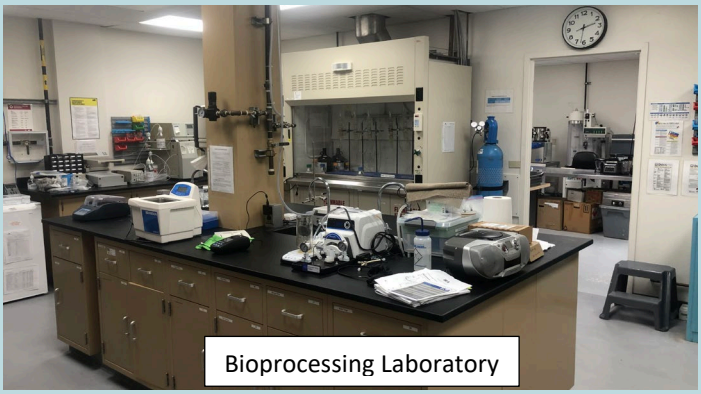

Seafood Pilot Plant


Aquaculture Facility


Bioprocessing Pilot Plant


Bioprocessing Laboratory

SEAWEED FORUM AND KNOWLEDGE TRANSFER

SEAWEED MISSION 2024

Submitted to:
MSRDF, Department of Fisheries, Forestry and Agriculture
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SEAWEED FORUM AND KNOWLEDGE TRANSFER

Seaweed Mission 2024

Centre for Aquaculture and Seafood Development Project No.: **P-5589**

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ACKNOWLEDGEMENT

The Centre for Aquaculture and Seafood Development (CASD) would like to thank the Department of Fisheries, Forestry and Agriculture (DFFA) and the Canadian Centre for Fisheries Innovation (CCFI) for their financial support of this project. A special thank-you is also extended to the Newfoundland Aquaculture Industry Association (NAIA) for their support with logistics, coordination and facilitation of the Seaweed Culture Workshop.

DFFA, through its Multi-Species Research and Development Fund (MSRDF) supports investments in the research and development of aquaculture production systems of new species not currently commercialized in the province. The MSRDF is intended to diversify and expand the Newfoundland and Labrador aquaculture sector, including the farming of cultured plants and new species.

CCFI is a conduit between industry, researchers, and academic institutions, providing guidance to project development and execution through its relationship and expertise in team building skills, securing/leveraging funding to support innovative projects, as well as project management. CCFI collaborates directly with industry to facilitate access to scientific knowledge and expertise of Memorial University, the Fisheries and Marine Institute and other Canadian institutions, providing access to new technologies and methodologies that lead to operational improvements, industry-wide growth, and prosperity.

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EXECUTIVE SUMMARY

The Marine Institute (MI), through its Centre for Aquaculture and Seafood Development (CASD), hosted a seaweed forum (October 8, 2024) and technology transfer mission (Oct 2024, Dec 2024 and Feb 2025) to provide development support to NL's emerging seaweed industry and to promote it across Canada. The forum was held in collaboration with the Newfoundland Aquaculture Industry Association's (NAIA's) 2024 Cold Harvest conference and included seaweed companies, research organizations, industry associations and government representatives from Atlantic Canada and British Columbia, who presented on successes, challenges, opportunities and lessons learned. In addition to the forum, MI organized a knowledge transfer mission for MI representatives to visit seaweed operations in the USA, BC, NS and PEI to learn about growing methods, industry specific logistics and processing requirements, and identify research and development needs for NL.

During the Seaweed Culture Workshop, both presenters and participants engaged in discussions on the development of seaweed culture throughout Canada. They also took part in a facilitated strategy session to analyze existing gaps in the industry. The workshop brought to light several challenges that the Newfoundland seaweed industry must address as it evolves ranging from regulatory reform to gaps in seed supply, genetic resources, reproductive techniques, and on-farm production timing.

In addition to the gaps and challenges, several opportunities with significant potential were identified in the following areas:

- Production of biostimulants along with stability studies and animal feed applications – perhaps supported by a graduate student program.
- Development of regenerative aquaculture practices, including sewage treatment, nutrient sequestration, and validation efforts.
- Establishment of a seed bank, potentially located at MI.
- Creation of small in-situ hatcheries/nurseries, accompanied by related training programs.
- Development of cascading biorefinery models for full utilization and value maximization with a focus on marine bioextracts for health applications.

The knowledge transfer mission was of great benefit for technical personnel of CASD to better prepare them for project work supporting NL seaweed industry development. Specifically, in nursery technology, harvesting technology and site selection, as well as processing and storage techniques, and new product development. This mission allowed the CASD team to visit and connect with most of the current groups/individuals who are active in seaweed research and production in Canada. The various site visits conducted during the knowledge transfer mission have opened the door for strong partnerships and collaborations between MI, NL seaweed companies, BC seaweed companies, Atlantic Canadian seaweed companies, Canadian research organizations and industry associations, as we all work towards a common goal of building a sustainable seaweed industry for Canada.

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1 BACKGROUND AND INTRODUCTION

The seaweed industry includes both cultivated and wild harvested species and is growing globally. In 2019, the FAO reported 35.8 million tons of algae was produced by 54 countries with Asia contributing 97%. From a value perspective, in 2021 Fortune Business Insights reported the industry had a value of $15 billion USD with predictions of $25 billion USD by 2028. Demand for pharmaceuticals, health supplements, sustainable local food production, extracts, and animal feed alternatives are providing opportunities for sourcing from non-traditional growing and harvesting locations. Historically, warmer climates with faster growing seasons have dominated the world market but with new technology, climate change mitigation and expanding applications for seaweed products, Atlantic Canada has potential to participate in this growing industry. Regions all over the world are investing in seaweed research and development as well as expanding operationally. From a regional perspective, Atlantic Canada has a long-standing relationship with seaweed as it was used for fertilizer on nutrient-lacking acidic soil and additives for small-scale cattle feed. In NL six companies (Shorefast, Holdfast, Connaigre Fish Farms, NL Seaweed Company, Kal-Up and 7 Fathoms) are currently involved in different aspects of the seaweed industry.

The Marine Institute (MI), through its Centre for Aquaculture and Seafood Development (CASD), hosted a seaweed forum (October 8, 2024) and technology transfer mission (Oct 2024, Dec 2024 and Feb 2025) to provide development support to NL's developing seaweed industry and to promote it across Canada. The forum was held in collaboration with the Newfoundland Aquaculture Industry Association's (NAIA's) Cold Harvest Conference and included seaweed companies, research organizations, industry associations and government representatives from Atlantic Canada and British Columbia, who presented on successes, challenges, opportunities and lessons learned. The desired outcome of the forum was to identify how the NL ocean industry can participate in the development of a NL seaweed industry strategy in collaboration with the rest of Canada. In addition to the forum, MI organized a knowledge transfer mission for MI representatives to visit seaweed operations in the USA, BC, NS and PEI to learn about seed production, growing methods, industry specific logistics and processing requirements, and identify research and development needs for NL.

2 SCOPE AND PURPOSE

The purpose of this initiative was to provide development support to the NL seaweed industry, and to promote NL's developing seaweed industry in Canada. A key goal of the project was to provide a platform for participants to share knowledge and experience, and to explore potential collaborative efforts within NL and across Canada.

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3 OBJECTIVES

The objectives of this project included:

1. To host a forum bringing together research, industry and government players from NL, Canada and abroad for discussing industry successes and struggles, and to identify opportunities for collaboration.
2. To identify how the NL ocean industry can participate in the development of a NL seaweed industry strategy in collaboration with the rest of Canada.
3. To send a NL delegation to visit industry operations in BC, NS, PEI and the US for knowledge transfer on growing, logistics and processing, and to identify key areas of research for NL.

4 METHODS

The project was divided into two components: (1) a seaweed forum; and (2) a knowledge transfer mission.

4.1 Seaweed Forum

In October 2024, the Marine Institute hosted a 1-day seaweed workshop session and discussions at the Sheraton Hotel in St. John's, NL. The workshop was held in conjunction with the NAIA 2024 Cold Harvest Conference. The program included opportunities for NL companies to present their work, participate in facilitated discussions, and ask questions from other invited speakers. It also allowed the Marine Institute, and other Canadian research organizations, to showcase what they have to offer in the industrial research space within the realm of seaweed development. Facilitated discussions on 5-key topics, identified in previous consultations and by follow-up survey with NL industry representatives, included farm operations, policy, processing technology, product development and marketing.

Companies and organizations were provided with opportunities to show case their operations/research through exhibit space, and oral presentations during the forum, and to avail of networking opportunities. The media were invited to attend and hear opening remarks from the Marine Institute and other forum participants. In addition, MI's social media accounts communicated and promoted the forum. Participants were also invited to tour the Marine Institute's seaweed nursery and processing facilities at its Ridge Road campus in St. John's, NL.

