High-Level Template

Regional 100% Fish Research & Development Center

PREPARED BY

The Iceland Ocean Cluster for the 100% Great Lakes Fish Project and the Great Lakes St. Lawrence Governors & Premiers

Contents

Executive Summary

This report explores several strong examples of international research and development centers globally that provide support to the seafood sector to create value from processing cut-offs. Many of these have similar characteristics that have enabled their success, including the locations where they have been established, the equipment and staff skill set they have acquired, their funding model and collaborative partnerships across research and industry, as well as links to the product supply chain through industry. These key characteristics have been mapped to locate three potential locations in the Great Lakes region that would be promising sites for a regional research and development center focused on full utilization and value creation of fish. Of these locations, Location 1 (Wheatley, Ontario) shows the greatest potential in terms of the surrounding businesses and potential collaboration or supply chain partnerships, as well as being close to an urban center and universities.

An investigation of potential capital costs and the steps that would be needed to establish a research and development center in the Great Lakes region are presented. The highlights of this step-by-step guide are that the specific research and development needs of the region (those which cannot easily be outsourced and for which there is high demand) must be established, the ownership and financing model must be determined, and the long-term financial sustainability and business model of the center must be determined. Regardless of the model selected, it will be essential for a center to be well connected to the local and global innovation community, and to business development, or startup hubs. This will be important when ensuring the next steps in the value chains and supply chains are reached and when exploiting the output from the research and development center, either by independent companies or as spin-offs from the center owners.

1. Project description and context

Two reports have now been created on exploring low-hanging fruit and high potential value chains for products from Lake Whitefish (in year 1 report) and from Yellow Perch, Walleye (Pickerel), Lake Trout and White Sucker (in year 2 report). Furthermore, pre-existing reporting was carried out on other, novel fish species in the Great Lakes region, such as invasive carp species. In all cases, biotechnological, contextual and value chain analyses have narrowed priorities for developing and reaching market with these products. In most cases, the development steps to move toward full utilization in the Great Lakes region require investigative, feasibility and scalability research and product development in order to be realized and to create a legacy of products that can move beyond low-hanging fruit to higher levels of the value pyramid (displayed in **Figure 1**). This will both fuel growth in the innovation and startup sector and support diversification of revenue portfolios, employment opportunities and economic growth connected to the regional blue economy and the Great Lakes. This will also help to take these initial finds to further species, further commercialization of products and further sectors with local expertise and know-how.

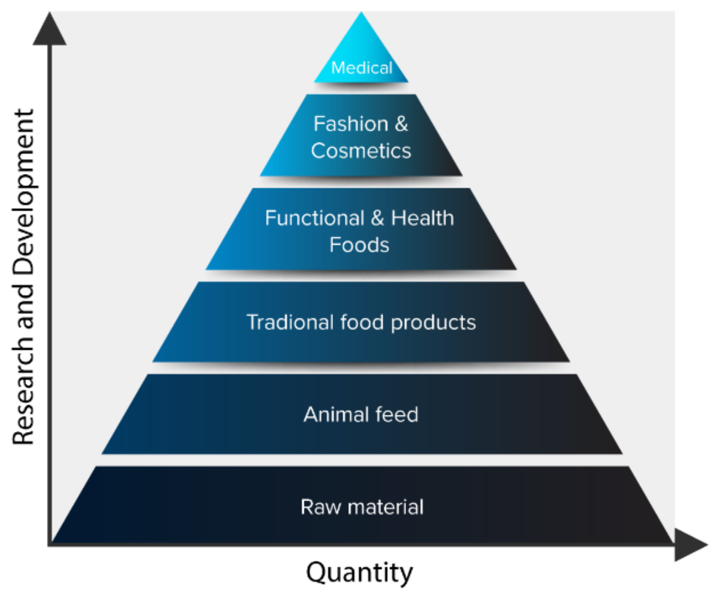


Figure 1. The value pyramid for full utilization of seafood products, from high biomass lower value product groups through to low biomass high value product groups.

This high-level template will map what a Research & Development (R&D) center in the Great Lakes region would look like by evaluating:

i. Case studies from R&D centers globally that are creating value-added products from seafood.

ii. Keys to success from existing examples.

iii. What equipment and facilities would be needed?

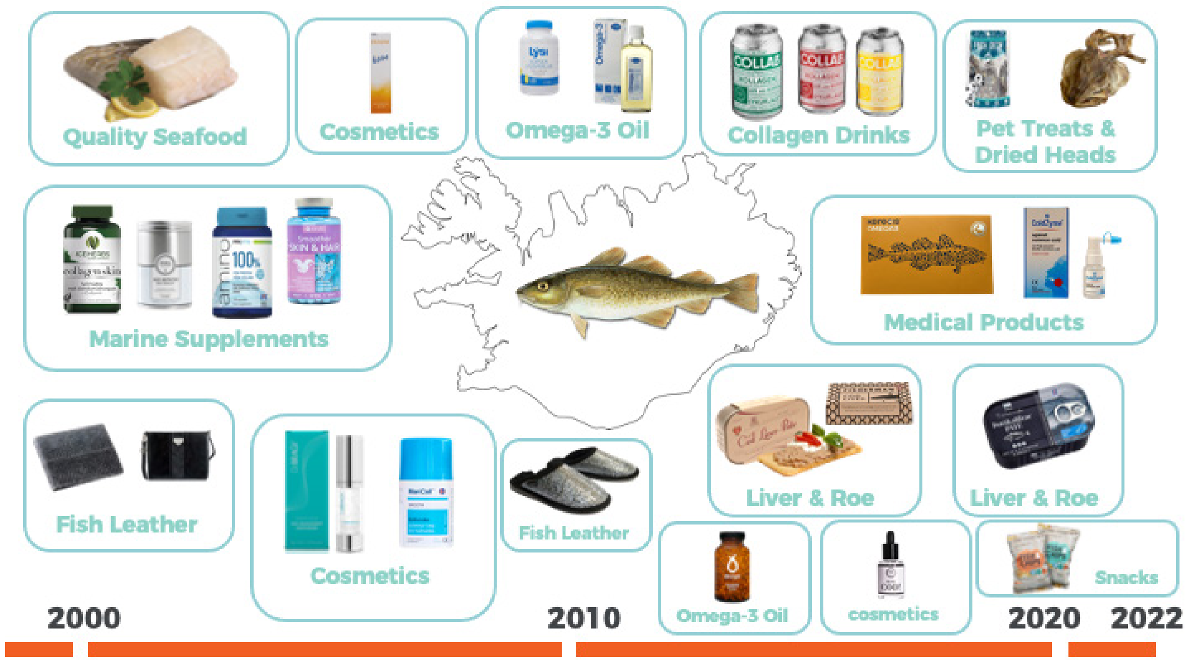
iv. Estimated capital equipment costs.

v. Required staff and technical expertise.

vi. Steps to establishing such a facility and its network for success – role of companies/industry/consortia.

vii. Types of locations that would be advantageous.

viii. Potential for a center in the Great Lakes region (e.g., Southwestern Ontario).



