor and umami boost. It appears that consumers are willing to try (and enjoy) seaweed when the flavor is less pronounced – less fishy and more complementary. These insights deeply inform the prototype products developed in this study.

Analysis of data from the United Kingdom, Spain, and Ireland suggest foodservice operators are using sea vegetables in the following forms:

1. Fresh Whole – as a salad, side, or component
2. Fresh Puree – as a flavoring, coloring agent, garnish
3. Dry Whole – as an infusion, flavoring element
4. Dried Powder – as a flour in crackers, crisps, dough

European usage in the restaurant and retail sector and market acceptance appears to be ahead of the U.S. when you consider the lack of sea vegetable availability in fine dining and retail outlets closer to home. Perhaps the European market is a model of what we can expect for sea vegetable consumption in the near future here in the U.S.

### Sea Vegetable Species & Product Prototypes

Upon conclusion of the benchmark phase of the project, more than three dozen ideas for product development were captured, sorted and ranked. Product development focused on five key seaweed species: Laver, Sea Lettuce (*Viva lactuca*), Dulse, Sugar Kelp, and Alaria, with an emphasis on Sugar Kelp and Dulse. Though foodservice provided the most examples of product innovation, during product ideation, equal consideration was given to product development for both foodservice and grocery retail.

When developing products for commercial foodservice and grocery retail it is critically important to target the consumer (end user) during ideation. Seaweed consumption appears to be growing in Europe and has long been part of diets in Asia. These markets, particularly in Asia, enjoy seaweed products that are robust in flavor. Market acceptance in the U.S. is more limited. Anecdotal discussions with potential consumers suggests a willingness to try sea vegetables but a preference for products that are mild (less fishy) in flavor. This suggests products developed with seaweed for restaurants and grocery retail must be engineered to assure a balanced and less intense flavor profile. Products developed as part of this research were informed by a desire to keep them approachable from a flavor and preparation perspective.

It is also important that the channel of sale within commercial foodservice, grocery retail be targeted. At present, sale of seaweed is more common at high-end grocery



retailers like Whole Foods and Wegmans, and upscale small format retailers like Trader Joes, compared to lower end retailers like Walmart and Aldi. In commercial foodservice, potential markets include mid-to high-end restaurants as well as onsite and non-commercial operators. Product prototypes developed as part of this research are intended for restaurants, non-commercial operators, and upscale retailers where a gateway for seaweed sales is already established.

Once a market perspective was in place, product ideation commenced. An initial list of thirty product concepts was produced and ranked for viability. Then this list was reduced to twenty items and ranked again. A list of the ten products most likely to appeal to consumers was finalized. Product supply, availability, cost, and seasonality influenced product development and final prototype selection. Presented below are descriptions of the ten final product prototypes developed for this project.

**1. Sea Vegetable Power Bar:** Dry dulse flakes are used to flavor a nutrient dense power bar that remains shelf stable after cooking. Laver and alaria can also be used in combination with or as a substitute to the dulse in the formula.

**2. Dulse Cucumber Salad:** This vegan, ready-to-consume fresh salad highlights Asian flavors and features rehydrated wild dulse, though rehydrated sea lettuce works well in the formula.

**3. Sugar Kelp Flat Bread:** This yeast raised bread with powdered kelp as an inclusion is intended to serve as a foundation for other preparations such as pizza or as an hors d'oeuvre base. The dry sugar kelp powder provides a nutritional boost and color agent.

**4. Sea Vegetable Lasagna:** Rehydrated dry sugar kelp is used in place of pasta when making this lasagna. The formula features a filling made with haddock trim and wild white shrimp though nearly any seafood can be substituted. Once cooked and cooled the item can be proportioned for packaged sale at retail or à la carte sale in foodservice.

**5. Maple Dulse Cranberry Scone:** Dry dulse flakes are used to flavor a traditional scone base, though dry alaria or laver can be used as a substitution.

**6. Sea Vegetable Chickpea Salad:** This vegan item features fresh frozen sugar kelp and rehydrated alaria and is intended for production and sale as a fresh, nutritious, ready to consume salad.

**7. Sea Vegetable Beans and Sausage:** Fresh frozen random cut sugar kelp is featured in this product adding umami intensity. Enzymes in the kelp help tenderize and flavor the beans in the dish. This item is intended to serve as a base for grilled, seared, or roasted proteins such as pork belly or chicken legs.

**8. Sugar Kelp Shrimp Tempura:** The tempura batter features dry sugar kelp powder and can be made with Dulse powder and powdered Alaria. This product is suitable for packing as a dry, ready to finish mix, and it works well on all types of seafood and poultry.