4.2 Knowledge Transfer Mission

A portion of funding was allocated to support travel for four (4) MI researchers to visit regions in Canada and the US that have been participating in the seaweed industry for several years. The MI team travelled to Connecticut, British Columbia, Nova Scotia and Prince Edward Island to visit grow out sites, processing plants, research facilities, and met with operators, staff, researchers and secondary suppliers of the industry. This allowed the MI team to determine how the MI can support research and industry development for NL seaweed.

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5 RESULTS

5.1 Seaweed Forum

On October 8, 2024, the CASD successfully organized and hosted a seaweed forum branded as a "Seaweed Culture Workshop" (Figure 1) at the Sheraton Hotel in St. John's, NL in collaboration with the NAIA 2024 Cold Harvest conference. Technical tours of the MI seafood processing pilot plant and aquaculture facilities showcasing the CASD's capability to support seaweed nursery and processing activities were also provided. During the workshop the Canadian Seaweed Indsutry Network was launched by Mark Smith, president of the Pacific Seaweed Industry Association.

Figure 1. Seaweed Culture Workshop social media advertisement.

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Seventy (70) people attended the event, including 14 invited speakers from industry, government and academia. The workshop program is presented in Table 1. Detailed minutes from the workshop discussions are available in Appendix A.

Table 1. Seaweed Culture Workshop Program

2024 NL Seaweed Culture Workshop @ NAIA Cold Harvest Hosted by Marine Institute Sponsored by CCFI and MSRDF	
TUESDAY, OCTOBER 8	
8:30 AM	**Coffee and Networking**
9:00 AM	Welcome and Opening Remarks (Heather Burke, Marine Institute)
9:10 AM	Canadian Seaweed Farming: Recent Advances Towards Commercialization (Cyr Couturier, Marine Institute)
9:30 AM	Pacific Seaweed Farming: Opportunities and Challenges (Mark Smith, Pacific Seaweed Industry Association)
9:50 AM	The Economics of Seaweed Farming in North America (Bill Collins, Cascadia Seaweed)
10:10 AM	Seaweed Product Development and Processing Considerations (Logan Zeinert, North Island College)
10:30 AM	**NUTRITION BREAK and POSTER SESSION**
10:50 AM	Starting Seaweed Aquaculture in Newfoundland (Dr. Rafael Sabioni, Marine Institute)
11:05 AM	NL Industry Perspective: HoldFastNL (Michael Teasdale)
11:20 AM	Primary/Secondary Seaweed Processing Technology in NL (Julia Pohling, Marine Institute)
11:35 AM	Extracting Seaweed Bioactives (Dr. Deepika Dave, Marine Institute)
11:50 PM	NL Industry Perspective: 7 Fathoms (Courtney Howell)
12:05 PM	Licensing and Policy (Gail Hoskins Dept. Fisheries, Forestry and Agriculture and Chris Hendry, Fisheries and Oceans Canada)
12:20 PM	Q&A Session

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12:30 PM	LUNCH and PANEL DISCUSSION (Lunch Provided)
1:00 PM	**PANEL DISCUSSION - The Future of Seaweed in NL - Moderator: Keith Hutchings, CCFI** **Panelists: Bill Collins (Cascadia Seaweed), Gail Hoskins (DFFA), Michael Teasdale (HoldFastNL), Marie-Evé Clark (MERINOV)**
1:30 PM	Topo-bathymetric Lidar to Map Wild Kelp in Support of Seaweed Aquaculture Operations (Dr. Tim Webster, Nova Scotia Community College)
1:45 PM	The Future of AI and Machine Learning Tools for Modular Multi-trophic Aquaculture (Joyeeta Das, Samudra Oceans Limited)
2:00 PM	BioLabMate: Pioneering Seaweed-Based Bioplastics in NL - Innovation, Technology, and Sustainability (Dr. Sarika Kumari and Sanjay Dubey, BioLabMate)
2:15 PM	Cascading Biorefinery of Seaweed (Dr. Ibraheem Adeoti, Holland College)
2:30 PM	Canadian Seaweed Industry Network (Mark Smith, Pacific Seaweed Industry Association)
2:45 PM	**NUTRITION BREAK and POSTER SESSION**
3:00 PM	NL Strategy Session: Gap Analysis and Way Forward - Facilitated Discussion (Cyr Couturier, Marine Institute)
4:00 PM	**WRAP-UP and MI TOUR**
4:20 PM	Bus Departs for Marine Institute
4:30 PM	Tour of Marine Institute Seaweed Research Facilities
5:20 PM	Bus Departs for Sheraton

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5.2 Knowledge Transfer Mission

5.2.1 Greenwave – New Haven, Connecticut, USA

Rachel Artuso, Marine Institute accompanied Nick Mercer, Holdfast NL on a technical site visit to Greenwave (https://www.greenwave.org/) in New Haven Connecticut October 21-22, 2024, to see their seaweed nursery operation, ocean site and part of their production facility.

OCT 21, 2024

R. Artsuo and N. Mercer met with the Greenwave staff including Toby Sheppard Bloch and Bren Smith. They discussed the history of Greenwave and the respective goals with the MI, Holdfast and Greenwave nursery operations.

MI and Holdfast personnel were given an in-depth tour of Greenwave's seaweed nursery including water storage, lab spaces, gametophyte lab and the nursery. This included discussions about Greenwave's nursery structure, procedures, spool seeding, as well as gametophyte seed bank maintenance and development. R. Artuso and N. Mercer were also given an opportunity to take part in the gametophyte grinding and processing, that would later be used for spool seeding. They worked with Maggie Aydlett, Greenwave's kelp seed production manager and Sophie Spiegel, kelp seed production coordinator reviewing procedures and methods used for spool seeding and gametophyte production.

OCT 22, 2024

Ben Kelsey, Greenwave's infrastructure manager, Maggie Aydlett and Sophie Spiegel invited MI and Holdfast out to their sea site to see their lines.

5.2.2 British Columbia

Site visits to British Columbia took place during the first week of December 2024 (Table 2). Two MI representatives, Dr. Heather Burke and Dr. Rafael Sabioni, participated in the mission.

In British Columbia (BC), the program started with meeting Mark Smith, President of the Pacific Seaweed Industry Association. Discussions focused on the newly announced Canadian Seaweed Industry Network and how MI, as a founding member, could support and promote the needs of the NL seaweed industry through the network and foster research and development collaborations. Follow-up discussions are ongoing, and a strategic planning session is being planned for May 2025.

The MI team, along with Mark Smith, visited North Island College's (NIC) Centre for Applied Research in Campbell River. Under the lead of Dr. Logan Zeinert, they are developing a project called "Canada's Seaweed Innovation Hub", with the objective of optimizing seaweed seed production to support the growth of the seaweed sector in BC. They are currently producing sugar kelp in spools to supply some of

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the farms and green gravel, rocks containing seaweed seeds, that will be deployed at specific sites for ecosystem restoration. This group also recently acquired a modular automated gametophyte incubator,

Table 2. Itinerary for BC knowledge transfer mission, December 1-7, 2024

Date	**Activity**
Mon Dec 2 – 9:00 AM (PST)	Meet with Mark Smith, Executive Director Pacific Seaweed Industry Association
Tues Dec 3 – 7:30 AM (PST)	Depart Sidney for North Island College, Campbell River Campus (~ 3-hour drive)
Tues Dec 3 – 11:00 AM (PST)	North Island College – Meet with Logan Zeinert and Rhianna Nagel
Tues Dec 3 – 2:00 PM (PST)	Depart Campbell River for Sidney (~ 3-hour drive)
Wed Dec 4 – 8:30 AM (PST)	Meet at Cascadia Seaweed Corp Headquarters in Sidney, BC – Meeting & Presentation
Wed Dec 4 – 11:00 AM (PST)	Tour of Cascadia Seaweed Farm – Central Saanich, BC
Wed Dec 4 – 5:00 PM (PST)	Dinner with Cascadia Team
Thurs Dec 5 – 7:15 AM (PST)	Depart Hotel for Nanaimo, BC
Thurs Dec 5 – 9:00 AM (PST)	Tour of Cascadia Nursery – Nanaimo, BC
Thurs Dec 5 – 10:30 AM (PST)	Depart for Port Alberni, BC
Thurs Dec 5 – 1:00 PM (PST)	Tour of Cascadia Processing Facility – Port Alberni, BC
Thurs Dec 5 – 2:30 PM (PST)	Travel Back to Sidney, BC (~ 3-hour drive)
Fri Dec 6 – 10:00 AM (PST)	Meet with Industrial Plankton™ - Victoria, BC

manufactured by Industrial Plankton™, that will allow the development of research techniques using seed replication and seed banks. Besides the research and industry partnership, the group is involved in an educational initiative, as they contribute in one of the college's programs, "Trades, Apprenticeship & Technical", "Resource trades", "Seaweed Production and Processing".