2. Research & development centers for new products

When developing new products for the market from any sector, there is a scale that is generally used to help other research teams, investors, and innovators to identify how close to the commercial market this product is. It is very useful to use this terminology both in general and in the following report since it is a standardized way to communicate both the stage of the idea and what steps are needed to bring that product to market successfully. These steps or levels from a new idea to a commercialized product are know as the Technological Readiness Level (TRL) **Figure 2**. These TRLs describe a product through three different stages, firstly TRL 1-3 which are the initial research stages of a project, TRL 4-6 which are the development of the successfully researched project idea, and finally TRL 7-9 which are the deployment stages, where the proven concept is being upscaled to a relevant commercial scale and being brought to the market "proven in operational environment". These TRLs will be referred to in the following section of this report to help standardize the information.

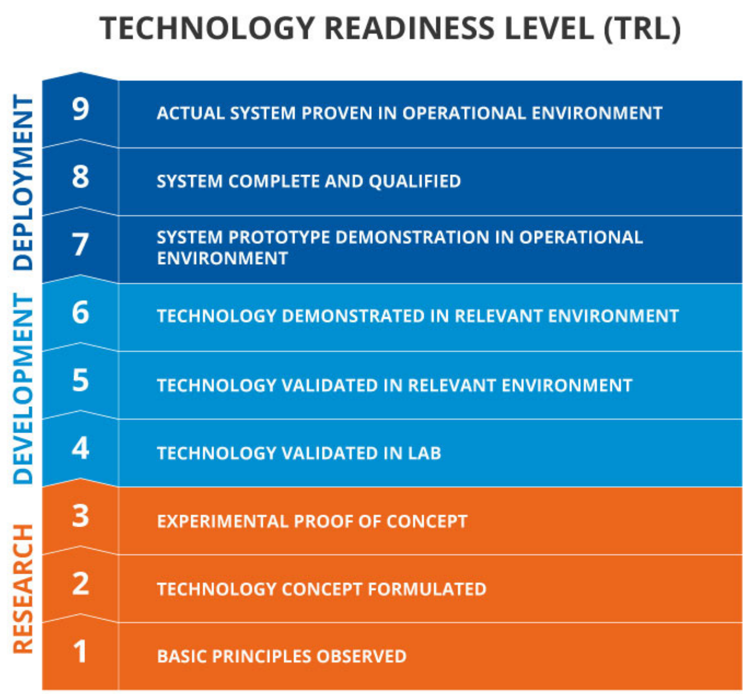


Figure 2. The Technological Readiness Levels (TRL) used to communicate the status of a new product from the initial idea through to entrance to the market.

To ensure the applicability of this information regarding TRLs to the Great Lakes region and to the 100% Great Lakes Fish project, a further **Figure 3**, has been generated that shows how these TRLs relate to research and value creation steps to bring Great Lakes secondary value chains to the market.

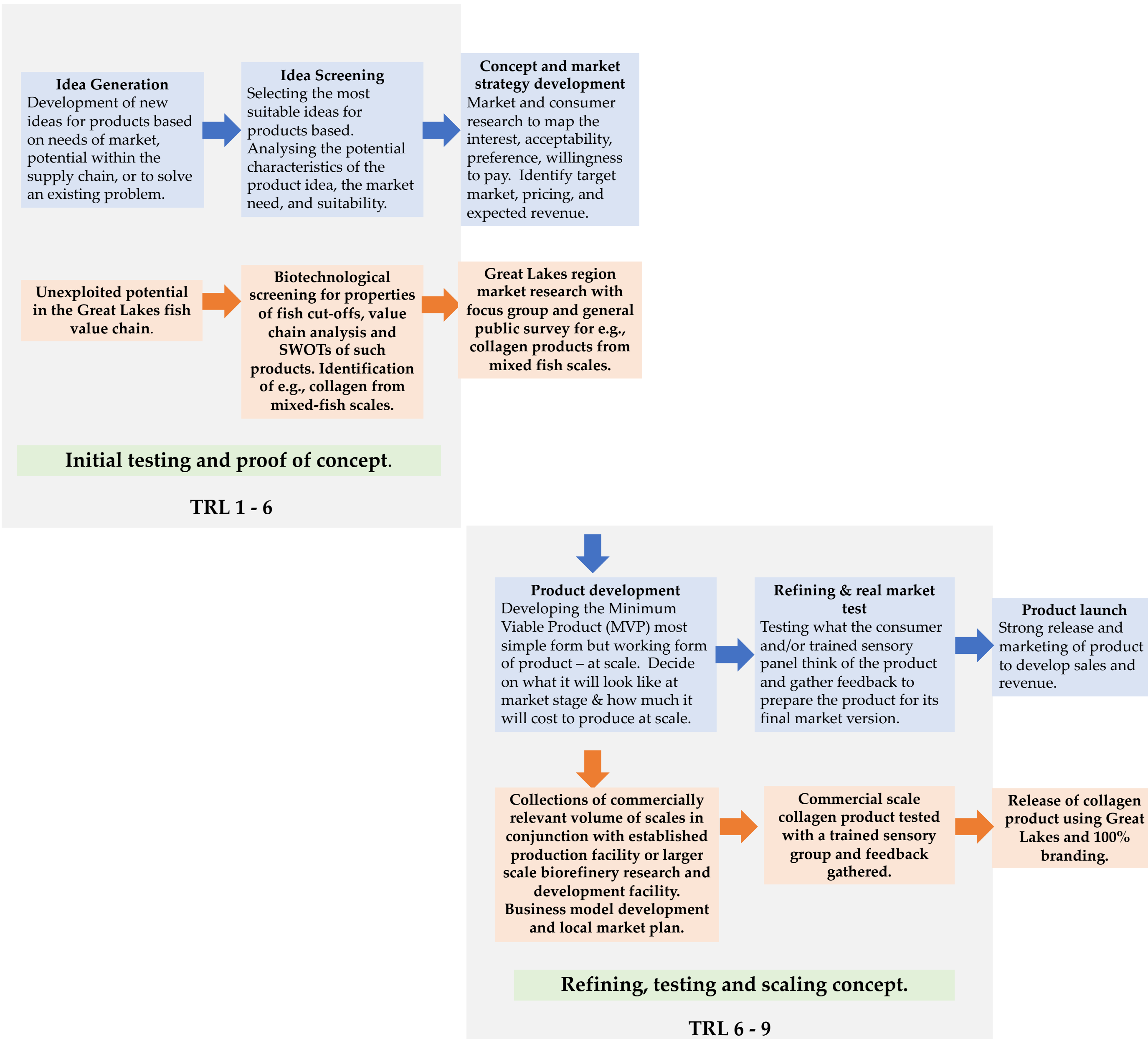


Figure 3. A flow diagram to explain how Technological Readiness Levels relate to each development stage of 100% fish products from the Great Lakes.