**9. Savory Sea Vegetable and Onion Broth:** This product features an umami rich onion-based broth infused with sugar kelp, dulse flakes, and tamari, and is suitable for sale as a packaged item at retail or a menu item component in foodservice.

**10. Dulse Ice Cream:** Dry powdered wild dulse is used to flavor and color traditional French vanilla ice cream base.

## Compatibility Map

Though certain seaweed species were found to work better than others, a compatibility map was created to illustrate the seaweed varieties appropriate for use in each of the product prototypes in light of potential challenges with availability. Many of the product prototypes allow for substitution of one type of seaweed for another or the use of a combination of seaweeds for flavor and color. The table below lists the product prototype on the left and the specific types of seaweed that are suitable for the item. In most cases, dulse and sugar kelp are the preferred sources since these are the most commonly available varieties on a year-round basis.

**Table 1: Product Concepts, Sea Vegetable Application, Sales Channel Alignment**

Product Concepts - Sea Vegetable Application - Sales Channel Alignment							
Item	Dulse	Laver	Sea Lettuce	Sugar Kelp	Alaria	Food Service	Grocery Retail
Power Bar	x	x	x	x	x		x
Dulse Cucumber Salad	x		x			x	
Sugar Kelp Flat Bread	x			x	x	x	x
Sea Vegetable Lasagna				x	x	x	x
Maple Dulse Cranberry Scone	x	x		x	x		x
Sea Vegetable Chickpea Salad			x	x	x	x	x
Maine Coast Beans and Sausage	x	x	x	x	x	x	x
Sugar Kelp Shrimp Tempura	x			x	x	x	
Savory Sea Vegetable Onion Broth	x	x	x	x	x		x
Dulse Ice Cream	x	x		x	x	x	x

## Tasting Panel Overview

A tasting panel was recruited from the local community to provide a sensory evaluation of each product prototype. Subjects were recruited via email and word-of-mouth. Potential volunteers were directed to complete a preliminary online survey intended to capture demographic information and information about prior exposure to or preference for seaweed. Subjects who completed the online survey were asked to disclose gender and age, describe whether they currently consume sea vegetables, and their opinion about consuming sea vegetables. They were also provided with proper disclosures about survey and tasting panel confidentiality via the online survey.

A total of 18 individuals were selected from the volunteer pool. Nine subjects were between 30-39 years of age. Two were between 21-29 years of age. Two were over the age of 60, and five were between 40-49 years of age. Ten subjects were male and eight were female. Thirteen subjects reported that they currently consume seaweed, three reported no current or prior consumption, and two failed to respond to this question. Sixteen of eighteen participants reported that they support consumption of seaweed. Understanding prior experience and attitude toward consuming seaweed is important. A possibility exists when conducting a sensory assessment that prior experience or familiarity with a product may influence survey results or create bias. This effect is often referred to as the familiarity heuristic, and research suggests that individuals may feel more positive about situations, people, or products they are familiar with compared to new situations, people, or products. There is potential for the results of this research to be biased due to the high number of subjects reporting familiarity and the fact that a majority of participants support seaweed consumption. In addition to the potential for bias in the results, the number of research subjects (N=18) was also extremely limited. Data should be interpreted accordingly. Additional research is recommended.

Sensory assessment was conducted on August 8th, 2017, in a conference room at the Holiday Inn by the Bay in Portland, Maine. Individual tasting stations for each participant were set up in a large conference room. At the start of the session, subjects were provided with a brief introduction including a reminder of protocols and an overview of the rating form to be used. Subjects were reminded verbally that all responses were confidential and encouraged to be completely honest and forthright. Data was collected using an individual paper and pencil rating form for each of the ten items sampled. Prior to the start of the assessment phase of the session, subjects were provided with a brief overview of the tasting form, including a review of the five-point rating scale and the place on the form designed for recording comments.

Panel members were encouraged to provide comments in addition to numerical ratings. A reminder about confidentiality was repeated and subjects were informed that completed surveys would not be linked in any way to a specific respondent. Subjects were informed that they could refrain from consuming any item for any reason (including dietary restrictions, preference, religious reasons, health, and wellness) and that they could depart at any point in the session. Reminders to refrain from talking or interacting during the tasting, and directions to complete the packaging rating, were offered prior to the start of the tasting session.

Once the introduction was complete, subjects were asked to sample and rate each of ten prototype products using a five-point numerical rating form to document preference levels for each prototype offered.