The visit to Cascadia Seaweed started with a meeting at their office in Sidney, BC, with Cascadia's chief scientist Dr. Jennifer Clark and CEO Michael Williamson, for an overview of their story and current operations and followed with a visit to one of their aquaculture sites at Saanichton Bay. They manage their sites in partnership with some of the First Nation groups and, as a commercial initiative, they use an

array system for their lines, being capable of seeding long distances and a high number of sugar Kelp seeded lines in a single operation. Jennifer Clark also guided a visit to their seed production site, that operates in a recirculation system built with insulated fish transport tanks. With this setup they can produce enough seeds for their operation using spools dimensioned to their outgrow lines optimizing the transfer process. They also keep a seed culture for future research and development of their seaweed nursery.

At their processing plant, located in Port Alberni, BC, they grind the harvested sugar kelp and transfer it to fermentation tanks with water at a 1:1 proportion of water:seaweed. The seaweed:water mixture is heated to 65° C by a hot water coil recirculating system, and takes approximately one week. The liquid is separated from the solids using a wine press, pasteurized, cooled and stored in sanitized intermediate bulk containers (IBC) that are shipped to customers in the USA as a biostimulant for agriculture. The solids are dried and used for animal feed products.

The British Columbia mission ended with a visit to Industrial Plankton™ manufacturing site, guided by Robert Roulston, Founder (CEO). The company produces automated bioreactors for micro and macroalgae. Their equipment for gametophyte (kelp seed) replication provides a controlled and monitored environment with low risk of contamination, making it a good option for strain selection, seed bank, and biomass production for direct seeding. In this process, seaweed spools or lines are prepared with developed, reproductive gametophytes instead of spores. The main advantage of this approach is that it eliminates the requirement to source mature seaweed for reproduction, as the replicated and stored seeds can be made available outside the regular reproduction season.

5.2.3 Nova Scotia and Prince Edward Island

The mission to Nova Scotia and Prince Edward Island took place in February 2025 (Table 3). Three MI representatives participate in this mission including Dr. Heather Burke, Dr. Juran Goyali and Dr. Rafael Sabioni.

The mission in Nova Scotia started with a visit to one of the labs of the National Research Council, in Ketch Harbour, NS, guided by Dr. Stephen O'Leary, team lead for Algal Genomic and Synthetic Biology. The lab is equipped with experimental bioreactors, tanks for seaweed nurseries, incubators, processing equipment and analytical labs. The group is conducting research in microalgae biomass culture and seaweed reproduction, replication, seed production, genetics and seed banks. The group is currently working with private sector and government on the development of commercial and conservation aspects for seaweed species like Sugar kelp (*Saccharina latissima*), Irish moss (*Chondrus crispus*) and *Laminaria digitata*. Dr. O'Leary is currently focused on seaweed production using Industrial Plankton's red light gametophyte system and have established a seed bank for Sugar kelp.

In Lower West Pubnico, NS, the MI group met with Charlene LeBlanc who runs a small-scale seaweed hatchery, Leblanc Seeded Lines. The company produces Sugar kelp seeds to supply kelp seeds for local

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community individuals or groups interested in establishing kelp farms. Charlene also acts as a consultant for research and commercial hatcheries along Atlantic Canada.

Table 3. Itinerary for NS and PE knowledge transfer mission February 2025

Date	Activity
Mon Feb 17 –10:00 AM (Atl)	Meet with Stephen O'Leary – NRC Marine Research Station, Ketch Harbour
Mon Feb 17 – 12:30 PM(Atl)	Lunch
Mon Feb 17 – 2:00 PM (Atl)	Drive to Yarmouth, NS
Tues Feb 18 – 9:30 AM (Atl)	Depart Yarmouth for Pubnico
Tues Feb 18 – 10:00 AM (Atl)	Meet with Charlene LeBlanc – Leblanc Seeded Lines
Tues Feb 18 – 12:00 PM (Atl)	Lunch with Charlene
Tues Feb 18 – 1:30 PM (Atl)	Drive back to Yarmouth, NS
Wed Feb 19 – 7:45 AM (Atl)	Depart Yarmouth for Pubnico
Wed Feb 19 – 8:30 AM (Atl)	Meet with Wyatt Gates – Tidal Organics
Wed Feb 19 – 10:00 AM (Atl)	Meet with Andrea Ward - Acadian Seaplants
Wed Feb 19 – 12:30 PM (Atl)	Lunch
Wed Feb 19 – 2:00 PM (Atl)	Drive to Halifax, NS
Thurs Feb 20 – 10:00 AM (Alt)	Meet with Shannon Arnold – Ecology Action Centre
Thurs Feb 20 – 12:00 PM (Alt)	Lunch
Thurs Feb 20 – 1:30 PM (Atl)	Depart Halifax – Drive to Charlottetown, PE
Fri Feb 21 – 10:00 AM (Atl)	Meet with Stacey Goldberg – Phyco Technologies
Fri Feb 21 – 12:00 PM(Atl)	Lunch
Fri Feb 21 – 1:30 PM (Atl)	Meet Magdalena Mahlstedt - CASTL
Fri Feb 21 – 2:30 PM (Atl)	Depart Charlottetown for Halifax Airport

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The mission continued with a visit to Tidal Organics, in Pubnico, NS, Guided by Wyatt Gates. The company processes wild harvested Ascophyllum nodosum to produce kelp meal, used for agriculture and animal feed. The company relies on lobster fisherman to harvest their seaweed. Upon receipt at their processing plant the harvested kelp is ground/chopped, dried using a customized drum drying system, cooled, milled, classified by particle size, and bagged. The milling system is equipped with inline magnets to remove metal contaminants. The production line can process approximately 8000 lbs of wet seaweed per hour.

In Charlesville, the group met with Andrea Ward, Cultivation manager at Acadian Seaplants. The company runs an inland Irish moss (*Chondrus crispus*) aquaculture. Using their own strain, they replicate the seaweed and induce the first vegetative grow in greenhouse tanks with fertilized saltwater and move them to finish growing in bigger outdoors tanks. The product is dried using a proprietary method to produce three different colors, red, yellow and green. After drying the product is milled, size graded, visually inspected and bulk packaged for export to Japan for niche food markets. The company is also developing cultivation and process for dulse (*Palmaria palmata*).

Prior to departing for Charlottetown, PE, the MI team met with the Ecology Action Centre in Halifax. The Centre has a nursery license for Sugar kelp and produces about 8000 tonnes annually which they sell via a fish monger to the local industry for research and commercial use at a price of $4.50/lb fresh. The Centre has partnered with Dr. O'Leary, NRC and Dalhousie University to optimize its nursery operations. The goal of the Centre' seaweed initiative is to use its farm as a means of educating industry and supporting commercial kelp production in NS by determining the economics of farming and processing seaweed while providing access to raw material for entrepreneurs as the industry develops. Currently there are no commercial ocean-based seaweed farms operating in NS.

The mission concluded with a visit to Phyco Technologies and CASTL in Charlottetown, PE. Phyco Technologies is a start-up company founded by Ranah Chavoshi and Dr. Stacey Goldberg. Their goal is to replace plastics currently used in the agriculture industry with a viable seaweed-based alternative. The MI team met with Dr. Goldberg to discuss their research, development and scale-up needs, and how MI might be able to assist. Dr. Goldberg expressed interest in further discussing potential collaborations with MI, as well as connecting with NL based seaweed farms such as Holdfast NL, for assistance with product development and scale-up, and raw material supply. CASTL, the Canadian Alliance for Skills & Training in Life Sciences, offers customized training for Canada's biomanufacturing industry. At their Charlottetown facility the MI team had a chance to meet with Magdalena Mahlstedt, Director of Training, and tour their training facility. This type of training and facility will be helpful for commercializing seaweed bioactive extracts such as those discussed by Dr. Deepika Dave (MI) and Courtney Howell (7 Fathoms) during the October 2024 Seaweed Culture Workshop.

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6 DISCUSSION

6.1 Seaweed Forum

Seaweed aquaculture is a relatively recent development in North America. Interest from various companies in Newfoundland to establish seaweed farms on the island has led them to collaborate with the Marine Institute's Centre for Aquaculture and Seafood Development (CASD). This partnership focuses on research and development related to seed production, site design, seeding and growing, harvesting, and processing of cultivated seaweed. The progress made through research and outcomes from local experimental farms has sparked interest in connecting with other seaweed researchers and commercial producers to exchange knowledge and experiences. As a result, the Seaweed Culture Workshop was organized, funded by DFFA and CCFI, and took place on October 8, in conjunction with the 2024 NAIA Cold Harvest conference.