3. Full utilization R & D facilities

There are already a number of research and development centers around the world that have the capacity and expertise to support the transformation of seafood biomass into market-ready products. Some of the key facilities that are involved with full utilization of fish activities in North America and Europe are shown in the map in **Figure 4.**

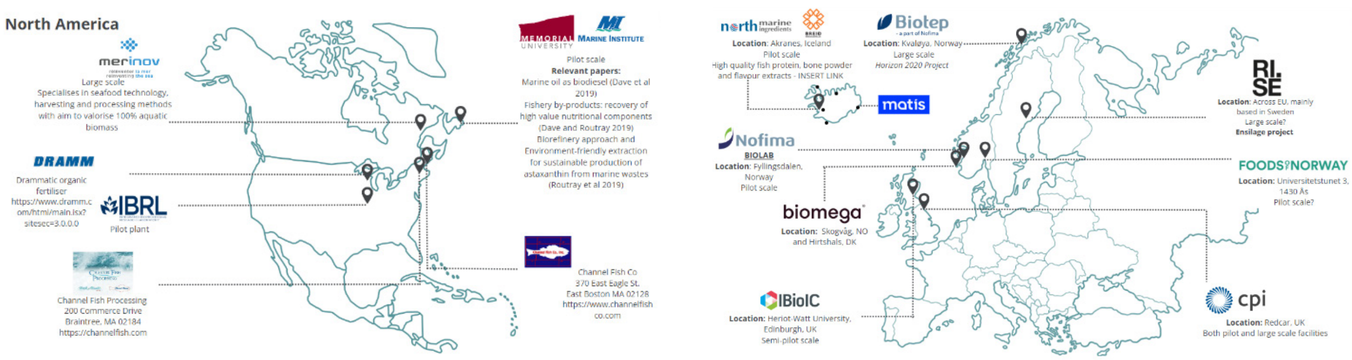


Figure 4. Global research and development facilities working on full utilization of seafood.

To understand what factors are key to the success of 100% fish R&D centers, this section of the report examines case studies. These case studies are dived into two sections – the first section focuses on TRL1-6 and the second section focuses on TRL6-9 facilities. In some cases, companies have more than one facility type. To establish what an R&D center in the Great Lakes region would need to be successful, this section investigates a number of these case studies, considering the type of company, facilities, equipment, location and examples of the projects carried out.

3.1. TRL 1 – 6 R&D facilities.

3.1.1. Matís Iceland

Matís (Matís - Value creation, food security and public health (matis.is)) is a food and biotechnological research institute in Iceland. It has been carrying out the lab research analysis of fish from the Great Lakes for the 100% Great Lakes Fish project and its expertise is in value creation in the seafood sector. It has multiple locations in Iceland including two key sites that comprise its research and development facilities. Matís has a mixed funding model; it is government owned, but only partially government funded. The rest of its activities are financed by competitive research and innovation grants, consultancy or purchased services. Its initial testing and lab scale research is carried out in the south of Iceland, in the capital city, Reykjavik (**Figure 5).** It is located close to universities, the international airport, heads of fisheries and aquaculture companies, and the most densely concentrated population and innovation community in the country. The small-scale facility has equipment suited to TRL1-6 development (**Table 1**).

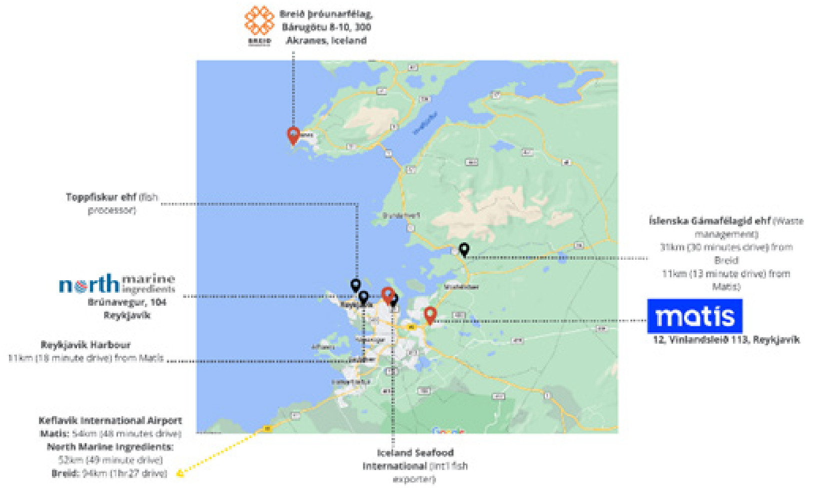


Figure 5. Pilot and lab scale facility of Matís in Reykjavik, capital city of Iceland.

Table 1. Key equipment that the Matís pilot testing lab has for 100% fish value creation.

Equipment
Sinks with warm and cold water, shaking-water controlled temperature bath (5-6L), freeze-drier (6kg), consumables (10-50L), centrifuge (1kg), measuring scale accuracy (.00), drying oven, general lab consumables (flasks, bottles, filters, cheese cloth, stirrers, sieves, containers), colorimeter (e.g. shows purity of gelatin), texture analyzer (e.g. shows blooms strength), fridge (4°C), freezer (-18°C), desktop extruder.

3.1.2. Biolab, Nofima – Norway

Nofima (Nofima - A leading institute for applied research within fisheries, aquaculture and food.) is a food research institute in Norway with a strong focus in the aquaculture and fisheries industry. It has both pilot scale and analysis facilities for seafood transformation. The pilot facility is called BioLabs, and a list of the methodologies it uses is available on its website: Akkrediteringsomfang | Norwegian Accreditation (akkreditert.no). The Biolab facility is located in Bergen (**Figure 6**), close to key infrastructure including harbors, international airports, the University of Bergen, a waste disposal facility, a number of fish processing facilities, aquaculture farms and Biomega (a bioscience company working with food and feed ingredients - Home - Biomega (biomegagroup.com). Nofima's key equipment is shown in **Table 2**.