## **Methodology**

As noted earlier, the methodology used for this research included the administration of a rating form to measure the variable of preference using a five point scale for each of six questions. In addition to ratings, qualitative data was collected in the form of written comments provided by subjects for each of ten items sampled. Data was collected from subjects during live product tasting sessions held on location in Portland, Maine.

### **Research questions**

Though the data collected during this study is broad and interpretation of results may be equally broad, the study itself is guided by two specific questions:

**Using a five point scale, how do subjects rate each of ten product prototypes that include seaweed for aroma, taste, visual appeal, concept, and overall perception?**

**Using a five-point scale, how do subjects rate their probability of purchase of each of ten product prototypes that include seaweed?**

A form employing a rating scale was developed to gather sufficient data from subjects to answer both research questions. Rating scales are frequently used to measure attributes such as attitudes and preference. Two rating scales were developed for this research; one for the sensory assessment of each product prototype and the second for rating likelihood of purchase.

## **Sensory Assessment Questions and Rating Scale**

The sensory assessment portion of the rating form consisted of five questions. Subjects were asked to use a five-point rating scale to rate each prototype for:

1. Aroma: how the product smells
2. Taste: how the product tastes
3. Visual Appeal: how the product looks
4. Concept: the product idea or concept itself
5. Overall Impression

The rating scale used for sensory assessment consisted of five points ranging from the extreme of “really good” to the opposite “really bad.” These are the five points on the rating scale that were employed:

- Really Good – score/marker of 5
- Good – score/marker of 4
- Neutral – score/marker of 3
- Bad – score/marker of 2
- Really Bad – score/marker of 1

## **Likelihood of Purchase Question and Rating Scale**

Subjects were also asked a sixth question to measure their likelihood of purchase of the item being sampled at the bottom of the rating form for each prototype. The sixth question read as follows:

**6. How likely are you to purchase this item if sold at retail (in a supermarket or at a restaurant)?**

The likelihood of purchase scale consisted of five points ranging from the extreme of “definitely” to the opposite “definitely not.” These are the five points on the rating scale that were employed:

- Definitely – score/marker of 5
- Probably – score/marker of 4
- Neutral – score/marker of 3
- Probably not – score/marker of 2
- Definitely not – score/marker of 1

Subjects provided comments for all six questions (in varying degrees) in addition to their numerical ratings of each product.

All 18 subjects completed the sensory assessment activity for each of the ten prototypes developed. For certain items, some subjects chose not to provide a rating for one or more of the five questions listed. Data reflects these gaps in response. Quantitative and qualitative data was compiled and analyzed. The results presented in this report are based on these findings.



**Product sampling occurred in the following order:**

1. Sea Vegetable Power Bar
2. Dulse Cucumber Salad
3. Sugar Kelp Flat Bread
4. Sea Vegetable Lasagna
5. Maple Dulse Cranberry Scone
6. Sea Vegetable Chick Pea Salad
7. Sea Vegetable Beans and Sausage
8. Sugar Kelp Shrimp Tempura
9. Savory Sea Vegetable and Onion Broth
10. Dulse Ice Cream

## **Recipes and Consumer Data Available**

This summary report provides an overview of the purpose for the research completed, the methodology used, and a general summary of results. However, the full report is available and includes more detail on the food products developed that are appropriate for production and sale at both foodservice and grocery retail outlets.

The Island Institute will hold the full-length “Sea Vegetable Market Expansion Report” including the scalable recipes, all detailed consumer data, packaging suggestions, and price points for each of the above, consumer tested products. This information will be released to Maine-based companies serious about producing any of the above products.

**For more information on these products and to discuss terms and conditions around use, please contact:**

**Briana Warner ([bwarners@islandinstitute.org](mailto:bwarners@islandinstitute.org)) and/or  
James Crimp ([jcrimp@islandinstitute.org](mailto:jcrimp@islandinstitute.org))**



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## References

<sup>i</sup> “Maine Algae Cluster Market Research,” submitted to Bigelow Laboratory for Ocean Sciences National Center for Marine Algae and Microbiota by Michael Gardner, [mgardner@gardnerpinfold.ca](mailto:mgardner@gardnerpinfold.ca) Gardner Pinfold Consultants Inc. and Heather Marriott Revenue Management Ltd, 2015.

<sup>ii</sup> “Maine Algae Cluster Market Research,” submitted to Bigelow Laboratory for Ocean Sciences National Center for Marine Algae and Microbiota by Michael Gardner, [mgardner@gardnerpinfold.ca](mailto:mgardner@gardnerpinfold.ca) Gardner Pinfold Consultants Inc. and Heather Marriott Revenue Management Ltd, 2015.