During the Seaweed Culture Workshop, both presenters and participants engaged in discussions on the development of seaweed culture throughout Canada. They also took part in a facilitated strategy session to analyze existing gaps in the industry. The workshop brought to light several challenges that the Newfoundland seaweed industry must address as it evolves:

- Limitations on harvesting wild seaweed; Fisheries, Forestry and Aquaculture (FFA) remains unclear on licensing processes.
- Transfer permits are required, preventing movement of seaweed from one area to another due to biosecurity concerns.
- Regulatory reforms will be essential, necessitating collaboration with the FFA, Department of Fisheries and Oceans (DFO), industry stakeholders, and academic institutions.
- Establishing a commercially viable industry will require several years of development.
- Significant gaps exist in seed supply, genetic resources, reproductive techniques, and on-farm production timing.

Several opportunities with significant potential have been identified in the following areas:

- Production of biostimulants along with stability studies and animal feed applications.
- Development of regenerative aquaculture practices, including sewage treatment, nutrient sequestration, and validation efforts.
- Establishment of a seed bank, potentially located at MI.
- Involvement of two to three MSc students to concentrate on reproduction (seed supplies) and biostimulant/animal feed assays.
- Creation of small in-situ hatcheries/nurseries, accompanied by related training programs.
- Development of cascading biorefinery models for full utilization and value maximization.

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6.2 Knowledge Transfer Mission

The knowledge transfer mission was of great benefit for technical personnel of CASD to better prepare them for project work supporting NL seaweed industry development. Specifically, in nursery technology, harvesting technology and site selection, as well as processing and storage techniques, and new product development. This mission allowed the CASD team to visit and connect with most of the current groups/individuals who are active in seaweed research and production in Canada, as well as Greenwave in the US which is one of the most important seaweed companies globally. This played an important role in the evaluation of the work CASD/MI has done so far and provided valuable information for the development of future initiatives in the province.

While interacting with and fostering relationships with Canadian companies and counterparts in the industry, CASD has created new opportunities for collaborative work to compare techniques used in different ecosystems and ocean conditions (e.g. east coast vs west coast) to optimize industry outputs, and to understand the opportunities and challenges related to handling, storage and processing of freshly harvested seaweed.

To have an in-depth and in-person view into Greenwave's and Cascadia's operations was very useful. It provided a better understanding of commercial site set-up. After working with various NL partners over the last three years and helping to develop experimental seaweed sites throughout the province, it was great insight for MI personnel to see the commercial line systems and seeding methods used in different geographical areas.

MI has used Greenwave's methods and procedures available from their online platform to develop what is now our nursery here at the Marine Institute. The MI nursery platform is currently being used for Holdfast NL and other local seaweed companies. Seeing Greenwave's and Cascadia's operations and learning about how they have developed over time gave important insight into next steps for improving our own nursery and to create a strong seaweed aquaculture industry in Newfoundland. For example, learning how Greenwave, Cascadia and NRC manage their gametophyte stock will facilitate the creation of a seed bank here in Newfoundland thus providing the backbone to a strong seaweed industry in the province.

Having the opportunity to meet with and tour various seaweed processing facilities (e.g. Dried kelp, biostimulants, biomanufacturing) has provided insight regarding scale-up and processing challenges, from both a technical and business development perspective, that will need to be considered as the industry develops in NL.

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7 CONCLUSIONS & RECOMMENDATIONS

The NL Seaweed Culture Workshop marked a significant milestone for the NL seaweed industry bringing together key stakeholders from across Canada to discuss successes, challenges, and opportunities. Key takeaways from the workshop include the necessity for regulatory reforms, a deeper understanding of the life cycles of various seaweed species, and a comprehensive grasp of seaweed markets and the complete value chain. Government funding must align with the seasonal timing of operations, and securing financing and investment poses a significant challenge and takes time. Scaling up operations from experimental to commercial stages and fostering a viable market is important, along with prioritizing investment in primary production over value-added processes — securing biomass is vital for market access, as wild harvests cannot always meet demand, highlighting the need for farms to ensure supply. It is crucial to effectively communicate the benefits of seaweed farming to the public and promote the benefits of the industry to build public trust.

Additionally, monitoring the waters of NL for species identification and genetic mapping is essential, as this can inform where to collect and cultivate seaweed. Establishing nursery sites adjacent to farm locations is a critical step for farming operations. Developing a seed bank to reduce dependence on collecting mature sori tissue, which is often unreliable, is also necessary. Furthermore, we need to clarify the products we aim to produce and assess the available or missing infrastructure and equipment. There should be a focus on cascading biorefinery models to maximize utilization and value of the raw biomass. Marine bioactives from seaweed and their health benefits is a promising market which should be further explored.

Research institutions can play a key role in addressing climate change issues, genetics, seed supply, product and process development. Small scale nursery facilities and pilot plant processing facilities are available at various institutions such as the Marine Institute, Verschuren Centre, NRC Ketch Harbour Marine Research Station, Merinov, and North Island College.

The various site visits conducted during the knowledge transfer mission have opened the door for strong partnerships and collaborations between MI, NL seaweed companies, BC seaweed companies, Atlantic Canadian seaweed companies, Canadian research organizations and industry associations, as we all work towards a common goal of building a sustainable seaweed industry for Canada.

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APPENDIX A – SUMMARY OF WORKSHOP PRESENTATIONS

October 8, 2024

Started on time - introduction by Heather and housekeeping

9:10-9:30 Cyr Couturier Canadian Seaweed farming: Recent Advances Towards commercialization

No questions ran over on time

Made a friendly reminder to the audience (including DFO) that DFO still doesn't have anything in place for seaweed licensing and regulation.

9:30-9:50 Mark Smith (PSIA), Pacific Seaweed Farming: Opportunities and Challenges

Theme: intersection of ocean health, truth and reconciliation and economic development

- From a Canadian perspective, speaking to spaces outside of Canada and what happens in the EU
- Excitement and potential but the business needs to be productive
- Financial sustainability important
- Not just food market, where are the new markets?
- Carbon story
- Radical balance, carbon credits in Alberta agriculture interested in seaweed, did a little study
- Example: BMO now called BMO Radical after a buy out. In 5-10 years going to be a part of the lending criteria as part of financials in the carbon market
- Regulatory challenges in BC like capacity. Currently 38 licenses in backlog as long as 14 months
- NIC microcredentials are a great step forward
- But issues getting farms in the water on top of skilled workforce
- Access to the water in indigenous areas - Social license
- Example: Scotland, went ahead without any public consultation and people got quite angry, need to be socially aware and education the population that will "interact" with farm sites
- Infrastructure: lots available platforms and timing that can be integrated with other activities on the water
- Seaweed Industry Development Plan on pause because the industry is still too early in development
- Globe and Mail article, Global affairs Canada declared support to industry to Mark (unnamed)

Q: Michael Teasdale: They went through 2 rounds with 2 species 20 years ago, what is the trick to cutting that timeline in half, so we can do it faster this time around?

A: Cyr Couturier: Wait to see what Bill Collins (Cascadia) is going to say on the development innovation cycle. Development was 1- 15 years for mussels but then got together and within 10 years had a viable industry. Visiting lots of people looking at the markets and making it shorter in about 10 years. Growing seaweed means different species so there are issues there from a regulatory perspective. 3 species of laminaria in NL, but not great tools for identifying it, which will make regulating hard. So have to work with DFO to look at the barriers. Food or other product within a10 year time period.

Requires private investment and that will take a while, we saw this in Maine with the lobster guys doing seaweed, took 15 years. Greenwave had the same issues as in Scotland and Ireland. Issues with the public need to be a big part of the conversation and planning.

A: Diane Hollett (NL Seaweed Co): One of the ways we can shorten that timeline, is to embrace different types of knowledge and schemes. Laura and I are working on seeding capacity.

There is a woman in a garage supplying seaweed to industry and she has developed her own knowledge. 2 eyes seeing and indigenous knowledge. Package research knowledge and nonacademic knowledge and sharing. Reinvent how we build and shape knowledge, it's out there for us to take. A lot of learnings out of Scotland and debate between wild harvest and farmed. We know wild harvest can be a fraction of growing so as we move forward with a strategy we need to embrace both aspects because there is a market fit for the both of them.

Understand the benefits of the history, $0.06/kg cant cultivate for that price.

Have to grow with our regulatory partners.

DFO revisiting mechanized wild harvest, hand cutting is more difficult.

Open mindedness is important here.