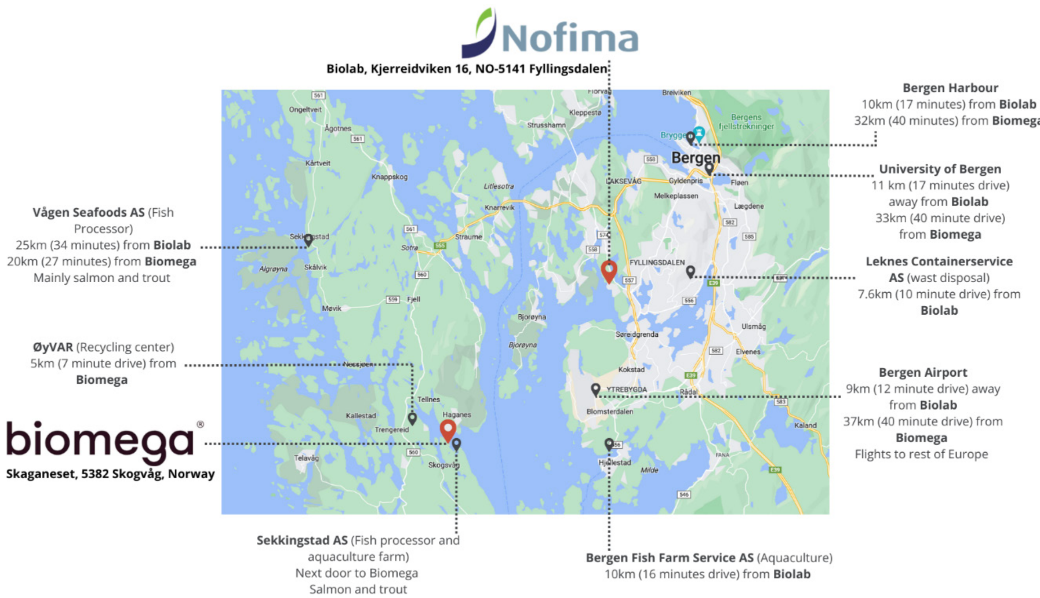


Figure 6. Pilot and lab scale facility of Biolab (Nofima), Norway

Table 2. Key equipment that the Nofima Biolab pilot testing lab has for 100% fish value creation.

Equipment
NIRO P-6.3 Spray drier (25kg water/hr), Jackerg UR III AS/CS Mill Dryer (110/40kg water/hr), 1-step falling film evaporator (40kg water/hr), Rannie Homogenizer, Stord Bartz P-10 Double screw press (60kg fish/hr), oil refining equipment, UV-visible spectrophotometers, Protein analyzer unit (Kjedahl).

3.1.3. IBRL, Illinois, USA

IBRL (Integrated Bioprocessing Research Laboratory — University of Illinois, Urbana-Champaign) is an integrated bioprocessing research laboratory associated with the University of Illinois working to support the link between research and industry for bioproducts. The facility is funded by user payments for the services and processes carried out based on a daily rate for facilities, equipment and staff required. The site is located about two hours from Lake Michigan (one of the Great Lakes) by car, in connection with and just one mile from the University of Illinois as well as two smaller airports. Nearby, there is also a recycling management services company. There is a wide range of equipment (**Table 3**), many of which are applicable to seafood transformation.

Table 3. Key equipment that the IBRL pilot testing lab has for 100% fish value creation.

Equipment
Appikon 3L fermenter, Decanter, Western States basket centrifuge, tray freeze drier, despatch tray drying oven, capillary tube centrifuge, IsoTemp hot water bath. The full equipment list is available online: https://ibrl.aces.illinois.edu/equipment-list/

3.1.4. IBIOIC, Scotland

IBIOIC (IBioIC - A networking and support organisation that connects industry, academia and government.) is an industrial biotechnology innovation center in Scotland. It supports companies in the development of innovative biotechnology processes and products. It is also a network community that runs on a membership scheme that helps to bring its community of users and stakeholders together. Its location and surrounding facilities are shown in **Figure 7**. The equipment available for pilot testing relevant to seafood value creation is shown in **Table 4.**

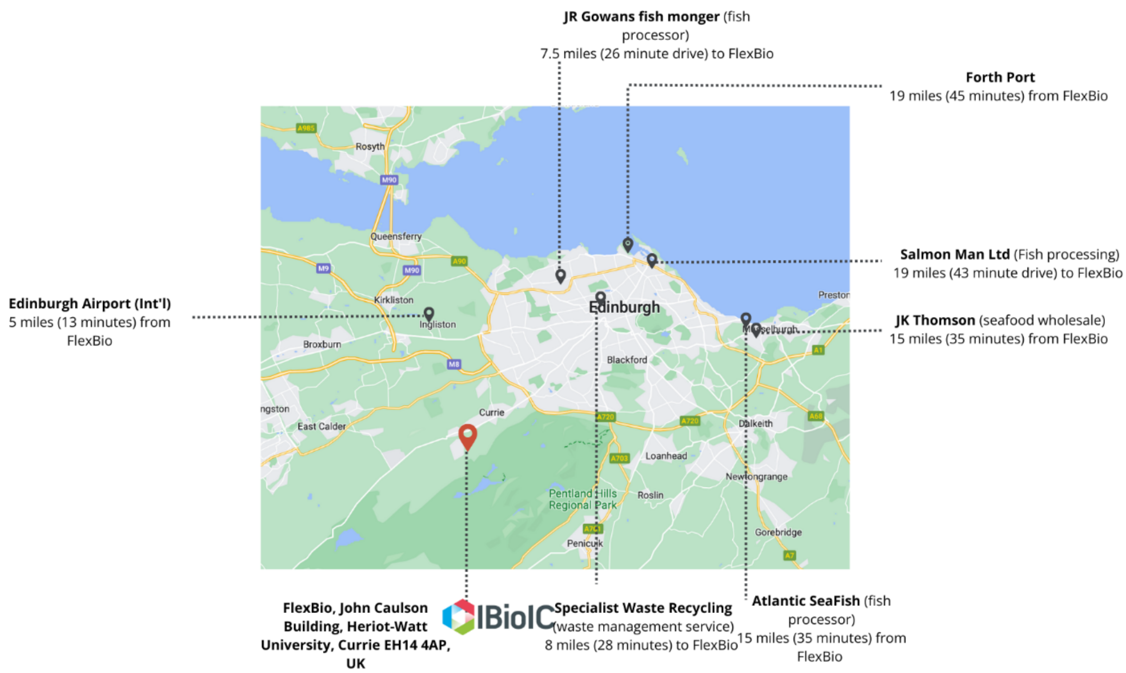


Figure 7. Pilot and lab scale facility of IBIOIC

Table 4. Key equipment that the IBIOIC pilot testing lab has for 100% fish value creation.

Equipment
Cooling water loop (1500L), 100L RO type II water production capacity, Applikon fermenters (7L autoclavable), 30L SIP fed-batch system, 2L parallel DASGIP vessels, continuous disk-stack cell centrifugation (1.4L bowl, 60L/hr), micro and diafiltration rig, AKTA avant chromotography, freeze dryer.

3.2. TRL 6 – 9 R&D facilities

3.2.1. Matís Iceland

Matís is listed separately in this section since its second listed facility, where later TRL stages are carried out, is based at another location than its TRL1-6 laboratories and with different locational settings that are relevant to consider for this report. This Matís site has a larger scale facility that allows the scale-up of product development closer to commercial scale, with the capacity to work with volumes of material up to around 300L. This facility is located in a coastal location of Iceland and runs in collaboration with a key pelagic fish processing company, Síldarvinnslan (Síldarvinnslan - SVN). The facility internally has its own commercial scale fish meal processing facility from HPP protein plant (HPP Solutions - proteinplant.is) and functions alongside the research and development biorefinery facilities of Matís. This provides additional facilities, onsite availability of industry trained fish processing technicians and know-how and provides a direct link between the R&D community. This location is shown in **Figure 8.** There is large scale equipment present onsite (**Table 5**).