<sup>iii</sup> “Maine Farmed Shellfish Market Analysis 2016, Gulf of Maine Research Institute,” Hale Group: [http://www.gmri.org/sites/default/files/resource/gmri\\_farmed\\_shellfish\\_final\\_with\\_cover\\_10.13.16.pdf](http://www.gmri.org/sites/default/files/resource/gmri_farmed_shellfish_final_with_cover_10.13.16.pdf)

<sup>iv</sup> <http://www.islandinstitute.org/working-waterfront/kelp-new-kale-and-possible-carbon-fix> AND <http://www.islandinstitute.org/blog-post/can-growing-sugar-kelp-locally-reduce-ocean-acidification-maine's-waters>

<sup>v</sup> Cottier-Cook, E.J., Nagabhatla, N., Badis, Y., Campbell, M., Chopin, T, Dai, W, Fang, J., He, P, Hewitt, C, Kim, G. H., Huo, Y, Jiang, Z, Kema, G, Li, X, Liu, F, Liu, H, Liu, Y, Lu, Q, Luo, Q, Mao, Y, Msuya, F. E, Rebours, C, Shen, H., Stentiford, G. D., Yarish, C, Wu, H, Yang, X, Zhang, J, Zhou, Y, Gachon, C. M. M. (2016). Safeguarding the future of the global seaweed aquaculture industry. United Nations University (INWEH) and Scottish Association for Marine Science Policy Brief. ISBN 978-92-808-6080-1. 12pp

<sup>vi</sup> Cottier-Cook, E.J., Nagabhatla, N., Badis, Y., Campbell, M., Chopin, T, Dai, W, Fang, J., He, P, Hewitt, C, Kim, G. H., Huo, Y, Jiang, Z, Kema, G, Li, X, Liu, F, Liu, H, Liu, Y, Lu, Q, Luo, Q, Mao, Y, Msuya, F. E, Rebours, C, Shen, H., Stentiford, G. D., Yarish, C, Wu, H, Yang, X, Zhang, J, Zhou, Y, Gachon, C. M. M. (2016). Safeguarding the future of the global seaweed aquaculture industry. United Nations University (INWEH) and Scottish Association for Marine Science Policy Brief. ISBN 978-92-808-6080-1. 12pp

- <sup>vii</sup> Rioux, Beaulieu, & Turgeon. (2017). Seaweeds: A traditional ingredients for new gastronomic sensation. *Food Hydrocolloids*, 68, 255-265.
- <sup>viii</sup> <http://www.bim.ie/media/bim/content/publications/TheEuropeanMarketforSeaVegetables-,2015.pdf>
- <sup>ix</sup> <https://trends.google.com/trends/explore?date=all&geo=US&q=seaweed>
- <sup>x</sup> <https://trends.google.com/trends/explore?date=all&geo=US&q=seaweed>
- <sup>xi</sup> <http://www.foodnavigator-usa.com/Suppliers2/Seaweed-gains-popularity-presenting-a-chance-to-get-in-at-ground-level>
- <sup>xii</sup> Mouritsen, O., Dawczynski, G., Duelund, C., Jahreis, L., Vetter, G., & Schröder, W. (2013). On the human consumption of the red seaweed dulse ( *Palmaria palmata* (L.) Weber & Mohr). *Journal of Applied Phycology*, 25(6), 1777-1791.
- <sup>xiii</sup> Cornish, M., Critchley, A., & Mouritsen, O. (2017). Consumption of seaweeds and the human brain. *Journal of Applied Phycology*, 1-22.
- <sup>xiv</sup> Pomin, V. H. (2012). *Seaweed : Ecology, Nutrient Composition, and Medicinal Uses*. New York: Nova Science Publishers, Inc.
- <sup>xv</sup> <http://www.theworlds50best.com/The-List-2017/21-30/The-Clove-Club.html>
- <sup>xvi</sup> <http://www.harrisdistillery.com/harris-gin>
- <sup>xvii</sup> Albarracín, D., Wyer, R., & Kruglanski, Arie W. (2000). The Cognitive Impact of Past Behavior: Influences on Beliefs, Attitudes, and Future Behavioral Decisions. *Journal of Personality and Social Psychology*, 79(1), 5-22.
- <sup>xviii</sup> Pedhazur, E. J., & Schmelkin, L. P. (2013). *Measurement, design, and analysis: An integrated approach*. Psychology Press.



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