9:50-10:10 Bill Collins Cascadia Seaweed, The economics of seaweed farming in North America

- Opened with a shoutout to MUN, and acknowledging the great students and skills coming from its programs
- I hope to help you Understand the economics of seaweed farming to enter the fray with full knowledge
- The 6 year journey and the innovation of Cascadia

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- Kelp highway in BC, community access to nutrition
- Net positive for the ocean
- Academically there are studies that show marry cultivation with knowledge gain, quantifying impact on the ocean
- COP16 - biodiversity is a priority
- Kelp is a critical component of the ecosystem
- There is money to be made, but dependent on wild harvest, you get what mother nature gives you
- New geographies and opportunity for new products
- Cultivation is a way to discover new products, innovate and educate the markets
- Gave a Cascadia history
    - Partnering with first nations, people with the right knowledge to allow the business to prosper
    - Uses foam filled floats
    - Production footprint is the key
    - Value chain perspective, where can we extract knowledge from those before us, back in the 80s to create knowledge so a seaweed sector can start, a long chain
    - After the first 6 million dollars, switch from the food market to the agricultural market (not a market in Canada and would take too long to change consumer habits)
    - Pay attention to the numbers "soul destroying"
    - Went through unit economics slide with some stories for each line
    - First farm sites and seeding and harvesting tries over the year
    - Timing issues
    - Stock piling and costs of storage of product
    - Massive fluctuations in the carrageenan market
    - $25K per HA
    - $50k per HA now budgeting
    - Using ropes and anchors not enough, have to have the right gear to handle the environment and weather
    - 10 kg/m business model, but working with 3 kg/m working on getting that up
    - Liquid kelp extract main product and dry for animal feed
    - $5-7/L product price
    - Registering products with CFIA takes 260 days or 6 months is realistic, expensive and time consuming. Way different in the US which is way faster and why we are selling into Wisconsin currently
    - Animal feed additives (been around a long time) registered as a whole meal dry kelp, people have had their animals graze on the beach for ages

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- Starting to see funding come through from the farm side and mention the wet biomass strategically to not engage DFO on the negative
- No guarantee of supply and generate the biomass for the market in NA
- In the states moving up in the market and going after larger distributors that sell stuff and there is space in the middle market coming up
- Unlimited supply (context of EU) beautiful waters in the Atlantic Ocean, 25000km coast in BC
- Exploit the right areas in the right way, improve AQ in general, employ people and use the environment responsibly
- Provide access with different species that have different benefits
- Can do that with cultivated seaweed
- Cattle, health benefits on top of the methane reduction, higher productivity reducing the carbon footprint
- Innovation in harvesting needed, special harvest vessels
- BC Macrocystis issues, make mats and cant access farms to harvest
- Average global production: 8 tons/HA
- Breakeven 20 tons/HA to come
- Market taking it seriously is the biggest challenge
- Every Californian farmer uses seaweed on veggie farms currently, a business opportunity for US market
- Social license and community education

10:10-10:30 Logan Zeinert (NIC), Seaweed product development and processing considerations

Asked the audience who is a grower/producer and asked what products they are producing.

- *Diane: seaweed food products, pantry basics line dried kombu into the market, had enough biomass for R and D so while we accumulated stock and had extra, a little segway with a little*
- *Mike: almost by accident, getting interest from cannabis companies, working with biostimulants with a cannabis company with a license for R and D*
- *Courtney: advanced skin care products at the cosmetic level and therapeutic side and functional foods*
- Look at some BC products including Cascadia products
- Moving forward something that is going to be important, is the new products and extractions that have high value
- Use of the whole plant after blade is used for production, lower grade products like the holdfast and stipe
- Drying, freezing, fertilizer, biostimulant

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- Harvesting window and processing logistics
- Expensive but smaller costs with drying and cheaper storage costs and good shelf life, and easy transport 10% of wet weight, batch store and use for later processing
- Sun drying outside as an option depending on weather with other options to dry indoors or industrial dehydrators, to flake or powder
- Regulatory considerations: CFIA has rules, monitor humidity and keep at a certain water content to prevent pathogens and bacteria
- Freezing: in blocks but expensive long term, paying for power and the space within a freezer company, still wet 90% water and is heavy
- Especially in NL that infrastructure is in place, lots of seafood processors around in NL
- Long term storage is a limiting factor
- Down sides, can be degraded when the cells break and it loses structure, not as high quality, caveats to food product production, cold transport is more expensive
- Blanching, salting and freezing in nice cubes, smoothie cubes
- Blast chilling before -18 storage
- Brining - long term storage and preserve most qualities is an option, room temperature
- Good for extractions of high-quality products later, 40% salt by weight and volume
- Different blends and chemicals to preserve as well
- Good for nutrient extraction and the quality is not compromised
- Depends season to season year to year and what the make up of those products are
- Similar caveats with storage but doesn't need temperature control and good shelf life once its stored away
- Fertilizer fantastic for anything at all levels of quality products, any fouling on the seaweed at harvest are not a huge issue and can be included, opposite of nutrient extraction which is a low yield, fertilizer is a higher yield
- Can create this product from any part of what comes off of the farm
- Leftovers and lower quality harvest can still be used so there is no wastage
- As simple as juicing the plant
- Fermenting the kelps using a bacteria to break down the kelp, and can be done at different scales
- Need controls and monitoring during all processes to ensure quality is maintained
- Traceability is important for consumers and product tracking
- Need nutrient profiles especially for food products
- What are the MPK ratios for fertilizer
- labeling - greenwashing or blue washing, don't want to mislead the consumers
- What is your product going to be and what is your process going to be

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NUTRITION BREAK

10:50-11:05 Rafael Sabioni CASD, Starting seaweed aquaculture in Newfoundland

- Potential in NL, the area, the people and the interest from the industry and why we started looking into starting the research with the culture
- How I started… first week at the lab and Rachel had high enthusiasm with the nursery
- First step is understanding the biology of the species and lifecycle and everything changed when we moved from the classic to the local life cycle
- Process of spawning and nursery activities and developing the procedures
- Can we develop a nursery? and we did, had issues with one because of ectoparasites and is part of the learning process
- Through the literature, spools are taken to site after 4 weeks, but we were more like 5-7 weeks before bringing to sea
- List of accomplishments to dates with projects to harvest
    - 1-2 tons/km line harvest
    - Adjustments we need to do mainly on the spore concentration for seeding, we don't have consistent coverage, still need to adjust
- Challenges/opportunites:
    - Find mature seaweed, not always consistent, location and timing, licensing and processing because we are producing a lot of seaweed even though it is experimental so there is more research needed on that side. Industry is looking for answers, but we need time to do that and do it properly
    - Trying other species as well right now, with seed incubation
    - Provincial money for nursery upgrades for more experimentation
    - Tech transfer is very important
    - Ideally need to have nursery tech to a site closer to the farm site
- Something else we are thinking about is that is very important is a multi year project involving monitoring and species ID and genetics and risk assessment
- Biggest concern is transferring things on genetics and AIS side of things
- Ideally we need to start this on the next season but we need collaboration and partnership to make that happen

11:05-11:20 Mike Teasdale (HoldfastNL), NL Industry Perspective: HoldfastNL

- The pieces in place to work with the industry, people on the water, infrastructure is in place, the fish plants, all the technology hubs to figure this stuff out, the place, the cold water

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- It makes perfect sense to develop this in NL
- This is not the first time we have tried it here, 100 years ago, not a new thing, it makes sense to do it here and now
- Progress needs to include social license and permitting
- Timeline slide - 2019 started researching and talking about it and in 2022 talking to Bill, and got something in the water
- Talk to local fishers, got some funding and licenses and a bigger project last year and now doing a commercial license this year
- "Blindly running ahead"
- Keith local fisher - they know what to do and the area, they are great people to have on board, they can communicate to the rest of the community
- Can see the wheels turning that the work is pretty basic and is doable for locals and with their vessels, etc. 1st round just vertical lines
- Water stays colder for longer so less biofouling means we might have a longer season, June great, August far gone
- 2nd project did the horizontal lines and 2 rounds and we got 2.5kg/m
- Learn a bit more every round so getting better and better, waiting for grants just to get it going and hoping it works
- Another lesson learned, working in the basement, just to rinse it wasn't a good idea
- MI has key facilities to work on processing and everything
- Greens seafoods sea cucumber drying facility which is very seasonal and is looking for more work for the equipment so tried blanching and drying it
- Trying to do extractions with a student, took some of the dried seaweed to look at it all, different fermentation and extraction techniques
- Back to the history thing that we've been putting seaweed on farms and gardens for 100s of years hormones and amino acids as it stimulates what the plants needs, already using these things and how to turn things into a product
- Doing some pot studies to look at growth
- Social licensing a big one, a year before we put anything in the water, went to the local committees, inshore people, lobster guys, near and on their grounds.
- Talk about the plans and look at the nautical charts and discussing it, while also explaining how a farm works
- Got them engaged and on side with a local guy to do the boat stuff
- Scallop draggers fell between the cracks without committees, static nonmoving fishers like lobster in contrast to draggers that don't have a stationary spot to so have to work with them to make sure you can work with them
- Commercial licensing ads in the paper post talking to fishers, what is this commercial farm

- Facility talk had to be cleared up based on issues with other places and users from the past
- Working through it and all part of the process
- Experimental license for the pilot and lots of different costs that come with that

11:20-11:35 Julia Pohling CASD, Primary/Secondary Seaweed Processing Technology in NL