Figure 8. Scale-up biorefinery facility, Matís, Iceland

Table 5. Key equipment that the Matís scale-up facility has for 100% fish value creation.

Equipment
Disk centrifuge or decanter – 100L, Membrane filtration system 100L, spray drier, high volume water access, open and hygienic space, hot water and cool water, heat exchange cooker, large scale grinder, large freezers (18°C), and large scale fridge (4°C).

3.2.2. BIOTEP – NOFIMA, Norway

Biotep (Biotep - Nofima) is the scale-up lab of Nofima in Norway, marketing its facility as a “flexible mini-factory” supporting the testing and optimization of processes to extract interesting compounds from marine and plant biomasses. It is listed here as a separate site for Nofima with a separate location from the TRL1-6 labs. It is geographically well positioned (**Figure 9**) and the facility has a wide range of medium to large scale equipment **Table 6**.

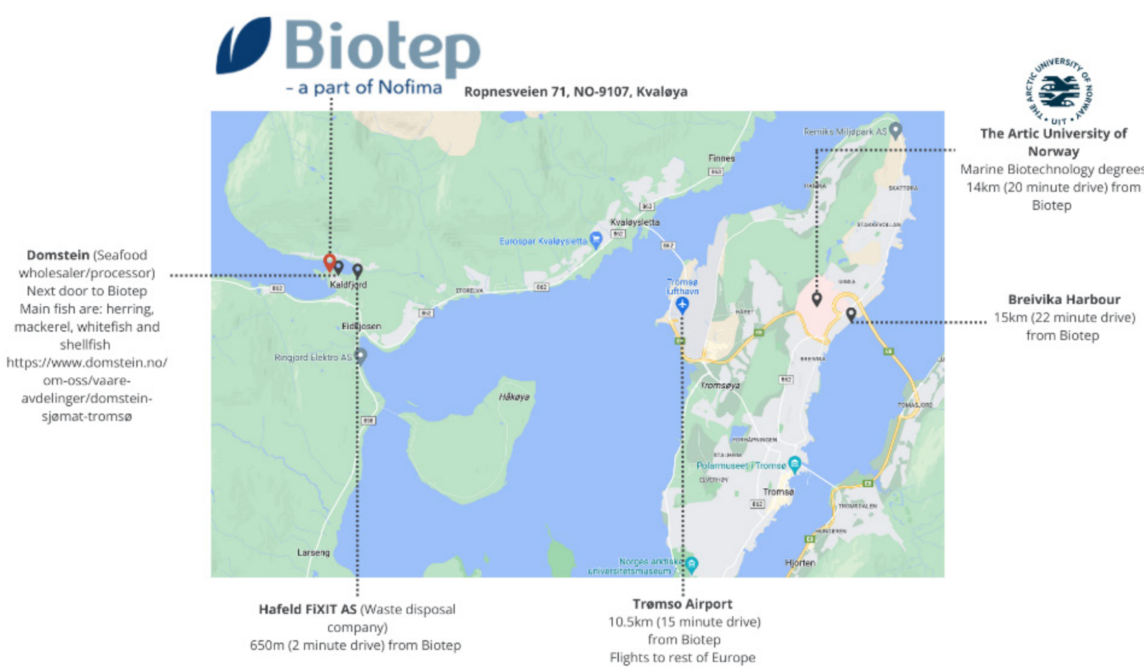


Figure 9. Scale-up biorefinery facility, Biotep, Nofima, Norway.

Table 6. Key equipment that the Biotep Nofima scale-up facility has for 100% fish value creation.

Equipment
Reactors (for hydrolysis), 2 and 3 phase separators, mill dryers, spray driers (high capacity), oil purification and filtration systems.

3.2.3. Merinov, Canada

Merinov (Home - Merinov) is a bioprocessing facility supporting R&D routes to market for innovative products from seafood resources. It supports both the piloting and scale-up to innovation products to market and has a focus on valorizing 100% of aquatic biomass, developing processing methods that allow successful transformation. These facilities can handle volumes of up to 1000L of material at a given time. It works closely with the fisheries in Québec and is located at the harbor of Gaspé, close to a recycling center, fish processing facilities and a regional airport (**Figure 10**). The international airport in Québec City is about 7.5 hours by road. It has a wide range of equipment facilities onsite (**Table 7**).

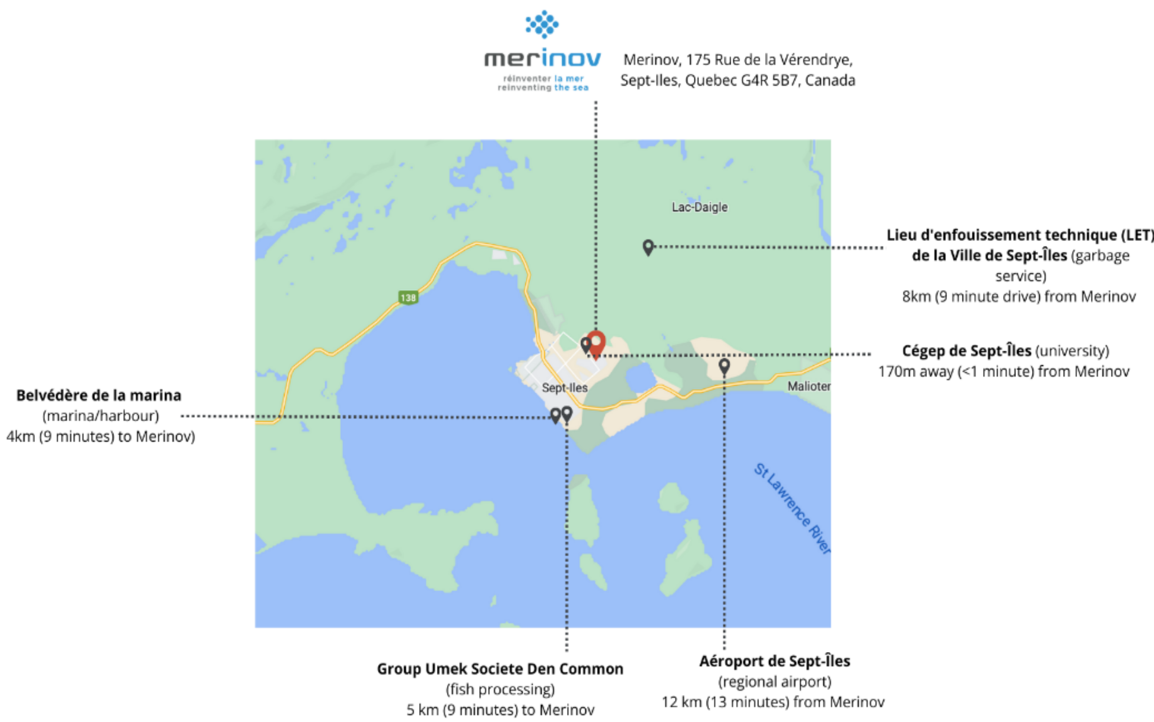


Figure 10. Scale-up biorefinery facility, Merinov, Canada.