- Processing in general food versus the biology and how it works in NL
- How to figure out technologies to get to the product they want
- Commercial equipment at small scale, quality and yield numbers
- Process to avoid spoilage, stabilize your biomass, have to have really good starting quality
    - Take away water, air and micro organisms
    - Primary and secondary processing
    - Timing from harvest
- Primary is straight forward, no extractions, secondary more complex where we create a final product, multi-step
- Steps of processing and bioprocessing
- Multiple techniques even at the simple stages and choose based on many factors
- Product specifications need to be considered with look, feel, taste and smell
- Extract is less exciting, liquid or dried need analytics required for purity and a goal that dictates the process you will need, including testing for heavy metals and contaminants
- So much processing technology out there, we can pick from that tech to make it happen
- Extract component of interest
- Importance of collaborating and looking at past work of all ages
- Can get in the literature but also through networking and talking about the things that might not be captured in the literature
- Experimental processes are expensive and need lots of product to work with
- High focus on the planning to make that happen, the baseline needs to be done right to set up for success
- Minimize chemical loss and cost to simplify the process to stretch the dollar as best we can
- Highlighted what the Center does and its capabilities

11:35-11:50 Deepika Dave CASD, Extracting Seaweed Bioactives

- Bioprocessing the main theme
- Went through the 3 types of seaweeds and how many species there are
- Biochemistry background including compounds that are within the seaweeds

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- Different applications: what to look for as it applies to the market you are interested in getting into
- Biomedical industry has lots of opportunities
- Agriculture biostimulant – great for soil life, root development,nutrition uptake of the plant and nutrient composition of the plant
- Animal feed is also an option because it has the prebiotic effect, vitamins and minerals and animal health overall, and reduces the need of antibiotics while increasing the uptake of vaccines
- Vegan and vegetarian, no major allergens, no dairy or gluten
- Presented on a list of bioactives in general seaweed categories
- All seaweeds have antioxidant qualities
- Carotenoids
- Presented a schematic for benefits to humans and animals
- Developing the model to look at the different species, and how we can look at the bioactivities and how it can be used for animal and human health
- All Atlantic species
- What the facility can offer and do with it
- Can extract the biotic components
- Using green methods and less chemical methods so are more environmentally aware
- Work with the clients on harvesting and processing to improve the raw material so it's in good condition for the lab procedures
- Extracting each and every molecule, isolation, categorization
- Sugar kelp methods, drying, freezing and HPP
- HPP and the chemical composition doesn't degrade some aspects as much
- Lipid and freeze drying has the highest phospholipids than HPP
- Organic biostimulant project ongoing, looking at how it can be beneficial for the agricultural sector

11:50-12:05 Courtney Howell (7 Fathoms), NL Industry Perspective

- Chronic skin condition relation and what 7 fathoms does for people with issues
- Story of how they discovered the digitata and dermatology help, resulting in improvements to quality of life
- Dive into the science
- Extracts and benefits for many ailments
- Lots of testimonials

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- Challenging skin conditions and remedies
- 3 products on the market and more in development
- Gut health and auto immune conditions
- Sustainable harvesting techniques
- On track to double sales this year
- Industry growing and poised for growth
- Continue sales increase and developing new products
- Marine bioactives and health
- Resilience of coastal communities
- Exciting new frontier for Atlantic Canada
- Mission chronic inflammatory conditions, improving health outcomes and eager to explore collaborators and others sharing mission for a healthier future

12:05-12:20 Gail Hoskins and Chris Hendry (DFFA and DFO)

- DFO and FFA Perspectives
- *Chris: Fisheries act and regulations: how DFO deals with that at species and sector level*
- Sea plants are not fish and not captured in the fisheries act
- Operator, not a lot of change from applications to the province and deliberate with DFO and FFA, fishing activity, fish and fish habitat
- Movement issue: introductions and transfers system, authority for moving kelp from place to place, challenge is that there is still an interest in the movements, AIS risks, Green crab reference, DFO needs to prevent that, but our legal authority is limited
- If you do it and your found out then there are repercussions but has to get caught
- Wild harvest: condition for marine plants for wild harvest in the fisheries act, authority to issue a license, require the application, methods, location and biomass collected
- Not a lot of a perspective, want to work together and protect and prevent
- *Gail: Brief overview of the licensing process*
- Lead regulator in the province for all aquaculture licensing
- Work closely with DFO and looking at applications together
- Ensuring that all regulatory items are captured in the provincial system
- Single point of contact for applicants as well as other agencies we work with, the applicant knows where to go
- Very coordinated and streamlined and officers to take care of it
- Manage under the provincial aquaculture act, updated fall 2023 and just finished a review of the regulations and out in 2025

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- How is this going to affect the processes? but we want our legislation to match up with everything else
- Timing is perfect for seaweed, when 2019 was developed it was done for finfish and shellfish, plants are not included there.
- Areas we want to work with the group on:
    - Require a complete application, lots of requirements and making sure nothing is omitted
    - Encourage people to start consultations with the public right away
    - May take up to a year to get a commercial license in NL
    - Non commercial license can be done quicker and within a couple of months
    - Internal review and external review which might take up to 30 days
    - Then make recommendations that go up to the minister
    - Validation every year that need to be kept up
    - external : environment and climate change, tourism, municipal affairs, federally transport Canada, DFO and environment and climate change Canada
    - FFAW, industry association, etc. so can take time
    - Excited as a department as seaweed industry develops
- Multispecies development strategy developed
- In 2023 to allocate 1.5 million for the strategy and a number of things to pull this together
- Field work 3 years in areas of interest
- Old abandoned sites, and internal map and focusing on some of those areas for people
- Funding program in place, to help with non commercial development, species of interest including seaweed
- Did research with other jurisdictions and what they did with regulations
- Updating live document to help ID sources, conferences, has been shared

Let's get all attendees on that list from the meeting

- Added a schedule for marine plants and all data will be available online
- Some focus in Fogo and other areas, Southwest coast, St. Mary's Bay and West coast
- Other work with the aquatic animal health work
- MSRDF fund advertising
- Finfish incident was the reason for the update in the policy where plants was added
- Variance process

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- Guidance document for applications, but not for seaweed so that will be worked on going forward
- AIS issues at the forefront
- This is an exciting sector and refreshing and when I hear about different companies

12:20-1:00 Lunch Q and A Session/Panel Discussion Logan moderating in Keith's absence

Panelists: Bill (Cascadia), Mike (Holdfast), Marie Eve (Merinov), Gail (FFA)

Question #1: What are the opportunities?

Mike: biggest opportunity, I think we have all the processes in place to develop the industry here in NL, we have the people, the infrastructure and the space

The big issue and concern is how to scale it up and how to get into the markets, the chick and the egg issue. Making those things line up and you need a lot of help from funders, government, and private investors. Lots of opportunity and is the most sustainable ways to grow biomas end of story, how to you turn that into a viable market

Bill:

Sell, sell, sell, have to have product, if you don't have the raw biomass you have to buy it. Looking at trends in the next 6-8 years in the value added, Oceania has their input price at 20 cents a wet kilo to make the model work. Have to turn to growing and can we get the economics to scale and the value add will come. Lots of opportunity there, raising capital for impact is really challenging. Convince investors to the primary production not the value added then we will have more opportunities.

Marie Eve: Tell investors that climate change offers places and temperatures to grow seaweed is quick and is not as high of a risk as for mussels, initially mussel sites can be used, less ice, longer growing season, to make a good industry out of it, climate change overall bad but some opportunities

Gail: Collaboration piece

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When we leave here today what is the plan? We might get into some of that this afternoon

How do we really pull all of that together so we can move it forward? The department is going to work with you but it has to come from the rest of us, time and people.

Make that collaboration happen after today.

Question #2: What are the challenges?

Gail: Perception of what aquaculture is, we see what is happening on the west coast, negative perceptions in some places. We work closely with companies and want to make sure there is a focus on the perception and improvements over time. There is a lot of negativity and a lot of the good things aren't getting highlighted, like employment for example. How we can change that? It's very difficult. Sometimes the voices are small but also have power. We have to be powerful with our message at this development stage. Pioneers of the finfish industry, on the south coast wouldn't be populated now otherwise. Communities are thriving and makes the difference and that's what we should be promoting. For me personally every opportunity to promote the industry that's what we need to be doing

Mike: I would say that, timing and the rates of things should be sped up. The timing of the funding doesn't always line up with the timing of the seaweed growing. Results aren't always timed right. The permitting is on an odd schedule too. I look at it as, how it was in world war 2, overnight things changed and things bombed and turned factories to build bombs, because there was a crisis at hand. There is global warming and we need to change our food system and sustainability and we all know what is going on with corn and soy, it's not the way of the future and we all know it. How many people died in the hurricanes last week. Business case, it shouldn't take 15 years, let's all get in and pool together and get it done faster in reaction. A big problem and I think that is how we should tackle things

Bill: I would say financing, we just completed a series A round and over the last 2 years is unheard of in the natural sector, so should give some momentum to the west coast

80% of that investment came from outside of Canada, Canada is risk adverse. Diversify from where you are going to get your money. 151 no's from the investment capital. Came from impact and patient capital. Build the individual elements of the value chain, break it down, de-risk it for investors, don't be afraid to go to Asia, EU or the US. Climate change is a risk not a reward for most of those people

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Question #3: What is the role of industry, government, and academia in moving the industry forward

Marie Eve: Research and academia can tackle climate change side of things, what are the right timings and adaptations so make them more efficient for marine waters, study the reproduction and hatchery for species on top of other species to be ready for warming waters, genetics and hearty species. Research centers are there to answer the industry needs and questions, we are there to back them, we have scientists. Regulation could help guide that, to help speed things up. NS municipality did a few of those steps, started the process of the lease before the industry, municipality got a pre-approval for the sites ahead of industry. Collected the data ahead of time to help speed up the application process. Taking insight from industry in preparation.