Table 7. Key equipment that the Merinov scale-up facility has for 100% fish value creation.

Equipment
Hammer mill (1/4-3/4in), comitrol 3600, Stephen & Hobargt cutter-mixers, Stimpson meat grinder, Sprayer, CP-4 screw press, Elnova hydraulic press, Baader 601 mechanical separator, Sweco vibrating screen, 8-10L fermenters, freeze dryer (6-12L/cycle), supercritical fluid extractor, continuous centrifuges, Atomiser, Vacuum crimper.

3.2.4. Bioprocessing center, Memorial University, Canada

The bioprocessing facility at Memorial University, Canada, is part of the university's Marine Institute. It has a wide range of medium to large-scale equipment that can reach volumes of up to 500kg of final product. The marine bioprocessing facility is part of this infrastructure which was established due to the high volume of seafood biomass from fisheries and aquaculture processing. The facility was opened with assistance from the Atlantic Canada Opportunities Agency, the Canadian Foundation for Innovation, the Newfoundland and Labrador Provincial Government, Atlantic Canadian universities and industry partners. The facility is located onsite with the Marine Institute of the University, giving onsite access to research and academic expertise. It is also near the Canadian Centre for Fisheries Innovation, fish processing facilities, waste recycling facilities and harbors (**Figure 11**). It has a wide range of equipment to facilitate its work (**Table 8**).

Figure 11. Scale-up biorefinery facility, Memorial University, Canada.

Table 8. Key equipment that the Memorial University facility has for 100% fish value creation.

Equipment
Oil extraction equipment: Alfa-Laval heat extractor (1000kg/h), 3-phase decanter (1000kg/h), Westfalia separator (20L/h), steam kettles. Biodiesel production: Pre-treatment tank, transesterification tank, methoxide preparation tank, methanol recovery system, dry wash column, cold clear filtration system. Processing: 600L fiberglass tank, 250L steel tank, washing system. Concentrating/drying: Votator Turba-film film evaporation, APV spray drier, continuous screw press. Separation equipment: 3-phase decanter centrifuge (1000kg/hr), Baader separator, Westfalia centrifuge (5-20L/h). Analytical equipment.

4. Lessons from case studies

There are several factors that all of these labs have in common that support their effectiveness in the transformation of seafood into value-added products. These factors are the location and, in particular, the other organizations that are in the vicinity of either the pilot or larger scale facility case studies. Whether they were established by a single entity or as a collaboration (and how this is reflected in their funding models), there is also some core equipment that is common across multiple sites.

The location for the pilot facilities, but even more so for the large scale-up facilities, is important to be close to the sources of biomass, for example fisheries processing. It is also important that transport and logistics of material (both raw material and market products) is accessible, either by water or air dependent on the volume and financing behind the project. Being close to fish processing facilities seems to provide an important link to the supply chain, both for knowledge access and for ease of access. Pilot facilities are more often closely associated or in proximity to universities, larger population centers and international connections. This locality provides access to academic knowledge, a consumer test base and direct market test and connections with international experts and transport which may also support knowledge transfer. In many cases, these facilities are located close to waste management or recycling facilities. This may be to support the existing supply chain infrastructure while creating greater value for high-potential biomasses. For example, this makes logistics easier when part of the biomass is a value creation opportunity, and the rest is not currently.

Collaboration models are common in the case studies investigated. A number of the facilities were developed in partnership between two or more organizations, with examples of private and public entities. This is evident from the location too, where being close to core industries and potential partners provides opportunities for collaboration toward biomass valorization.

Financial models are varied across the case studies explored, suggesting there are several possible business or financing models that are suitable to both pilot and scale-up R&D centers. In several cases, there are mixed financing and ownership models, with partial or full government ownership. But, funding for R&D activities is often provided on a project-by-project basis through research and innovation grants, industry contracts or consultancy. The financial model is often dependent on the ownership of the organization and whether it is part of a collaboration, government or privately owned.

Core equipment was highlighted from these case studies and is to an extent dependent on the lab's focus, which in turn is dependent on where local interest and financing are focused. Core equipment have been mapped in detail in section 7 of this report.

5. Staff and expertise

In the labs explored as case studies in this report, the number of staff depends on the volume of work. In the cases of smaller-scale facilities, particularly the lab-based pilot facilities connected to work on 100% fish, or in large scale facilities like Matís that share space with fish-processing facilities, there are one or two full-time staff dedicated to the lab. In many cases, there is one lab manager and one lab technician. Where there is not dedicated equipment or sufficient staff numbers, then work is outsourced to other specialist labs. Larger labs have an increasing number of staff to meet work effort demand. As teams increase, the roles become more diverse, and the pay and management structure more complicated. To give some examples of the roles that drive the work in larger research and development teams, both connected to 100% fish and wider biorefinery research activities, **Table 9** illustrates the different staffing models.

Table 9. Staff roles at large scale R&D centers that support work on full utilization.

Matís	Merinov	IBRL	BIOTEP	BIOLAB	IBioIC
PhD student x2	Laboratory assistants and workers	Pilot plant specialist x4	Operations manager	Senior engineer x3	Biofacilities & operations manager
Project manager x3	Technicians	Senior pilot plant specialist x2	Process technician x4	Engineer x8	RapidBio senior scientist
Specialist x6	Project managers	Junior pilot plant specialist		Laboratory technician	Fermentation scientist x3
Strategic scientist	Project leaders	Analytical laboratory specialist x2		Scientist x3	Laboratory trainee x3
MSc student	Industrial researchers			Research technician x7	Senior downstream bioprocessing scientist x2
Research Group leader x2	Research professionals			Work Manager	
Research scientist x2				Manager Coordinator	
				Principal engineer	
				Research director	

6. Identifying potential Great Lakes locations

To identify some potential locations for an R&D center in the Great Lakes region focused on 100% Great Lakes fish, an in-depth mapping exercise was done based on learning from the international lab case studies applied to the local context. An initial mapping of fish processing facilities in the vicinity of the Great Lakes was carried out (**Figure 12**). This initial mapping revealed three clustered localities in the Great Lakes region for more densely concentrated fish processing facilities. These have been numbered on this map as Location 1, Location 2, and Location 3. Each of these locations was then mapped in more detail to explore what organizations or facilities are nearby.

Figure 12. Fish processing map of the Great Lakes region highlighting three clustered locations of fish processing activities.

The Location 1 cluster (**Figure 13**) is located next to Wheatley, Ontario, close to Lake Erie and the border of the United States and Canada. There are seven large processing facilities located within this cluster, fish distribution organizations, several fish restaurants, a green technology company, waste management, harbor access, nearby international airports and universities, as well as being located near a densely populated urban center. This site has several attributes comparable to the R&D labs highlighted in this report and is a strong location case due to the high number of fish processing companies nearby and the other factors. The Iceland Ocean Cluster´s 2022 visit to the Great Lakes region also identified one of this fish processing companies as having extensive cold storage facilities onsite which might further facilitate the development of secondary fish value chains. This site is a very good candidate for a Great Lakes R&D center.

Figure 13. Location 1 cluster of fish processing facilities with relevant nearby infrastructure highlighted.

In the Location 2 cluster (**Figure 14**), there are five fish processing facilities of varying size. This site is located between Lake Michigan and Lake Huron around Mackinaw City, Michigan. There are several restaurants in this area, a harbor, fish market and the small population center of Mackinaw City. It is a drive of about four hours from Detroit. It has a university site with a biological station which would likely be well suited for collaboration with a 100% fish lab, and there is a college and regional airport nearby too. This is a good candidate for a Great Lakes R&D center.

Figure 14. Location 2 cluster of fish processing facilities with relevant nearby infrastructure highlighted.

In the Location 3 cluster (**Figure 15**), there are two larger and one smaller fish processor. The location is on the shores of Lake Superior near the cities of Duluth, Minnesota, and Superior, Wisconsin, with a moderate population density, and it is about a two-hour drive to the urban center of Minneapolis/St. Paul. There is an international airport, train station and marina harbor locations in this area. There are multiple sites of the University of Wisconsin nearby including an experimental station and the Sea Grant institute which would be well placed to support the infrastructure and knowledge of a Great Lakes R&D center. There is a waste-water treatment facility and multiple fish restaurants in this location which may also support the supply chain for value creation from fish cut offs. This is a good candidate for a Great Lakes R&D center.

Figure 15. Location 3 cluster of fish processing facilities with relevant nearby infrastructure highlighted.

7. Estimated capital cost

7.1. Equipment

The tables below are split into two sections to reflect the two stages identified as key in the research, development and scale-up to market process identified in this high-level template: the proof-of-concept facilities that take ideas and prototypes from TRL1-6 to the scale-up state; and, the route to market facilities from TRL6-9 since these require different equipment. Some of the core equipment that facilitates this and their estimated costs from online sales are shown for pilot facilities in **Table 10** and for scale-up facilities in **Table 11**.

Table 10. Costs of core equipment for pilot facilities for seafood transformation.

Pilot facility core equipment		
Equipment	**Price**	**Website (shown for illustrative purposes)**
Small shaking water bath (12L)	US$2926	https://orbitalshakers.net/collections/shaking-water-baths/products/sb-12l-shaking-water-bath
6kg capacity freeze drier	US$2760	https://zzwellknown.en.made-in-china.com/product/bdHavzQDgGrq/China-6kg-Small-Capacity-Home-Vacuum-Freeze-Dryer-for-Freezing-Food-and-Vegetables.html
1kg capacity centrifuge	US$500	https://www.indiamart.com/proddetail/1kg-basket-centrifuge-machine-26137307562.html
Small benchtop Muffle furnace	US$2820-3880	https://www.fishersci.com/shop/products/thermolyne-benchtop-1100-c-muffle-furnaces/p-4529138#?keyword=
Colorimeter	US$1046	https://www.fishersci.com/shop/products/orion-aquafast-aq3140-cod-colorimeter/13301151#?keyword=
4°C lab fridge	US$6986	https://www.terrauniversal.com/tsx-upright-high-performance-lab-refrigerators-thermo-fisher-scientific.html
-18 lab freezer (smaller)	US$1512	https://www.fishersci.com/shop/products/isotemp-value-lab-freezer-3/p-6966028#?keyword=
Desktop extruder	US$1276.19 – French company	https://www.extrudersmachine.com/supplier-3727584-feed-extruder-machine https://french.pvcmoldingmachine.com/sale-29251092-aquaculture-fish-feed-extruder-machine-floating-snacks-making-machine-dog-cat-food-extruder-machine.html

Table 11. Costs of core equipment for scale-up facilities for seafood transformation.

Pilot facility core equipment		
Equipment	**Price**	**Website (shown for illustrative purposes)**
Membrane filtration system (100L capacity)	Quote basis	https://www.directindustry.com/prod/gruenbeck-wasseraufbereitung/product-25856-2470051.html
Spray drier	$14,000	https://www.usalab.com/usa-lab-spray-dryer-mini/

Large drying oven	Quote basis	Laboratory oven & industrial oven range - Carbolite Gero (carbolite-gero.com)
Large scale grinder	Quote basis	https://franklinmiller.com/product/taskmaster-tm2300/
Large fridge (4degs) grinder	$10,662	https://www.fishersci.com/shop/products/isotemp-general-purpose-laboratory-refrigerators-19/p-8601014#?keyword=
Large freezer (-18)	$2,550	https://labfreezers.net/collections/all-freezers/products/standard-manual-defrost-chest-freezer
100L disk centrifuge	US$21,999	https://www.usalab.com/usa-lab-100l-jacketed-stainless-steel-centrifuge-xtc-100/

7.2. Staff costs

There is a range of average salaries for both roles across the United States and Canada, with some variation dependent on state/province, and variation in salary dependent on the level of education and experience of lab managers or technicians. The total average range is an annual salary between US$38,688-$60,000 with some examples of salaries currently advertised for lab roles shown in **Table 12** for the Detroit area, and **Table 13** for the Minneapolis/St. Paul area.

Table 12. The average salaries for roles of lab managers and lab technicians being advertised in 2023 in the Detroit area.

Average Salary - Lab Manager
Indeed / Salary.com – Lab manager = average $109,783 (Low $83,800 - High $143,822)
Salary.com – Lab coordinator = average $58,798 Low $51,231 - High $68,840)
Salary.com –Biotech research scientist = average $108,800 (low $98,900 – high $121,20)
Salary.com – Research Lab Manager = average $110,090 (low $97,610 - high $122,400)
Average Salary - Lab Technician
Indeed – Principal lab technician = Average $85,638 (Low $43,074 - High $170,261)
Indeed - Lab technician part time = Average $32.96/hr (Low $16.58/ hr - High $65.53/hr)
Indeed - Research technician part time = Average $16.69 (Low $11.27/hr - High $24.74/hr)
Indeed Research technician = Average $39,760 (Low $26,830 - High $58,920)

Table 13. The average salaries for roles of lab managers and lab technicians being advertised in 2023 in the Minneapolis/St. Paul area.