Gail: I think that there is a lot of things govt can do to push the industry forward, 20-30 years ago with finfish, lots of money for research and capital so it would be great to see. Other government departments have programs in place for those kinds of things. I think for seaweed our little150k won't get very far, but the industry does need resources. As government we should be doing more to support that, and the other role we have is to work with everyone and there are areas we need to do better in, talk to people about policies. Can't review in isolation and we want to see it happen and the opportunities for communities. We can improve the timelines and some of our processes and we hope that will be what we focus on and actions completed. Seeing some growth.

Mike: At your retirement party and now we are the biggest seaweed producers in North America

Floor questions:

Iian McGaw: Teaching the aqua course at MUN, touching on many species. One lecture is seaweed and they all come up and start talking about it and looking for where they can buy it and eat it. Young people there is at least excitement as a new food and does good for the environment and is sustainable. What is there to market and education to the general public and

Education program so people can interact with seaweed?

Bamfield seaweed days etc. in BC

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Gail: We have been involved with NAIA promote with them the species so we can add in seaweed. There was an aquaculture 101 in the k-12 system, Micro credentials, UPEI seaweed food competition, EAC event kelp curious event for the food side of things as part of a festival

Marie Eve: Still a market for food but that is a campaign for it to increase the knowledge about seaweed as a consumable, local good for the environment

When i was young, milk ads that pushed by industry for strong bones

Still concerned about the health side of things that need to be monitored, complications and the fluctuations that come with those products

Laura: "Poking the bear"

Bill I was interested in the statement of 80% investment is outside of Canada and that is a result of our government?

Bill: It took us 6 months to raise 500k at first and then went to the government and said it is going to be big, minister of agriculture, environment and fisheries, lots of discussion around the table. What they said, we are in (not with much money) but senior discussions, 2 years past and then talked again with the minister and she said I've been talking about it, and the conversation went stale.

Getting the timing right so the general public and industry are interested, people want jobs, and the time is right, we need to put the pressure on because the world will pass us by otherwise

1:30-1:45 Tim Webster (NSCC), Topo-bathymetric lidar to map wild kelp in support of seaweed aquaculture operations

- Remote sensing technology to try and do kelp mapping funded by NSERC
- Canada's smartest kitchen holland collage
- Lots of stories coming out that will help the public understand things
- Lidar technology, topo-bathymetric lidar, only academic institution that owns one of these things, lasers that penetrate the water and can measure what is there.
- CNA partners
- Returns to identify seaweed

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- Sea grass and other species and now on to deeper kelp
- Acadian sea plants, worked with them who process rockweed, can we map that so we can get a good biomass estimate at low tide, but want to know how thick it is
- Survey at low and high tide for comparison purposes, super thick areas
- Worried about how thick it is so have to get down to the bedrock
- Published work in something Britannia
- How to support the wild harvest
- Cascadia seaweed supported the project and people at Holland Collage in the food side of things
- We do our own ground truthing
- Photography and bathymetric modeling, on the land lots of things work in the terrestrial world, in the ocean bottom mapping is good, but the shallows is tricky so this tech is good for that
- Bottom typing as habitat for seaweed, sand versus bedrock, gravel etc.
- Lots of machine learning involved as wel
- Has tried to map out different species of kelp, tricky to distinguish between species. But can do kelp from fucus or from sea grass
- Actual cross section of the bottom and canopy thickness of vegetation can give a better estimate on biomass in addition to coverage
- Thin coverage can't send back the 2 signals needed
- 2022 did work around the Avalon peninsula with Gangon
- 2023 did port aux basque and Mike's site
- Kelp was different in NL compared to NS, not much sugar kelp on the Avalon and more on the west coast
- Nice conditions in NL with clear water and good conditions
- Classified the coverage
- Also used a drop camera for ground truthing
- Bottom types matched up with what species might be in those areas
- Showed examples of Chance Cove and Flatrock in 2022/2023
- Haven't processed any of the newest data yet, presenting at the NAIA conference tomorrow
- Mapping wild kelp shows us where we can collect that broodstock and how well it is doing and what those site characteristics are like and if they are good for growing
- Less issues with the methods and this one is good, clear data and information
- Sunlight is not an issue and conditions need not be perfect for weather
- Thickness and area is a better biomass estimate system and watch urchin grazing as well

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Joyeeta Das, Samundra Oceans Limited Presentation cancelled

2:00-2:13 Dr. Sakira Kumari (Biolabmate), Biolabmate: Pioneering Seaweed-based bioplastics in NL-Innovation, Technology and Sustainability

- Bioplastics applications
- Reducing plastic waste
- Specifically, in medical and lab environments
- Stats of production and use in those sectors and staggering amounts
- Plant based solutions and wanted to work on it here in NL
- Biodegradable, easy to cultivate and harvest
- Seaweed was chosen because of the access and possibilities in NL and Atlantic Canada
- PCR plates and pipette tips, etc.
- Can be used with existing plastics infrastructure
- 3 sectors industry labs, academic labs and medical labs
- Providing an ecofriendly option
- Still a growing demand for plastics so there is an option for the seaweed industry
- Local support and coastal community involvement
- Looking for capital for expanding efforts, infrastructures for scaling, seaweed supply chain and collaboration in NL
- Lesley James Science advisor MUN, Gordon Slade advisor, Rina Carlini business advisor OIG group
- Won an innovation award from Econext and climate innovation

2:15-2:30 Ibraheem Adeoti (Holland Collage), Cascading Biorefinery of Seaweed

- Research at Holland Collage
- Seaweed biorefinery
- What is a biorefinery? How to do it sustainably
- Product range, its a big complex thing and could be more financially intensive
- From cosmetics to energy, biostimulants, etc. its more than that so we need to look at what approach we take to make sure it's a sustainable process
- If we are looking at traditional approach the focus is on single products but by applying more processes with chemical, physical, biological there is waste generation and not using everything you can use.
- With a cascade there can be more than one product from that process

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- Integrated processes, each step is different process and a range of products can be so vast.
- Cascade process the products can be done in a matter that is carried out without being detrimental to products
- Harvesting - Pretreatment - fractionation (extractions) - valorization (biofuel, biogas and biochar)
- This system like the old system needs the right products
- Objectives and objective products
- Its a no brainer, it would be the best way to go with high yield and create alot of product other than the traditional way
- Highly economical
- Less waste, getting the most out of the raw material
- Sustainability and makes it economically viable
- Seaweed cultivation is in the spotlight right now, with the climate change help it can offer
- Global perspective FAO 2021 cultivation data globally
- Increase by 3 fold, but it is something that is worth looking at and is an opportunity
- Availability of area for growing in different continents
- Asia has the dominance 97% on production, other areas are still evolving and interesting to see that it is still growing
- World Bank Global Seaweed New and Emerging Market Report 2023 looking really promising
- Circular economy of it all is very beneficial on top of the climate change remediation, clean energy, etc.
- Seaweed refinery research paper Ravi S. Baghel 2023 Chemical Engineering Journal
- Future directions
- Technology is still evolving and research has to come into place
- Knowhow, logistics and scale up
- There is also skepticism with risk and market investment etc.
- R and D opportunities

PSIA announcement: Canadian Seaweed Industry Network

- Friends at Oceanwise quote: formation and launch of the seaweed industry network
- mandate, connecting ideas, initiatives and opportunities
- Regional scenarios
- Seaweed association, and could all emerge and evolve
- Fully national network (not ready for association yet)

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- Thrilled to be up here
- Much more of an opportunity in the Canadian context the ecosystem is just too small
- We have all the pieces, and we need to put them all together
- Slide with all the logos of people who are involved in the new network
- Look for those companies and sector partnerships to try and fast track those things
- Bills comment with scaling up things
- Have to do everything concurrently together and we need to get started
- Lots of conversations but at the end of the day how to we execute that
- Who's who at the start
- List of companies and investors on the list (look at slide for full list)
- Oceanwise and seaweed initiatives and event in 2 weeks
- Seaweed colour pigment extractions
- HUB insurance - for industry clients to come to them, doing and agricultural campaign and integrating in aquaculture as part of that
- Coastal Computing
- Indigenous engagement sessions
- Canadian cosmetic cluster, beauty of the sea press release just out - chemical formulation challenge with a black box in Vancouver
- About conversations and collaborations
- May 4-9th international seaweed symposium
- Education piece from consumer awareness to OL to micro credentials and concurrently with other organizations with k-12 groups
- Inviting everyone to be a part of that conversation
- We need everyone in this room
- Would love to hear from you
- Starting up working groups for everyone to benefit from and mandate those working groups to have deliverables to move it across the country