Average Salary - Lab Manager
Indeed / Salary.com – Lab manager = average $115,998 (Low $102,850 – High $128,96)
Salary.com – Lab coordinator = average $61,955 (low $53,983- high $72,537)
Salary.com –Biotech research scientist = average $114,600 (low $104,200 – high $127,700
Salary.com – Research Lab Manager = average $116,000 (low $102,860 - high $128,970)

Average Salary - Lab Technician
Indeed - Principal lab technician = Average $62,758 (Low $38,229 - High $103,027)
Indeed - Lab technician part time = Average $24.16 (Low $14.71 - High $39.66)
Indeed - Research technician part time = Average $16.86 (Low $14.76 -High $19.27)
Indeed - Research technician = Average Average $40,157 (Low $35,145 - High $45,884)

7.3. Facility

Whether the facility will be for a pilot, scale-up or combined facility will be one of the major cost considerations of establishing Great Lakes R&D centers. Costs will vary depending on if a purpose-built facility is constructed or an existing facility can be used. Using an existing facility would likely reduce costs and would be advantageous if well located in one of the cluster locations and/or at a site with an existing processing facility or at a university building. Both the facility and the purchase of core equipment will be dependent on the ownership and financial model of the Great Lakes R&D center--for example, whether it is government, university, single-industry or a collaborative ownership model.

8. Steps to establishing a Great Lakes R & D facility

In order to establish an R&D facility in the Great Lakes region, it will be necessary to consider a number of different factors, in terms of determining the need and demand for a center, and how the center creation and ongoing projects will be financed. It will also be important to determine if the facility will support the entire product development process from wasted raw material to market, or if there will be separate facilities for lab-scale testing and scale-up to commercial volumes. It will also be important to determine what functionality the lab should have, based on what is core regionally and what could potentially be outsourced. For example, infrequent tests that require low volumes of material or that require very specialized equipment or staff might be good candidates to outsource and so would not need to be part of the core functionality of the facility. With these complex details in mind, a step-by-step flow diagram for establishing an R&D facility in the Great Lakes region is provided in **Figure 16**. It will be important at all stages that there is strong communication and collaboration with the initiation of such a project, with the local community and with the industries this R&D center would serve.

In the wider context of a successful R&D facility for the Great Lakes region, it will be important for the center to be well connected to the local and global innovation community, and to business development or startup hubs. This will be important when ensuring the next steps in the value chains and supply chains are reached and when exploiting the output from the R&D center, either by independent companies or as spin-offs from the center owners.

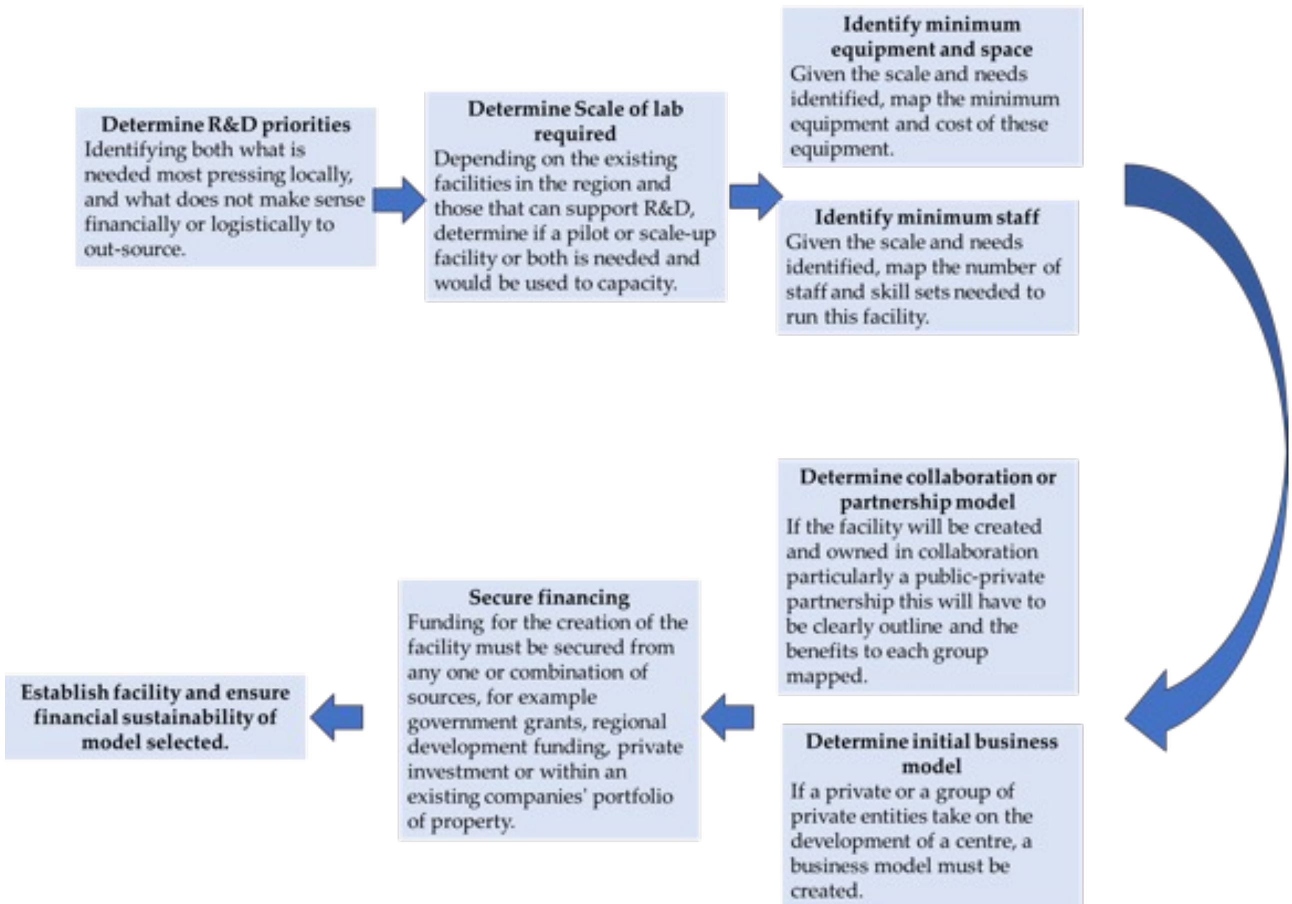


Figure 16. General model of steps to establish an R&D center in the Great Lakes region for 100% Great Lakes Fish.

9. Conclusions

There are several strong examples of international R&D centers globally that provide support to the seafood sector to create value from processing cut-offs. Many of these centers have similar characteristics that have enabled their success, including location, equipment and staff skills, funding model and collaborative partnerships across research and industry, as well as links to the product supply chain through industry. These key characteristics have been mapped to locate three potential locations in the Great Lakes region that would be most promising for a regional R&D center focused on full utilization and value creation of fish. Of these locations, Location 1 (Wheatley, Ontario) shows the greatest potential in terms of the surrounding businesses and potential collaboration or supply chain partnerships, as well as being close to an urban center and universities. Preliminary capital costs and the steps that would be needed to establish an R&D center in the Great Lakes region are presented in this report and offer a starting point for further action.

ICELAND OCEAN CLUSTER

GREAT LAKES ST. LAWRENCE GOVERNORS & PREMIERS