3:00-4:00 Cyr Couturier Marine Institute: NL Strategy Session: Gap analysis and way forward-Facilitated Discussion

- Innovation ecosystem and cash for those things
- In NL Mike's question when we finally took on that initiative in 95 for mussels, scale up can happen pretty fast and you have to work together and have all stakeholders at the table
- Funders, etc.
- Micheal's timeline ambitions

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- Acadian sea plants example, 40 years old and been at it a long time and have diversified over the years
- Bill gave an overview of their project and we have heard today egg to plate what you have to decide you final market and the whole process and the value chain
- Gaps that we have, challenges and public perception and trust is important
- Financing at all stages of the continuum
- Need access to capital and financing
- DFO regulation and definitions of sea plants and regulations
- We all know that aquaculture and fishing is a political thing all over Canada
- And collaboration is important
- If we are going to move NL forward, we are going to need strategic investments, like what Bill has done with his company and what we did with the mussel industry
- Something we can do is what Marie Eve mentioned and friends at NIC, is to develop seed banks, with strains that we know are robust enough to withstand changes in environment and keep genetic diversity, NL should think about that
- Providing seed is the easy part but it has to be profitable or is a social enterprise
- Direct rock seeding for restoration in coastal areas, are other things that can be done adjacent to commercial activity
- Sewage and seaweed and habitat, regenerative aquaculture

After all that we heard today:

Bearing in mind we have a potential to grow a variety of things we can grow here, if we are going to create an industry here and coastal areas. How are we going to get there?

(Aside from saying we need more money)

Bill: a clear definition of stakeholders rights and responsibilities and definition of their role

Logan: is there an opportunity so that these small companies can sell into a coop for small growers within smaller community? Secondary coop for marketing

Cyr: has to have access to product, short window here in NL, landing right at the time when fishers are busy with other activities

Bill: in NA Greenwave is based on the main lobster industry, Atlantic sea farms creates the seed for fisherman and then buy back 50 cents US a pound which isn't bad. Cascadia has said that they will buy at

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a set price. Must have a little more maturity in the value chain. Good at the growing but everything else needs more work. Food distribution companies. Coop model is great so when that value chain is there and in small communities, but we need 10-15 years of value chain investment first.

Cyr: used the example of the Indonesian coop system and Fogo Island coop for seafood

Fisheries is not as reliable, I agree a coop could do it

Bill: nature base solutions in Kenya and with Jane Goodall foundation, women's involvement

Depend on coop, use Malasian genetics (old genetics) farming activities are vulnerable to climate change and there is only one buyer in Tanzania and then they were selling to carageenan model, but competing with Chinese.

Cyr: women are integral in all the processes

Steve Moyse: I'm someone who has been around a while and seen the mussele industry start

Wild harvest versus cultivation

If we want to look at supplying markets, they aren't here, what can we do, what have we got here to go market, look at the value chain vertically and horizontally, have to get our head around our resource and its reliability. Is there a back up if you have a bad year? Federal regulations?

Cyr: you need to know your market before you start, we do need to work on the regulatory piece so they understand what we need. Some that exist aren't even realistic, like AIS transfer risk, but if you are taking the seaweed out and harvesting and into a process, then not back into the water. Have to adjust regulations to do it. DFO in BC deals with fisheries and not alot of regulations for seaweed. Need regulatory reform for DFO.

Kathy Patterson (7 fathoms): public health background, well school by Dr. Hillier, its important to have people in the room that are a part of the health world. Because what I am seeing on the health side is a real increase in chronic inflammation, the basis of 7 fathoms so they are processing and the extract as a whole and not fractured. A little different pathway.

If there were health people in the room, to see where seaweed can be helpful to those people. More than one pathway to get there, wild and cultivated.

Cyr: phytomedicine has lots of applications and can be advanced also

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Cyr: we know we want to grow it but the value chain needs to be engaged aside from the growing side, equipment investment, marketing has to be integrated at all stages, all niche products, food?, bioactives? Biostimulant?

Mike: is it a service or is it a product? Ecosystem service to clean the water then the product, maybe there is a way to do both so that the ecosystem services will pay for some of the overhead costs and compete with the wild harvest people and do the culturing

Cyr: nutrient credits and green financing instead of carbon sequestration

Christina Smeeton: one of the things we need to identify are the voices that are not in the room

There is a large indigenous community on the west coast

Use this new network and to learn from more advanced industries and apply for funding through NSERC Alliance, and Gabby from Shorefast about doing exchanges and learning about that critical information that only comes from hands on experience.

Economists, social scientists

Could be really powerful

Cyr: Bill touched on it and I agree with you, is that how we are going to develop aquaculture?

Bill said how do we create an industry sustainable, how do we employ lots of people, if we think about that what is our final product

$20million Cascadia has raised

What's the way forward?

Where are we going to get the money?

The province really wants this to happen, this was mentioned from the premier's office and they want to see it work and they want a plan and might be willing to invest

Need a network with high profile scientists and industry, not relying on innovation money but also strong research dollars

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Provincial issues can be done here but also needs to happen at the national level for federal support

Bill: a congressional report from US 2022, removing ocean acidification but turned into seaweed and sea grass cultivation, for how they want to manage the growth

Investment-remove uncertainty and de-risk, DFO is a regulatory bost that pays lip service to a growing sector, agrofoods Canada are an advocacy bost for food security and the programs that are available are far more important than those that are available through DFO. No way we are going to change the structure, we have to work around the room a little differently, ECCC, or other bodies AFC Agrofoods Canada. Looking at SDGs.

Cyr: I make sure to include aquaculture as part of that and its not always easy with this government.

Logan: large focus now on farming seaweeds but would there be consideration for wild harvest in NL and to continue down that path there would need to be some changes in regulation and monitoring for offering quotas and biomass available that is there too

Cyr: NSCC can help out, it depends on what you want to make, harvesting with clippers is another things, something that can't be overcome by one person

Diane: if it was easy everyone would be doing it

Cyr: been happening for 1000 of years, indigenous people

Diane: lots of wild harvest in St. Philips etc. and we see an abundance of seaweed species all around the coastline, not always easy to collect and different from other maritime provinces. The other companies are not here for a reason, there are pockets of easy to harvest, not a lot. I spent a lot of time looking at how to move that forward and talking to others. Need the end use product and as we build out the refinery there is a role for seaweed. Its easy to get and would we work with them, would it be cheaper? Not sure yet. Without a doubt we can get started and do what we need with wild harvest and then scale up as needed.

I think about the way forward, it won't be a mega project, have to penetrate the market, how to we create value for end users. I think the next step is an integrated biorefinery.

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We are working with Marine Biomass initiative with Dr's. Thomas, Abby and Cheema. If we collaborate there is a lot of a margin in our economy. Some ideas need to be sorted out and there are more on the seaweed piece. Promising to see indigenous communities using seaweed to restore and bring that on up through.

Cyr: what are we going to tell the aquaculture fund people

Diane: can't ignore wild harvest, versus culture, have to figure that out, I think its a twin sollution and is good for the sector on all sides

Cyr: disputing the wild versus culture and the challenges are different and with different bodies

Costs a few million dollars and now they have a 20 million industry

Diane: biorefinery route there would be a different set of opportunities if we looked at it earlier

Cyr: let's look at other places and learn from them and design something that will work and use information.

Diane: entrepreneurs don't have opportunities to visit other countries, there is a need for curiosity to be embraced and research things and passion. Support people with passions

Cyr: the province has supported some travel for people to do some market research and knowledge transfer

Research is always looking for funding to get to that innovation part

Ibraheem: I'm still on the why, players in that space are saying its not

EU Faro Islands, use wild catch to supplement

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Cyr: Scotland, processors cant take it because its not clean enough, quality control issues need to be put in place

Alliance society, NSERC a question that is always a societal issue and use that money and network to really investigate what you want to do with this and use it to help small users and supplement harvesting, really important to see how to we help and empower our producers and capitalizing on networks and what people have done before us, big names yes and a really good idea. In the past we have demonstrated that before. Rolling deadline and submit 1mill per year…lets apply

Clear guidance on what needs to be done from the entrepreneurs

Laura: when you look at it from the industry side need real dollars and the industry still has to fork out to back up those research funds

Bill: Avoid thinking about products that you must create a market for, enter an existing market, don't do both things at the same time